

Nutrición Hospitalaria



ÓRGANO OFICIAL DE LA SOCIEDAD ESPAÑOLA DE NUTRICIÓN PARENTERAL Y ENTERAL

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Esta publicación recoge revisiones y trabajos originales, experimentales o clínicos, relacionados con el vasto campo de la nutrición. Su número extraordinario, dedicado a la reunión o Congreso Nacional de la Sociedad Española de Nutrición Parenteral y Enteral, presenta en sus páginas los avances más importantes en este campo.

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NUTRICIÓN HOSPITALARIA, es la publicación científica oficial de la Sociedad Española de Nutrición Parenteral y Enteral (SENPE), de la Sociedad Española de Nutrición (SEN), de la Federación Latino Americana de Nutrición Parenteral y Enteral (FELANPE) y de la Federación Española de Sociedades de Nutrición, Alimentación y Dietética (FESNAD).

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Jordi.salas@urv.cat

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Revisión

Intuitive eating: An emerging approach to eating behavior

Leslie Cadena-Schlam and Gemma López-Guimerà¹

¹Dept. Clinical and Health Psychology, Universitat Autònoma de Barcelona, Barcelona, Spain.

Abstract

Introduction: In an effort to treat obesity, health care professionals pursue, by means of dieting and exercise interventions, weight loss as a primary goal of treatment. Although in few cases these interventions induce short-term moderate weight loss, in the long-term, the efficacy of these treatments is at least questionable. Weight-loss interventions based on restrictive diets may be associated to adverse health and well-being. In this regard, some researchers have considered shifting the focus of obesity treatment into a health-centered paradigm. Among the models derived from this new paradigm, Health at Every Size (HAES) is one of the most referenced. HAES has enhanced intuitive eating as a core component of the paradigm, which refers to the reliance on biological mechanisms to regulate food intake (i.e., internal hunger and satiety cues). Recently, intuitive eating has been winning recognition since it have been associated with numerous indices of physical and psychological well-being, and noteworthy, it have not been related to any adverse effects.

Objective: The present paper reviews the concept of intuitive eating, as well as the existing evidence that upholds this emerging approach. Also, it discusses the implication of shifting the focus of dietetic interventions into a health-centered paradigm.

Design: Narrative Review.

Conclusions: Although it is certain there is a need to extend current research on health-centered interventions, this approach may be a more promising and realistic alternative to address overweight and obesity than the conventional weight-loss treatments.

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Key words: *Intuitive eating. Health-centered paradigm. Weight-neutral approach. Obesity.*

INGESTA INTUITIVA: UN NUEVO ABORDAJE DEL COMPORTAMIENTO ALIMENTARIO

Resumen

Introducción: Con la finalidad de tratar la obesidad, los profesionales en salud buscan, por medio de intervenciones dietéticas restrictivas y ejercicio, la pérdida de peso como objetivo principal del tratamiento. Aunque en algunos casos estas intervenciones inducen pérdida de peso a corto plazo, en el largo plazo la eficacia de estos tratamientos es, al menos, cuestionable. Investigaciones recientes han sugerido que los tratamientos dirigidos a la pérdida de peso basados en dietas restrictivas no resultan eficaces a largo plazo e incluso pueden comprometer la salud y el bienestar del paciente. En este sentido, algunos investigadores han considerado cambiar el enfoque del tratamiento de la obesidad a un paradigma centrado en la salud y no en la pérdida de peso. Entre los modelos derivados de este nuevo paradigma, Salud a Cualquier Talla (HAES, por sus siglas en inglés) es uno de los más referenciados. Como componente central de este paradigma se sitúa la ingesta intuitiva, la cual se refiere a la confianza en los mecanismos biológicos para regular la ingesta de alimentos (i.e., las señales internas de hambre y saciedad). Recientemente, la ingesta intuitiva ha ganado reconocimiento, pues se ha asociado a diversos parámetros de bienestar físico y psicológico, además, no se ha observado ningún efecto adverso en pacientes que la practican.

Objetivo: El presente artículo revisa el concepto de la ingesta intuitiva, así como la evidencia que sustenta este nuevo enfoque. Además, se discute la implicación de cambiar el enfoque convencional de los tratamientos dietéticos a un paradigma centrado en la salud.

Diseño: Revisión Narrativa

Conclusiones: A pesar de la necesidad de ampliar la investigación de las intervenciones centradas en la salud, este enfoque podría ser una alternativa más prometedora y realista para el abordaje del sobrepeso y la obesidad que los tratamientos de pérdida de peso convencionales.

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Palabras clave: *Ingesta intuitiva. Enfoque en salud. Percepción neutral del peso. Obesidad.*

Correspondence: Leslie Cadena-Schlam
Jurel 37, Costa de Oro.
Boca del Río, Veracruz. CP 94299.
E-mail: cadena.schlam@gmail.com

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Abbreviations

BMI: Body Mass Index.
ED: Eating disorders.
HAES: Health at Every Size.
HDL: High Density Lipoprotein.
IES: Intuitive Eating Scale.
IES-A: Intuitive Eating Scale for Adolescents.
IES-2: Intuitive Eating Scale version 2.
IH: Initial hunger.
IS: Interoceptive Sensitivity.
LDL: Low Density Lipoprotein.

Introduction

According to traditional weight-centered paradigm, weight loss must occur in order to achieve health. Therefore, in an effort to treat obesity, health care professionals pursue weight loss as a primary goal of treatment by means of dieting and exercise interventions. In few cases, these interventions induce short-term moderate weight loss (between 5 and 10 % of body weight), which in turn, may result in improvements of certain health parameters such as blood pressure, cholesterol and blood glucose^{1,2}. However, a growing body of evidence demonstrates that, in the long-term, the efficacy of these treatments is at least questionable. Most of the patients (95-98%) regain weight over three to four years, being unable to maintain neither the behavioral lifestyle changes, nor the improvements in health³⁻⁵. In fact, several longitudinal studies reveal that restraint eating (i.e. dieting) may prompt weight gain⁶⁻⁸.

Furthermore, it has been mentioned that weight-loss interventions based on restrictive diets may be associated to adverse health and well-being. In this line, research also indicates that these types of interventions may increase psychological distress, food/weight preoccupation, depression and dissatisfaction, prompt weight fluctuations, lower self-esteem, and embolden disordered eating^{4,9-12}. In addition, the strong focus placed on weight and appearance may endorse weight stigmatization¹³⁻¹⁵. Weight stigmatization and discrimination are highly associated with several unhealthy practices, such as increasing food intake, engaging in binge eating behaviors, avoiding exercise and postponing medical care, which in turn may heighten the risk of obesity^{11,16}.

Besides, it has been suggested that dieting, as not being consistent with internal physiological hunger and satiety signals, disrupts interoceptive awareness, i.e. the perception of sensations that originate within the body, which in turn increases the susceptibility to other stimulus that incite eating, such as external or emotional motivations^{9,17}. Indeed, it has been suggested that the stronger the emphasis on external factors (e.g., weight and appearance), the higher the interference with energy intake regulation mechanisms¹⁸.

Thus, the attempts to restrict caloric intake may backfire by disconnecting individuals from their natural hunger and satiety cues¹⁹. Such internal disconnection is considered to be a potent risk factor of eating disorders (ED), as well as overweight and obesity^{6,20-22}.

Regarding the adverse effects associated to weight-loss interventions, some researchers have considered shifting the focus of obesity treatment into a health-centered paradigm, by supporting interventions that encourage the adoption of healthy behaviors regardless of weight status. Among the models derived from this new paradigm, Health at Every Size (HAES) is one of the most referenced^{11,16,23,24}. In order to address eating behavior, HAES has enhanced intuitive eating as a core component of the paradigm, which refers to the reliance on biological mechanisms to regulate food intake (i.e., internal hunger and satiety cues), while a sense of body appreciation is well infused. In other words, intuitive eating intervention aims to address the cause of energy deregulation by retrieving the innate abilities of food intake regulation and promoting positive attitudes towards food and body image.

Recently, intuitive eating has been winning recognition since a broad range of research has associated this eating behavior with numerous indices of physical and psychological well-being²⁵⁻²⁹. Most importantly, intuitive eating interventions, in addition to improving health outcomes such as cholesterol levels, blood pressure and insulin sensitivity, have not been associated with any adverse effects. In fact, body acceptance and intuitive-based interventions have proven effective in reducing the risk of disordered eating, by decreasing thin-ideal internalization, dietary restraint, and psychological impairment³⁰.

In order to raise a proper state of affairs, the first part of this paper aims to review the concept of intuitive eating as well as the existing evidence that upholds this emerging approach. In the second part, the implication of shifting the focus into a health-centered paradigm in current research and clinical practice will be discussed.

Definition of Intuitive Eating

Intuitive Eating is defined as “the dynamic process-integrating attunement of mind, body and food”³¹. It refers to an adaptative form of eating essentially based on hunger and satiety cues to regulate food intake. Thus, a strong connection with internal body signals, known as interoceptive awareness, is fundamental to this process.

This eating style was initially developed by Tribole and Resch in 1995, but it was not until 2006, that Tylka and cols. operationalized intuitive eating features.^{31,32} Since then, four core components of intuitive eating have been identified and empirically supported by several studies^{25,27,32}. The four components of intuitive eating help remove the barriers that interfere with

interoceptive awareness and improve such awareness in relation to food intake, while a sense of body appreciation is well infused³¹. The main components of intuitive eating style are: 1) *Unconditional permission to eat when hungry and whatever food is desire* goes on the opposite direction to diet mentality. As people who respond unconditionally to feelings of hunger and food cravings do not tend to classify food into categories of “good” or “bad” and instead perceive every food as emotionally-neutral; 2) *Eating for physical rather than emotional reasons* reflects the tendency to eat to satisfy physical hunger rather than to cope with emotional distress; 3) The intuitive eater’s *reliance on internal hunger and satiety cues to determine when and how much to eat*. Perceiving hunger and satiety cues is not sufficient to eat intuitively; a sense of strong reliance to these cues has to be developed, and 4) *Body-Food Choice Congruence* has been identified recently²⁷. It consists in using gentle nutrition to guide food choices that meet both physical and sensory needs. This means that intuitive eaters tend to be mindful about how their body responds to certain foods, usually choosing foods that better contribute to their body functions, but also considering flavor as a central component of food choice.

Self-report measures of Intuitive Eating

In order to be able to gauge the above-mentioned features, self-report measures had to be developed. To our knowledge, there are only two validated questionnaires that measure intuitive eating in adults. Both are referred to as Intuitive Eating Scale (IES). The first one was developed by Steven Hawks and cols. in 2004, and the other one by Tracy Tylka in 2006^{32,33}. Despite the fact that both seem to measure intuitive eating features, they do not share the same factor structure. While Hawk’s IES encompasses a four-factor structure (intrinsic eating, extrinsic eating, antidiets, self-care), Tylka’s IES embraces a three-factor model (unconditional permission to eat, eating for physical rather than emotional reason, and reliance on internal hunger and satiety cues to determine when and how much to eat). Nevertheless, most researchers preferred Tylka’s IES to better assess intuitive eating style, and have been using it widely in subsequent studies^{25,27-29,34}. Moreover, building on Tylka’s work, new scales have emerged. In 2012, Dockendorff et al. developed Intuitive Eating Scale-Adolescents (IES-A) to assess intuitive eating in adolescent population²⁸. Some of the items included in this questionnaire are: 8) *I can tell when I’m slightly hungry*, 16) *I use food to help me soothe my negative emotions, such as feeling sad or angry*, and 20) *I don’t trust myself around fattening or high-calorie foods*. More recently, the Tylka’s IES questionnaire has been updated to the latest version named Intuitive Eating Scale-2 (IES-2), in order to address certain limitations of the previous scale²⁷. In this

new version IES-2, the fourth factor Body-Food Choice Congruence was included. The IES-2 consists of 23 items, such as: 7) *I trust my body to tell me what to eat*, 12) *I am able to cope with negative emotions (e.g. anxiety, sadness) without turning to food for comfort*, and 20) *I mostly eat foods that make my body perform efficiently (well)*. Responses are rated on a 5-point scale ranging from 1=“strongly disagree” to 5=“strongly agree”. The possible range for total IES score is 21-105, where a higher total score corresponds to more intuitive eating.

According to current evidence, IES-2 and IES-A are considered viable measures to assess intuitive eating in both men and women, and within adult and adolescent populations²⁷⁻²⁹. Moreover, it has been stated that IES-2 could be a useful clinical tool to assess not only adaptative behaviors (i.e., intuitive eating), but also the risk of developing maladaptative comportments (e.g., emotional eating, dieting) that could result in disordered eating and obesity, due to the fact that this questionnaire predicts psychological wellness beyond the mere absence of eating disorder symptomatology²⁷.

Intuitive Eating Correlations

The above mentioned instruments have been the basis for many subsequent investigations aimed at exploring intuitive eating correlations with other constructs^{25,27-29,35,36}. This research demonstrates that intuitive eating is inversely related to, although distinct from, ED symptomatology, but it is also positively related to several parameters of physical and psychological well-being. Since, the newest version of the IES (IES-2) is very recent, previous studies have used the IES-1 which encompass only three components of intuitive eating^{27,32}. These correlations are reviewed in the following sections.

Intuitive Eating as the absence of ED symptomatology

Recent studies claim that the intuitive eating components are inversely associated with various risk factors of ED, such as internalization of the thin ideal, pressure to lose weight, body dissatisfaction, body surveillance, body shame, lack of interoceptive awareness, emotional eating and negative affect^{25,27,28}. Particularly, intuitive eater’s unconditional permission to eat predicts lower levels of ED symptomatology because it is strongly associated with lower cognitive restraint and dieting²⁵. In fact, intuitive eaters are 40% less likely to indulge in extreme weight control behaviors, and less likely to experience chronic binge eating and dieting²⁹. Moreover, unconditional permission to eat is highly related to the perception of bodily signals (interoceptive awareness), which directly influences the vulnerability to emotional and external stimuli^{17,32}. Interestingly, this relation is bidirectional, creating a spiral effect. To be-

gin, people with low interoceptive awareness are more susceptible to develop disordered eating, because they tend to adjust food intake based on other reasons rather than their physiological needs (e.g. emotional eating). Subsequently, people that already have an ED strive to ignore their internal signals of hunger and satiety to the extent that, at some point, they no longer perceive them normally (e.g. anorexia nervosa), preserving and aggravating the disordered eating cycle. Although the causality of this association is not yet well defined, it is certain that the lack of interoceptive awareness is particularly seen in people suffering from an ED²¹.

Based on these results, it appears that low levels of intuitive eating might be a risk factor for ED. Inversely, high levels of intuitive eating may guard against disordered eating, by endorsing psychological wellness²⁵.

Intuitive Eating as a distinct construct associated with indices of physical and psychological wellbeing

The absence of ED symptomatology does not necessarily predicts adaptative eating (e.g. people could eat in absence of hunger but without experiencing a binge). This fact supports the idea that intuitive eating has distinctive characteristics that go beyond its relation with ED.²⁵ In this sense, several clinical trials have associated intuitive eating with significant improvements in psychological wellbeing indices (e.g. self-esteem, body appreciation, optimism), cardio-metabolic parameters (e.g. blood pressure, total cholesterol, LDL cholesterol and triglycerides), and healthy behaviors (e.g. dietary and physical activity habits, nutritional quality of food intake)^{23,24,26,35}.

In regard to its psychological benefits, research has associated intuitive eating with higher levels of body appreciation, self-esteem and feelings of satisfaction²⁷. These findings suggest that people who eat intuitively are more likely to be satisfied with their own body and feel less pressure to achieve societal thinness ideals. Thus, it is presumed that intuitive eaters show greater psychological well-being because they do not condition their self-worth to weight or body image. In addition, two components of intuitive eating, eating for physical rather than emotional reasons and relying on hunger and satiety cues, have been positively associated with certain adaptative psychological features, such as positive affect, proactive coping, optimism and social problem solving²⁵.

Furthermore, studies focused on examining the relationship between intuitive eating and physical health have shown that intuitive eating is significantly correlated with lower levels of blood triglycerides, lower levels of total cholesterol and LDL cholesterol, higher levels of HDL cholesterol, decreased diastolic blood pressure, and therefore, diminished cardiovascular risk^{26,37}. Moreover, intuitive eating has been associated with lower body mass index (BMI) in numerous cross-sectional surveys^{17,26,27,29,32,34,35,38,39}. This broadly

suggests that having a stronger awareness of physiological signals and relying on them to decide what, when and how much to eat can be associated with a lower caloric intake³⁵ (in regard to the amount of food rather than the type of food eaten)³⁴. Thus, it seems that intuitive eaters are less likely to engage in behaviors that may lead to weight gain (e.g. binge eating) than those who follow external rules³². However, the causality of this relationship needs to be further investigated, as intuitive eating and BMI can be bidirectional related²⁹. On the one hand, it is well-demonstrated that intuitive eating promotes a healthy weight status, but on the other hand, people with normal weight are more likely to trust their internal hunger and satiety cues to regulate their intake, being therefore more intuitive²⁹.

In addition, since there is some concern about whether intuitive eating (particularly the unconditional permission to eat premise) could result in an excessive and unbalanced diet, some studies have focused on examining its relationship with the nutritional quality of food intake. Research has shown that intuitive eaters do not tend to consume more high-fat/sugar foods than restrictive eaters³⁴. In fact, intuitive eating has been associated with a more varied and nutritious diet, as well as, the adoption of healthy eating habits (e.g. eat breakfast)³⁵.

The role of interoceptive sensitivity

The findings mentioned above are based solely on self-report measures of intuitive eating, which reveal only subjective data. In this regard, some researchers, attempting to find a more objective marker, have used interoceptive sensitivity (IS) as measured by a heart-beat perception¹⁷. Because interoceptive sensitivity represents a significant predictor of intuitive eating behavior, researchers have explored its association with BMI and health outcomes. In this sense, Herbert and cols. reveal that training in self-perception of bodily signals could prove effective for increasing responsiveness to bodily symptoms in regard to food intake regulation¹⁷. Furthermore, interoceptive sensitivity could partly explain the inverse association between intuitive eating and BMI, as it directly influences the degree of individual vulnerability to external factors that incite eating¹⁷.

Meanwhile, Ciampolini and colleagues have evaluated the effects of training in the recognition of initial hunger (IH) by using levels of pre-prandial blood glucose as a biochemical marker of hunger³⁸. This method aims to standardize the training program by helping identify more accurately interoceptive sensations. As Ciampolini has stated, “blood glucose acts to clarify, verify, and validate what might otherwise remain as undifferentiated interoceptive sensations”²². In this sense, people who have been trained in perceiving initial hunger have significantly improved energy regulation (i.e. intuitive eating), reduced their caloric

intake by a third, increased their insulin sensitivity levels, and lowered their BMI by 2 points²². Based on these findings, the authors suggest that overweight and insulin resistance might be rooted in the unconsciousness of body signals^{22,38}.

Potential benefits of an intervention based on Intuitive Eating

Recent evidence suggests that intuitive eating intervention has shown several benefits. Primarily, training in intuitive eating has a relative long-term lasting effect on improving physical and psychological wellness in comparison with conventional weight loss interventions^{23,24,40-42}. Secondly, this model has an integrative scope for action. As it not only reduces the risk of developing disordered eating by endorsing numerous adaptative strategies (e.g. increasing interoceptive sensitivity); but also reduces the onset of chronic diet-related diseases (e.g. obesity) by improving physical and psychological outcomes.

The table I shows the studies aimed to explore the efficacy of interventions based on Intuitive Eating and HAES principles.

Implications for research and practice

Weight loss strategies are widely encouraged in public health policy and health care practice as an answer to the increasing rates of obesity affecting the general population. However, since dieting has been associated with disordered eating, health risk and psychological distress, encouraging patients to start dieting may be uncertainly ethical^{11,43}. Therefore, the pursuit of a more ethical and effective approach to eating behavior should be the priority for health care professionals^{16,44}.

In this regard, an alternative approach with a main focus on health and inclusive focus on weight has been proposed. So far, such health-centered interventions have met ethical standards of beneficence and non-maleficence by stopping weight stigma, honoring size diversity, and being constructed from a holistic focus where all aspects of health are considered¹⁶. Instead of pursuing weight-loss by means of food restriction, these interventions aim at adopting healthy behaviors regardless of weight status. Plenty of evidence has shown that it is likely the behavior to change (and not the weight loss per se) that plays a greater role in health improvement¹¹. In a recent study conducted by Matheson and cols., healthy life style habits (moderate drinking, not smoking, regular exercise, fruit and vegetable consumption) were inversely associated with mortality risk, irrespective of the subject's initial BMI⁴⁵. In fact, the researchers revealed that the "obese individuals who adopted all 4 healthy lifestyle habits had the lowest risk of mortality compared with every other weight strata and life style combination⁴⁵".

Furthermore, despite of what is commonly thought, weight is not a modifiable behavior, but a result of involuntary factors both personal and environmental¹⁶. Therefore, weight suppression may be an unattainable target for health care interventions. The fact that intuitive eating interventions may offer a more realistic longer-lasting improvement of health outcomes and general wellness, independent of weight loss, makes them more promising than conventional treatments. This might be linked to the significantly higher retention rates seen in health-centered interventions when compared to diet and control groups^{37,41}, as patients involved in this approach may be less likely to become discouraged and may continue to engage in healthy behaviors by not using weight loss as a marker of success⁴⁴. However, although it is not the central aim of the health-focused and intuitive-based interventions, modest weight loss might occur^{37,41,42}. And it could continue to occur post-treatment, contrary to dieting outcomes where weight rebound is particularly common. The mentioned weight loss can be explained by the fact that intuitive eaters have shown to be able to maintain a stable eating behavior over time, while dieters tend to increase their food intake post-treatment⁴⁶. That being said, an intervention based on intuitive eating skills might be a viable strategy towards weight management and weight gain prevention.

In addition, since intuitive eating not only promotes adaptative behaviors, but also prevents the occurrence of future ED, this intervention should be especially useful for chronic dieters who have not obtained satisfactory results with conventional treatments and are at risk of engaging in disordered eating. Moreover, some surveys have revealed that women who binge especially benefit from training intuitive eating skills^{31,34,47}. Finally, a further advantage of intuitive eating interventions is that, from a clinical point of view, it could be applied to a wide range of areas. For instance, it could work as health diffusion strategies in workshops or support groups, health campaigns at college centers, educational courses with curricular value or even as individual therapy session⁴⁸.

Some limitations of the present paper should be acknowledged. Firstly, it is not a systematic review. Secondly, the studies presented in this paper were the ones consider having a greater scientific rigor, leaving a side part of the literature related to this subject. Last but not least, it is worth addressing some limitations of the intuitive eating framework. Further research is required to describe more precisely the effectiveness of this new approach. Future studies should focus on deeply examined adaptative eating behaviors in order to extend the current evidence regarding health-centered interventions and address unsolved matters in this subject. It could be meaningful to explore the effects of intuitive eating interventions in specific cases where its implementation can present certain complications (e.g. low-income population)²⁷. Also, it seems necessary to estimate the impact of weight-neutral

Table I
Controlled trials that used interventions based on Intuitive Eating and HAES principles

Study	Design Group type (n)	Population	Tx sessions / length in weeks	Follow-up (weeks post-tx)	Attrition	Main findings
Mellin et al., 1997	Training group 22	Obese men and women	18/18	78	T group 18%	The intervention showed several positive effects: improved health indexes, as well as various aspects of psychosocial, vocational and economic functioning, decreased depression and lowered body weight.
Goodrick et al., 1998	Nondiet group 62 Diet group 65 Control group 58	Overweight and obese women, binge-eaters	50 sessions	78	Not reported	Both intervention groups, Non Diet and Diet, reduce binge eating episodes in a similar way, but none of them showed significant weight loss.
Bacon et al., 2002 & 2005	HAES group (39) Diet group (39)	obese female chronic dieters	30/24	72	HAES 8% Diet 42%	Despite de HAES group do not showed significant weight loss, the improvements in metabolic fitness, psychology and eating behavior were remarkable. Also, the attrition rates within de HAES group were significantly lower in comparison to the diet group. After a two-year follow-up, only the HAES group maintained weight and sustained improvements in all outcome variables.
Provencher et al., 2007 & 2009	HAES group (48) Social Support (48) Control group (48)	Pre-menopausal obese and overweight women	14/16	48	HAES 8% S.S 19% Control 21%	Larger decreases in habitual susceptibility to disinhibition and susceptibility to external hunger, as well as higher increase in flexible restraint, were associated with the maintenance of a lower body weight in the HAES group (63.4% of HAES women maintained a 2% weight loss at follow-up). No large difference was noted between HAES and SS groups.
Gagnon-Girouard et al, 2010	HAES group (48) Social Support (48) Control group (48)	Weight-preoccupied obese and overweight women	14/14	48	Not reported	In the long-term, psychological variables (depressive symptoms, body and self-esteem, binge eating and quality of life) and body weight remained stable or continued to improve among the HAES group, but not in the other groups.
Ciampolini et al., 2010	IH Training 89 Control group 31	Men and women adults, suffering from symptoms of functional bowel disorders	7 weeks	12	IHT 20% Control 16%	Over a 5-month period, training in hunger recognition improved insulin sensitivity index and cardiovascular risk factors, and decreased energy intake, body weight and BMI.
Leblanc et al., 2012	HAES group (48) Social Support (46) Control group (46)	Pre-menopausal obese and overweight women	14/16	24	HAES 8% S.S 19% Control 21%	HAES group reported decrease in hunger and external hunger, which were associated with a decrease in overall energy intake.
Gravel et al. (2013)	Sensory-based (24) Control group (26)	Restrictive overweight women	6/6	12	S-Based 20% Control 30%	Sensory-based intervention improved eating-related attitudes and behaviors among restrained women. Intervention group showed a significant decrease in disinhibition and situational susceptibility to disinhibition, after treatment and in the follow-up.

T group: Training group; HAES: Health at Every Size; SS: Social support intervention group; BMI: Body Mass Index; IHT: Initial Hunger Training.

health policies in a broader context. Regarding this last point, scholars agree that “the implementation of global strategies for people of all sizes and shapes may be a more effective method for addressing weight related problems than focusing exclusively on obese individuals⁴⁴.”

Conclusions

Although it is certain there is a need to extend current research on health-centered interventions, it is worth mentioning the several advantages encompassed in this approach:

- a) Intuitive Eating intervention may be a more promising and realistic alternative to address overweight and obesity than the conventional weight-loss treatments.
- b) This method, in addition to meeting health goals, does not affect the integrity and welfare of the patient.
- c) Instead, it guards people of all sizes and shapes from unhealthy weight-control behaviors that may diminish their health and wellbeing.

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Revisión

Protocolo para el manejo de nutrición parenteral periférica lista para usar en paciente quirúrgico

Olga Lucia Pinzón Espitia¹ y Martha Liliana Varón Vega².

¹Méderi. Universidad del Rosario - Doctorando en Ciencias de la Dirección. Bogotá D.C. Colombia. ²Universidad Universitat Pompeu Fabra - Máster en curso. Barcelona. España.

Resumen

Introducción: Los pacientes sometidos a cirugía electiva, requieren de un tratamiento clínico integral que propenda por mantener o evitar el deterioro del estado nutricional y favorecer los resultados clínicos, y a su vez mejorar la seguridad de la terapia nutricional parenteral mediante la optimización de la tecnología, como una opción enfocada a la minimización de riesgo y la disminución de los costos operativos en las instituciones de prestación de servicios de salud.

Objetivo: Realizar una revisión de la literatura con el fin de estudiar las indicaciones y recomendaciones del soporte nutricional parenteral periférico y/o complementario listo para usar en personas sometidas a una intervención quirúrgica.

Métodos: Síntesis de datos tras la revisión de la bibliografía pertinente, que permitiera el diseño del protocolo. Se realizó la búsqueda en las siguientes bases de datos: PubMed, Medline, ScienceDirect y Embase.

Conclusiones: La nutrición parenteral periférica lista para usar es una alternativa de soporte nutricional, que permite mejorar el aporte Proteico-Energético así como demostrar mejoras en la seguridad del paciente, disminución de los costos y aumentar la satisfacción del paciente.

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Palabras clave: Nutrición Parenteral. Alimentación Intravenosa. Procedimiento Quirúrgico. Soluciones Farmacéuticas.

Introducción

La nutrición parenteral (NP) es una solución compuesta de nutrientes infundidos a través de una vía intravenosa que no pasa por el tracto gastrointestinal¹. La determinación de la ruta más apropiada, ya sea vía central o vía periférica es determinada por el riesgo

PROTOCOL FOR PERIPHERAL PARENTERAL NUTRITION MANAGEMENT READY TO USE IN SURGICAL PATIENTS

Abstract

Introduction: Patients undergoing elective surgery, require a comprehensive clinical treatment that tends to maintain or prevent deterioration of nutritional status and promote clinical outcomes, and in turn improve the safety of parenteral nutrition therapy through optimization of technology, as a option aimed at minimizing risk and lower operating costs in institutions providing health services.

Aim: To review the literature in order to study the requirements and recommendations of peripheral parenteral nutritional support and / or complementary ready to use in people undergoing surgery.

Methods: Data synthesis after reviewing the relevant literature, to allow the protocol design. The search was conducted in the following databases: PubMed, Medline, Embase and ScienceDirect.

Conclusions: Peripheral parenteral nutrition is a ready to use alternative nutritional support that improves the contribution Protein-Energy and demonstrate improvements in patient safety, decrease costs and increase patient satisfaction.

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Key words: Parenteral Nutrition. Intravenous Feeding. Surgical Procedures. Operative. Pharmaceutical Solutions.

nutricional del paciente, el diagnóstico clínico, la condición clínica del paciente y la duración de la terapia nutricional parenteral².

La nutrición parenteral vía periférica (NPP), objeto del presente protocolo, es definida como un tipo de nutrición parenteral que permite aportar nutrientes directamente al torrente circulatorio por vía periférica al tener una osmolaridad menor a 900 mOsm/L³.

En pacientes, una vez valorada la condición clínica, el estado nutricional y calculados los requerimientos nutricionales del paciente con indicación de NPP, se prescribe la NPP con una osmolaridad menor de 900 mOsm/L y un pH entre 6,0, y 7,4 permitiendo su

Correspondence/Correspondencia: Olga Lucia Pinzón Espitia.
olga@urosario.edu.co

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administración por vía periférica y evitando los posibles efectos deletéreos del acceso venoso central⁴.

El presente protocolo presenta la Nutrición Parenteral Periférica Lista Para Usar (NPP – LPU) como una terapia nutricional que facilita a los especialistas en nutrición el poder cubrir las necesidades nutricionales de los pacientes hospitalizados, jugando un papel fundamental para mejorar la calidad de la atención, la prevención y el tratamiento de la desnutrición hospitalaria en pacientes con indicaciones de nutrición parenteral periférica.

Por consiguiente, el presente protocolo hace una revisión exhaustiva del uso adecuado de la nutrición parenteral periférica, la cual se constituye en una terapia que maximiza el beneficio clínico y conlleva a reducir al mínimo el potencial riesgo de eventos adversos⁵, eventos que en ocasiones son asociados a las complicaciones derivadas del soporte nutricional parenteral total o periférico, que pueden resultar por inadecuado manejo técnico de la propia mezcla de nutrición parenteral como de los procesos de suministro.

El hecho de que la nutrición parenteral sea un medicamento, debe ser manejado como una terapia de máxima alerta, la cual requiere que las organizaciones de salud desarrollen políticas basadas en la evidencia, procedimientos y prácticas seguras⁵, que a su vez, evolucionen hacia sistemas que se articulen a políticas de seguridad del paciente, por lo cual un sistema de fórmulas parenterales listas para usar, se constituye en una alternativa que brinda mayor seguridad, durante el tiempo que el paciente requiera el tratamiento.

Los pacientes sometidos a cirugía electiva, requieren de un tratamiento clínico integral que propenda por mantener o evitar el deterioro del estado nutricional. El efecto del estado nutricional sobre la morbilidad y mortalidad de la cirugía mayor gastrointestinal para enfermedades benignas es relevante, dado que después de la cirugía, la duración media del período de ingesta oral inadecuada (ingesta menor al 60% de los requerimientos calóricos), se puede prolongar significativamente, siendo mayor en pacientes con desnutrición, lo cual puede conllevar a mayor morbilidad, y por lo cual se justifica la consideración de apoyo (postoperatorio) con terapia nutricional parenteral en pacientes que se someten a cirugía mayor gastrointestinal por enfermedad benigna⁶.

En la atención de los pacientes llevados a cirugía, la malnutrición unida a la ingesta oral inadecuada, sigue siendo un problema común, que requiere atención. En los pacientes con cáncer colorrectal, la malnutrición es una consecuencia directa de las enfermedades, como por ejemplo, la enfermedad inflamatoria intestinal y el cáncer colorrectal. La literatura reporta que la incidencia global de malnutrición sigue siendo poco reconocida, sin embargo, la desnutrición sigue afectando negativamente la recuperación postoperatoria y los resultados clínicos del paciente⁷.

Teniendo en cuenta lo anteriormente descrito, el apoyo nutricional debe ser suministrado en el preope-

riorio o postoperatorio, según la condición clínica del paciente, y las vías de administración enteral y parenteral indicadas, con el fin de favorecer los resultados clínicos esperados. Cada método conlleva sus retos únicos, que instaurados oportunamente, en el paciente desnutrido impacta los resultados, al ofrecer beneficios como un menor número de complicaciones postoperatorias, menor duración de la estancia hospitalaria y una mortalidad potencialmente menor⁷.

Objetivos

Realizar una revisión de la literatura con el fin de estudiar las indicaciones y recomendaciones del soporte nutricional parenteral periférico y/o complementario listo para usar en personas sometidas a una intervención quirúrgica.

Métodos

Síntesis de datos tras la revisión de la bibliografía pertinente, que permitiera el diseño del protocolo. Se realizó la búsqueda en las siguientes bases de datos: PubMed, Medline, ScienceDirect y Embase. Las palabras claves utilizadas fueron las siguientes: Nutrición Parenteral, Alimentación Intravenosa, Procedimiento Quirúrgico Operativo, Soluciones Farmacéuticas.

Requerimientos nutricionales en paciente quirúrgico

Para determinar los requerimientos nutricionales es necesario realizar el tamizaje y/o evaluación nutricional con el fin de detectar de manera oportuna el riesgo de desnutrición en los pacientes hospitalizados. Seguido, se sugiere la evaluación nutricional para todos los pacientes que estén identificados como en riesgo de desnutrición con el fin de realizar una intervención de apoyo nutricional tanto para los pacientes en riesgo como los que se encuentran en estado de malnutrición⁸.

La NPP se recomienda por un periodo de duración que no sea superior a los 7-10 días, la cual estará determinada tanto por la calidad, como por la localización de los accesos venosos, los cuales determinan la composición de macro y micronutrientes y por el cubrimiento de las necesidades calórico - proteicas. En algunas indicaciones se puede evaluar su empleo en periodos de tiempos cortos (3-4 días), salvo que sea complementaria a una nutrición oral/enteral en cuyo caso no existe límite de tiempo⁴.

En una investigación realizada por De Waele, De Bondt⁹, que incluyó doscientos pacientes, reclutados durante un período de 10 meses, se encontró que el 42,5% de los pacientes tenían una puntuación mayor a 3 en NRS 2002 (NRS: Nutritional Risk Screening), siendo clasificados en riesgo nutricional. En referencia a los requerimientos nutricionales de los pacientes ob-

jeto de estudio, la media de requerimiento de energía fue 2046 ± 347 kcal y la ingesta media diaria 1.452 ± 335 kcal, dando un cubrimiento del 62% de los requerimientos nutricionales durante toda la estancia en el hospital, siendo la intervención nutricional necesaria en el 52% de los casos, con el fin de disminuir el déficit de calorías.

En los pacientes hospitalizados con riesgo nutricional que requieren nutrición parenteral (NP), dicho apoyo nutricional tiene efectos positivos sobre la duración de la estancia hospitalaria, la morbilidad, la mortalidad y las tasas de complicaciones. Un estudio que tuvo como objetivo investigar el cumplimiento de las pautas nutricionales para NP en hospitales universitarios, durante un período de 6 meses, y el cual reclutó prospectivamente pacientes médicos - quirúrgicos que requirieron NP, identificó que sólo se cumplió el 75% del requerimiento calórico indicado, siendo necesario incluir en la práctica de rutina del hospital, protocolos de NP que permitieran mejorar la calidad de la terapia nutricional, sugiriendo que dichos protocolos deben ser incluidos en los procesos de capacitación periódica para el personal médico y de enfermería, así como en los procedimientos operativos estándar de las Instituciones¹⁰.

Para la elaboración del presente protocolo y establecer la recomendación de calorías y proteínas se revisaron documentos de la Sociedad Europea de Nutrición Clínica y Metabolismo (ESPEN por su sigla en inglés), los cuales tienen una alta aceptación por parte de los profesionales de la salud¹¹.

Requerimientos energéticos

Las directrices ESPEN sobre Nutrición Parenteral en Cirugía, sugieren el uso de la fórmula general de 25 kcal / kg de peso corporal ideal, la cual proporciona una estimación aproximada del gasto diario de energía y los requerimientos de calorías de los pacientes. En condiciones de estrés severo los requerimientos pueden acercarse a 30 kcal / kg peso corporal ideal¹².

En cirugía, la pérdida clínicamente significativa de peso sigue siendo frecuente, por ejemplo, en pacientes con cáncer de cabeza y cuello, a pesar de las intervenciones preventivas, dicha pérdida es evidente. Los predictores de pérdida de peso se soportan en las categorías de riesgo de las directrices basadas en la evidencia¹³, por lo cual es importante tener en cuenta que el gasto de energía y la pérdida de proteínas varían en gran medida a través de diversas poblaciones. El aumento del gasto de energía y de nitrógeno por encima de los valores normales se asocian directamente con la gravedad de la lesión de una cirugía electiva^{14, 15}.

Adicionalmente, es de resaltar que los pacientes con mayor gravedad de las lesiones tienen un mayor gasto de energía y las pérdidas de nitrógeno (como consecuencia del aumento actividades metabólicas de diversos órganos, incluyendo el aumento de la proteólisis asociadas a la herida y alteraciones del sistema inmunológico¹⁴.

Requerimientos proteicos

Los principales objetivos del soporte nutricional peri-operatorio son minimizar el balance proteico negativo, con el propósito de mantener la reserva muscular, evitar el deterioro del sistema inmunológico, y mejorar la recuperación postoperatoria¹².

En las enfermedades y/o condiciones de estrés el aporte diario de nitrógeno equivalente a una ingesta de proteínas de 1,5 g / kg de peso ideal, aproximadamente el 20% de las necesidades totales de energía, es generalmente eficaz para limitar las pérdidas de nitrógeno¹².

Los estudios han reportado efectos positivos en el periodo postoperatorio, al favorecer el equilibrio de proteínas¹⁶, la conservación y fuerza de la masa muscular^{17, 18} y la reducción de la estancia hospitalaria posterior al procedimiento quirúrgico^{19, 20}.

Autores como Kreymann, DeLegge¹⁴ describen, que aunque el 35% de los pacientes en trauma reciben un aporte mayor a 1,5 g/kg de peso corporal/ día, el 60% de las cohortes objeto de estudio, tuvieron una pérdida de proteínas mayor a 1,5 g/kg de peso corporal, el cual los llevó a un balance negativo de proteína, no derivado de la sobrealimentación de proteína, sino como resultado de factores como la enfermedad y la subyacente ingesta de proteínas que no cubrió las pérdidas. Identificando de manera complementaria que la excreción de nitrógeno y la pérdida de proteínas en sujetos sanos fue mayor que la ingesta diaria recomendada de proteína es decir, aproximadamente 0.7 a 0.8 g / Kg/ día, siendo la pérdida de proteína promedio en personas sanas de 0,94 g / kg peso corporal / día.

Las directrices actuales para pacientes en estado crítico ESPEN²¹, recomiendan una ingesta de proteínas de 1.3 a 1.5 g / kg peso corporal / día, mientras que las directrices para pacientes en estado crítico editado por la Sociedad Americana de Nutrición enteral y Parenteral (ASPEN por su sigla en inglés)²², recomiendan 1.2 a 2.0 g / kg peso corporal / día (con el peso corporal real para los pacientes con un IMC <30); de manera complementaria recomiendan tener en cuenta que las necesidades de proteínas en pacientes con quemadura, obesos o pacientes politraumatizados, es mayor. Para efectos del presente protocolo se sugieren las directrices ESPEN, dadas la diferencia en las recomendaciones dadas por las dos Sociedades.

Sistema venoso periférico como alternativa de soporte nutricional por vía parenteral, para mejorar el aporte Proteico-Energético.

Indicaciones de la Nutrición Parenteral Periférica

Las recomendaciones actuales para el uso de la nutrición parenteral (NP) incluyen, utilizar únicamente NP cuando la vía enteral no es posible, prescribir NP basado en el tamizaje de riesgo nutricional del paciente, si el riesgo nutricional es medio o alto (2, 23), y

Tabla I
Nutrición enteral precoz inviable

Repleción nutricional < 7 días
Progresión de la nutrición enteral
Nutrición enteral insuficiente (< 60% de los requerimientos nutricionales)
Deterioro del estado nutricional Vs necesidad de cubrir requerimientos nutricionales
Inicio temprano y/o inmediato del soporte nutricional parenteral

finalmente tan pronto sea tolerada la nutrición enteral, y se hayan alcanzado las metas de aporte de energía y proteína, reducir el aporte nutricional vía parenteral con el fin de reducir los riesgos asociados con la NP². Ver tabla I.

Los estudios de eficacia, seguridad y farmacoeconomía demuestran que la NPP es un recurso terapéutico muy útil en determinadas situaciones clínicas tanto médicas como quirúrgicas para evitar el deterioro metabólico y nutricional del paciente, lo cual repercute en una reducción significativa de las complicaciones clínicas y el número de días de estancia hospitalaria⁴.

La NPP también está indicada como nutrición parenteral complementaria (NPC), la cual se ha definido como el aporte de nutrición parenteral, como su nombre lo dice, complementaria a la nutrición enteral, cuando con el aporte vía enteral no permite alcanzar los requerimientos nutricionales calculados para el paciente. La NPC se debe iniciar cuando no se consiga cubrir el 60% de los requerimientos nutricionales al cuarto día de ingreso, o a lo largo de la estancia, durante al menos 2 días consecutivos³. Teniendo en cuenta la oportunidad de atención con la que se debe dar cumplimiento a los requerimientos nutricionales, las mezclas listas para usar son una opción con la cual el equipo multidisciplinario puede prescribir la NPP oportunamente en la Institución de salud.

La desnutrición se ha reconocido como un factor de riesgo significativo para los pacientes post operados, especialmente para aquellos pacientes sometidos a cirugías abdominales. Un estudio evaluó el efecto de las nutriciones hipocalóricas con adición de micronutrientes suministradas a través del apoyo nutricional parenteral periférico (NPP) para los pacientes con cáncer rectal, encontrando resultados que mostraron que la albúmina de suero post-operatoria de los 25 pacientes que recibieron NPP (promedio de $2,5 \pm 0,32$ g/dl) fue significativamente mayor que los de los 15 pacientes que no recibieron NPP (promedio de $1,92 \pm 0,42$ g/dl). Siendo menor el número de días de estancia hospitalaria post-operatoria para los pacientes que recibieron NPP, de $18,2 \pm 10,5$ días, Vs $33,7 \pm 20,0$ días, de los pacientes que no recibieron NPP. Más del 25% de los pacientes que no recibieron NPP estaba infectado con sepsis, poniendo en evidencia los beneficios del apo-

yo nutricional parenteral para pacientes con cáncer de recto²⁴.

Otro estudio, muestra que la nutrición parenteral preoperatoria y postoperatoria ha demostrado que reduce las complicaciones infecciosas en pacientes severamente malnutridos, con cáncer gastrointestinal superior, si se les administra nutrición parenteral de 7-10 días en la fase preoperatoria²⁵. Los pacientes con cáncer de colon son menos propensos a tener malnutrición en comparación con los pacientes con cánceres del tracto gastrointestinal superior²⁶.

En un ensayo clínico comparativo para examinar la influencia de los 10 días de nutrición parenteral preoperatoria (PPN) en la tasa de complicaciones postoperatorias para el carcinoma gastrointestinal, 59 pacientes (controles) recibieron la dieta regular del hospital y 66 recibieron NPP, siendo los dos grupos similares en el estado nutricional y en la distribución del sitio y la etapa del tumor y el tipo de operación. Las tasas de infección postoperatoria de la herida, neumonía, complicaciones mayores y mortalidad fueron generalmente más bajas en el grupo que recibió NPP, siendo significativas las diferencias sólo para las complicaciones y la mortalidad. Los resultados clínicos pueden ser explicados por la mejora en diversos índices de inmunocompetencia humoral y celular y el estado de la proteína en el grupo de que recibe NPP y su deterioro en el grupo de control durante el curso de la fase preoperatoria⁶.

Accesos vasculares

Las recomendaciones de la ASPEN sugieren que la nutrición parenteral periférica tenga una osmolaridad de hasta 900 mOsm / L para ser infundida de manera segura^{5, 27-31}. La NP puede ser administrada de manera segura por un acceso periférico (cánula corta o catéter de línea media), siempre que se asegure el uso de una solución con baja osmolaridad³².

La administración de NPP a través de una vena periférica, requiere de un seguimiento con el fin de prevenir una de las complicaciones más importantes asociadas a la limitación de la tolerancia como es el desarrollo de tromboflebitis, ya que la incidencia de tromboflebitis se relaciona con la osmolaridad de la fórmula infundida, así como la velocidad de infusión.

Factores a considerar en la formulación de la nutrición parenteral periférica lista para usar (NPP_LPU)

Los factores a considerar al momento de realizar la formulación de la NPP-LPU propenden por la seguridad del paciente.

La prescripción segura de la nutrición parenteral periférica, requiere de tres puntos clave: 1) educación al equipo interdisciplinario que procederá con la for-

mulación 2) cálculo de las necesidades de proteínas y energía, macronutrientes, micronutrientes, la homeostasis de fluidos y el equilibrio ácido-base, del paciente y 3) el profesional una vez ha determinado las indicaciones apropiadas para la nutrición parenteral, calculará el volumen y la velocidad de infusión³³.

Las instituciones de salud deben disponer de protocolos y procesos estandarizados para la gestión del soporte nutricional parenteral, y este proceso deberá incluir el personal idóneo con experiencia en el área de soporte nutricional con apoyo preferiblemente de múltiples disciplinas^{33, 34}.

Las prácticas seguras en nutrición parenteral incluyen^{33, 35}:

- a. Disponer por escrito de políticas, procedimientos y protocolos para todos los aspectos de la terapia nutricional parenteral total y periférica.
- b. Informar acerca de los riesgos y beneficios asociados con la nutrición parenteral, al paciente y los cuidadores.
- c. Articular los procedimientos y/o protocolos institucionales de manejo nutricional parenteral a un programa integral de educación, en el que se realizará evaluación de las competencias de los profesionales involucrados en el cuidado de los pacientes que reciben terapia nutricional parenteral, la cual se debe realizar por lo menos anualmente.
- d. Evaluar la condición clínica del paciente y las indicaciones para la nutrición parenteral, por parte del equipo o profesionales médicos con el apoyo de los profesionales de soporte nutricional.
- e. Confirmar que el paciente tiene el acceso intravenoso (IV) apropiado para soporte nutricional antes de prescribir la terapia, o dará la orden médica de colocación del acceso.
- f. Especificar y registrar en la historia clínica el objetivo terapéutico de la terapia nutricional parenteral, incluyendo las metas de energía y proteínas determinadas según la condición del paciente.
- g. Realizar un monitoreo con una frecuencia apropiada, establecida en la institución de salud, en la que se determinará, para la condición del paciente la evaluación de la eficacia del soporte nutricional parenteral, recomendaciones para detectar y prevenir las complicaciones, asociadas a la terapia.
- h. Evaluar los siguientes parámetros de control: necesidades de líquidos, electrolitos séricos, concentraciones de glucosa en suero, función hepática, función renal, concentraciones de triglicéridos en suero y los signos o síntomas relacionados con el acceso vascular.
- i. Registrar en historia clínica una vez finalizada la terapia nutricional parenteral la respuesta al tratamiento, y las indicaciones para poder cum-

plir las metas nutricionales con la administración de un soporte nutricional enteral.

- j. Minimizar los riesgos inherentes de contaminación asociados a preparación de la mezcla, se sugiere optar por sistemas listos para usar.

Tendencias uso de la nutrición parenteral periférica lista para usar

Las instituciones de salud tienen la oportunidad de mejorar la seguridad de la terapia nutricional parenteral mediante la optimización de la tecnología para la prescripción, generación de ordenes e información, así como la estandarización de la revisión de la orden de la nutrición parenteral y los procesos de verificación³³, siendo las mezclas de nutrición parenteral listas para usar una opción enfocada a la minimización de riesgo y los costos operativos.

Las formulaciones de NP se adaptan a las necesidades nutricionales individuales de cada paciente, las cuales deben ser preparadas por farmacéuticos especialmente certificados en procesos de elaboración, ya sea de forma manual o automatizada a través de los dispositivos disponibles. Sin embargo, numerosos casos de error son evidenciados en la producción de la NP, los cuales se pueden dar en el momento de la elaboración de la mezcla, errores en los pedidos, la transcripción, composición, conllevando a reportes como las complicaciones infecciosas³⁶⁻³⁸.

Para abordar estos problemas, la preparación de NP puede ser subcontratada a través de centrales de mezclas, teniendo en cuenta los costos adicionales que implica la maquila de la NP. Existen en el mercado mezclas estandarizadas y premezcladas, que pueden contribuir a mejorar la administración segura de la NP, unido a la facilidad de reconstitución, facilitando al equipo de salud la elaboración de las ordenes, la dosificación de los nutrientes, la administración y monitoreo^{36, 37, 39}.

Las fórmulas de nutrición parenteral comercialmente disponibles en bolsas individuales con múltiples cámaras, referenciadas a menudo como “premezcladas”, se han promovido como sistemas más seguros y eficientes^{5, 40}. La literatura disponible centrada en evaluaciones secuenciales en las instituciones, después de la conversión del enfoque de nutrición parenteral calculada a sistemas estandarizados listos para usar, se derivan de experiencias europeas⁴¹, los cuales soportan las siguientes ventajas de las mezclas listas para usar, disminución de la mano de obra y los costos de inventario, menor tiempo de preparación, y menor esfuerzo de enfermería para su entrega y administración⁵.

Un Consenso de ASPEN, emitió la siguiente recomendación, como base para la identificación del mejor sistema de entrega de la nutrición parenteral, teniendo en cuenta el número y tipo de pacientes que requieren nutrición parenteral en una institución de salud^{5, 38}, cada institución debe realizar la comparación del costo y el

beneficio de uso de las bolsas multicámara listas para usar Vs las mezclas elaboradas en central de mezclas⁴².

Complementariamente, el Grupo Británico de Nutrición Farmacéutica concluyó que la idoneidad del paciente y la decisión de utilizar mezclas de nutrición parenteral listas para usar deben ser determinadas por personal clínico debidamente entrenado, para así brindar un apoyo nutricional adecuado^{5,43}.

Teniendo en cuenta lo anterior, tres factores, deben ser considerados por las instituciones para la toma de la decisión de utilizar mezclas de nutrición parenteral listas para usar, estos son el seguimiento de los resultados clínicos, la seguridad y el costo^{5,44}, por lo cual se puede concluir, que las mezclas para nutrición parenteral listas para usar, son recomendadas con un adecuado tamizaje de los pacientes y la evaluación por parte de los clínicos debidamente capacitados y con experiencia en soporte nutricional.

Otro factor relevante a tener en cuenta en el uso de las mezclas listas para usar es la disminución de los errores de formulación y en la administración del soporte nutricional parenteral, ya que disminuye los errores con la eliminación de ordenes escritas a mano y /o el uso de editable de órdenes electrónicas por cada uno de los componentes requeridos para la prescripción.

Adicionalmente y previo entrenamiento del equipo médico y de soporte nutricional se disminuyen errores asociados con el proceso de verificación por parte de los profesionales en enfermería, dado que se cuenta con un sistema de fórmulas balanceadas con indicaciones precisas para la infusión de paso³³.

En cuanto a la participación en el equipo de nutrición de los Servicios Farmacéuticos, estos se ven beneficiados en la medida que disminuyen los errores asociados a la práctica clínica y opiniones farmacéuticas³³, como por ejemplo errores asociados con la transcripción de los datos de la orden de nutrición parenteral. Esto puede ser evidenciado y demostrado a través de listas de control estandarizadas para la verificación y la revisión de las órdenes.

Lo anterior permite a los profesionales de la salud dedicados al cuidado nutricional demostrar mejoras de la seguridad del paciente, disminución de los costos y aumentar la satisfacción del paciente.

Un estudio cuyo objetivo fue evaluar la disminución de la carga de trabajo de la farmacia y las adaptaciones de la mezcla para el cumplimiento de los requerimientos de los pacientes, concluyó que las mezclas listas para usar tienen progresivamente un tiempo sustituido que resulta en una disminución de la carga de trabajo⁴⁵, constituyéndose así la NPP-LPU en un factor atractivo para la gestión de personal.

Prácticas seguras para la administración de la nutrición parenteral periférica, lista para usar

Las formulaciones parenterales deben ser preparadas con precisión y seguridad utilizando políticas y

procedimientos establecidos. La formulación parenteral debe ser preparada y revisadas bajo la supervisión directa de un farmacéutico. Todas las formulaciones nutricionales deben ser debidamente etiquetadas y administradas según los protocolos y procedimientos de cada institución, los cuales deben cumplirse con el fin de reducir y prevenir los riesgos de la regurgitación, aspiración e infección².

Orden de Nutrición Parenteral Periférica

En referencia a la orden de Nutrición Parenteral Periférica, en la práctica clínica a nivel mundial se sugiere el uso de mezclas listas para usar, como estrategia para disminuir errores en el momento en que los profesionales en salud generan la orden de nutrición parenteral, en las unidades.

ASPEN, establece que la nutrición parenteral es una terapia compleja de prescribir, que en ocasiones se asocia con efectos adversos significativos. La literatura ha referenciado casos de muerte asociados a prácticas no seguras, por lo que contar con un orden en la prescripción de la nutrición parenteral es un primer paso crítico⁵.

Teniendo en cuenta lo anteriormente descrito, es necesario ser enfáticos en participar en programas de educación asociados con prácticas seguras de prescripción, los cuales conllevan a una disminución sustancial de los errores generales de prescripción que pueden llevar a sobrealimentación, y /o incremento de los costos asociados a la atención⁵.

Revisión de la orden, etiquetado y dispensación

Las mezclas de nutrición parenteral listas para usar, una vez se han mezclado los tres compartimientos, facilitan la inspección visual, el etiquetado y dispensación de la NPP.

La manera en que se etiquetan los componentes de la NP tienen un orden sugerido, en función de los componentes de base de la NP, dextrosa y aminoácidos, los cuales se deben etiquetar registrando el volumen y el porcentaje de concentración de la solución (250 ml de dextrosa al 50%), seguido el porcentaje de concentración final después de la mezcla (25% de dextrosa), y los gramos por litro o gramos en el volumen total de la mezclada de NP (250 g por litro o 375 g por total en el volumen preparado)⁴⁶.

Los aditivos, especialmente los electrolitos, se etiquetan como mmol o mEq por litro o por volumen. Por ejemplo, cloruro de sodio (NaCl) en una dosis de 80 mEq / L de mezclado en una NP con un volumen de 2 litros, facultativamente, de la siguiente manera⁴⁶:

- NaCl 80 mEq / L
- NaCl 160 mEq por volumen total
- Na 80 mEq / L, Cl 80 mEq / L
- Na 160 mEq Cl y 160 mEq por volumen total.

Una vez revisada la orden médica Vs la etiqueta, se procede a la dispensación de la NPP-LPU, en este paso es relevante verificar los cinco correctos en la administración de medicamentos, usuario correcto, medicamento correcto, vía correcta, dosis correcta y hora correcta.

Minimizando los riesgos potenciales con las nutricionales parenterales

Las bolsas multicámara para nutrición parenteral, están diseñados para reducir el riesgo de inestabilidad o precipitación, se encuentran disponibles comercialmente y disponen de una separación de sus componentes que se activa cuando se va a administrar³³.

Otro de los aspectos relevantes de las nutriciones parenterales listas para usar, es la disminución de la infección en el torrente sanguíneo, una revisión retrospectiva de una gran base de datos (n = 15.328 pacientes), encontró que la probabilidad ajustada de infección del torrente sanguíneo fue significativamente menor en los pacientes que recibieron NP-LPU Vs NP preparada en las centrales de mezclas⁴⁷,

Las ventajas adicionalmente relevantes de las mezclas listas para usar, son una vida útil más larga, al ser empacados los nutrientes en bolsas de materiales recién desarrollados y con tecnología de punta⁴⁸, previniendo riesgos de pérdidas de recursos económicos asociados al tiempo de colgado.

Seguimiento y monitoreo de la administración de la nutrición parenteral periférica lista para usar

El seguimiento a la administración, forma parte del rol de los integrantes del equipo de soporte nutricional y de las enfermeras en los diferentes servicios de atención, en la administración y los procedimientos de verificación, los cuales deben incluir³³:

Antes de la administración

1. Confirmación de la identidad del paciente de acuerdo con la política de la Institución.
2. Comprobación de la etiqueta de nutrición parenteral contra la orden, incluyendo componentes de la formulación, la vía, la velocidad de infusión y la fecha de caducidad.
3. Inspección visual de la formulación para detectar defectos o cambios en la mezcla.
4. Verificación de las condiciones adecuadas del acceso vascular antes de iniciar la infusión de la nutrición parenteral.
5. Confirmación de la permeabilidad.

Durante la administración

1. Verificación de la configuración de la bomba de infusión.
2. Observación de la integridad de la formulación durante la infusión.
3. Cumplimiento de la tasa de infusión ordenada, con el fin de evitar interrupciones durante la atención.
4. Cumplimiento de las directrices para la administración de medicamentos para los pacientes que reciben nutrición parenteral.
5. Implementación de las medidas de control de la infección por contaminación del catéter.
6. Verificación del tiempo de colgado.
7. Reducción al mínimo de manipulaciones.
8. Seguimiento a la efectividad del protocolo de apoyo nutricional que incorpore evaluaciones periódicas de la función gastrointestinal y la tolerancia de alimentación parenteral y enteral³.

Monitoreo y Seguimiento

Los autores, Ayers, Adams³³ definen los siguientes cuatro puntos a tener en cuenta durante el monitoreo del soporte nutricional parenteral:

1. Realizar un adecuado seguimiento de la glucosa en sangre en función del estado clínico y el horario de infusión de la nutrición parenteral (administración ciclada Vs infusión continua).
2. Monitoreo de los exámenes de laboratorios solicitados.
3. Evaluación de la respuesta a la terapia nutricional parenteral.
4. Evaluación y tratamiento de las complicaciones, y resolución de problemas

Después de la administración

1. Realizar la terminación de la terapia y registro en la historia clínica.
2. Realizar la educación del paciente, referente al plan nutricional a seguir.
3. Verificación de la documentación relacionada con la administración de la nutrición parenteral de acuerdo con los requisitos legales y reglamentarios, del sistema de salud.

Conclusión

La Nutrición Parenteral Periférica Lista Para Usar, es una terapia nutricional que facilita el poder cubrir las necesidades nutricionales de los pacientes hospitalizados, jugando un papel fundamental para mejorar la calidad

de la atención, la prevención y el tratamiento de la malnutrición hospitalaria, en un periodo inferior a 10 días.

De manera complementaria, sirve como forma parte integral del tratamiento médico, en los pacientes con indicaciones de uso, al ser una terapia compleja que tiene como objetivo maximizar el beneficio clínico y reducir al mínimo los riesgos potenciales para los eventos adversos debe ser manejado como una terapia de máxima alerta, la cual requiere que las organizaciones de salud desarrollen protocolos de uso, en pro de la seguridad del paciente. Al ser administrado por un acceso venoso periférico la osmolaridad de la solución a administrar debe ser menor a 900 mOsm/L.

En el paciente quirúrgico la NPP – LPU se constituye en una alternativa para alcanzar los requerimientos nutricionales de los pacientes, una vez se ha realizado la valoración nutricional. Los requerimientos de energía establecidos por ESPEN corresponden a 25 a 30 Kcal/kg/ día, y los requerimientos de proteína pueden variar de 1,3 a >1,5 gr/Kg/día.

La NPP-LPU es una alternativa de soporte nutricional por vía parenteral, para mejorar el aporte Proteico-Energético, está indicado en las siguientes situaciones: nutrición enteral precoz inviable, repleción nutricional menor a 7 días, progresión de la nutrición enteral, nutrición enteral insuficiente (< 60% de los requerimientos nutricionales y deterioro del estado nutricional versus la necesidad de cubrir requerimientos nutricionales, cuando la vía enteral es limitada.

La NPP_LPU permite a los profesionales de la salud dedicados al cuidado nutricional demostrar mejoras de la seguridad del paciente, disminución de los costos y aumentar la satisfacción del paciente.

Las limitaciones para el uso de NPP dependen en la frecuencia de tromboflebitis de las vías periféricas que impide que pueda administrarse durante periodos prolongados y de la situación clínica del paciente, siendo relevante el uso de NPP-LPU Versus la NPP – preparada en central de mezclas, en la disminución en la incidencia de las infecciones del torrente sanguíneo. El impacto de la preparación de la nutrición parenteral lista para usar se evidencia en la disminución en el riesgo de infección del torrente sanguíneo y los costos asociados⁴⁹.

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Revisión

Mediterranean diet adherence and prostate cancer risk

Olga López-Guarnido¹, Maria Jesús Álvarez-Cubero^{1,2,5}, María Saiz^{1,2,5}, David Lozano¹, Lourdes Rodrigo¹, Manrique Pascual³, Jose Manuel Cozar³ and Ana Rivas⁴

¹Legal Medicine and Toxicology Department, University of Granada, Granada, Spain. ²Center GENYO (Pfizer-University of Granada-Andalusian Government Center for Genomics and Oncological Research), Granada, Spain. ³Service of Urology, University Hospital Virgen de las Nieves, Granada, Spain. ⁴Nutrition and Food Science Department, University of Granada, Granada, Spain.

Abstract

Background: Countries following the traditional Mediterranean Diet, particularly Southern European countries, have lower prostate cancer incidence and mortality compared to other European regions. The beneficial effect has been attributed to a specific eating pattern.

Objective: The purpose of this review is to examine the evidence to date on the effects of adherence to a Mediterranean Diet on prostate cancer risk; and to identify which elements of the Mediterranean diet are likely to protect against prostate cancer.

Methods: The search for articles came from extensive research in the following databases: PubMed, Scopus and Web of Science. We used the search terms “Mediterranean diet”, “adherence”, “fruit and vegetable”, “olive oil”, “fish”, “legume”, “cereal”, “alcohol”, “milk”, “dairy product”, “prostate cancer”, and combinations, such as “Mediterranean diet and prostate cancer” or “Olive oil and prostate cancer”.

Results: There is strong evidence supporting associations between foods that are typical of a Mediterranean eating pattern and reduced prostate cancer risk. However, there are few studies that have assessed the effect of the Mediterranean diet on cancer prostate incidence. Recent data do not support associations to adherence to a Mediterranean Diet and risk of prostate cancer or disease progression. However, Mediterranean eating pattern after diagnosis of nonmetastatic cancer was associated with lower overall mortality.

Conclusion: Further large-scale studies are required to clarify the effect of Mediterranean diet on prostate health, in order to establish the role of this diet in the prevention of prostate cancer.

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Key words: Mediterranean diet. Nutrition. Prostate cancer.

Correspondence: Ana Rivas Velasco.
Dpto. Nutrición y Bromatología.
Facultad de Farmacia, Campus de Cartuja.
Universidad de Granada, 18071 Granada.
E-mail: amrivas@ugr.es

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⁵These authors contributed equally to this work.

ADHERENCIA A LA DIETA MEDITERRÁNEA Y CÁNCER DE PRÓSTATA

Resumen

Introducción: Los países del sur de Europa, tienen una menor incidencia y mortalidad por cáncer de próstata en comparación con otras regiones europeas. Este efecto beneficioso se ha atribuido a un patrón de alimentación específica.

Objetivo: El objetivo de esta revisión es examinar la evidencia sobre los efectos de la adhesión a la dieta mediterránea en el riesgo de cáncer de próstata; e identificar que componentes de la dieta mediterránea protegen contra el cáncer de próstata.

Métodos: Se realizó una búsqueda en la literatura científica utilizando las siguientes base de datos: PubMed, Scopus and Web of Science. Utilizamos los términos de búsqueda “dieta mediterránea”, “adhesión”, “frutas y verduras”, “aceite de oliva”, “pescado” “legumbres”, “cereal” “alcohol” “leche”, “producto lácteo”, “cáncer de próstata”, y combinaciones, tales como “dieta mediterránea y cáncer de próstata” o “aceite de oliva y cáncer de próstata”.

Resultados: Existe una fuerte evidencia que soporta una asociación entre alimentos que son típicos de un patrón de alimentación mediterránea y un menor riesgo de cáncer de próstata. Sin embargo, son pocos los estudios que han evaluado el efecto de la dieta mediterránea sobre la incidencia del cáncer de próstata. Los datos recientes no apoyan una asociación entre el seguimiento de este tipo de dieta y el riesgo de cáncer de próstata o su progresión. Sin embargo, un patrón de alimentación mediterránea después del diagnóstico de cáncer no metastásico se ha asociado con una disminución de la mortalidad global.

Conclusión: Se requieren más estudios a gran escala para aclarar el efecto de la dieta mediterránea sobre la salud prostática, con el fin de establecer su papel en la prevención de cáncer de próstata.

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Palabras Clave: Dieta Mediterránea. Cáncer de Próstata. Nutrición.

Introduction

Prostate cancer (PCa) is the second most common cancer in men worldwide, after lung cancer, but still little is known about the etiology of this disease¹. Epidemiological studies have suggested that environmental exposure, including diet and nutrition, may play a role in its etiology because of the wide international variation in its incidence². The dramatic increase in its occurrence among migrants from low-risk to high-risk countries also points to this hypothesis³. The World Cancer Research Fund has identified selenium, lycopene, and calcium as probable modifiers of PCa risk^{4,5}. In addition, animal model studies implicate dietary carcinogens, such as the heterocyclic amines from over-cooked meats and sex steroid hormones, particularly estrogens, as candidate etiologies for PCa⁶. With dietary carcinogens and estrogens driving pro-carcinogenic inflammation in the developed world, it is tempting to speculate that dietary components associated with decreased PCa risk, such as intake of fruits and vegetables, especially tomatoes and crucifers, might act to attenuate the ravages of the chronic or recurrent inflammatory processes⁶.

To date, the most consistently followed approach to examine the potential relation between dietary factors and PCa was based on particular nutrients such as lycopene and selenium. However, results from studies on individual nutrients are largely inconsistent. This might be partly due to limitations in single nutrient investigations owing to that we do not eat isolated nutrients but meals consisting of a variety of foods with complex combinations of nutrients and bioactive components. The traditional analysis considering the effect of a few isolated nutrients on prostate health misses much key information regarding complex or cumulative correlations and interactions between these compounds contained in food. For this reason, there is an increasing interest in the study of dietary patterns that could answer some questions and promote the development of appropriate recommendations for overall dietary habits⁷.

Prostate cancer has emerged as the most frequent cancer amongst men in Europe, with incidence increasing rapidly over the past two decades. Countries following the traditional Mediterranean Diet (MeDi), particularly Southern European countries, have lower PCa incidence and mortality compared to other European regions⁸. The beneficial effect has been attributed to a specific eating pattern. The Mediterranean diet's key characteristics are high intake of vegetables, legumes, fruits and cereals; moderate to high intake of fish; low intake of saturated lipids and high intake of unsaturated lipids, particularly olive oil; low to moderate intake of dairy products, low intake of meat; and modest intake of ethanol, mostly in the form of wine.⁹ The MeDi was introduced to the scientific community by the classic Seven Countries study. Since then, data on the association between this diet and lower risk of can-

cer at various sites have been accumulating^{10,11}. However, a limited number of cross-sectional studies have examined the relationship between MeDi adherence and PCa, and they have reported conflicting results. Therefore, the purpose of this review is to examine the evidence to date on the effects of adherence to a Mediterranean diet on prostate cancer risk and to identify which elements of the Mediterranean diet are likely to protect against prostate cancer.

Methods

The search for articles came from extensive research in the following databases: PubMed, Scopus and Web of Science. We used the search terms "Mediterranean diet", "adherence", "fruit and vegetable", "olive oil", "fish", "legume", "cereal", "alcohol", "milk", "dairy product", "lycopene", "vitamin E", "vitamin C", "resveratrol", "prostate cancer", and combinations, such as "Mediterranean diet and prostate cancer" or "Olive oil and prostate cancer". The titles and abstracts of the located documents were initially reviewed and the reference lists of selected papers were searched to identify additional articles. We narrowed the search to studies published in English.

Results and discussion

Adherence to Mediterranean diet and prostate health

The MeDi is characterized by a high intake of olive oil, plant products, fish and seafood; a low intake of dairies, meat and meat products; and a moderate ethanol intake⁹. These food items contain a complex array of naturally occurring bioactive molecules with antioxidant, anti-inflammatory and alkalinising properties that may protect against PCa. In order to analyze the role of Mediterranean eating habits on PCa risk, dietary pattern analyses should be considered. These studies examine the association between overall diet and disease risk, taking into account the fact that foods are eaten in combination¹². The ability of a diet quality index score to predict PCa risk depends on how well the index measures dietary risk factors for PCa as these indices have been associated with other chronic disease outcomes¹³⁻¹⁴.

Previous studies on dietary patterns and risk of PCa have used different methodological approaches and reported inconsistent findings¹⁴. A small, clinic based case-control study conducted in Canada reported that men in the highest tertile for the processed pattern, which key characteristics are consumption of red meats, organ meats, processed meats, refined grains, vegetable oils, and soft drinks, had an adjusted odds ratio (OR) of 2.75 [95% confidence interval (CI): 1.40-5.39, $p=0.0035$]. On the other hand, the Western diet, characterized by high intake of energy, red

meats and fat, and low intake of fiber, has been associated with an increased risk for advanced PCa according to separate Australian¹⁵ and Uruguayan studies¹⁶; however, in 3 prospective studies in US men, investigators found no significant association between any identified dietary patterns and the risk of PCa. incidence¹⁷⁻¹⁹. Recently, Bosire et al. incidence¹⁴ investigated the relationship between index-based dietary patterns and the risk of PCa in a cohort of 293,464 US men. Among men who reported a history of prostate-specific antigen testing, high Healthy Eating Index-2005 (HEI-2005), and Alternate Healthy Eating Index-2010 (AHEI-2010) scores were associated with lower risk of total PCa (for the highest quintile compared with the lowest), [hazard ratio (HR) = 0.92, 95% CI: 0.86-0.98, $p = 0.01$; and HR = 0.93, 95% CI: 0.88, 0.99, $p = 0.05$, respectively]. No significant association was observed between any of the indices and advanced or fatal PCa. Eating habits based on cornbread, grits, sweet potatoes, okra, beans, and rice—that is, similar to those of the MeDi—were proven by the National Health and Nutrition Examination Survey Epidemiological Follow-up study to be significantly associated with PCa risk¹⁹. Both black and nonblack men in the highest tertile for this dietary pattern had a reduced risk of PCa (OR= 0.6, 95% CI: 0.4-1.10, $p = 0.008$).

There are a few studies that have assessed the effect of the MeDi on cancer prostate incidence. Besides these, the impact of MeDi adherence on prostate health remains unclear. Table I summarizes the characteristics of these studies: where the work was conducted, the number of participants in each study, the methods used to evaluate MeDi adherence, and the main results. A comprehensive review of studies on cancer and the Mediterranean dietary pattern in the Mediterranean region incidence²⁰ concluded that adherence to principles of the MeDi may significantly reduce PCa incidence. Trichopoulou and coworkers used effect estimates from studies of dietary intake and cancer in the Mediterranean region, incidence rates of PCa, and food consumption patterns to calculate the fraction of PCa incidence that could be avoided by adherence to the principles of the MeDi. They estimated that approximately 10% of PCa cases in the United States could be prevented by adherence to the traditional healthy MeDi. Kenfield et al.²¹ described that adherence to a MeDi evaluated through a Mediterranean Diet Score (MDS) was not associated with risk of advanced PCa or disease progression in a prospective study following 47,867 US men in the Health Professionals Follow-up Study. However, greater adherence to the MeDi after diagnosis of non-metastatic cancer was associated with lower overall mortality. Bosire et al.¹⁴ examined the relationship between diet quality and the risk of PCa in the National Institutes of Health (NIH)-AARP Diet and Health Study cohort (293,464 US men) using the alternate Mediterranean diet score (aMED). There was no association between total PCa and the aMED score

(HR=0.97, 95% CI: 0.91, 1.03, $p = 0.09$). In addition, it was found little support for an association between the MeDi and PCa in a Northern European case-control study²². The authors defined five MDS variants with different components using either study-specific intakes or intakes in a Greek reference population as cut-off values between low and high intake of each component. No statistically significant association was found between adherence to the MeDi based on any of the MDS variants and PCa risk (OR range: 0.96–1.19 for total PCa, comparing high with low adherence). Recently, Ax et al.⁴ studied the relationship between adherence to a modified Mediterranean Diet Score (mMDS) and PCa risk in the Uppsala Longitudinal Cohort Study of Adult Men. No associations were found between Mediterranean dietary patterns and PCa in the whole study population (HR = 1.0, 95% CI: 0.75-1.34; $p = 0.91$).

Components of the Mediterranean diet and prostate cancer

There is evidence that specific components of MeDi are involved in prostate carcinogenesis prevention. In this context, the principal studies that demonstrate this association are described below.

Olive oil as the principal source of fat

Olive oil is the major common characteristic of diet in Mediterranean populations, where it accounts for one to two-thirds of total vegetable fat intake, and is therefore a relevant source not only of unsaturated fats, but of several other dietary components and micronutrients, as well.²³ Various studies have consistently revealed that total fat intake and particularly saturated fat intake were significantly associated with an increased risk for advanced PCa.^{16, 24} However, dietary intake of monounsaturated and polyunsaturated fat was generally not associated with advanced PCa risk^{16, 25, 26}.

A Greek study provided limited data on added lipids -including olive oil- and PCa risk. The authors concluded that among added lipids, seed oils were significantly associated, and butter and margarine were non-significantly positively associated with PCa risk, whereas olive oil was unrelated to this risk²⁷. An Australian case-control study compared subjects consuming <0.25 and ≥ 0.25 l/month to non users of olive oil, and reported no significant association between olive oil consumption and PCa risk (both ORs=0.8)²⁸. A population-based case-control study was conducted in Auckland, New Zealand, involving 317 PCa cases and 480 controls²⁹. A food-frequency questionnaire was used to collect data concerning consumption of monounsaturated fatty acids (MUFA)-rich vegetable oils (including olive oil, canola or peanut

Table I
Description of the studies that have assessed the effect of the Mediterranean diet on prostate cancer

Reference	Country	Subjects	Type of study	Method used to evaluate MeDi adherence	Results	Conclusions
Kenfiel et al. ²¹	USA	N= 42867 Aged 40-75 yr	The Health Professionals Follow-up Study Prospective cohort	MeDi Score Alternative MeDi Score	The MeDi was not associated with risk of advanced (HR: 0.95; 95% CI: 0.81-1.11; p=0.56) or lethal PCa (HR: 0.95; 95% CI: 0.79-1.13; p=0.65). In the case-only analysis, there was no association between the MeDi after diagnosis and risk of lethal (HR: 0.98; 95% CI: 0.75-1.29; p=0.76) or fatal PCa (HR: 1.01; 95% CI: 0.75-1.38; p=0.95). There was a 22% lower risk of overall mortality (HR: 0.78; 95% CI: 0.67-0.90; p=0.0007) among men with greater adherence to the MeDi after PCa diagnosis.	A higher MeDi score was not associated with risk of advanced PCa or disease progression. Greater adherence to the MeDi after diagnosis of nonmetastatic PCa was associated with lower overall mortality.
Bosire et al. ¹⁴	USA	N= 293464 Aged 50-71 yr	the National Institutes of Health (NIH)-AARP Diet and Health Study Prospective cohort	Alternative MeDi Score	There was no association between total PCa. and the alternative MeDi score (HR = 0.97, 95% CI: 0.91-1.03; p = 0.09).	No significant association was observed between alternative MeDi score and total PCa or advanced or fatal PCa, regardless of prostate-specific antigen testing status.
Möller et al. ²²	Sweden	N=1482 cases, 1108 controls	Aged 35–79 yr	Cancer of the Prostate in Sweden (CAPS) study.	Case-control MeDi Score	Five MeDi Score variants. No statistically significant association was found between adherence to the MeDi based on any of the MDS variants and PCa risk (OR range: 0.96–1.19 for total PCa, comparing high with low adherence).
Ax et al. ⁴	Sweden	N=1044 Mean age 71±1 yr	Uppsala Longitudinal Study of Adult Men Prospective cohort	A Modified MeDi Score	There were no associations between modified MeDi score and PCa in the whole study population (HR = 1.0, 95% CI: 0.75-1.34; p = 0.91).	No association was found between a Mediterranean-like diet and PCa risk.

MeDi: Mediterranean diet; PCa: Prostate cancer; HR: Hazard ratio; OR: Odds ratio; CI: Confidence interval.

oil) and other dietary variables. Increasing levels of MUFA-rich vegetable oil intake were associated with a progressive reduction in PCa risk [Relative risk (RR)= 0.5; 95% CI: 0.3-0.9; > 5.5 ml per day vs. nonconsumption, $p= 0.005$]. However, PCa risk was not associated with intake of total MUFA or its major

animal food sources. The authors conclude that their finding may be attributable to a protective dietary pattern associated with their consumption involving a high intake of plant-derived foods and fish oils, to a specific protective effect of these oils or to a combination of these factors²⁹.

Regular consumption of fish

Fish consumption is a characteristic component of the traditional MeDi. Cross-national studies showed inverse associations between per capita consumption of fish and the incidence of and mortality rates from PCa^{30,31}. Pre-clinical studies utilizing xenografts and genetically engineered mouse models demonstrated that reducing dietary fat from corn oil and increasing fish oil intake delays the development and progression of PCa^{32,33}. Moreover, intake of fish and marine-derived ω -3 fatty acids has been shown to be associated with decreased PCa mortality³⁴. It should be noted that ω -3 fatty acids have been shown consistently to inhibit the proliferation of PCa cell lines in vitro and to reduce the risk and progression of these tumors in animal experiments³⁵. Various biological mechanisms have been proposed to explain these findings, e.g., a reduction in circulating testosterone concentrations³⁶.

A meta-analysis of fish intake and PCa concluded that there was an association between fish consumption and a significant 63% reduction in PCa-specific mortality [4 cohort studies ($n = 49,661$), RR: 0.37; 95% CI: 0.18-0.74]³⁷. Recently, Bosire and coworkers¹⁴ showed that in individual component analyses, the fish component of Alternate Mediterranean Diet Score and ω -3 fatty acids component of Alternate Healthy Eating Index were inversely associated with fatal PCa (HR = 0.79, 95% CI: 0.65-0.96, and HR = 0.94, 95% CI: 0.90-0.98, respectively).

High consumption of fruit and vegetables

Fruits and vegetables are an important element of the MeDi and are rich in fiber, micronutrients, and phytochemicals which may have anti-carcinogenic actions². A few case-control studies have reported an overall inverse association between intake of fruits and vegetables and the risk for advanced PCa. Kolonel et al.³⁸ reported that yellow-green vegetables, cruciferous vegetables and carrots were associated with a 33% reduced risk for advanced PCa. Hardin et al.³⁹ investigated the associations between vegetable, fruit, and grains and more aggressive PCa in a case-control study of 982 men. Comparing the highest to lowest quartiles of intake, the authors found that increasing intakes of leafy vegetables were inversely associated with risk of aggressive PCa (OR = 0.66, 95% CI: 0.46-0.96, $p = 0.02$). The results from cohort studies examining the association between intake of fruits and vegetables and the risk of advanced PCa were largely inconsistent²⁴. Takachi et al.⁴⁰ did not find any association between fruit intake and the risk for advanced PCa. A recent metaanalysis that included 16 cohort studies² showed that the combined adjusted relative risk comparing highest with lowest categories showed that there was no association between vegetable and

fruit consumption and PCa incidence. The pooled RR was 0.97 (95% CI: 0.93-1.01) for vegetables and 1.02 (95% CI: 0.98-1.07) for fruit. The authors concluded that the intakes of certain types of fruit and vegetables may be more important than others in reducing the risk of PCa, owing to the different compounds found in each.

High consumption of legumes and cereals

Cereals and legumes are the main energy sources in the MeDi. It should be noted that high consumption of these foods, increases the intake of vegetable fiber, which is involved in the neoplastic risk by reducing the glycemic load, improving insulin sensitivity and decreasing the concentration of IGF-1⁴¹. Higher intake of legumes and cereals has been associated with a decreased risk of several cancers⁴². In addition, Deschaux et al.⁴³ showed that PCa risk was inversely associated with legume fiber intakes (HR = 0.55, 95% CI: 0.32-0.95; $p = 0.04$). In contrast, there was not significant association between PCa risk and cereal fiber ($p = 0.7$). Surprisingly, in the study of Bosire et al.¹⁴, the legume construct of the alternate MeDi score was positively associated with increased risk of fatal PCa. The authors explained that it was possible that consumption of legumes in their population was associated with higher intake of other foods, for example, red and processed meat. No other studies have reported similar findings, and there is no plausible explanation for this association.

Moderate to low intake of dairy products

Mediterranean eating also typically includes low to moderate consumption of dairy products. The positive association between dairy product intake and PCa has been reported in several studies, including the European Prospective Investigation into Cancer and Nutrition⁴⁴ and studies in Canada⁴⁵ and Japan⁴⁶. However, the results of 2 meta-analyses of the relation between dairy product intake and PCa provided conflicting conclusions: one showed a significantly positive association⁴⁷ and the other (supported by the National Dairy Council) showed an overall null association⁴⁸.

In a recent study, Song et al.⁴⁹ investigated the association between intake of dairy products and the incidence and survival of PCa during a 28-years follow-up. They conducted a cohort study in the Physicians Health Study ($n = 21,660$) and a survival analysis among the incident PCa cases ($n = 2806$). The intake of total dairy products was associated with increased PCa incidence (HR = 1.12, 95% CI: 0.93-1.35; >2.5 servings/d vs. 0.5 servings/d). In addition, in the survival analysis, whole milk intake remained associated with risk of progression to fatal disease after diagnosis [(HR = 2.17, 95% CI: 1.34-3.51)].

MeDi is associated with moderate alcohol consumption, especially of red wine, usually at meals. Furthermore, alcohol intake is a modifiable lifestyle factor on the risk of prostate carcinogenesis, so the finding of a tiny association with this kind of cancer incidence could have a significant impact on public health. Red wine contains high concentrations of polyphenols, a potent antioxidant that is particularly prevalent in the skin and seed of grapes and may alter cell growth.

A 2010 review about alcohol consumption and PCa⁵⁰ concluded that moderate alcohol consumption, up to about three drinks per day, does not appear to influence PCa risk. However, heavy consumption may be associated with an excess risk for this disease. The level of risk at this level of exposure is modest and could be due to confounding of other causal factors or due to biases inherent in observational studies. These conclusions are in concordance with one previous epidemiologic review⁵¹. Related to these, we can also find different meta-analyses. Most of them did not see any evidence of a significant relationship between moderate alcohol consumption and PCa⁵²⁻⁵⁴. Nevertheless, a Fillmore et al.⁵⁴ meta-analysis suggests a statistically significant positive association between number of drinks per day and PCa (OR = 1.158, 95% CI: 1.051 - 1.263).

While many epidemiologic studies have investigated associations between alcohol consumption and PCa with largely null results, fewer have investigated associations between specific alcoholic beverages, such as red wine, and PCa⁵⁵. Some of these cohort and case-control studies did not find any appreciable role for moderate red wine drinking on the risk of PCa⁵⁵⁻⁶⁰. A 2005 case-control study involving 753 cases and 703 controls found an inverse association with risk of PCa for level of wine consumption, particularly for red wine (OR = 0.94, 95% CI: 0.90-0.98), especially in more aggressive forms of the disease⁶¹. It accords with a previous study which had a slight but not significantly divergence between abstainers from wine⁶² and subjects who drank 1–13 glasses of wine/week (RR = 1.13, 95% CI: 0.84-1.53) or more than 13 glasses of wine/week (RR = 0.92, 95% CI: 0.42-1.99) respectively. In contrast, few other studies were found concluding that consumption of total alcohol is associated with an increase in the risk of PCa, but did not find any association with red wine⁶³⁻⁶⁵.

Finally, we can also find one study carried out in three human PCa cell lines⁶⁶: the hormone-sensitive LNCaP cell line, possessing a high number of functional androgen receptors; PC3 cells, possessing non-functional androgen receptors; and DU145 cells, containing no androgen receptors. The effect of red wine on the proliferation of these cell lines after five days of incubation was a dose-dependent inhibitory effect on cell proliferation for all cell lines tested (LNCaP and PC3 cells were more sensitive than DU145 cell to the

effect of wine). At wine dilutions of 1:50 (comparable to the ingestion of 1 liter), the maximum effect of wine was found (inhibition >80%). However at higher concentrations, a reverse effect was observed, indicating that other substances, different from the examined polyphenols, might interfere with this growth effect or that high concentrations of specific polyphenols could act as growth stimulants, rather than inhibitors.

Conclusion

Epidemiological studies have suggested that MeDi may play a role in PCa etiology because of the wide variation in its incidence across the European Union. There is strong evidence supporting associations between foods and bioactive components that are typical of a Mediterranean eating pattern and reduced PCa risk; therefore it could be argued that a combination of these foods, as would be achieved in a Mediterranean eating pattern, would have synergistic effect providing greater protection against PCa. However, there are few studies that have assessed the effect of the MeDi on cancer prostate incidence. Recent data do not support associations to adherence to a MeDi and risk of PCa or disease progression. However, Mediterranean eating pattern after diagnosis of nonmetastatic cancer was associated with lower overall mortality. Hence, relations between Mediterranean dietary patterns and PCa are still inconclusive and merit further investigations. Further large-scale studies are required to clarify the effect of MeDi on prostate health, in order to establish the role of this diet in the prevention of PCa.

Declaration of interest

The authors have no relevant interests to declare.

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Revisión

Propuesta de una nueva clasificación de los oligoelementos para su aplicación en nutrición, oligoterapia, y otras estrategias terapéuticas

Javier Ramírez Hernández, María José Bonete y Rosa María Martínez-Espinosa

División de Bioquímica y Biología Molecular, Facultad de Ciencias, Universidad de Alicante. Spain.

Resumen

Objetivos: 1) Proponer una nueva clasificación de los oligoelementos fundamentada en el estudio detallado de las investigaciones más recientes sobre los mismos; 2) ofrecer información detallada y actualizada sobre todos los oligoelementos.

Resultados: el análisis de todos los resultados de investigación consultados pone de manifiesto que los avances en las técnicas de análisis molecular permiten dilucidar la importancia que presentan ciertos oligoelementos para la salud humana. Se ofrece un análisis detallado de la función catalítica que podrían tener determinados elementos no considerados hasta ahora como esenciales o posiblemente esenciales, gracias al uso de plataformas informáticas que permiten el análisis integrado de datos sobre enzimas. Asimismo se presenta información integrada y actualizada del papel fisiológico, cinéticas y metabolismo, fuentes dietéticas y factores que propician la carencia o la toxicidad de cada uno de los oligoelementos.

Conclusiones: La Oligoterapia plantea el uso de oligoelementos catalíticamente activos con fines terapéuticos. La nueva clasificación de oligoelementos planteada en este trabajo será de interés para diversos sectores profesionales: médicos y demás personal sanitario, nutricionistas, farmacéuticos, etc. Así podrán diseñarse nuevas estrategias terapéuticas que permitan paliar la sintomatología de diversas patologías, en particular las enfermedades carenciales y metabólicas.

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Palabras clave: *Oligoelementos. Oligoterapia. Enfermedades Carenciales. Enfermedades Metabólicas.*

PROPOSAL OF NEW TRACE ELEMENTS CLASSIFICATION TO BE USED IN NUTRITION, OLIGOTHERAPY AND OTHER THERAPEUTICS STRATEGIES

Abstract

Objectives: 1) to propose a new classification of the trace elements based on a study of the recently reported research; 2) to offer detailed and actualized information about trace elements.

Results: the analysis of the research results recently reported reveals that the advances of the molecular analysis techniques point out the importance of certain trace elements in human health. A detailed analysis of the catalytic function related to several elements not considered essential or probably essentials up to now is also offered. To perform the integral analysis of the enzymes containing trace elements informatics tools have been used. Actualized information about physiological role, kinetics, metabolism, dietetic sources and factors promoting trace elements scarcity or toxicity is also presented.

Results: Oligotherapy uses catalytic active trace elements with therapeutic proposals. The new trace element classification here presented will be of high interest for different professional sectors: doctors and other professions related to medicine; nutritionist, pharmacists, etc. Using this new classification and approaches, new therapeutic strategies could be designed to mitigate symptomatology related to several pathologies, particularly carential and metabolic diseases.

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Key words: *Trace Elements. Oligotherapy. Carential Diseases. Metabolic Diseases.*

Correspondencia: Rosa María Martínez Espinosa.
Facultad de Ciencias.
Universidad de Alicante.
Carretera San Vicente del Raspeig s/n.
03690 San Vicente del Raspeig, Alicante, España.
E-mail: rosa.martinez@ua.es

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Introducción

Los elementos minerales son elementos químicos inorgánicos sólidos que realizan dos de las tres funciones básicas de los nutrientes de los alimentos: participan en la construcción de los tejidos corporales (biomoléculas), y algunos forman parte de metaloenzimas y metaloproteínas implicadas en el desarrollo y la regulación del metabolismo. Los elementos minerales se clasifican en los siguientes grupos dependiendo de su concentración en el cuerpo humano:

- Elementos mayoritarios (Macrominerales): presentes en cantidades superiores al 0,1% del peso del cuerpo. Se dividen en: elementos primarios: (98% del peso del organismo) son indispensables para la formación de las biomoléculas (oxígeno (O), carbono (C), hidrógeno (H), nitrógeno (N), fósforo (P) y azufre (S)); y elementos secundarios: forman parte de sales minerales o iones (calcio (Ca), sodio (Na), potasio (K) y cloro (Cl)).

- Elementos minoritarios, microminerales o elementos traza (Oligoelementos): en cantidades inferiores al 0,01% del peso del organismo.

El concepto “elemento traza (oligoelemento)” fue utilizado por primera vez en 1885 por Gabriel Bertrand, quien afirmó más tarde que los oligoelementos son vitales para todas las células vivas aun cuando se requieren en pequeñas cantidades.

Determinar qué elementos minerales son oligoelementos en humanos requiere técnicas analíticas precisas para la identificación y cuantificación de los mismos, así como estudios minuciosos que prueben su papel fisiológico. Según el conocimiento actual sobre los oligoelementos, algunos se consideran esenciales en tanto que su carencia o ausencia en humanos provoca alteraciones metabólicas y fisiológicas denominadas enfermedades carenciales^{1,2}. También se les vincula en general con las enfermedades metabólicas.

Los oligoelementos son multifuncionales y actúan en: actividad catalítica de las enzimas (forman parte sus centros activos) y configuración estructural y reguladora de múltiples estructuras (hormonas, enzimas, membranas biológicas).

Por ello, alteraciones en la homeostasis de los oligoelementos dan lugar a anomalías tanto específicas como inespecíficas a nivel sistémico por déficit de los mismos, llegando incluso a cuadros de toxicidad cuando se acumulan en los tejidos.

La principal fuente de exposición a los elementos traza es el medio ambiente y los alimentos ingeridos, aunque la presencia y acumulación de los mismos en el organismo depende en definitiva de las características físico-químicas de los oligoelementos.

Clasificación de los oligoelementos

La primera clasificación separaba los oligoelementos en dos grupos³: los que participan en reacciones bioquímicas y los que no lo hacen. Poco después, los oligoelementos se dividen en esenciales, posiblemente esenciales y no esenciales según los requerimientos dietéticos de los animales superiores⁴.

- Esenciales: pertenecen a la primera serie de transición y presentan propiedades físico-químicas similares: (V, Mo, Cr, Mn, Co, Ni, Cu, Fe, Zn, Si, I, Se y F). La carencia de estos oligoelementos es origen de enfermedades carenciales tal y como se ha mencionado, causantes de alteraciones en el crecimiento y en el estado de salud⁵. Los oligoelementos esenciales se pueden subdividir en 3 grupos según su naturaleza química⁶: elementos catiónicos, elementos aniónicos y elementos que forman parte de complejos orgánicos.

- Posiblemente esenciales: tienen esencialidad probada pero se desconoce su mecanismo de acción (As, B, Br, Li, Sn, V)⁴.

- No esenciales: clasificados como no tóxicos a las concentraciones en que se encuentran en el medio ambiente (As, B, Li, Sn, V, Bi, Cs, Pt, Rb, Ab y Sr; los 5 primeros son considerados como no esenciales o posiblemente esenciales según autores) y tóxicos: producen alteraciones indeseables reversibles o irreversibles en el organismo, pudiendo ser incluso letales (destacan el Pb y el Hg, tóxicos a cualquier concentración. Otros elementos también considerados tóxicos son el Be, Cd, Ta, Tl)⁴.

Teniendo en cuenta todos estos aspectos, la clasificación de oligoelementos empleada como punto de partida para este estudio es la basada en las fuentes de Escanero⁷ y Parson y Barbosa⁸ (tabla 1).

Los oligoelementos y la salud humana

Los oligoelementos son vitales para todas las células y alteraciones en la homeostasis de los mismos da

Tabla I
Clasificación actual de los oligoelementos según y Parson y Barbosa⁸ y Escanero⁹.

	<i>Elementos traza u oligoelementos</i>
Con funciones probadas de esencialidad	Co, Cr, Cu, Mn, Mo, F, Ni, Se, I, Zn
Con función esencial sospechada, pero con mecanismos de acción desconocidos	As, B, Br, Li, Sn, V
Elementos traza tóxicos	Al, Be, Cd, Hg, Nb, Pb, Re, Te, Ti, Tl, U, W

lugar a cambios en el estado salud-enfermedad. Por ello, la ingesta oral de oligoelementos y su homeostasis se ha convertido en una de las mayores preocupaciones para la comunidad científica, médica y para organismos reguladores como la FAO o la OMS.

El uso de los oligoelementos con fines terapéuticos, Oligoterapia, comienza en Francia con las investigaciones de Gabriel Bertrand (finales del siglo XIX) y Jacques Menetrier (mediados del siglo XX). Desde entonces y hasta ahora, diversos estudios muestran que alteraciones en el equilibrio homeostático de los oligoelementos pueden provocar efectos negativos sobre la salud⁹. La Oligoterapia intenta aportar al organismo aquellos oligoelementos necesarios para un óptimo funcionamiento celular y vigilar que todos ellos estén en perfecto equilibrio.

Según la naturaleza del tratamiento oligoterápico se distingue entre¹⁰:

- Oligoterapia catalítica (o Menetrier): activa un oligoelemento presente en el organismo para así regular una determinada ruta metabólica.

- Oligoterapia nutricional: administración de oligoelementos en dosis nutricionales para la prevención y tratamiento de estados patológicos.

- Oligoterapia farmacológica: administración de dosis elevadas de oligoelementos para obtener efectos terapéuticos preventivos o curativos.

Antes de aplicar cualquiera de estos tratamientos es conveniente realizar un análisis de oligoelementos en muestras tomadas al paciente. Hasta hace poco las análisis de minerales en muestras humanas no despertaba ningún interés en la comunidad científico-médica. Sin embargo, estudios recientes han relacionado de forma directa concentraciones anómalas de oligoelementos y determinadas patologías^{4,10-14}.

El objetivo de esta revisión es analizar los trabajos de investigación más recientes sobre los oligoelementos y su función en humanos. Las preguntas que se pretenden responder son:

¿Ha cambiado sustancialmente el conocimiento que se tiene sobre los oligoelementos?

¿Es posible proponer una nueva clasificación actualizada de los oligoelementos?

Objetivos

Los objetivos del presente estudio son dos:

- i) Realizar una revisión exhaustiva del conocimiento que se tiene sobre el papel de los oligoelementos en salud humana aportando datos sobre funciones biológicas, efectos de la ingesta deficiente o masiva de oligoelementos, fuentes de alimentos ricos en ellos, etc.

- ii) Partiendo de la revisión anterior, se plantea una nueva clasificación de oligoelementos basada en criterios de esencialidad que puede ser de utilidad en el diseño de dietas, nutrición hospitalaria, oligoterapia y otras estrategias terapéuticas.

Métodos

Consulta de fuentes bibliográficas/bibliométricas.

Como etapa inicial del trabajo se ha realizado una revisión bibliográfica/bibliométrica exhaustiva para conocer los orígenes y fundamentos que sustentan la clasificación vigente de los oligoelementos. Para optimizar la búsqueda de información en Internet se han utilizado buscadores incluyendo portales o bases de datos tanto genéricos (Google Scholar) como específicos (PubMed, Scopus, EMBASE, MEDLINE, Web of Knowledge). Asimismo, se han consultado manuales de referencia en bioquímica clínica y nutrición. Las fuentes de información bibliográfica usadas son tanto primarias como secundarias.

Para la realización de la búsqueda se han utilizado los términos: trace elements, oligotherapy, minerals, trace elements & human health y trace elements & metabolic diseases. Para la revisión y evaluación de los criterios de calidad de la información obtenida se ha seguido el esquema clásico propuesto por Vilanova¹⁵.

Análisis del papel de los oligoelementos en relación al metabolismo en humanos.

Tras la revisión de la información obtenida y con el objetivo de proponer una nueva clasificación de los oligoelementos en relación al metabolismo en humanos, se ha utilizado la plataforma BRENDA. Dicha plataforma integra información de bioquímica y biología molecular de enzimas que ya han sido clasificadas por la IUBMB (Internacional Union of Biochemistry and Molecular Biology). BRENDA contiene información sobre nomenclatura de enzimas, reacción que catalizan y especificidad, datos estructurales, parámetros farmacocinéticos, mutantes, etc. Con esta plataforma se pretende conocer qué metal traza forma parte de una enzima o complejo enzimático, para así relacionarlo con rutas metabólicas implicadas en el origen/desarrollo de enfermedades.

Resultados

Conocimiento actual que se tiene de los oligoelementos y sus implicaciones en salud humana.

La búsqueda bibliográfica realizada puso de manifiesto el incremento de publicaciones centradas en este tema tal y como se recoge en la Figura 1, lo que denota el interés de la comunidad médico-científica en este campo. Los nuevos datos encontrados sugieren la necesidad de actualizar e integrar todos los conocimientos actuales sobre los oligoelementos, y por ello, se ha elaborado una nueva tabla resumen completa y actualizada (tabla 2), recogiendo aspectos importantes relativos al: papel fisiológico, fuentes dietéticas, metabolismo, etc.

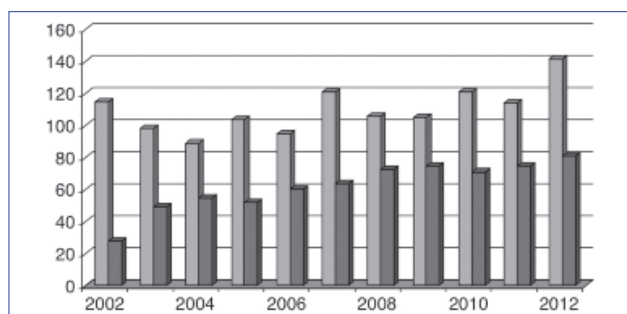


Fig. 1.—Evolución del número de publicaciones durante un periodo de 10 años. (Las barras azules indican la búsqueda en PubMed y las barras granate la búsqueda en Scopus).

Tabla II

Tabla general de los oligoelementos con información adicional actualizada. Los oligoelementos aparecen clasificados según el criterio de esencialidad según la nueva propuesta de clasificación que se resumen en la tabla 3.

a) Oligoelementos con funciones probadas de esencialidad, b) oligoelementos con función esencial sospechada y c) elementos traza tóxicos.

	Cobre ^{a)}	Molibdeno ^{a)}	Cromo ^{a)}	Manganeso ^{a)}
Papel fisiológico	-Forma parte de diversas proteínas (citocromo oxidasa, SOD y ceruloplasmina). -Síntesis de Hb. -Procesos fisiológicos generales, procesos del SNC, funciones del tejido conectivo y desarrollo de vasos sanguíneos.	-Cofactor de enzimas (aldehído oxidasa, sulfito oxidasa, xantina oxidasa,...) del metabolismo de pirimidinas, purinas, pteridinas y aminoácidos azufrados.	-Constituyente del GTF, (metabolismo de la glucosa). -Beneficioso en el metabolismo lipídico (disminución del colesterol total y triglicéridos).	-Antioxidante por SOD. -Regulador del metabolismo de macronutrientes (cofactor de la piruvato carboxilasa, arginasa, fosfoenolpiruvato, carboxiquinasa, acetil-CoA carboxilasa y tirosina sulfotransferasa). -Formación de hueso.
Fuentes dietéticas	Marisco, carnes, nueces, judías, productos de grano entero.	Leche y productos lácteos, legumbres, hígado y riñón, cereales y derivados y nueces.	Pimienta negra, levadura de cerveza, ostiones, carne e hígado, setas, uvas, patatas y cerveza.	Alimentos de origen vegetal: frutos secos, cereales, legumbres y granos enteros. Té y café.
Cinética y Metabolismo	Cu isotópico administrado por vía oral (absorción intestinal rápida). El hígado recibe el Cu absorbido y es el principal lugar de excreción.	Absorción (25 – 80%). Absorción disminuida por interacción con Cu. Transporte por α_2 -microglobulina. Excreción urinaria y menor proporción por bilis.	Absorción intestinal <5% (0,5 – 2%). Cr^{3+} se transporta por transferrina y albúmina. Biodisponibilidad aumenta con oxalato y ascorbato. Excreción urinaria.	Baja absorción $\approx$ 6%. Absorción y biodisponibilidad inhibidas por Fe no hemo, fibra y ácido fítico. Transporte unido a α_2 -microglobulina, albumina; transferrina y transmanganina. Excreción en heces (99%)
Ingestas	2 mg/día.	50 – 350 μg /día.	< 50 – 200 μg /día.	0,52 – 10,8 mg /día.
Deficiencias	Modifica la eficacia de liberación del Fe en la mucosa duodenal produciendo pérdidas de peso y anemia hipocrómica macrocítica.	Xanturinuria. Alteraciones neurológicas y del metabolismo. La deficiencia de Mo coexiste con la de Se en la enfermedad de Keshan.	Intolerancia a glucosa Alteración del metabolismo lipídico.	Alteración del crecimiento y la reproducción. Anormalidades en esqueleto. Mayor frecuencia en infantes por baja [Mn] en leche humana.
Toxicidad	Por causas genéticas: enfermedad de Wilson.	Poco tóxico. Dosis orales 10 – 15 mg/día provoca sintomatología similar a la enfermedad de la gota.	Poco tóxico por vía oral debido a bajas concentraciones de Cr^{3+} . Fallo renal crónico.	No tóxico por vía oral. Alteraciones neurológicas en trabajadores con mayor exposición.

Tabla II (cont.)

Tabla general de los oligoelementos con información adicional actualizada. Los oligoelementos aparecen clasificados según el criterio de esencialidad según la nueva propuesta de clasificación que se resumen en la tabla 3.

a) Oligoelementos con funciones probadas de esencialidad, b) oligoelementos con función esencial sospechada y c) elementos traza tóxicos.

	<i>Cobalto^{a)}</i>	<i>Níquel^{a)}</i>	<i>Zinc^{a)}</i>	<i>Yodo^{a)}</i>
Papel fisiológico	-Componente de la vitamina B12 (cobalamina). -Compuestos orgánicos de Co involucrados en procesos de estabilización de la estructura del DNA.	-Componente de metaloenzimas (deshidrogenasas de varios tipos, hidrogenasas, reductasas y aminotransferasas) -Importante en metabolismo intermediario. -Aumenta absorción de Fe ³⁺ .	-Tetrámeros que se complejan con O ₂ , N _x y sulfuro de moléculas hidrofílicas (oxidoreductasas, transferasas, liasas, isomerasas y ligasas) -En enzimas que intervienen en el metabolismo del DNA, y en proteínas de la traducción.	-Síntesis de hormonas tiroideas. -Regulación del metabolismo energético y producción de calor. -Control del crecimiento y desarrollo.
Fuentes dietéticas	Hígado, carne (riqueza de vitamina B12), verdura, moluscos, col, levadura de cerveza.	Abunda en vegetales, chocolate, especias, frutos secos, legumbres, edulcorantes, golosinas.	Champiñones, levadura de cerveza, germen de trigo, leche, judías, nueces, hígado, espinacas, manzanas, yema de huevo, pescado.	Alimentos marinos (pescados, mariscos y algas), alimentos procesados con yodóforos y sal yodada.
Cinética y Metabolismo	Absorción en mayor cantidad por el intestino (albúmina y lactosa favorecen la absorción). Excreción vía renal (60 – 65% cantidad ingerida) y a través de intestino.	Absorción (20-25%), se estimula por déficit de Fe. Biodisponibilidad entre 1 y 10%. Transporte por unión a albúmina y niquelplasma. Excreción fecal y urinaria.	20 – 30% de Zn ingerido se absorbe por intestino delgado y yeyuno. En plasma se encuentra unido a proteínas (albúmina y α_2 -microglobulina). Excreción estimulada por enfermedad, estrés y alcohol.	Absorción rápida y casi completa por intestino. Transporte sanguíneo en forma libre (I-) y unido a proteínas. Excreción urinaria.
Ingestas	5 – 40 μ g/día.	Muy variables dependiendo de la localización geográfica (87-600 μ g/día).	7,5 – 20 mg/día (15-50 mg/día).	100 – 150 μ g/día.
Deficiencias	Coincide con el déficit de vitamina B12 y a menudo se debe a problemas de déficit de absorción.	Retraso en crecimiento. Hematopoyesis deprimida.	Mal nutrición y mala absorción provoca déficit en embarazadas. Enfermedades y lesiones del DNA que derivan en cáncer.	Bocio endémico o simple. Deficiencia mental y cretinismo endémico. Aumento del número de abortos y malformaciones congénitas.
Toxicidad	Poco tóxico. Elevadas cantidades para provocar toxicidad (por sobre ingesta terapéutica o ingestión alimentaria).	Dietas $\geq 250\mu$ g de Ni. Alteraciones gastrointestinales, neurológicas, pulmonares y reproductivas. Aumento de riesgo de cáncer de pulmón y nariz. Dermatitis por contacto.	Ingestas agudas o crónicas. Ingestas de 150 – 450 mg de Zn asociadas con bajos niveles de Co.	Ingesta ≥ 2 mg/día (potencialmente peligrosa). Hipertiroidismo. Bocio por consumo excesivo. Gota nodular tóxica.

Tabla II (cont.)

Tabla general de los oligoelementos con información adicional actualizada. Los oligoelementos aparecen clasificados según el criterio de esencialidad según la nueva propuesta de clasificación que se resumen en la tabla 3.

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	<i>Selenio^{a)}</i>	<i>Vanadio^{a)}</i>	<i>Flúor^{a)}</i>	<i>Litio^{a)}</i>
Papel fisiológico	-Antioxidante por glutatión peroxidasa. -Regulación de la función tiroidea por tiroxina – 5'-deyodasas. Contrarresta metales pesados contaminantes. Cardioprotector.	-Controla bomba Na-K celular a nivel cardiaco, renal, etc. -Inhibe la síntesis de coleserina, colesterol bajando la tasa de fosfolípidos.	-Efecto directo en metabolismo de Ca y P. -En adultos participan en mantenimiento de la integridad estructural de los huesos. -Mejora la absorción de Ca.	-Inhibe la glucógeno sintasa 3 provocando una disminución de la proteína Tau. -Efecto termopoyético. -Acción metabolismo ácido fólico, vitamina B12 y DNA. -Bloquea liberación de tiroxina por la hormona de estimulación tiroidea.
Fuentes dietéticas	Alimentos proteicos: productos pesqueros, carnes y vísceras, legumbres, frutos secos y cereales. Contenido en planta depende del suelo.	Aceite de oliva virgen, aceitunas, magras, cereales.	Pescado de mar, crustáceos, aguas minerales, espinacas, té, algas, girasol germinado, cebolla, alfalfa, hortalizas.	Cereales, agua potable, huevos, leche, carne, queso, patatas.
Cinética y Metabolismo	Absorción (50-100%). La biodisponibilidad de las formas orgánicas es mayor (selenocisteína, selenometionina, etc.) Excreción en orina (vía principal), heces y aire expirado.	A nivel gastrointestinal en poca cantidad (1%). Transporte por Hb, transferrina y ferritina. Se elimina por heces, aunque también por vía urinaria y bilis.	90% flúor ingerido es absorbido por intestino, ½ fijada por dientes y huesos y ½ se elimina por la orina y sudor. Absorción favorecida por Fe, S y fosfatos.	Se absorbe fácilmente pero tiene problemas para atravesar la barrera hematoencefálica. Se elimina por el riñón y se reabsorbe por túbulo y se excreta por la orina.
Ingestas	< 10 – 220 µg/día (normalmente entre 50 – 200 µg/día).	1 – 2 mg/día.	Recién nacidos-6 meses (0,1-0-5 mg), 6-12 meses (0,2-1mg), 1-3 años (0,5 – 1,5 mg), 4 – 6 años (1-2,5 mg), 7-15 años (4,5-2,5mg), + 15 años (1 – 4 mg).	0,1 – 2,0 mg/día.
Deficiencias	Enfermedad de Keshan (cardiomiopatía endémica). Enfermedad de Kashin – Beck (osteoartropatía endémica) Pacientes con NPT. Alcohólicos.	Alta tasa abortos, aumento creatinina, disminución de glucosa, alteraciones orgánicas con deformidades en esqueleto.	Debido a inhibición de absorción por Al, Ca y Mg produciendo caries, retraso en el crecimiento, etc.	En humanos no se conocen signos de deficiencia.
Toxicidad	Ingestas > 700 ug/día (potencialmente peligroso). Pérdida de pelo y cambios en morfología de las vías de los dedos.	No es tóxico debido a una pobre absorción.	Acumulación en glándula pineal provocando una alteración en la síntesis de melatonina. Cáncer óseo. Interfiere en la función cerebral provocando una disminución del coeficiente de inteligencia.	Afectan a estructuras intracelulares relacionadas con mitocondrias y lisosomas.

Tabla II (cont.)

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	<i>Estaño^{a)}</i>	<i>Bromo^{b)}</i>	<i>Boro^{b)}</i>	<i>Arsénico^{b)}</i>
Papel fisiológico	-Catalizador de reacciones redox. -Interviene en mantenimiento de la estructura 3ª de las proteínas. -Interfiere con riboflavina.	-Sustituto del Cl. -Afecta a la calidad del sueño.	-Síntesis de glucógeno en hígado. -Regulación de la actividad de la paratohormona del metabolismo de Ca, F, Mg y colecálciferol disminuyendo el riesgo de cáncer de próstata.	-Inhibe el ciclo de la urea. -Antagonista de la hormona tiroidea. -Interfiere en el metabolismo de la porfirina.
Fuentes dietéticas	Cereales de grano entero (salvado), conservantes, colorantes alimentarios.	Desconocido.	Soja, prunas, frutos secos, aguacate, uva, nueces, legumbres, etc.	No definido.
Cinética y Metabolismo	Vida media biológica en huesos de 20 – 40 días. Eliminación por las heces. Absorción débil, no es retenido se elimina el 99% de lo absorbido.	Desconocido.	De absorción rápida, se almacena en huesos y cerebro. Se excreta por la orina y la excreción renal depende de la ingesta alimentaria.	De rápida absorción y eliminación. Se absorbe por todas las vías, incluida la piel. Absorción gastrointestinal está relacionada con la solubilidad del agua.
Ingestas	Desconocido.	Desconocido.	Desconocido.	12 – 25 µg/día.
Deficiencias	Alteración o retraso en el crecimiento.	Retraso del crecimiento. Insomnio.	Retraso del crecimiento, cambios óseos similares a la osteoporosis.	Retraso del crecimiento, infertilidad y afecciones musculares.
Toxicidad	Sn inorgánico es poco tóxico.	Debilidad.	Dosis letal: 15 – 20 mg de ácido bórico (2.5 – 3.5 mg/boro natural). Déficit vitamina B12, Mg y Ca.	Debido a pesticidas, insecticidas y herbicidas.

Tabla II (cont.)

Tabla general de los oligoelementos con información adicional actualizada. Los oligoelementos aparecen clasificados según el criterio de esencialidad según la nueva propuesta de clasificación que se resumen en la tabla 3.

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	<i>Renio^{b)}</i>	<i>Teluro^{b)}</i>	<i>Berilio^{c)}</i>	<i>Cadmio^{c)}</i>
Papel fisiológico	No definido.	-Te y Se propiedades químicas similares. -Posible efecto antioxidante en determinados compuestos orgánicos contra la peroxidación lipídica y en el SNC sin provocar efectos sobre el sistema glutamatérgico.	-Inhibición de muchos enzimas. -Alteran la síntesis de DNA y ATP. -Provoca depleción de Mg.	-Interfiere en la absorción de Ca, Fe y Cu. -Puede sustituir al Zn en el enzima carboxipeptidasa. -Inhibición de las funciones de la metalotioneína. -Posible efecto estrógeno en dosis 5 – 10 mg.
Fuentes dietéticas	No definido.	No definido.	Desconocido.	Comida refinada (azúcar blanco, pan blanco).
Cinética y Metabolismo	Acumulación en la glándula tiroides.	Absorción por inhalación.	Desconocido.	Absorción (1 – 1,5%) en intestino. Transporte por unión a metalotioneína. Se acumula en eritrocitos, pero el mayor acumulo se encuentra en riñones, hígado, huesos, tiroides, etc. Se elimina por la orina, pero en poca cantidad unida a creatinina en intestino y faneras.
Ingestas	No definido.	No definido.	Desconocido.	Desconocido.
Deficiencias	No definido.	No definido.	Desconocido.	Disminución del crecimiento.
Toxicidad	Alteraciones en el sistema nervioso y circulatorio.	Efectos en hígado y SNC.	Daño pulmonar.	Contaminante del medio ambiente. Aumento de fosfatasa alcalinas. Afección del riñón, disfunción renal con proteinuria, pérdida de la β_2 -microglobulina. Irritación de las vías respiratorias y mucosas. Alteración de la inmunidad (disminución de la síntesis de anticuerpos).

Tabla II (cont.)

Tabla general de los oligoelementos con información adicional actualizada. Los oligoelementos aparecen clasificados según el criterio de esencialidad según la nueva propuesta de clasificación que se resumen en la tabla 3.

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	<i>Niobio^{c)}</i>	<i>Plomo^{c)}</i>	<i>Titanio^{c)}</i>	<i>Uranio^{c)}</i>
Papel fisiológico	Desconocido.	-Perturba funciones fisiológicas normales. -Inhibe la expresión génica. -Acorta la vida eritrocitaria. -Interfiere en el canal de K dependiente de Na así como en el canal de Ca dependiente de voltaje. -Afecta a la pirimidin -5'- nucleotidasa (participa en la degradación del RNA del eritrocito maduro). -Inhibe ATPasa.	-Inhibición de enzimas hidrolíticos. -Estimula el crecimiento.	-Afecta al metabolismo del lactato, piruvato, citrato, fosfato y carbonato.
Fuentes dietéticas	Comidas animales y vegetales.	Vino, colorantes de alimentos (aguas, conservas, mariscos, etc.)	Desconocido.	Algas, raíces.
Cinética y Metabolismo	Absorción mediana. Eliminación por orina.	Desconocido.	Tejidos ricos en sílice, aparece en niveles elevados en pulmones y se cree que podría ser por inhalación de polvo. Eliminación por orina y heces.	Desconocido.
Ingestas	600 µg/día.	Desconocido.	800 µg/día.	Desconocido.
Deficiencias	Desconocido.	Desconocido.	Desconocido.	Desconocido.
Toxicidad	Aumento de la incidencia de degeneración de grasas hepáticas. Inhibe el crecimiento.	Síndrome de Falconi, disfunción hepática, renal y cardíaca. Disminución del rendimiento intelectual. Trastorno psicológico y comportamental, alteración del SNP, déficit visual y auditivo.	Debilidad. Es poco tóxico, pero puede ser carcinógeno. Estimula la toxicidad de oligoelementos tóxicos como Hg y Pb.	Fatigas. Neurotóxico con desórdenes renales con proteinuria, albuminuria. Cancerígeno.

Tabla II (cont.)

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	<i>Aluminio^{c)}</i>	<i>Wolframio^{c)}</i>	<i>Talio^{c)}</i>	<i>Mercurio^{c)}</i>
Papel fisiológico	-Interferencia con procesos biológicos. -Inhibe la producción del cofactor para la formación de neurotransmisores.	-Constitución de la formación de la deshidrogenasa bacteriana. -Antagonista del Mo.	-Unión a grupos sulfhidrilos de proteínas y membranas.	-Inactiva el enzima activador de Se. -Bloquea el transportador de azúcares. -Aumenta la permeabilidad de K.
Fuentes dietéticas	Desconocido.	Jarabe de arce y nueces (en forma de ácido túngstico)	Frutas y vegetales cultivados con aguas contaminadas.	Pescado.
Cinética y Metabolismo	En intestino delgado, también puede tener vía de absorción directa a través de las fosas nasales. Se elimina por heces y en poca cantidad a través de riñones y vía biliar.	Se absorbe bien, se fija en huesos. Se elimina por la orina.	Acumulación en riñones principalmente. Vía urinaria (principal vía de excreción, pero lenta)	Hg inorgánico se absorbe pobremente a nivel intestinal y Hg orgánico se absorbe en pulmones e intestino. Eliminación por orina y una pequeña porción por heces.
Ingestas	Desconocido.	No definido.	No definido.	1.5 – 3.6 μg (Kg/peso)
Deficiencias	Pérdida de memoria y fatiga mental.	No definido.	No definido.	No definido.
Toxicidad	En pequeña cantidad no manifiesta sintomatología. Aun aumento de [Al] provoca afección neurológica, inmunológica, etc.	Debilidad.	Mecanismos relacionados con la sustitución de K, inhibición de la peroxidación de la neuropatía periférica.	Retraso del crecimiento. Fetotoxicidad. Pérdida de peso y apetito. Daño cerebral.

Propuesta de una nueva clasificación de los oligoelementos según su esencialidad en base a los nuevos avances del conocimiento en este campo.

La revisión bibliográfica/bibliométrica realizada en combinación con el uso de la plataforma BRENDA permite plantear una reclasificación de los oligoelementos según su esencialidad (Tabla 3). El uso de esta plataforma se justifica en tanto que ha sido demostrado que muchos oligoelementos actúan como elementos catalíticos esenciales para diversas enzimas, por lo que es necesario conocer la/s enzima/s con las que se encuentran relacionados y cuál es su mecanismo de actuación.

Para el establecimiento de esta nueva propuesta de clasificación se han analizado de forma individual los oligoelementos cuya esencialidad, posible esencialidad o toxicidad ha estado en tela de juicio recientemente: V, Li, Sn, Al, Hg, Ni, Pb, Ti, U, W, Re, Te, Tl. A continuación, se ofrece un resumen de las implicaciones fisiológicas y metabólicas de cada uno de ellos que justifican la consideración de una nueva propuesta de clasificación de oligoelementos:

Vanadio: oligoelemento con función esencial sospechada, de fácil eliminación por vía urinaria y pobre absorción, lo que hace poco posible la aparición de toxicidad por acumulación. El V podría considerarse oligoelemento esencial debido a las múltiples funciones fisiológicas que realiza (control de la bomba de Na-K celular a nivel cardíaco y renal y regulación de patologías hematológicas)¹⁶⁻¹⁸. Asimismo, en modelos animales se ha probado su uso para el tratamiento de patologías como la diabetes¹⁹. No obstante, se ha descrito algún caso de envenenamiento por vanadato amónico²⁰ y presenta actividad redox que podría generar ROS (especies reactivas de oxígeno). Aunque por el momento hay pocos indicios de que los radicales libres derivados de V pueden estar relacionados con patologías neurodegenerativas, es necesario seguir estudiando este aspecto. Así pues, mientras no quede demostrado su papel en la generación de compuestos ROS, *el vanadio podría incluirse entre los oligoelementos con funciones probadas de esencialidad.*

Litio: considerado un oligoelemento con función esencial sospechada, ya que se le relaciona con la proteína Tau, encargada de estabilizar los microtúbulos axonales a través de la interacción con la tubulina. Alteraciones en la proteína Tau se asocian a patologías

neurodegenerativas^{21,22}, por lo que la administración de Li serviría como un neuroprotector que mejoraría la calidad de vida de individuos con estas alteraciones. No se han descrito efectos nocivos por el momento. Por tanto, *el Li se podría considerar un oligoelemento con funciones probadas de esencialidad de especial interés para el tratamiento de patologías neurodegenerativas o maniaco-depresivas, donde las sales de Li ya se están usando actualmente*²³⁻²⁵.

Estaño: actualmente es considerado un oligoelemento con funciones esenciales sospechadas. Los estudios sobre sus efectos en humanos son escasos y con resultados contrapuestos. Algunos trabajos lo destacan como agente terapéutico para tratamientos de cáncer de mama²⁶, sin embargo, en otros casos es presentado como un elemento altamente tóxico para las células²⁷. Dada la escasez de estudios y puesto que la exposición masiva al mismo es poco probable y su vinculación con reacciones tipo redox no está del todo clara, *se considera un oligoelemento con funciones esenciales sospechadas.*

Aluminio: oligoelemento tóxico que se acumula en los tejidos y es capaz de desplazar el ión Ca²⁺ en los sistemas biológicos con los correspondientes efectos secundarios que esto tiene en el sistema nervioso (inhibición de neurotransmisores L-glutamato, GABA, etc)^{28,29}. Por tanto, *el Al se mantiene en el grupo de oligoelementos tóxicos.*

Mercurio: oligoelemento tóxico que afecta al sistema nervioso central y periférico. Además, el Hg se une a proteínas alterando la síntesis de las mismas y su función. Puede dañar el DNA llegando a interrumpir el ciclo celular. Se le ha relacionado con distintos tipos de cáncer³⁰ y con autismo³¹. Por tanto, *el Hg seguiría considerándose oligoelemento tóxico.*

Niobio: considerado oligoelemento tóxico. No se conoce su papel fisiológico, pero presenta una absorción media y se elimina por la orina. No se ha descrito deficiencia de este elemento aunque en exceso inhibe el crecimiento, y la incidencia de la degeneración de grasas hepáticas^{32,33}. *Por todo ello, se seguiría considerando un oligoelemento tóxico.*

Plomo: se considera oligoelemento tóxico ya que perturba la mayoría de las funciones normales fisiológicas. Afecta a la expresión génica y produce alteraciones en el sistema nervioso periférico, así como un déficit visual y auditivo³⁴. *Este oligoelemento se mantiene en el grupo de tóxicos.*

Tabla III

Propuesta de clasificación de oligoelementos. Se resalta en negrita los oligoelementos cuya adscripción a grupo ha sido modificada respecto a clasificaciones anteriores.

<i>Elementos traza u oligoelementos</i>	
Con funciones probadas de esencialidad	Co, Cr, Cu, Mn, Mo, F, Ni, Se, I, Zn, Li, V, Sn
Con función esencial sospechada, pero con mecanismos de acción desconocidos	As, B, Br, Re, Te
Elementos traza tóxicos	Al, Be, Cd, Hg, Nb, Pb, Ti, U, Tl, W

Titanio: oligoelemento tóxico carcinogénico. Su presencia estimula la toxicidad de oligoelementos como el Hg y el Pb. Además, altera la actividad de los neutrófilos e inhibe las enzimas hidrolíticas lisosomales que son esenciales para la digestión, regulación y degradación de biomoléculas^{35,36}. *Por tanto, seguiría considerándose tóxico.*

Uranio: oligoelemento tóxico que afecta a distintas rutas metabólicas (metabolismo del lactato, citrato en otras). No se conocen los mecanismos de absorción ni excreción. Exposiciones a altas concentraciones de U producen patologías renales, y aunque no está demostrado todavía su poder cancerígeno se le ha relacionado con autismo y otros trastornos similares severos en jóvenes^{31,37}. *Por tanto, se mantiene en el grupo de oligoelementos tóxicos.*

Wolframio: oligoelemento tóxico que presenta efectos antagonistas al molibdeno. El Mo, elemento esencial, forma parte de los cofactores de las molibdoenzimas³⁸, por lo que el efecto antagonista del W resulta nocivo para diversas rutas metabólicas. Presenta buena absorción y se elimina sin problemas vía urinaria. Aunque exposiciones muy elevadas a este mineral son poco probables, pequeñas dosis en la forma de tungstato impiden las reacciones celulares de fosforilación y defosforilación³⁹, vitales para muchos procesos de señalización celular. Por ello, *este oligoelemento se mantiene en el grupo de tóxicos.*

Renio: se sabe muy poco sobre su toxicidad y tradicionalmente se le ha considerado oligoelemento tóxico ya que puede acumularse en la glándula tiroidea, al igual que el I, produciendo patologías relacionadas con la tiroides, sistema nervioso y circulatorio⁴⁰. Es usado en radioterapia con éxito para el tratamiento de distintos tipos de cáncer⁴¹⁻⁴³ y en terapia génica⁴⁴. *Por ello, podría considerarse como oligoelemento con función esencial sospechada.*

Teluro: se considera oligoelemento tóxico ya que actúa en procesos de excitotoxicidad mediados por radicales libres que pueden generar Parkinson y Alzheimer. Asimismo, se ha demostrado que la exposición por un período prolongado de tiempo al Te provoca desmielinización⁴⁵; sin embargo, no está claro si estos efectos se deben al Te por sí mismo o a la deficiencia de Se (elemento que actúa fisiológicamente como antagonista del Te)⁴⁶. Se ha propuesto que en pequeñas dosis puede reducir la producción hepática endógena de escualeno, disminuyendo así los niveles de colesterol⁴⁷. Recientemente se ha demostrado que ciertos compuestos que contienen Te actúan como potentes inmunomoduladores de interés para el tratamiento de hiperglucemias⁴⁸. *Por ello, podría considerarse como oligoelemento con función esencial sospechada.*

Talio: oligoelemento tóxico con efectos adversos para el sistema nervioso cuando está presente en el medio ambiente en grandes concentraciones como producto de la industrialización en determinados países⁴⁹. Se ha usado en el tratamiento de la sífilis y la tuberculosis pero estudios recientes han incrementado

la lista de efectos adversos en humanos por exposición a Tl³⁴, por ello, debe ser *considerado un oligoelemento tóxico.*

Discusión

El concepto de “esencialidad” ha dado paso a nuevas precisiones en la clasificación de los oligoelementos que incluyen tanto aspectos cuantitativos como cualitativos⁴. La obtención de nuevos y numerosos datos sobre oligoelementos en muestras humanas ha puesto de manifiesto el interés y la necesidad de cuantificarlos para determinar la naturaleza de ciertos diagnósticos clínicos. Además, el desarrollo de técnicas analíticas moleculares ha contribuido igualmente al estudio de los elementos traza en tanto que permiten cuantificaciones e identificaciones precisas de oligoelementos en muestras biológicas⁵⁰.

El diagnóstico de un déficit o de una intoxicación de oligoelementos revela la existencia de una alteración funcional y/o fisiológica, pero es difícil catalogarlo clínicamente, ya que este diagnóstico presenta ciertos inconvenientes que son un reto para la investigación en la próxima década:

- El diagnóstico clínico normalmente se realiza en un estadio avanzado de la patología.
- La naturaleza e importancia de los signos clínicos varían con la edad y el sexo, y
- Presencia de desórdenes funcionales o estructurales como consecuencia de una anomalía del metabolismo particular.

Conscientes de la importancia de los oligoelementos para la salud humana, diferentes instituciones y grupos de investigación de todo el mundo han invertido esfuerzos para propiciar la comprensión del papel de los oligoelementos en la salud humana. Como resultado de esta actividad han aparecido una gran cantidad de artículos y tratados sobre este tema y han nacido distintas instituciones para velar por el uso y consumo de oligoelementos. Así nace la Federación de Sociedades Europeas de Oligoelementos y Minerales (FESTEM), organización que pretende fomentar todo tipo de actividades en el campo de los oligoelementos y minerales incluyendo el desarrollo de investigación o proyectos educativos que eviten situaciones de carencia de oligoelementos.

Ingestas controladas de oligoelementos a través de suplementos dietéticos podría permitir la recuperación de las funciones biológicas mermadas bajo carencia de los mismos, al optimizar de nuevo las concentraciones de oligoelementos en el organismo. No obstante, la ingesta incontrolada y masiva de oligoelementos puede generar efectos nocivos por acumulación masiva de alguno o varios oligoelementos. La ventana de concentraciones que separa la ingesta dietética beneficiosa de la ingesta tóxica depende del elemento en cuestión y de la naturaleza de las especies químicas presentes en la dieta, campo donde todavía queda mucho por avan-

zar para determinar los rangos de ingesta beneficiosos propios de cada oligoelemento.

En la propuesta de clasificación de oligoelementos en base a su esencialidad que se presenta en este trabajo, tres de los oligoelementos con función esencial sospechada hasta ahora (Li, V, Sn) pasan a formar parte del grupo de oligoelementos con funciones probadas de esencialidad. Además, dos elementos considerados hasta ahora tóxicos (Re, Te), pasan al grupo de oligoelementos con función esencial sospechada. Esta propuesta de clasificación revisada y actualizada podrá servir de ayuda para la formulación y administración de complementos alimenticios ricos en oligoelementos en personas con enfermedades metabólicas, carenciales o con cualquier otro tipo de patología directa o indirectamente asociada a alteraciones en la homeostasis de los oligoelementos, contribuyendo así a una mejora de su calidad de vida. Los sectores profesionales que podrían utilizar esta información en adelante son:

- Médicos y demás personal sanitario: podrían utilizarla a la hora de diseñar tratamientos basados en la oligoterapia.

- Nutricionistas: podrían tener en cuenta dicha clasificación para elaborar dietas equilibradas en términos de oligoelementos.

- Farmacéuticos: podrían usarla para elaborar suplementos alimenticios que garanticen el suministro diario recomendado de oligoelementos.

Páginas de internet consultadas

Plataforma BRENDA <http://www.brenda-enzymes.org/>
FAO (Food and Agriculture organization) <http://www.fao.org/home/es>.

FESTEM (Federación Europea de Sociedades de Elementos Traza) <http://www.festem.eu>.

IUBMB (International Union of Biochemistry and Molecular Biology) <http://www.chem.qmul.ac.uk/iubmb>.

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Revisión

Somatotype tendency in Chilean adolescents from Valparaíso: review from 1979 to 2011

Pablo A. Lizana¹, Rossy Olivares^{1,2} and Francisco J. Berral³.

¹Laboratory of Anatomical Techniques, Institute of Biology, Pontificia Universidad Católica de Valparaíso, Campus Curauma, Valparaíso 2373223, Chile. ²Programa de Magister Mención Morfología, Universidad de la Frontera, Chile. ³Laboratory of Biomechanics, Cineanthropometry and kinesiology, Universidad Pablo de Olavide, Sevilla 41013, Spain.

Abstract

Introduction: A good tool to determine the biotype of growing and developing subjects that has been observed is the somatotype (ST).

Objective: This research study aims to describe the ST tendency in Chilean adolescents along the years.

Methods: The bibliographic review was carried out using data from Medline, ISI Web of Knowledge, and SciELO. The key words used for the search were: somatotype, somatotyping, adolescent (in English and Spanish). The selected articles must describe ST in Chilean adolescents between 15 and 18 years of age. The graphic representation was made through a somatochart and the series ST. To analyze the trajectory of the ST, the moving average method was used (SM), and the tendency line (lineal; TL), which expresses the data direction and projection.

Results: Eight articles complied with the inclusion criteria. Samples of students between 1979 and 2011 from the Regions of Valparaíso, Araucanía, and the Metropolitan region of Chile were reported. All studies correspond to transversal samples. The authors cite and/or describe the Heath-Carter anthropometric methods to assess the ST. The results showed positive TL for the endomorph component in all ages and genders. The mesomorph component maintained in male, unlike the female's component, which was negative except for the one at 18 years old. SM trajectory describes a regularity of the mesomorphic endomorph profile in female, yet with an increase in the endomorphy. In male, a change was observed from an ectomorphic mesomorph to endomorphic mesomorph.

Conclusions: This progressive rise of the adipose component in both genders increases the risk of suffering non-communicable diseases.

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Key words: *Endomorphy. Anthropometry. Mesomorphy. Adiposity.*

Correspondence: Pablo A. Lizana.
Instituto de Biología. Laboratorio de Técnicas Anatómicas
Pontificia Universidad Católica de Valparaíso
Av. Universidad 330, Curauma, Placilla, Valparaíso, Chile.
E-mail: pablo.lizana@ucv.cl

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TENDENCIA DEL SOMATOTIPO EN ADOLESCENTES CHILENOS DE VALPARAÍSO: REVISIÓN DE 1979 AL 2011

Resumen

Introducción: Se ha observado que el somatotipo (ST) antropométrico es un buen método para determinar el biotipo de sujetos en crecimiento y desarrollo.

Objetivo: Describir la tendencia del ST en adolescentes chilenos a lo largo de los años.

Métodos: La búsqueda bibliográfica se realizó en bases de datos Medline, ISI Web of Knowledge y SciELO. Las palabras claves utilizadas para la búsqueda fueron: somatotipo, adolescente (tanto en inglés como español). Los artículos seleccionados debían describir el ST en adolescentes chilenos de 15 a 18 años de edad. Para la representación gráfica se utilizó la somatocarta y el ST de series, para el análisis de la trayectoria del ST se ocupó el método de medias móviles (SM) y líneas de tendencia (TL).

Resultados: Los artículos que cumplieron con los criterios de inclusión fueron ocho. Las muestras de estudiantes se describen desde los años 1979 hasta el 2011, en las regiones de Valparaíso, Araucanía y Metropolitana. Todos los estudios corresponden a estudios transversales. Los autores citan y/o describen el método antropométrico de Heath-Carter para evaluar el ST. Se registraron TL positivas para el componente endomorfo en todas las edades y géneros, el componente mesomorfo se mantuvo en hombres, no así en mujeres que fue negativo a excepción de los 18 años. La trayectoria SM describe una persistencia del perfil meso-endomorfo en mujeres, pero con aumento de la endomorfía. En hombres se observó el cambio de un perfil ecto-mesomorfo hacia uno meso-endomorfo.

Conclusiones: Este aumento progresivo del componente endomórfico en ambos géneros incrementa el riesgo de padecer enfermedades crónicas no transmisibles.

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Palabras Clave: *Endomorfía. Antropometría. Mesomorfía. Adiposidad.*

Introduction

In the last 30 years, Chile has experienced important socio-cultural and economic changes which have deeply modified the lifestyle of the population. Thus, at present we are in what is called post-epidemiological and nutritional transition, with practically the same characteristics as developed countries¹. During the 1960s, Chile was characterized as a country with high prevalence of infant and maternal mortality, infectious diseases, and malnutrition. However, during the 1990s, a decrease in the infant mortality rate became apparent, moving gradually to a rise in rates of malnutrition by excess, and an increase in the rates of non-communicable diseases (NCDs). Cardiovascular diseases were leading cause of death^{2,3}.

In Chile, malnutrition by excess represents the most relevant nutritional health issue in the population of all ages, increasingly in the school adolescent population, especially in the female gender^{1,4}.

Obesity in children is currently an urgent issue in the public health system^{5,6}, not only for this population might become obese in adulthood, but also because malnutrition by excess increases the risk of suffering psycho-social complications and NCDs, such as coronary arterial disease, metabolic syndrome in adulthood, and mellitus diabetes^{7,8}.

During adolescence, exogenous factors are the chief conductors in the development of obesity, which are mainly related to diet, and lack of physical activity^{6,9}. Such factors have remarkably influenced the change in the result of body mass index (BMI) in child and adolescent population in the last few decades where it has increased¹⁰.

According to a health survey carried by the Ministry of Health¹¹ (Chilean National Health Surveys 2010; NHS), 40.2% of 8th grade students aged 13 to 15 presented overweight, or obesity. The most alarming finding was that 90.8% of the students' performance ability or global physical condition is insufficient.

The students' nutritional assessment has been carried mainly through the BMI, whose measurement norms have been stated by the Ministry of Health's Nutrition Unit¹². However, several researchers have characterized the students' corporeal composition through somatotype (ST)¹³⁻¹⁶. The ST describes biotype as of three components: endomorphy (relative adiposity), mesomorphy (muscle-skeletal robustness), and ectomorphy (lineal relation). The current concept of ST was introduced by Heath and Carter, who based on the theoretical concepts of Sheldon from 1940¹⁷. Samples of development and growth have been taken using this method, enabling comparison of the relative form of their components in male and female^{13,15,18}.

The latest researches in Chile show dominant endomorphy components in women followed by a mesomorph. In men, the mesomorph component dominates, followed by endomorph^{15,19-21}. Before this high relative adiposity phenomenon, mostly in female, it becomes

important to describe the trajectory of this population throughout the years as well as their projection, so that appropriate policies in public health can be originated. This research intends to describe the tendency ST has developed in late Chilean adolescents, comprehended between the ages of 15 and 18.

Materials and Methods

The review of the bibliography was carried out using the data base of Medline, ISI Web of Knowledge and SciELO (Scientific Electronic Library Online) as well as *Annals of Normal Anatomy* (*Anales de Anatomía Normal*), and *Chilean Journal of Anatomy* (*Revista Chilena de Anatomía*), being the precedent journals of the *International Journal of Morphology* (ISI). The review of the data base was made until October 30th 2014. The key words used were: somatotype, somatotyping, adolescent, in english and spanish. Selection criteria comprehend: publications contained in the previously mentioned data base, students in late adolescence stage between 15 and 18 years of age according to the World Health Organization (WHO), Chilean population samples, and results of publications containing the three ST components (endomorphy- mesomorphy- ectomorphy).

The exclusion criteria comprehend: individuals with diseases which modify their body composition, students out of age group subject to study and with special characteristics (sport specialties).

For the graphic presentation of the gathered data a somatochart, and the series ST were used. The former is a two-dimensional representation which contains the interrelation of the three ST components. The latter expresses the ST components.

To analyze the trajectory of the evolution of the ST, the moving average method was used, based on the variation parameter, which in this case is the years studied. This is built with the arithmetic average of consecutive values groups (pairs of values), and the curve which passes through the moving averages in the somatochart (SM)²². The tendency line (lineal; TL), which expresses the data direction and projection, is indicated in the representation of the series ST.

Results

After the exclusion criteria were applied, 8 researches carried out in the period between 1983 and 2013 in the region of Valparaíso (32°02' and 33°57' South latitude, and 70° and 71° West longitude) Metropolitan (32°55' and 34°19' South latitude, and 69°46' and 71°43' West longitude), and Araucanía (37°35' and 39°37' South latitude, and 70°55' West longitude until the Pacific Ocean)²³ were analyzed.

The first studies of ST in adolescents were obtained in the region of Valparaíso (Table I and II). Toro et al.²⁴

Table I
Somatotypes mean adolescent male of Chile

<i>Reference</i>	<i>MY</i>	<i>n</i>	<i>Region</i>	<i>TS</i>	<i>Caliper</i>	<i>En (SD)</i>	<i>Me (SD)</i>	<i>Ec (SD)</i>
15 years								
Toro et al. (1983a)	1979-80	13	Valparaíso	DNR	Harpender	2.1 (*)	3.7 (*)	3.5 (*)
Toro et al. (1983b)*	DNR	DNR	Valparaíso	DNR	Harpender	2.3 (*)	3.9 (*)	3.4 (*)
Lizana et al. (2012)	1984-1985	17	Valparaíso	P-PS-PN	DNR	2.7 (0.8)	4.7 (1.2)	3.4 (1.3)
Almagià et al. (1986)**	DNR	17	Valparaíso	P-PS-PN	Harpender	5.7 (1.4)	5.1 (1.4)	3.2 (1.4)
Almagià et al. (1996)	DNR	19	Valparaíso	P-PS-PN	DNR	2.4 (0.3)	4.3 (0.7)	3.4 (1.2)
Silva et al. (2005)	DNR	DNR	Araucanía	P	Harpender	3.9 (*)	4.8 (*)	2.6 (*)
Lizana et al. (2012)	2010	21	Valparaíso	P-PS-PN	Slim Guide	3.5 (1.1)	4.5 (1.1)	2.7 (1.0)
Tapia et al. (2013)	2011	172	Metropolitana	P-PS-PN	Slim Guide	3.8 (1.9)	4.2 (1.2)	2.5 (1.3)
16 years								
Toro et al. (1983a)	1979-80	46	Valparaíso	DNR	Harpender	2.3 (*)	4.0 (*)	3.4 (*)
Toro et al. (1983b)*	DNR	DNR	Valparaíso	DNR	Harpender	2.0 (*)	3.8 (*)	3.5 (*)
Lizana et al. (2012)	1984-1985	29	Valparaíso	P-PS-PN	DNR	2.5 (1.1)	4.9 (1.1)	3.0 (1.1)
Almagià et al. (1986)**	DNR	48	Valparaíso	P-PS-PN	Harpender	4.3 (1.0)	4.6 (1.0)	3.6 (0.9)
Almagià et al. (1996)	DNR	95	Valparaíso	P-PS-PN	DNR	2.4 (0.2)	4.7 (0.6)	3.2 (1.2)
Lizana et al. (2012)	2010	27	Valparaíso	P-PS-PN	Slim Guide	4.0 (1.9)	4.4 (1.0)	2.3 (1.3)
Tapia et al. (2013)	2011	81	Metropolitana	P-PS-PN	Slim Guide	3.6 (1.9)	4.3 (1.5)	2.6 (1.4)
17 years								
Toro et al. (1983a)	1979-80	58	Valparaíso	DNR	Harpender	1.9 (*)	3.9 (*)	3.5 (*)
Toro et al. (1983b)*	DNR	DNR	Valparaíso	DNR	Harpender	2.7 (*)	4.1 (*)	2.5 (*)
Lizana et al. (2012)	1984-1985	24	Valparaíso	P-PS-PN	DNR	2.5 (1.2)	4.5 (1.4)	3.3 (1.4)
Almagià et al. (1986)**	DNR	59	Valparaíso	P-PS-PN	Harpender	4.3 (1.1)	4.7 (1.3)	3.3 (1.3)
Almagià et al. (1996)	DNR	113	Valparaíso	P-PS-PN	DNR	2.3 (0.2)	4.4 (0.6)	3.4 (1.2)
Lizana et al. (2012)	2010	22	Valparaíso	P-PS-PN	Slim Guide	3.9 (1.9)	4.3 (1.0)	2.4 (1.4)
18 years								
Toro et al. (1983a)	1979-80	29	Valparaíso	DNR	Harpender	2.2 (*)	3.8 (*)	3.4 (*)
Toro et al. (1983b)*	DNR	DNR	Valparaíso	DNR	Harpender	2.3 (*)	4.0 (*)	3.2 (*)
Lizana et al. (2012)	1984-1985	16	Valparaíso	P-PS-PN	DNR	3.3 (1.6)	5.0 (1.2)	2.8 (1.2)
Almagià et al. (1986)**	DNR	30	Valparaíso	P-PS-PN	Harpender	4.4 (0.9)	4.6 (1.1)	3.4 (1.0)
Almagià et al. (1996)	DNR	54	Valparaíso	P-PS-PN	DNR	2.3 (1.0)	4.5 (0.7)	3.2 (1.2)
Lizana et al. (2012)	2010	7	Valparaíso	P-PS-PN	Slim Guide	4.1 (2.5)	4.2 (1.4)	2.4 (1.6)

MY, measuring year; n, number of subjects; TS, type of school subsidy of educational establishment, Chile; SD, standard deviation; En, endomorphy; Me, mesomorphy; Ec, ectomorphy; DNR, data not reported; P, public schools; PS, private schools; PN, private nonsubsidized schools; (*), data not reported. *, The authors classified the ages of the subjects in the following ranges: A.13.7-14.10; B.14.11-15.9; C.15.10-16.9; D.16.10-17.9; E.17.10-18.9; F.18.10-21. In the following table are shown: C, D, E, and F respectively; **, The authors classified the ages of the subjects in the following ranges: 15.00-15.11; 16.00-16.06; 16.07-16.11(4.5-5.3-2.8); 17.00-17.06; 17.07-17.11(4.6-4.7-3.2); 18.00-18.06; 18.07-18.11(4.5-4.7-3.1), in table only the first range is shown.

Table II
Somatotypes mean adolescent female of Chile

Reference	MY	n	Region	TS	Caliper	En (SD)	Me (SD)	Ec (SD)
15 years								
Toro et al. (1983a)	1979-80	8	Valparaíso	DNR	Harpender	4.7 (*)	3.9 (*)	2.0 (*)
Lizana et al. (2012)	1984-1985	15	Valparaíso	P-PS-PN	DNR	4.6 (1.0)	5.0 (1.0)	1.8 (1.0)
Almagià et al. (1986)*	DNR	15	Valparaíso	P-PS-PN	Harpender	6.1 (1.0)	5.3 (0.9)	2.1 (0.9)
Almagià et al. (1996)	DNR	21	Valparaíso	P-PS-PN	DNR	4.5 (1.0)	4.8 (1.2)	2.1 (1.2)
Silva et al. (2005)	DNR	DNR	Araucanía	P	Harpender	5.6 (*)	5.2 (*)	1.8 (*)
Lizana et al. (2012)	2010	19	Valparaíso	P-PS-PN	Slim Guide	6.4 (1.7)	4.0 (1.2)	1.6 (1.2)
Tapia et al. (2013)	2011	153	Metropolitana	P-PS-PN	Slim Guide	6.0 (1.7)	4.0 (1.4)	1.5 (1.2)
16 years								
Toro et al. (1983a)	1979-80	13	Valparaíso	DNR	Harpender	5.3 (*)	4.0 (*)	1.5 (*)
Lizana et al. (2012)	1984-1985	23	Valparaíso	P-PS-PN	DNR	3.6 (1.3)	4.5 (1.6)	2.7 (1.4)
Almagià et al. (1986)	DNR	41	Valparaíso	P-PS-PN	Harpender	5.8 (1.1)	5.1 (1.6)	2.3 (1.1)
Almagià et al. (1996)	DNR	71	Valparaíso	P-PS-PN	DNR	4.5 (1.4)	4.8 (1.4)	2.1 (1.1)
Lizana et al. (2012)	2010	30	Valparaíso	P-PS-PN	Slim Guide	6.7 (1.4)	4.2 (1.3)	1.3 (1.0)
Tapia et al. (2013)	2011	109	Metropolitana	P-PS-PN	Slim Guide	5.7 (1.5)	4.0 (1.4)	1.6 (1.0)
17 years								
Toro et al. (1983a)	1979-80	34	Valparaíso	DNR	Harpender	4.5 (*)	4.0 (*)	1.9 (*)
Lizana et al. (2012)	1984-1985	22	Valparaíso	P-PS-PN	DNR	4.3 (1.3)	4.9 (1.5)	2.0 (1.0)
Almagià et al. (1986)	DNR	46	Valparaíso	P-PS-PN	Harpender	5.8 (1.2)	5.3 (1.5)	2.0 (1.0)
Almagià et al. (1996)	DNR	81	Valparaíso	P-PS-PN	DNR	4.5 (1.2)	4.9 (1.2)	1.9 (1.0)
Lizana et al. (2012)	2010	29	Valparaíso	P-PS-PN	Slim Guide	6.7 (1.4)	4.0 (1.1)	1.3 (0.9)
18 years								
Toro et al. (1983a)	1979-80	23	Valparaíso	DNR	Harpender	4.8 (*)	3.9 (*)	1.8 (*)
Lizana et al. (2012)	1984-1985	11	Valparaíso	P-PS-PN	DNR	4.4 (1.0)	4.5 (1.2)	1.9 (0.8)
Almagià et al. (1986)	DNR	35	Valparaíso	P-PS-PN	Harpender	6.2 (1.3)	5.5 (1.4)	1.6 (1.1)
Almagià et al. (1996)	DNR	51	Valparaíso	P-PS-PN	DNR	4.7 (1.4)	4.8 (1.4)	1.9 (1.2)
Lizana et al. (2012)	2010	8	Valparaíso	P-PS-PN	Slim Guide	6.7 (1.8)	4.3 (1.7)	1.3 (1.4)

MY, measuring year; n, number of subjects; TS, type of school subsidy of educational establishment, Chile; SD, standard deviation; En, endomorphy; Me, mesomorphy; Ec, ectomorphy; DNR, data not reported; P, public schools; PS, private schools; PN, private nonsubsidized schools; (*), data not reported. The authors classified the ages of the subjects in the following ranges: 15.00-15.11; 16.00-16.06; 16.07-16.11(6.2-5.5-1.8); 17.00-17.06; 17.07-17.11(6.3-5.5-1.7); 18.00-18.06; 18.07-18.11(6.0-4.8-2.3), in table only the first range is shown.

registered students' STs of both sexes, finding a clear sexual dimorphism by ages, where the mesomorphic endomorph component would be characteristic of the group of women without significant variations among ages. Male have serious changes in their mesomorphy, which is statistically significant between the ages of 15 and 18. In this case, male presented an inclination toward mesomorph-ectomorph²⁴. The authors of this research project, taking into account the tendency of male toward mesomorphy, specified their description in the relation between ST and age, in which it was found that only at 13.7 and 15.9 years of age a balanced mesomorph is presented, and a tendency toward ectomorphic mesomorph in groups of 15.10 to 18.9²⁵.

In 1986, a similar ST is described in male and female of 15 to 21 years of age with distinct dispersions between the ages of 16 and 18. However, despite the similarities, the average of subjects positioned male with an ST 4-5-4 in the mesomorph component, and female with an ST 6-6-2 in the endomorph-mesomorph¹⁸.

In 1996, the description of ST was carried out in an important sample of the population between 6 and 23 years of age in Valparaíso, in public, private, and unsubsidized private educational institutions, finding that the endomorph component remains constant in both sexes, higher in female (Table I and II). The authors stand out that endomorph in female is characterized by doubling the one in male, and that its difference is much higher over 14 years of age. An example of this case is given at the age of 18: the researchers report an endomorphy of 2.3 in male and 4.7 in female. As regards the educational institutions, a major homo-

geneity was found in municipal and subsidized private schools compared to the unsubsidized schools¹⁸.

The following search is carried in Temuco, Region of Araucanía, Chile¹⁹. When evaluated a private school (unsubsidized), it was observed that the values of the endomorph component at 15 years old are higher in female than in male, whose mesomorph component is predominant¹⁹. This predominance of the endomorph component in female over male is maintained in later studies by Lizana et al. and Tapia et al. carried out in Valparaíso and Metropolitan Region respectively^{15,21}.

As regards ectomorph, third component of ST, reports indicate that it has declined. Both female and male's values are in the low category (1.3 and 2.7), which indicates great volume and round shapes, characteristics of people with an increase of the relative adiposity¹⁷. This component in Chilean female has not have important changes throughout the studied period. However, a decrease is observed in male from 1983 until 2011 where it is considered a moderate-to-low category (3 to 5).

In male's SM (Fig. 1-4C) ectomorphic mesomorph biotype is observed moving toward mesomorphic endomorph; the projection indicates that the endomorphy rise will continue in progress, except at 15 years old when it can move to more central components. In female, SM's indicates a biotype characterized by mesomorphic endomorph in the first reported studies, and that has remained along the years, but with an increase in the endomorph component. SM projection in women indicates that it will continue to move toward endomorph components.

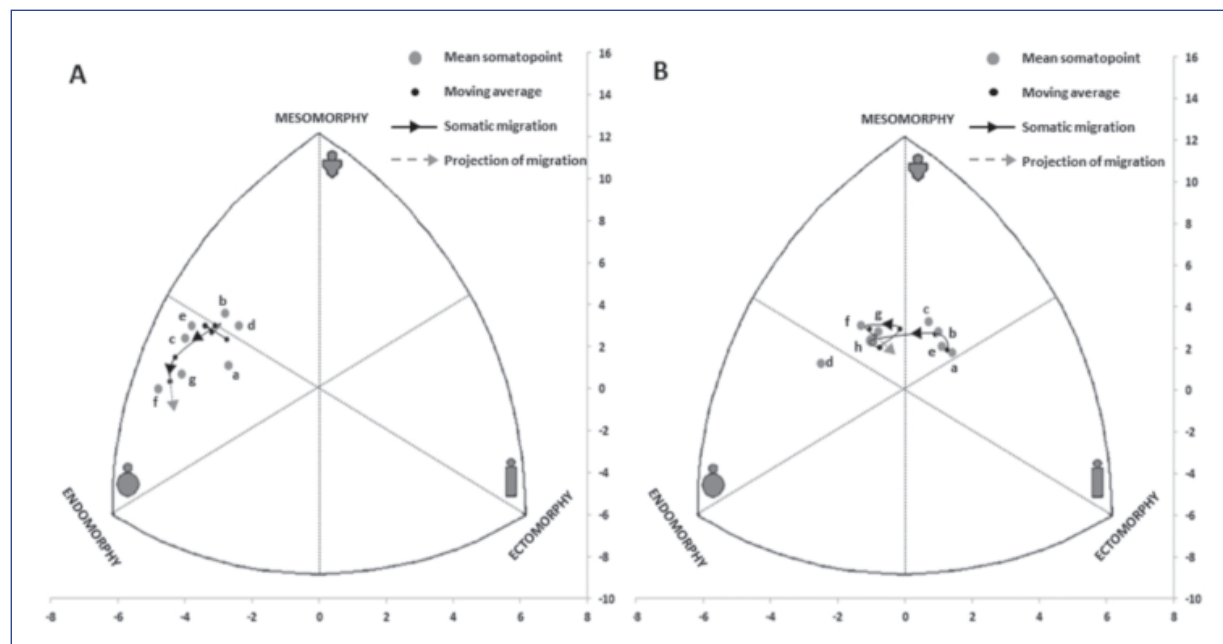


Fig. 1.—Somatic migration of mean somatopoint samples between 1979-2011, through 15 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Silva et al., 2005); f (Lizana et al., 2012); g (Tapia et al., 2013). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Silva et al., 2005); g (Lizana et al., 2012); h (Tapia et al., 2013).

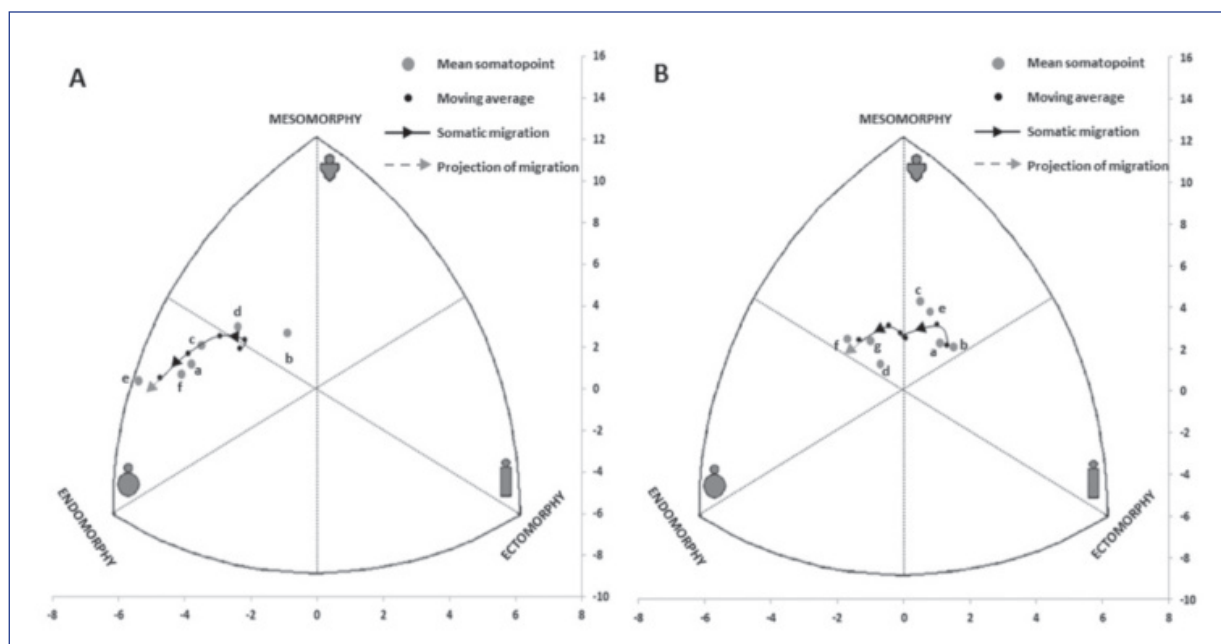


Fig. 2.—Somatic migration of mean somatopoint samples between 1979 -2011, through 16 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); f (Tapia et al., 2013). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); g (Tapia et al., 2013).

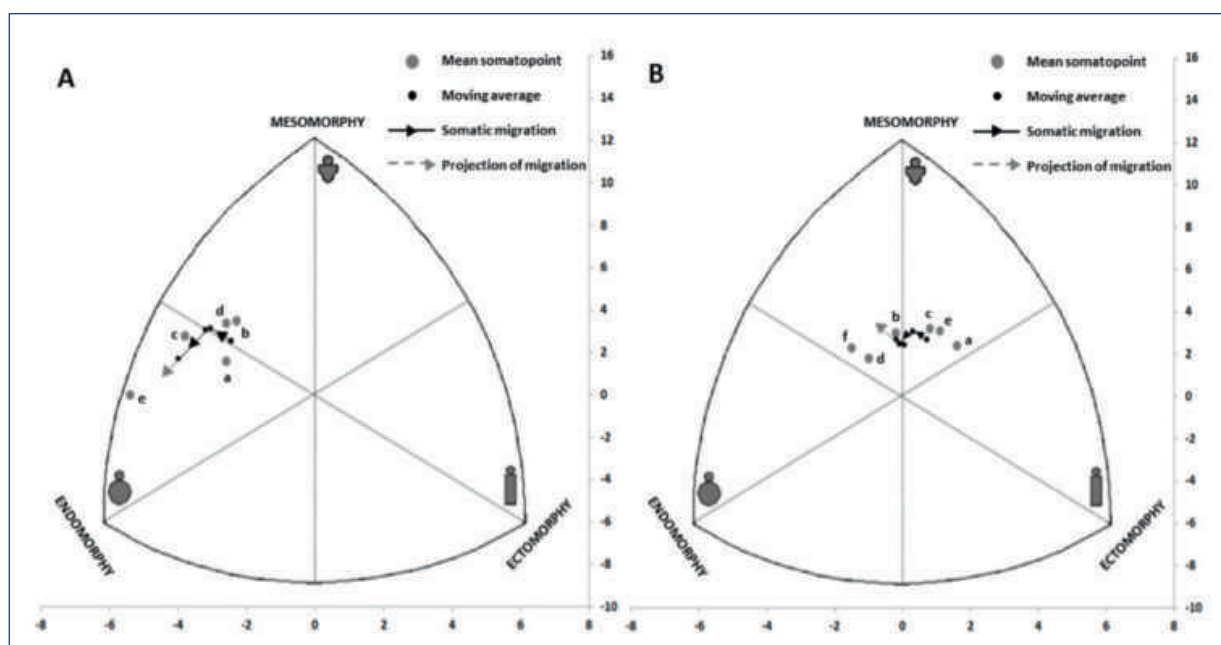


Fig. 3.—Somatic migration of mean somatopoint samples between 1979 -2010, through 17 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012).

Female's TL (Fig. 5-6A) show mesomorph component decreasing along time (equations, 15 years old: $y = -0.0643x + 4.8571$; 16 years old: $y = -0.0343x + 4.5533$). At 17 years old, it maintains stable (equation not represented dates, $R^2=0$; $y=4.62$), and at 18 a slight increase is observed ($y=0.11x + 4.27$; Fig. 8A). As regards endomorph

component, it rises in all age ranges along the years and prevails over the rest of the components (equations, 15 years old: $y = 0.25x + 4.4143$; 16 years old: $y = 0.2857x + 4.2667$; 17 years old $y = 0.46x + 3.78$; 18 years old: $y = 0.41x + 4.13$). Ectomorph component shows a decrease during the observed period (TL all negative).

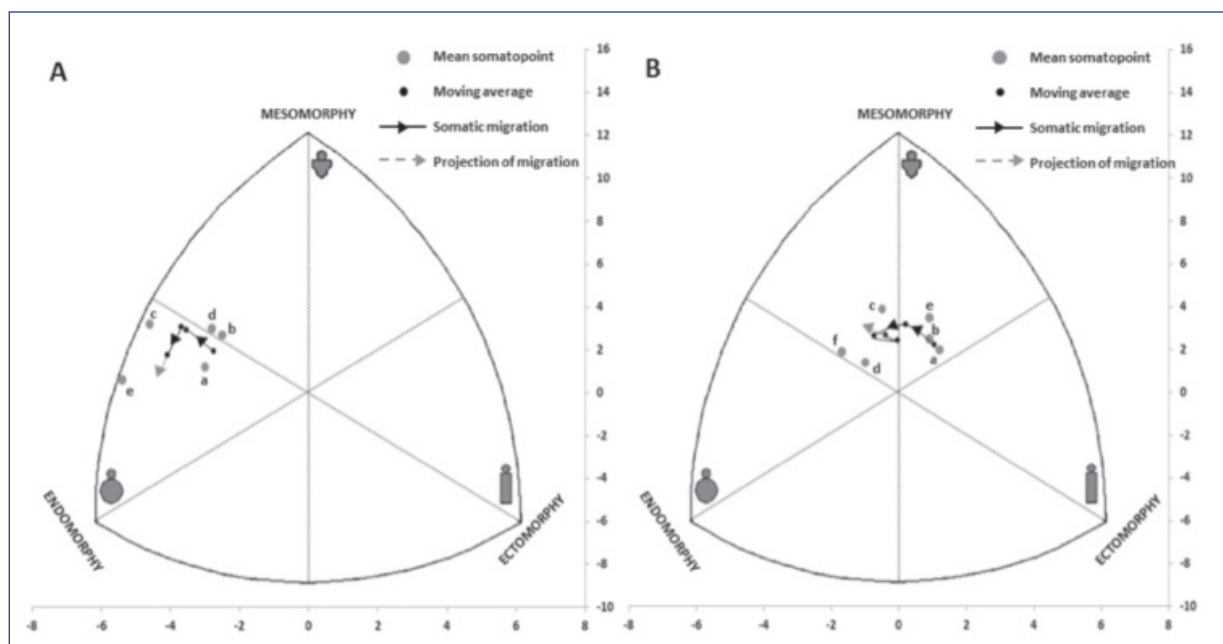


Fig. 4.—Somatic migration of mean somatopoint samples between 1979 -2010, through 18 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012).

Male's TL (Fig. 5-8B) show a dominant mesomorph component, which presents a positive TL in all ages. Even if the mesomorph component prevails over the rest, it is observed that the endomorph component increases along the years. In relation to the endomorph component, a minor predominance compared to the rest of the components during the periods 1979-85 (Fig. 5-8B). However, from 1986 this situation changes, since the endomorph component value exceeded the ectomorph component. Similarly to female, ecto-

morph component diminishes in the described period (negative TL).

Discussion

Results of this study show that from 1979 until 2011 an increase in the endomorph component in association to adiposity has been produced from 15 to 18 years of age, projecting a change in the corporal composition of

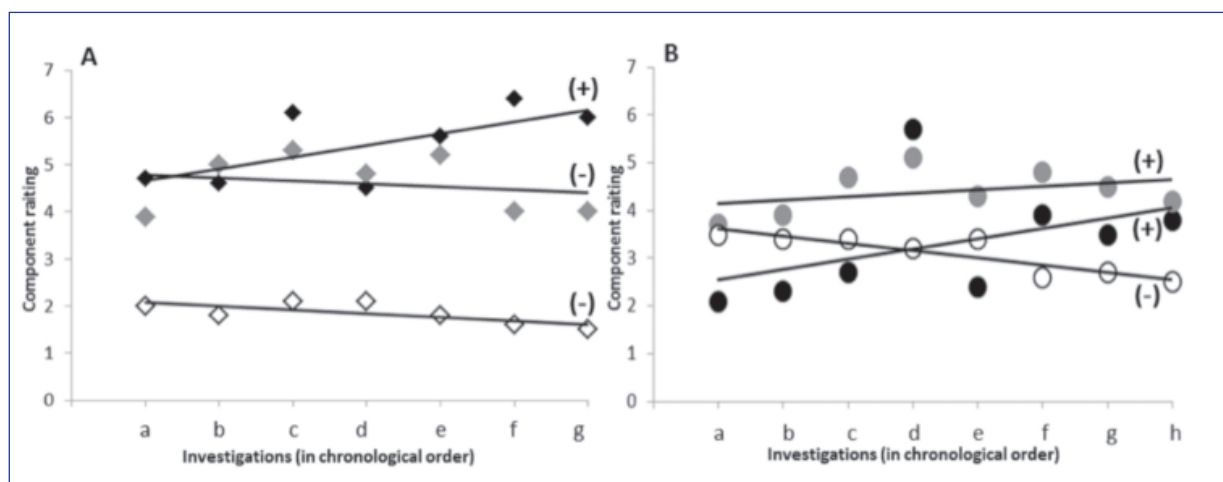


Fig. 5.—Somatotype component rating of samples between 1979 -2011, through 15 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Silva et al., 2005); f (Lizana et al., 2012); g (Tapia et al., 2013); black diamond = endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Silva et al., 2005); g (Lizana et al., 2012); h (Tapia et al., 2013); black circle = endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

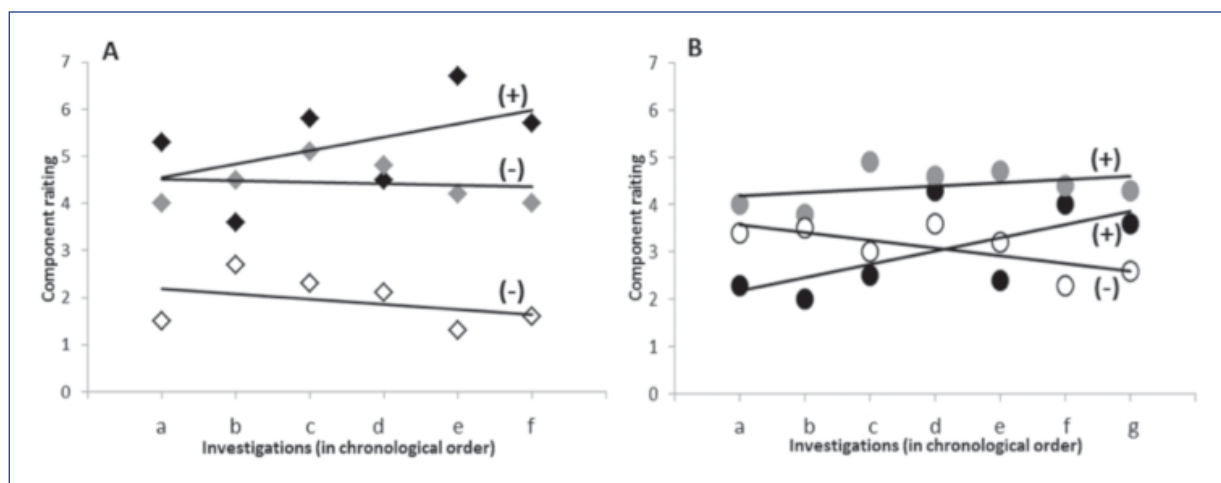


Fig. 6.—Somatotype component rating of samples between 1979 -2011, through 16 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); f (Tapia et al., 2013); black diamond = endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); g (Tapia et al., 2013); black circle = endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

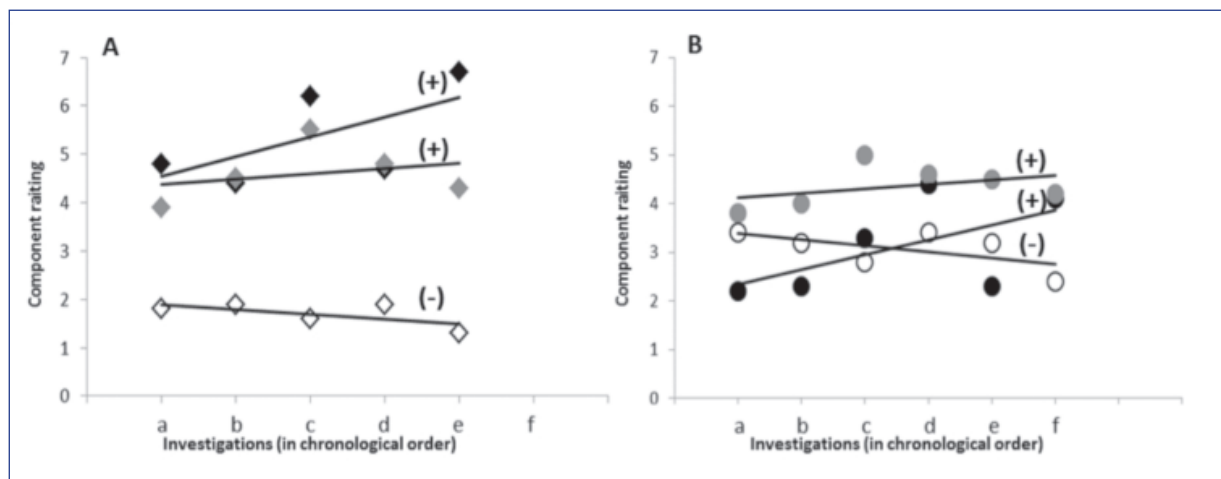


Fig. 7.—Somatotype component rating of samples between 1979 -2010, through 17 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); black diamond = endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); black circle = endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

both sexes along the years. The tendency of the female population is presenting a mesomorphic endomorph somatotype. A predominant endomorph component is described in both genders, which indicates the existence of a high component of adipose tissue.

Even if both sexes present different SM and projections, the endomorph component prevails and rises in both genders throughout the years. This research project has determined a sexual dimorphism which has also been reported in other populations around the world^{13,26}. In the case of this study, a higher sexual dimorphism was found in women's endomorph component, whereas men have higher mesomorph component. However, it

is important to remark that both genders have moved toward endomorphy. It is interesting to see how teenage women present changes at 15 years of age in their endomorph component (regardless the region they are from): 4.7 in 1983, 4.5 in 1985, 6.1 in 1986, 4.4 in 1996, 5.6 in 2005, 6.4 in 2010, and 5.7 in 2011. Figures indicate an increase of 1.8 somatotype units in 28 years, thus adiposity has changed from moderate (range between 3 and 5) to high in the last few decades (table II). At same age, male have moved to the limit of moderate and high relative adiposity (table I). These results agree with the comparison carried out by Lizana et al. (2012)¹⁵ with adolescents from the Region of Valparaíso.

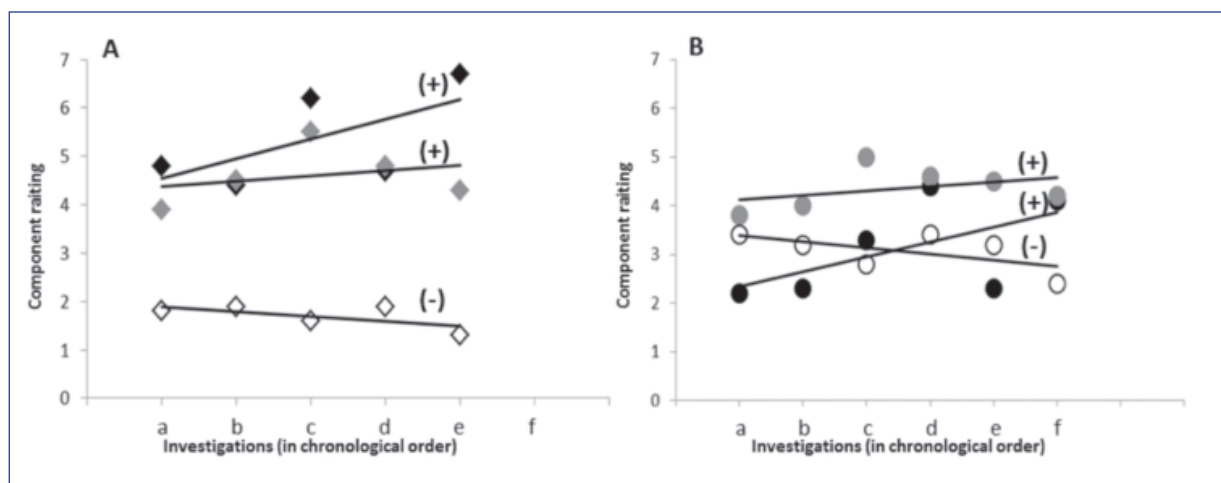


Fig. 8.—Somatotype component rating of samples between 1979 -2010, through 18 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); black diamond =endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); black circle =endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

so in 1984/1985, and 2010, resulting in a significant increase in the endomorph component, which was higher in women, in all studied ages. Results also coincide with late NHS (2003-2010), in which a rise in the prevalence of obesity has been registered, especially higher in women. Moreover, NHS data denote obesity rises as age increases, only with a drop during elderly. This rise of overweight and obesity (evaluated by BMI) has high correspondence to the endomorph component, which was described in the work of Silva's et al. (2008), who evaluated a group of overweight and obese adolescents (BMI according to WHO). An endomorph component over 7 in men, and over 8 women was obtained in the study, which corresponds to extreme categories¹⁷.

The phenomenon is perceived in the evaluation carried out by the NHS¹¹(2003-2010). However, a decrease of mesomorph component was reported in our study attributed to a lack of physical activity, as several authors have reported^{9,27,28}. In addition, a tendency to a rising endomorph component is observed. This type of profile with high relative adiposity contributes to increasing the probabilities for population to suffer from cardiovascular, and NCDs, even in adulthood²⁹.

Results interpretation is limited by methodological issues of research projects which include: instruments used, available data (3 papers did not have standard deviations data^{19,24,25}), and the variability of sample sizes which may be from 7 to 172 by age, type of school subsidy, and region. Such factors introduce possible biases that should not affect results systematically. The cross-cutting nature of the studies, of which there are no reports of ST cohort, limits interpretation of tendencies. However, it is interesting to observe that an endomorphism increase has been reported in independent studies in three different regions of Chile. Similar studies of a territory are scarce, since there is only one that com-

res subjects from a region (Valparaíso) in two different periods in order to observe changes of ST components through time¹⁵. In this regard, it would be important to describe particular populations such as the native peoples, whose studies has only been focused on Mapuches¹⁶, and with the characterization of the rural school population compared to urban which has not been explored in Chile either. Additionally, comparisons with different geographical areas are neither registered. ST in Chile requires more studies in children and adolescents, incorporating variables that may modify it (physical activity, intake, among other), since it is an important evaluation tool of body shapes that must cause impact in public health guidelines.

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Original/*Obesidad*

Asociación entre la conducta alimentaria y polimorfismos genéticos de la leptina y su receptor en niños obesos chilenos

Macarena Valladares^{1,2}, Ana María Obregón^{2,3}, Gerardo Weisstaub⁴, Raquel Burrows³, Ana Patiño⁵, Judith Ho-Urriola² y José Luis Santos².

¹Dirección de Investigación y Relaciones Internacionales. Universidad Bernardo O'Higgins, Santiago, Chile. ²Departamento de Nutrición, Diabetes y Metabolismo. Facultad de Medicina. Pontificia Universidad Católica de Chile. Santiago, Chile. ³Carrera de Nutrición y Dietética. Universidad San Sebastián. Concepción Chile. ⁴Instituto de Nutrición y Tecnología de los Alimentos (INTA). Universidad de Chile. Santiago, Chile. ⁵Departamento de Pediatría. Universidad de Navarra. Pamplona. España.

Resumen

Introducción: La leptina (LEP) se produce principalmente en el tejido adiposo y actúa en el hipotálamo regulando la ingesta energética. Mutaciones en el gen LEP o en su receptor (LEPR) que generen obesidad monogénica son pocos frecuentes. Sin embargo, polimorfismos de LEP y LEPR han sido relacionados con la obesidad multifactorial, debido a la asociación encontrada con el peso corporal y la conducta alimentaria.

Objetivo: Medir la asociación entre polimorfismos de LEP y LEPR con obesidad infantil y conducta alimentaria en niños obesos.

Métodos: Se reclutaron 221 niños obesos Chilenos (IMC sobre el percentil 95). Los progenitores de 134 de esos niños también fueron reclutados, para determinar la asociación entre los polimorfismos de LEP y LEPR con la obesidad en un estudio de tríos caso-progenitor. La conducta alimentaria se midió a través del cuestionario de alimentación de tres factores versión progenitores (TFEQ-P19) y el de conducta alimentaria en niños (CEBQ).

Resultados: No se observa una diferencia significativa entre los polimorfismos estudiados y la obesidad infantil, luego de la corrección por comparaciones múltiples. Por otro lado, se encontraron asociaciones significativas entre ciertos polimorfismos de LEP y LEPR con dimensiones de la conducta alimentaria tales como: "lentitud para comer", "alimentación emocional", "disfrute de los alimentos" y "alimentación sin control".

Conclusiones: Existiría una asociación entre polimorfismos de los genes LEP y LEPR con la conducta alimentaria en niños obesos Chilenos.

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Palabras clave: *Leptina. Receptor de leptina. Polimorfismos. Obesidad. Conducta alimentaria.*

ASSOCIATION BETWEEN FEEDING BEHAVIOR, AND GENETIC POLYMORPHISM OF LEPTIN AND ITS RECEPTOR IN OBESE CHILEAN CHILDREN

Abstract

Introduction: Leptin (LEP) is mainly produced in adipose tissue and acts in the hypothalamus to regulate energy intake. Mutations in the LEP gene or its receptor (LEPR) that produce monogenic obesity are infrequent. However, LEP and LEPR polymorphisms have been associated with obesity multifactorial, due to the association found with body weight and eating behavior.

Aim: Measure the association between LEP and LEPR polymorphisms with childhood obesity and eating behavior.

Methods: 221 Chilean obese children (BMI above the 95th percentile) were recruited. Parents of 134 of these children were also recruited to determine the association between LEP and LEPR polymorphisms with obesity in a case study-parent trio. Eating behavior was measured through the questionnaire of three factors progenitors' version (TFEQ-P19) and eating behavior in children (CEBQ).

Results: No significant difference between the studied polymorphisms and childhood obesity, after correction for multiple comparisons, was observed. The dimensions; "Slow eating", "emotional eating", "enjoyment of food" and "uncontrolling eating" were significant associated with certain polymorphisms of LEP and LEPR.

Conclusions: There would be an association between polymorphisms of the LEP and LEPR genes with eating behavior in Chilean obese children.

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Key words: *Leptin. Leptin receptor. Polymorphism. Obesity. Eating behavior.*

Correspondencia: Macarena Valladares Vega.
macarena.valladares@ubo.cl

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Introducción

La obesidad es una enfermedad multifactorial causada por la interacción de factores genéticos y factores ambientales causados por el estilo de vida¹. La existencia de un efecto neto de la genética en el desarrollo del sobrepeso u obesidad se ha demostrado por la comparación de la similitud de pares de gemelos monozigóticos (MZ) y gemelos dizigóticos (DZ)². Los gemelos comparten el ambiente con intensidad similar, por lo tanto, cuando existe una similitud mayor en un rasgo entre gemelos MZ que DZ se puede atribuir a la genética³. Dichos estudios muestran una heredabilidad del IMC (Índice de masa corporal Kg/m²) de un 70%^{2,4}.

Por otro lado, la conducta alimentaria que también está determinada por factores genéticos⁵, se define como un conjunto de actos relacionados con hábitos de ingesta energética, selección de alimentos consumidos, preparaciones culinarias y cantidad de alimentos ingeridos⁶. Esta conducta responde a diferentes factores tales como: necesidades biológicas, sensación de placer, parámetros socio-culturales, entre otros⁷. Se ha establecido que el desarrollo de la conducta alimentaria se determina por disponibilidad de alimentos, preferencias alimentarias, tamaño de la porción, aspectos culturales, comportamientos familiares y estilos de vida⁷. De esta manera dichos factores condicionan la conducta alimentaria principalmente en los primeros años de vida⁸. La conducta alimentaria se estructura, a través, de un conjunto de comportamientos denominados “dimensiones” relacionados con la comida. De esta manera se han definido distintas dimensiones de la conducta alimentaria tales como: alimentación emocional, disfrute de los alimentos, respuesta a la saciedad, restricción cognitiva, entre otras⁷.

La asociación entre conducta alimentaria y factores genéticos muestra que el tamaño de las raciones y la frecuencia de las comidas son patrones que muestran heredabilidad⁶. Además, en este mismo estudio se estableció que existe una relación entre el IMC y la conducta alimentaria en niños de 5-6 años, observándose que aquellos niños con mayores puntajes en las dimensiones de “alimentación emocional” y “deseo de beber” tienen un IMC más alto. Por otro lado, los niños con mayores puntajes en la dimensión “respuesta a la saciedad” presentan un IMC más bajo.

La obesidad genera una ganancia excesiva de tejido adiposo, el cual es considerado actualmente un tejido endocrino. En este sentido dicho tejido secreta una hormona denominada leptina (LEP) cuyos niveles son directamente proporcionales al contenido de tejido graso⁹. LEP atraviesa la barrera hematoencefálica y se une a su receptor específico (LEPR) expresado en neuronas encargadas de regular el balance energético. La acción de la leptina sobre LEPR genera una disminución del apetito y aumenta la termogénesis⁹.

Se han descrito variantes genéticas comunes o polimorfismos en el gen LEP que han sido asociados con

la obesidad poligénica en diferentes poblaciones¹⁰. Por otro lado, existen diversos estudios que han evaluado polimorfismos del gen LEPR y su relación con obesidad¹¹, sin embargo, no está claro el efecto de dichos polimorfismos en la obesidad multifactorial y patrones de la conducta alimentaria.

El objetivo del presente estudio fue medir la asociación entre polimorfismos de los genes LEP y LEPR con obesidad infantil y puntajes de la conducta alimentaria en un estudio de casos-progenitores. Adicionalmente, se midió la asociación de los niveles de leptina y el receptor soluble en suero con los puntajes de conducta alimentaria.

Materiales y Métodos

Sujetos

Se seleccionaron 221 niñas y niños sin relación familiar (“casos índice”) que tenían un IMC por sobre el percentil 95 según la curva NCHS/CDC 2000 (promedio de edad $\pm$ desviación estándar: 9.7 ± 2.2 años, 44.3% fueron niñas). En la Tabla I se detallan las características generales de los niños obesos que participaron en este estudio. Adicionalmente, se incorporaron al estudio 268 padres de los casos índices, de esta manera se conformaron 134 tríos caso-progenitor. Al seleccionar familias a través del caso índice, la existencia de asociación entre el factor genético y la enfermedad origina que, en estas familias, la transmisión de los alelos desde los progenitores heterocigotos hacia sus hijos enfermos se aparten del valor esperado (probabilidad de transmisión = 50%), por lo tanto, la evaluación de la transmisión alélica constituye un test de asociación genotipo-enfermedad.

El criterio de exclusión, para los niños, fue estar en tratamiento intensivo por obesidad al momento de ingresar al estudio. Este estudio fue aprobado por el comité de ética del INTA (Instituto de Nutrición y Tecnología de los Alimentos), Universidad de Chile. Todas las familias participantes firmaron previamente un consentimiento informado individual para cada miembro incluido en el estudio.

Mediciones antropométricas

A cada miembro del grupo familiar se le midió peso y talla. El diagnóstico nutricional de obesidad en los niñas/os se estableció con el IMC (peso/talla²) según género y edad, y se consideró obeso al niño/a que superó el percentil 95. Las curvas de referencia utilizadas fueron la NCHS/CDC – 2000 para niños y adolescentes entre 2- 19 años, vigente al iniciar el reclutamiento de las familias¹⁰. En los progenitores, se utilizaron los puntos de corte de IMC para adultos, donde un IMC $\geq$ a 25 kg/m² es considerado como sobrepeso¹². Las mediciones antropométricas: peso, talla, y circunferencia

Table II
Puntajes de conducta alimentaria en niños obesos chilenos

	<i>P</i> ₂₅	<i>P</i> ₅₀	<i>P</i> ₇₅
Niñas			
TFEQ-P19 (n=80)			
Restricción Cognitiva	1.4	2.0	2.6
Alimentación Emocional	1.3	2.0*	3.0
Alimentación sin control	2.3	2.6	3.2
CEBQ (n=60)			
Respuesta a los alimentos	2.2	3.5	4.8
Sobrealimentación emocional	2.0	3.0	3.5
Disfrute de los alimentos	3.3	4.5	5.0
Deseo de beber	2.0	4.0	5.0
Respuesta de saciedad	1.6	2.1	2.8
Lentitud al comer	1.2	2.0**	3.0
Subalimentación emocional	2.2	2.8	3.2
Exigencia frente a los alimentos	1.8	3.0	3.6
Índice combinado saciedad/Lentitud	1.4	2.2***	3.0
Niños			
TFEQP-19 (n=115)			
Restricción Cognitiva	1.4	2.2	2.8
Alimentación sin Control	2.1	2.6	3.2
Alimentación Emocional	2.0	2.7	3.3
CEBQ (n=88)			
Respuesta a los alimentos	3.5	4.2	4.9
Sobrealimentación emocional	1.7	2.7	3.7
Disfrute de los alimentos	2.0	2.5	3.0
Deseo de beber	1.8	2.8	3.8
Respuesta de saciedad	2.6	3.8	4.6
Lentitud al comer	1.0	1.5	2.0
Subalimentación emocional	1.6	2.2	2.6
Exigencia frente a los alimentos	2.0	3.7	5.0
Índice combinado saciedad/Lentitud	1.4	1.8	2.3

*Alimentación emocional (p= 0.01). **Lentitud para comer (p= 0.001). *** Índice saciedad/lentitud (p= 0.01). El índice combinado saciedad-lentitud es el promedio de los puntajes de las dimensiones respuesta a la saciedad y lentitud para comer.

de cintura, se realizaron por procedimientos estándar. Posteriormente se calcularon los percentiles y Z-scores de estatura, peso e IMC mediante el software <http://www.cdc.gov/EpiInfo/>.

Análisis genético

El gen humano de la leptina (gen ID 3952 7q31.3) se compone de tres exones de los cuales dos codifican para una proteína de 167 aminoácidos (NC_000000.13; NM_000230.2; NP_000221.1). Existe una región hipervariable no traducible en el extremo 3' del gen LEP que presenta repeticiones de un tetranucleótido (TTTC)n. Dicha repetición fue analizada mediante la amplificación por la reacción en cadena de la polimerasa (PCR), de acuerdo al protocolo descrito por Snousi et al.¹³. Es frecuente en la literatura agrupar los alelos del microsatélite (TTTC)n en alelos de clase I (fragmentos de PCR comprendidos entre 145 – 200 pb, que corresponden entre 10 y 24 repeticiones) y alelos clase II (fragmentos de 201 – 261pb, que corresponden entre 25 y 39 repeticiones). Esta clasificación se ha basado en los estudios publicados por Hinuy et al.¹⁴.

Análisis genético de LEPR

El gen humano del receptor de leptina (gene ID 3953 1p31) está compuesto por 20 exones, de los cuales 18 codifican para el receptor de leptina (NC_000001.10). Existen tres polimorfismos de LEPR, en los cuales el cambio de un nucleótido provoca el cambio de un aminoácido: Lys109Arg (rs1137100 c.326A>G) en el exón 2, Gln223Arg (rs1137101 c.668A>G) en el exón 4, y Lys656Asn (rs8179183 c.1968 G>C) en el exón 12, la amplificación de dichos genes se realizó de acuerdo a lo descrito por Gotoda et al.¹⁵. Además, el 20% de las determinaciones se realizaron exclusivamente mediante ensayos Taqman.

Determinaciones de leptina y su receptor soluble en suero

Las concentraciones de leptina y su receptor soluble en suero (sRLeptina) fueron medidas en niñas/os con un tunner de 1 y 2 (promedio de edad= 9,6 ± 1.9; n= 119). El suero se obtuvo luego de la centrifugación de la muestra de sangre y se guardaron a -20°C para su posterior análisis. La concentración de leptina y sR-Leptina se determinaron a través de un test de ELISA Quantikine R&D DLP00 y DOBR00 (<http://www.RnDSystems.com>). Las lecturas de las muestras se interpolaron utilizando la curva de cuatro parámetros (ELISA assay for sRLeptin) o el análisis de regresión (ELISA assay for leptin).

La conducta alimentaria se midió a través de dos cuestionarios psicométricos: el cuestionario de alimentación de tres factores (Three-Factor Eating Questionnaire TFEQ-P19) (niñas= 80, niños= 115,) y el cuestionario de alimentación infantil (The Child Eating Behavior Questionnaire CEBQ niñas= 60, niños= 88), los cuestionarios se aplicaron mediante una entrevista directa y lo contestó uno de los progenitores.

El cuestionario TFEQ-P19 es una versión adaptada de la versión original TFEQ, de 51 preguntas, desarrollada por De lauzon et al. 2004, para su uso en estudios epidemiológicos aplicable a sujetos obesos y normopeso, mediante la información entregada por los progenitores¹⁶. El TFEQ evalúa tres dimensiones de la conducta alimentaria: “restricción cognitiva” (6 preguntas), “alimentación sin control” (10 preguntas) y “alimentación emocional” (3 preguntas). Las respuestas se miden en una escala tipo likert que abarcan desde 1 (completamente cierto) a 4 (completamente falso).

El cuestionario de alimentación infantil (CEBQ) fue diseñado por Wardle y cols.¹⁷ para identificar patrones de conducta alimentaria como posibles factores de riesgo de obesidad o desórdenes alimenticios en niños, utilizando información entregada por los padres. El CEBQ está compuesto de 35 preguntas que miden ocho dimensiones de la conducta alimentaria agrupadas en inclinaciones positivas hacia la comida: “disfrute de los alimentos” (4 preguntas), “respuesta a los alimentos” (5 preguntas), “sobrealimentación emocional” (4 preguntas), “deseo de beber” (3 preguntas), e inclinaciones negativas hacia la comida: “respuesta a la saciedad” (5 preguntas), “lentitud para comer” (4 preguntas), “exigencia a los alimentos” (6 preguntas), y “sub ingesta emocional” (4 preguntas). Además, se ha descrito una dimensión de conducta alimentaria que combina la “respuesta a la saciedad” con “lentitud para comer”, debido a que ambas se encuentran en el mismo factor (índice “saciedad-lentitud”)¹⁸. Cada pregunta fue respondida en una escala tipo Likert, con puntajes posibles de 1-5, donde 1 es absoluta ausencia y 5 es la máxima intensidad de la dimensión.

Los puntajes estandarizados de cada dimensión, en ambos cuestionarios, se calcularon como la suma de las preguntas de cada dimensión dividida por el número de preguntas. Debido a que no existen puntos de corte establecidos para cada dimensión con fines diagnósticos, se realizó una comparación entre los puntajes de niños obesos con diferentes genotipos en una misma variante genética. En la Tabla II se muestran los percentiles de los puntajes de conducta alimentaria de niñas y niños obesos que participaron en este estudio.

Las variables antropométricas medidas se expresan como promedio $\pm$ desviación estándar (tabla I). Por otro lado, los puntajes de conducta alimentaria se expresan en percentiles y se comparan a través del test de Mann-Whitney.

Los puntajes de conducta alimentaria mostraron una desviación de la normalidad medido, a través, de un test combinado de “skewness” y “kurtosis” (comando “sktest” del paquete de STATA 11.0). En los datos obtenidos de puntajes de conducta alimentaria, los valores para “skewness” están dentro de lo aceptable para la normalidad, sin embargo, los valores para la kurtosis fueron muy altos para ser aceptados dentro de la distribución normal. La aplicación de una serie de transformaciones utilizadas (square, cubit, log y square-root comando “ladder” en STATA 11.0) tampoco permitieron la transformación de los puntajes de conducta alimentaria en variables con distribución normal, por eso se presentaron distribuidos por percentiles.

La asociación entre los diferentes polimorfismos analizados y la obesidad se determinó mediante el Test de Desequilibrio de Transmisión (TDT) en los tríos caso-progenitor⁴. Además, se realizó un análisis de los haplotipos de los polimorfismos de LEPR mediante el programa UNPHASED. Los haplotipos corresponden a una combinación de alelos de diferentes loci de un cromosoma y son transmitidos juntos.

Resultados

Asociación de mediciones antropométricas, niveles plasmáticos de leptina y de conducta alimentaria entre niñas y niños obesos

Dentro de las medidas antropométricas analizadas (Tabla I) se observa una diferencia en el puntaje Z de estatura, que muestra valores mayores en niños ($p=0.01$). Las otras medidas antropométricas no muestran diferencias significativas por género. La distribución del estado puberal de acuerdo a la clasificación de Tanner fue: Tanner 1 (60.8%); Tanner 2 (20.6%); Tanner 3 (11.2%); Tanner 4 y 5 (7.5%).

Puntajes de conducta alimentaria entre niñas y niños obesos

Los puntajes de conducta alimentaria muestran diferencias significativas entre niñas y niños, en donde para la dimensión de “alimentación emocional” (medido con el cuestionario TFEQ-P19) los niños presentan mayores puntajes ($p=0.01$). Por otro lado, las niñas presentan mayores puntajes en las dimensiones de “lentitud al comer” y el “índice saciedad/lentitud” (medido a través del cuestionario CEBQ) ($p=0.001$ y $p=0.01$ respectivamente) (Tabla II).

Tabla I Variables antropométricas en niñas/niños obesos Chilenos.

	Niñas (n=99)	Niños (n=122)
	Promedio ± DS	Promedio ± DS
Edad (años)	9.5 ± 2.4	9.6 ± 2.4
IMC puntaje Z	2.1 ± 0.3	2.1 ± 0.3
Peso puntaje Z	2.1 ± 0.4	2.2 ± 0.6
Altura puntaje Z	0.3 ± 0.8	0.6 ± 0.9*
Waist-to-height ratio	0.61 ± 0.05	0.61 ± 0.05
Leptina sérica (ng/ml)	29.1 ± 16.8	31.8 ± 21.3
Receptor soluble de leptina (ng/mL)	32.5 ± 6.9	32.4 ± 7.3
Relación leptina/RSleptina	0.97 ± 0.6	1.1 ± 0.8

*p=0.01.

Niveles séricos de leptina

Los niveles séricos de leptina se asocian significativamente con el IMC en niñas ($r = 0.65$; $p = 0.0001$) y niños ($r = 0.59$ $p = 0.0001$) (datos no mostrados). Debido a que el IMC se relaciona con la edad y el peso, la asociación entre niveles séricos de leptina y los puntajes Z del IMC también es significativa (niñas $r = 0.38$ $p = 0.01$; niños $r = 0.27$ $p = 0.02$), pero en un nivel menor que el encontrado para el IMC (datos no mostrados).

Asociación de las variantes genéticas con mediciones antropométricas y puntajes de la conducta alimentaria

El microsatélite (CTTT)n del gen de leptina muestra una asociación con la conducta alimentaria, donde las niñas portadoras del alelo clase II presentan puntajes más altos en la dimensión “lentitud para comer” en relación con las no portadoras ($p = 0.04$) sin embargo, esta diferencia no se observa en los niños portadores del alelo clase II ($p = 0.31$) (datos no mostrados).

Por otro lado, en la Tabla III se observa la asociación entre polimorfismos de LEPR y puntajes de conducta alimentaria en niños obesos. Se observa que existe una diferencia significativa entre los niños portadores de la variante 109Arg de LEPR para la dimensión de “alimentación emocional” en relación a los no portadores ($p = 0.02$). Adicionalmente, los niños portadores de la variante 223Arg presentan puntajes más altos de la dimensión “alimentación sin control” que los no portadores ($p = 0.04$) y “disfrute de los alimentos” ($p = 0.03$). Los portadores de la variante 656Asn comparado con los no portadores presentan valores más altos en la dimensión respuesta a la saciedad ($p = 0.03$).

En las niñas anañizadas (Tabla IV), también se observan diferencias significativas entre las portadoras de la variantes 223Arg y las no portadoras en la dimensión “deseo de beber” ($p = 0.04$) y en las portadoras de la InsCTTTA versus la no portadoras para la dimensión “respuesta de saciedad” ($p = 0.02$).

Después de la corrección por comparaciones múltiples, no se observa una diferencia estadísticamente significativa entre polimorfismos de LEP, LEPR y puntajes de conducta alimentaria, ya sea medida a través del cuestionario CEBQ o TFEQP-19.

Asociación de polimorfismos de LEPR con variables antropométricas

Para las variantes genéticas de LEPR se encontraron diferencias entre genotipos y variables antropométricas: las niñas portadoras de alelo 656Asn de LEPR presentan un menor puntaje Z para el peso y la relación cintura/estatura que las no portadoras ($p = 0.03$), diferencia que no se observa en niños ($P = 0.25$, y 0.54 , respectivamente). Adicionalmente, los niños portadores del alelo 109Arg de LEPR presentan un menor puntaje Z para la altura comparado con los no portadores ($p = 0.04$), las niñas no muestran dichas diferencias ($p = 0.33$).

Asociación entre polimorfismos de LEP y LEPR con obesidad en un caso de tríos caso-progenitor

La asociación entre variantes genéticas de LEP y LEPR con obesidad se determinó, mediante el test de desequilibrio de transmisión (TDT). No se observan diferencias significativas en la transmisión de los alelos de los diferentes polimorfismos analizados. Si embargo para la variante Lys656Asn se observa una diferencia levemente significativa en la transmisión alélica de los padres heterocigotos a los hijos obesos, con una probabilidad de transmisión de 38% ($P = 0.05$). Sin embargo, al analizar por comparaciones múltiples no se observa dicha asociación.

Por otro lado, el análisis de los haplotipos de las variantes de LEPR, no muestra una diferencia estadísticamente significativa asociada con obesidad en ninguno de los polimorfismos estudiados.

Los niveles séricos de leptina no muestran una diferencia estadísticamente significativa en la asociación con los puntajes de conducta alimentaria ajustados por edad, género e IMC.

Todas las frecuencias genotípicas estudiadas concuerdan con el equilibrio de Hardy-Weinberg.

Discusión

En este estudio se estableció una asociación significativa entre polimorfismos de LEPR: Lys109Arg,

Table III
Puntajes de conducta alimentaria distribuida por portador del alelo alternativo de polimorfismos de LEPR en niños obesos

	109Arg			223Arg			656Asn			Ins CTTTA		
	P	NP	vp	P	NP	vp	P	NP	vp	P	NP	vp
TFEQP-19	n=30	n=60		n=62	n=28		n=30	n=60		n=36	n=54	
Restricción cognitiva	2.1	2.2	0.34	2.1	2.2	0.94	2.2	2.1	0.60	2.2	2.1	0.58
Alimentación emocional	2.6	2.3	0.02*	2.4	2.5	0.56	2.4	2.4	0.75	2.5	2.4	0.28
Alimentación sin control	2.7	2.5	0.41	2.7	2.4	0.04*	2.4	2.7	0.08	2.5	2.6	0.55
CEBQ	n=24	n=43		n=43	n=24		n=25	n=42		n=28	n=39	
Respuesta a los alimentos	3.8	3.2	0.08	3.6	3.2	0.29	3.1	3.6	0.09	3.3	3.6	0.32
Sobrealimentación emocional	2.6	2.7	0.86	2.7	2.6	0.74	2.6	2.7	0.72	2.8	2.6	0.51
Disfrute de los alimentos	4.1	4.0	0.02	4.1	3.7	0.03*	3.8	4.1	0.10	3.8	4.1	0.26
Deseo de beber	3.2	3.4	0.58	3.3	3.4	0.76	3.3	3.4	0.85	3.5	3.3	0.62
Respuesta de saciedad	2.0	2.2	0.24	2.0	2.3	0.24	2.3	2.0	0.03*	2.2	2.1	0.18
Lentitud para comer	1.6	1.7	0.45	1.7	1.6	0.52	1.6	1.7	0.55	1.6	1.7	0.40
Subalimentación emocional	2.0	2.2	0.60	2.2	1.9	0.31	2.0	2.2	0.55	2.0	2.2	0.74
Exigencia frente a los alimentos	3.2	2.7	0.07	2.9	2.9	0.91	2.8	2.9	0.88	2.8	3.0	0.49
**Índice saciedad/lentitud	1.8	1.9	0.12	1.8	1.9	0.63	1.9	1.8	0.13	1.9	1.9	0.84

portadores, NP: no portadores.

Gln223Arg, y Lys656Asn, con diferentes dimensiones de la conducta alimentaria tales como: “alimentación emocional”, “disfrute de los alimentos”, “alimentación sin control” y “respuesta a la saciedad”. Además, en el microsatélite de LEP también se encontró una asociación con la dimensión “lentitud para comer”. Estos resultados se relacionan con los encontrados por de Krom y cols¹⁹ y Dougkas y cols²⁰ donde diferentes variantes de LEP (rs4731413, rs4577902, rs2060736, rs7799039) se asociaron significativamente con algunas dimensiones de la conducta alimentaria relacionadas con la sensación de saciedad. Por otro lado, el polimorfismo de LEP rs21672709 y de LEPR Lys109Arg y Gln223Arg han sido asociados a otros patrones de conducta alimentaria como la preferencia hacia alimentos dulces, que es un factor de riesgo para desarrollar obesidad²¹. Dichos resultados indicarían que los genes de LEP y LEPR participan en la regulación de la conducta alimentaria y esta relación puede ser detectada a través del análisis de polimorfismos genéticos. Sin embargo, es importante considerar que, en nues-

tros resultados, al hacer el análisis por comparaciones múltiples no se observa una diferencia significativa, lo que puede deberse al tamaño de la muestra analizada del estudio.

En este estudio encontramos que la distribución de los puntajes de conducta alimentaria y su asociación con los polimorfismos de LEP y LEPR, presentan diferencias por género, lo que también se observó en el estudio de Mizuta y cols²¹ respecto a la preferencia de alimentos dulces. La conducta alimentaria está influenciada por diferentes factores socio-culturales, lo cual dificulta determinar la razón de las diferencias en puntajes de la conducta alimentaria encontradas entre niñas y niños obesos.

El hecho que existan asociaciones entre polimorfismos de LEP y LEPR con diferentes dimensiones de la conducta alimentaria concuerda con las funciones que dichos genes realizan a nivel cerebral, en donde existen diferentes motivaciones que regulan la conducta alimentaria, que no necesariamente se relacionan con el balance energético²². De esta manera las dimensiones

Table IV
Puntajes de conducta alimentaria distribuida por portador del alelo alternativo de polimorfismos de LEPR en niñas obesas

	109Arg			223Arg			656Asn			Ins CTTTA		
	P	NP	vp	P	NP	vp	P	NP	vp	P	NP	vp
TFEQP-19	n=34	n=35		n=51	n=18		n=19	n=50		n=21	n=48	
Restricción cognitiva	2.0	2.2	0.45	2.0	2.2	0.30	2.0	2.1	0.52	2.2	2.0	0.61
Alimentación emocional	2.1	2.3	0.24	2.1	2.5	0.06	2.2	2.2	0.81	2.2	2.2	0.95
Alimentación sin control	2.7	2.6	0.50	2.6	2.5	0.58	2.8	2.5	0.13	2.6	2.6	0.97
CEBQ	n=24	n=28		n=36	n=16		n=18	n=34		n=20	n=32	
Respuesta a los alimentos	3.2	3.6	0.16	3.5	3.3	0.49	3.5	3.3	0.56	3.2	3.6	0.40
Sobrealimentación emocional	2.9	2.7	0.53	2.9	2.7	0.55	3.0	2.8	0.50	2.8	2.9	0.81
Disfrute de los alimentos	4.1	4.2	0.37	4.2	4.0	0.55	4.2	4.1	0.56	4.1	4.2	0.66
Deseo de beber	3.5	3.3	0.64	3.6	2.9	0.04*	3.2	3.5	0.43	3.0	3.6	0.18
Respuesta de saciedad	2.3	2.0	0.39	2.3	2.0	0.56	2.2	2.2	0.69	2.5	2.0	0.02*
Lentitud para comer	2.4	2.1	0.18	2.3	2.2	0.90	2.4	2.2	0.45	2.5	2.1	0.09
Subalimentación emocional	2.6	2.5	0.69	2.6	2.4	0.41	2.5	2.5	0.93	2.7	2.5	0.30
Exigencia frente a los alimentos	2.8	2.7	0.96	2.9	2.6	0.67	2.8	2.8	0.95	2.8	2.8	0.88
**Índice saciedad/lentitud	2.3	2.0	0.12	2.3	2.1	0.63	2.3	2.2	0.13	2.5	2.0	0.84

P: portadores, NP: no portadores

* Los valores P fueron calculados utilizando el test de Mann-Whitney. ** El índice combinado de lentitud/saciedad se calculó promediando los puntajes de lentitud para comer y respuesta a la saciedad.

de “alimentación emocional” y “disfrute de los alimentos”, que nosotros encontramos asociadas con polimorfismos de LEPR, podrían explicarse porque la leptina modula la activación neuronal en regiones estriadas del cerebro, relacionadas con la sensación de gratificación de la comida (no homeostáticas), debido a la acción directa de la leptina sobre los centros de dopamina en el cerebro²³. En este sentido, se ha descrito que existe una mayor sensibilidad a la sensación de gratificación por la comida en personas obesas que en personas normopeso, posiblemente determinada por los niveles y actividad de receptores de dopamina en el cerebro²³.

Por otro lado, en relación con las dimensiones de “alimentación sin control”, “respuesta a la saciedad” y “lentitud para comer” que también encontramos asociadas a polimorfismos de LEP y LEPR, se explicarían debido a que en personas obesas existirían alteraciones en la respuesta a las señales internas de saciedad (homeostáticas) y una respuesta aumentada hacia los alimentos²⁴.

Las dimensiones de la conducta alimentaria están asociadas al peso corporal, se ha establecido que puntajes bajos de “respuesta a la saciedad” y “lentitud para comer”, así como puntajes altos de “disfrute de los alimentos” se asocian con altos niveles de adiposidad tanto en niños como adultos²⁵. Lo anterior concuerda con los resultados obtenidos en este estudio, donde variantes genéticas de LEP, LEPR estarían asociadas a estas dimensiones. Diferentes dimensiones medidas a través del CEBQ (“respuesta a la saciedad”, “disfrute de los alimentos”, “alimentación emocional”, y “exigencia frente a los alimentos”) estarían relacionadas con el peso corporal, puntaje Z de IMC y puntaje Z de circunferencia de cintura¹⁷. Lo anterior se relaciona con los resultados que encontramos en este estudio, donde se observó una asociación entre variantes genéticas de LEP y LEPR con estas dimensiones, y podrían considerarse los puntajes de CEBQ como marcadores de riesgo frente al peso corporal. Sin embargo, en este estudio no se notó una asociación entre polimorfismos

genéticos y obesidad en el estudio de casos-progenitores, lo que podría deberse al tamaño y las características de la muestra analizada. En este sentido, diferentes estudios han demostrado el componente genético de la obesidad, incluso diferentes genes han sido asociados con la variación del IMC en diferentes poblaciones. Sin embargo, un estudio que analiza 15 variantes genéticas en niños, estableció que cada una de dichas variantes permiten explicar el 1.12% de la variación total del puntaje Z del IMC²⁶. Lo anterior permite establecer que la búsqueda de factores genéticos que estén asociados con la obesidad es compleja, debido principalmente a que es un fenotipo altamente heterogéneo incluso entre miembros de una misma familia. Además, existe una contribución variable de la genética, ambiente y comportamiento.

Conclusión

En este estudio se encontraron asociaciones entre variantes genéticas de LEP y LEPR y ciertas dimensiones de la conducta alimentaria en niños obesos chilenos, lo que concuerda con el efecto que ejerce la leptina sobre ciertos centros cerebrales homeostáticos y no homeostáticos. Sin embargo, es importante realizar más estudios a futuro que involucren un mayor número de niños obesos estudiados.

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Original/*Obesidad*

Are subjects with criteria for adult attention-deficit/hyperactivity disorder doing worse after bariatric surgery? A case-control study

Joana Nicolau¹, Luisa Ayala¹, Carla Francés¹, Pilar Sanchís¹, Ivana Zubillaga¹, Salvador Pascual², Regina Fortuny³ and Lluís Masmiquel¹

¹Endocrinology and Nutrition Department. Hospital Son Llàtzer, University Institute of Health Sciences Research (IUNICS) and Health Research Institute of Palma. ²Surgery Department. ³Hormonal Laboratory Department. Hospital Son Llàtzer. Spain.

Abstract

Introduction: There is an increasing awareness of the strong associations between obesity and adult attention-deficit/hyperactivity disorder (ADHD), with high rates of ADHD (26-61%) in patients seeking weight loss.

Aims: To determine the frequency of ADHD in a bariatric surgery (BS) sample and investigate whether there were any differences among clinical, analytical and psychological parameters in individuals with criteria for ADHD.

Methods: Sixty patients (78.3% female, age 46.3±9.8, months since BS 46.28±18.1) who underwent BS, with a minimum follow-up of 18 months, were evaluated cross-sectionally. Initial and current BMI, eating patterns, comorbidity, socio-demographic and biochemical parameters were recorded. For the screening of ADHD, ADHD self rating scale-v1.1 was administered.

Results: Nineteen individuals (31.6%) had a positive screening for ADHD. This group had higher levels of HDL-cholesterol (62.8±17.3mg/dl vs 53.5±9.9mg/dl; p=0.011) and Apo-A (177.7±28.4mg/dl vs 154.9±34.7mg/dl; p=0.015), and an increased consumption of lipids (42.2±7.1% vs 36.7±8.3%; p=0.019). Subjects with ADHD symptoms had more difficulties in following visits after BS (52.6% vs 24.3%; p= 0.011). We could not find any differences in achieved BMI, depressive symptoms or quality of life.

Conclusions: Patients who met criteria for ADHD face significant difficulties with compliance in follow-up, but we could not find differences in major clinical outcomes. Surprisingly, these patients could have a protective lipid profile.

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Key words: Adult ADHD. Bariatric surgery. Obesity. HDL cholesterol. Depression.

Correspondence: Joana Nicolau.
Endocrinology and Nutrition Department.
Hospital Son Llàtzer.
Ctra. Manacor km 4.
07198, Palma de Mallorca (Balears). Spain.
E-mail: jnicolauramis@gmail.com

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¿TIENEN PEORES RESULTADOS LOS INDIVIDUOS CON CRITERIOS PARA TRASTORNO POR DÉFICIT DE ATENCIÓN/HIPERACTIVIDAD TRAS LA CIRUGÍA BARIÁTRICA? ESTUDIO DE CASOS Y CONTROLES.

Resumen

Introducción: Hay una creciente concienciación de la fuerte asociación entre la obesidad y el trastorno por déficit de atención/hiperactividad del adulto (TDAH), con elevadas tasas de TDAH (26-61%) en los pacientes que consultan por pérdida ponderal.

Objetivos: conocer la frecuencia del TDAH en una muestra de sujetos sometidos a cirugía bariátrica (CB) e investigar si existen diferencias clínicas, analíticas y psicológicas en estos sujetos.

Métodos: Sesenta pacientes (78.3% mujeres, edad 46.3±9.8, meses desde la CB 46.28±18.1) sometidos a CB, con un seguimiento mínimo desde ésta de 18 meses, fueron evaluados transversalmente. Se recogieron y analizaron el IMC inicial y en el momento de la evaluación, patrones alimentarios, comorbilidades, y parámetros sociodemográficos y bioquímicos. Para el screening del TDAH se administró la versión española del "ADHD self-rating scale v 1.1".

Resultados: Diecinueve individuos (31.6%) tenían un screening positivo para TDAH. Estos sujetos tenían niveles superiores de HDL colesterol (62.8±17.3mg/dl vs 53.5±9.9mg/dl; p=0.011) y Apo-A (177.7±28.4mg/dl vs 154.9±34.7mg/dl; p=0.015), y un consumo mayor de lípidos en la dieta (42.2±7.1% vs 36.7±8.3%; p=0.019). Estos sujetos tenían más dificultades en seguir las visitas protocolizadas tras la CB (52.6% vs 24.3%; p= 0.011). No se evidenciaron diferencias en el IMC alcanzado, síntomas depresivos o calidad de vida.

Conclusiones: Los pacientes sometidos a CB con criterios para TDAH presentan más dificultades en la adherencia al seguimiento, pero no se evidenciaron diferencias en resultados clínicos relevantes. Curiosamente, estos sujetos podrían presentar un perfil lipídico protector.

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Palabras clave: TDAH del adulto. Cirugía bariátrica. Obesidad. HDL-colesterol. Depresión.

Introduction

The prevalence of obesity is increasing worldwide and so are individuals who undergo bariatric surgery. In selected candidates, bariatric surgery offers positive effects on weight as well as on comorbidities related to obesity. However, the Swedish Obese Subjects study showed that 8.8% of the participants had lost less than 5% of their pre-surgery weight ten years after bypass surgery¹. Nowadays, risk factors which could contribute to unsuccessful weight loss or regaining of weight after bariatric surgery are poorly defined. Psychiatric disorders, with eating disorders and depression being the most evaluated ones, were early identified as potential risk factors for failed weight loss after bariatric surgery²⁻⁶. However, there have been contradictory results regarding the impact of psychiatric illness on the outcomes of obesity surgery. It has been suggested that psychiatric disorders directly related to obesity tend to improve or even resolve after weight loss is achieved. In contrast, psychiatric comorbidities not related to weight issues usually persist after surgery^{7,8}.

Patients with a greater number or moderate to severe intensity of psychiatric illness who have undergone bariatric surgery can face more difficulties in following recommendations and complying with prescribed drugs as well as with the follow-up visits⁹.

Attention-deficit hyperactivity disorder (ADHD) is a common, inherited neurological disorder, with onset in childhood that consists of signs of distractibility, impulsiveness and inattention¹⁰. Traditionally, it has been thought to be a childhood disorder, but it has been shown to persist into adulthood in up to 30 to 60 percent of the cases¹¹. In adults, however, the core symptoms are inattention, mood lability, hot temper, disorganization, stress sensitivity, restlessness and impulsivity¹². ADHD may coexist with a host of other psychiatric conditions, such as major depression, generalized anxiety and bipolar disorder¹³. In recent years, research has suggested that there is a link between obesity and ADHD^{14,15}. The first two studies highlighting this association were published in 2002. Both studies found a significantly higher than expected proportion of ADHD among adults seeking treatment for obesity, with a prevalence of 27.4%, a rate six-fold greater than reported for the general population. This prevalence increased up to 42.6% among those with class III obesity¹⁶.

Although results in the literature regarding pathways through which psychiatric conditions can negatively affect the outcomes after bariatric surgery are inconsistent, it is usually mandatory to assess for the presence of eating disorders and major depressive disorder before considering such intervention. However, other psychiatric problems, such as ADHD, can be overlooked. Moreover, ADHD has also been associ-

ated with altered eating patterns such as binge eating disorder and bulimia nervosa and substance abuse^{13,17}.

There are, at present, limited data regarding the potential negative effect of adult ADHD on post-operative compliance with recommendations and treatment and, as a result, weight loss maintenance.

Objectives

The aim of our study is to investigate whether there are any differences among psychological, metabolic, dietary and weight variables in individuals with ADHD symptoms when compared with subjects without criteria for ADHD, in a sample of obese patients who have undergone bariatric surgery.

Methods

Subjects

Patients with a minimum follow-up of twelve months after undergoing bariatric surgery were consecutively invited to participate in this study and a total of sixty subjects were included. The study was approved by the ethics committee of the hospital. Written informed consent was obtained from all patients prior to study participation.

Assessment of attention-deficit hyperactivity disorder symptomatology

Adult ADHD was assessed using standard self-report screening instruments. Participants rated current adult ADHD symptoms with the ADHD self-rating scale (ADHD-S), which includes the 18 DSM-IV items of inattention, hyperactivity and impulsivity on a four-point Likert-scale (0-3, "not at all" to "severe")¹⁸. The recommended cut-off of ≥ 15 was used to indicate that subjects met criteria for adult ADHD. This cut-off has a sensitivity of 77% and a specificity of 76% for adult ADHD¹⁹.

Assessment of comorbidity and quality of life

In order to rule out other psychiatric comorbidities, two further scales were used. The patients rated the severity of depressive symptoms by using the Spanish version of the Beck Depression Inventory (BDI)²⁰. The Spanish version of the Revised Questionnaire of Eating and Weight patterns was also self-administered to screen for binge eating disorder and other abnormal eating patterns²¹. In order to assess how changes after bariatric surgery had affected quality of life in these subjects, we used the SF-36 Health Survey Spanish version²².

Assessment of dietary habits and complications after bariatric surgery

In order to determine the proportion of macronutrients as well as the energy intake, a weekly dietary survey, including one weekend, was completed by all participants. A semi-structured interview regarding food intolerances was also performed by a nutritionist. Common problems after bariatric surgery, such as constipation, irregular menses, dumping syndrome, nausea or vomiting, dizziness, hair loss, nail frailty and early fullness were also registered.

Height and weight

Height and weight were measured while each participant was wearing indoor clothing without shoes. Body mass index (BMI) was calculated as weight divided by height squared.

Metabolic profile

Blood samples were drawn for the following analyses: fasting glucose, glycated hemoglobin (HbA1c), total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, apolipoproteins, ionogram, plasma creatinine, microalbuminuria, hepatic profile, albumin, 25OH vitamin D, Vitamins A, E, B1, B12, C and folic acid, serum cortisol, leptin, insulin and homocysteine. All measurements were made after an overnight fast (at least 8 hours fasting).

Other assessments

Initial weight and BMI were obtained from computerized medical history. Comorbidities related to obesity prior to surgery, such as diabetes, hypertension, dyslipidemia, sleep apnea syndrome, hyperuricemia,

as well as other psychiatric conditions were also recorded from computerized medical history.

Statistical Analysis

Data were analyzed using SPSS v.16 statistical software (SPSS Inc., Chicago, IL, USA). The estimated prevalence rates of adult ADHD were calculated using the suggested cut-off score of ≥ 15 for the ADHD-S scale. Differences between ADHD groups were compared using non parametric tests (Mann-Whitney U-tests) for continuous variables and chi-squared tests for categorical variables. A p-value < 0.05 on the two-tail was considered to indicate statistical significance.

Results

All sixty participants had undergone a laparoscopic Roux-en-Y gastric bypass. Forty-seven participants (78.3%) were female. The mean age of the patients was 46.35 ± 9.9 years and the mean follow-up after bariatric surgery was 46.48 ± 28.21 months. The mean pre-surgical BMI was 48.35 ± 7.46 kg/m² and, at the time of the evaluation, the mean BMI had decreased to 33.67 ± 6.15 kg/m². Forty-seven out of sixty (78.3%) patients were married. In terms of employment status, 48.3% of the total sample had a stable job and the remaining 51.7% were unemployed or retired. Only five participants (8.3%) had a university degree.

Nineteen (31.6%) of the sixty subjects met criteria for ADHD. No significant differences in gender, age, mean follow-up since bariatric surgery, initial BMI, type of bariatric surgery, labor situation, marital status or educational level were found between patients who met criteria for adult ADHD and patients without this condition. These data are summarized in table I.

In addition, no differences were seen in terms of comorbidities related to obesity, such as type 2 Diabetes,

Table I
Comparison of demographic characteristics between the group with criteria for ADHD and the group without this comorbidity

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
Gender (% female)	78.9	78	NS
Age (years)	46.8 ± 8.6	46.1 ± 10.5	NS
Type of bariatric surgery (% Roux-en-Y)	94.74	78.81	NS
Months since bariatric surgery	50.95 ± 16	44.41 ± 19	NS
Presurgical BMI (kg/m ²)	45.84 ± 4.39	49.51 ± 8.31	NS
Employment status (% unemployed)	68.42	53.9	NS
Marital status (% married)	68.42	82.93	NS
Educational level (% university degree)	10.53	7.32	NS

hypertension, dyslipidemia, sleep obstructive apnea or hyperuricemia.

HDL cholesterol levels were significantly greater in subjects who screened positive for ADHD (62.84±17.35mg/dl vs 53.59±9.92mg/dl; p=0.011). Furthermore, apolipoprotein A levels were also higher in this group (177.79±28.48mg/dl vs 154.94±34.77mg/dl; p=0.015). No differences in other biochemical parameters were found. Data are shown in table II.

Subjects with a positive screening for ADHD consumed a greater proportion of lipids in their diet (42.2±7.12% vs 36.76±8.34%; p=0.019) and a lesser percentage of carbohydrates (36.99±9.48% vs 44.43±9.75%; p=0.009). Moreover, the proportion of mono and polyunsaturated lipids was significantly greater in people with ADHD (66.56±13.44% vs

43.9±16.49%; p<0.001). Subjects with ADHD were more likely to consume alcoholic beverages (p=0.003). The mean time used in main meals intake was lower in the group with an abnormal ADHD test (13.89±9.99 minutes vs 20.49±11.55 minutes; p=0.036). Subjects with ADHD were also more prone to graze (63.2% vs 34.1%; p= 0.035). Data are shown in table III.

However, there were no significant differences in either terms of food intolerances or in problems directly related to bariatric surgery.

Before bariatric surgery, individuals with ADHD had a more frequent personal history of psychiatric illnesses (84.2% vs 48.8%; p= 0.009), with major depressive disorder (n=12) and anxiety (n=5) being the most prevalent. Furthermore, after bariatric surgery, there was a greater tendency to develop eating disorder

Table II

Comparison of biochemical characteristics between the group with criteria for ADHD and the group without this comorbidity

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
Fasting glucose (mg/dl)	86.95±10.33	95.49±28.8	NS
HbA1c (%)	5.38±0.51	5.68±0.99	NS
Total cholesterol (mg/dl)	178.58±42.88	171.56±26.17	NS
LDL-cholesterol (mg/dl)	96.05±38.86	97.98±22.08	NS
HDL-cholesterol (mg/dl)	62.85±17.35	53.51±9.92	p=0.011
Tryglicerides (mg/dl)	97.84±31.8	104.7±52.87	NS
Apolipoprotein A (mg/dl)	177.79±28.48	154.94±34.77	P= 0.015
Apolipoprotein B (mg/dl)	85.25±26.23	90.63±23.91	NS
Lipoprotein a (mg/dl)	31.57±30.5	28.68±26.73	NS
Homocysteine (mMol/l)	13.39±3.95	14.66±5.78	NS
Ultrasensible CRP (mg/dl)	0.18±0.2	0.44±0.96	NS
Leptin (ng/ml)	38.54±20.58	41.18±24.56	NS
Albumin (g/dl)	4±0.79	4±0.32	NS

Table III

Comparison of dietary habits and current BMI between the group with criteria for ADHD and the group without this comorbidity

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
% lipids in diet	42.2±7.12	36.76±8.34	p=0.019
% carbohydrates in diet	36.99±9.48	44.43±9.75	p=0.009
% mono/ polyunsaturated fat	66.56±13.44	43.9±16.49	P<0.001
Alcohol intake ≥3 times per week (% people)	36.8	17	p=0.003
Minutes used for mail meals intake	13.89±9.99	20.49±11.55	p=0.036
% individuals with grazing	63.2	34.1	p= 0.035
Current BMI (kg/m ²)	32.19±7.14	34.36±5.59	p=0.205

ders in the group with ADHD (52.6% vs 21.9%; $p=0.059$).

However, patients with ADHD did not have more depressive symptoms when compared with individuals without criteria for ADHD.

On the other hand, when assessing quality of life in these group of individuals with ADHD, general health was the only domain with a lower score compared with non-ADHD individuals (59.63 ± 24.05 vs 72.87 ± 21.44 ; $p=0.037$).

The only two subjects in our sample who met criteria for Night Eating Syndrome also screened positive for ADHD.

After bariatric surgery, ADHD subjects had more difficulties in following the standardized visits according to our hospital's protocol for bariatric surgery (52.6% vs 24.3%; $p=0.011$). Despite this, however, there were no differences between the two groups in achieved BMI (32.19 ± 7.14 kg/m² vs 34.36 ± 5.59 kg/m²; $p=0.205$). Data are summarized in table IV.

Discussion

The prevalence of individuals with a positive screening for ADHD in our sample of 60 obese subjects who underwent bariatric surgery was 31.6%. We found that this group of patients was significantly associated with psychiatric comorbidity, both pre- and post-surgery. Moreover, these individuals were more prone to graze, consume alcohol regularly and were less able to follow the scheduled visits established for this type of intervention. Despite this, we found no association between the presence of ADHD and clinical outcomes such as the lowest BMI achieved. On the other hand, patients with a positive screening for ADHD had higher proportion of lipids in their diet, specifically mono and polyunsaturated fats. Moreover, these sub-

jects had greater levels of HDL cholesterol and apolipoprotein A.

In our study, the proportion of individuals who screened positive for ADHD was comparable with the results of other studies that have assessed this condition in a clinical setting. These studies reported prevalence rates of adult ADHD between 27.4% and 38.2%, finding even greater rates in patients with BMI ≥ 40 kg/m² (42.6%)¹⁶.

In the current study, there was a strong association between adult ADHD and different disordered eating patterns, either BED or bulimia nervosa or non-specific eating disorders such as grazing or night eating syndrome. When taking into account eating disorders separately, there was a higher proportion of BED in the ADHD group (36.8% vs 14.6%; $p<0.05$). General population studies have found clear associations between BED and adult ADHD, suggesting that dysregulated eating could be a potential pathway between ADHD and obesity^{14,17}.

Since all the studies published so far which point to an association between obesity and ADHD are cross-sectional, this important factor has restricted exploring an explanation of the causality between ADHD and obesity^{14-16, 23, 24}. It has been suggested that obesity and ADHD share biological mechanisms such as the "reward deficiency syndrome". This condition is characterized by an insufficient dopamine-related natural reward that leads to the use of "unnatural" immediate rewards such as substance use and inappropriate eating. Different studies have found dysfunctions of the dopamine receptor D2 and D4 in both obese and ADHD patients. It has therefore been suggested that food could be used as a form of self-medication in subjects with ADHD^{17, 25}. The "reward deficiency syndrome" mentioned above could also explain the greater alcohol consumption in this population.

As depressive disorder is well known to occur more often in obese individuals and might be erroneously

Table IV
Comparison of psychological features between the group with criteria for ADHD and the group without this comorbidity

	Adult ADHD (n= 19)	No ADHD (n=41)	P value
Presurgical psychiatric comorbidities (% subjects)	84.2	48.8	$p=0.009$
% individuals with postsurgical positive eating disorder criteria	52.6	21.9	$p=0.059$
% individuals with positive screening for depression (BDI ≥ 16)	26.3	24.4	NS
General health (SF-36)	59.63 ± 24.05	72.87 ± 21.44	$p=0.037$
Mental health (SF-36)	51.58 ± 13.96	60.59 ± 23.61	NS
Bodily pain (SF-36)	64.79 ± 25.35	71.15 ± 23.78	NS
Vitality (SF-36)	60.79 ± 22.1	65 ± 24.44	NS
Social Functioning (SF-36)	76.18 ± 27.23	81.65 ± 25.77	NS
% subjects with adherence to protocol	52.6	24.3	$p=0.011$

misdiagnosed as ADHD, we also screened for depression. We found no differences in the prevalence rate of depressive symptoms between the groups in our study and, therefore, the observed symptoms of ADHD could not be explained. Furthermore, we could not find differences between the groups in terms of quality of life. To our knowledge, there are no studies addressing this issue between both populations.

We also observed a greater proportion of individuals in the ADHD group who had difficulties in following the standardized program according to our hospital's protocol for bariatric surgery. Nonetheless, despite all these findings, we could not prove any differences in terms of clinical outcomes such as achieved BMI, post surgical complications or nutritional deficiencies. There are, at present, no studies assessing the potential disruptive effect of adult ADHD on post-operative compliance and weight loss maintenance among bariatric patients.

On the other hand, when we analyzed the dietary habits, we found that the group with ADHD consumed a greater proportion of lipids in their diet, particularly mono and polyunsaturated fats. In the eighties, some investigators observed signs of fatty acid deficiency in children with ADHD²⁶; thereafter, some other studies showed lower omega-3 PUFA levels in children with ADHD compared with controls. There is evidence that this molecule is required for nerve cell myelination and is thus critical for neural transmission²⁷. Randomized controlled trials have found controversial results that can be explained by differences in selection criteria, sample size, dosage and nature of the omega-3 PUFA supplement as well as duration of this supplementation²⁸⁻³⁰. As far as we know, there are no studies assessing the effects of omega-3 PUFA supplementation in adults with ADHD. This eating pattern could respond to an unconscious way to supply a deficit of a molecule, as a natural self-medication. Consecutively, the greater consumption of mono and polyunsaturated fats and, probably, the higher proportion of alcohol intake, could be a reasonable explanation for the higher levels of HDL-cholesterol in this group of patients. However, more studies are needed before establishing conclusions regarding this theory.

This is the first study assessing post-bariatric surgery outcomes on patients with a positive screening for ADHD after a bariatric surgery. However, there are limitations to acknowledge. The cross-sectional nature of our data precludes causal conclusions; however, temporal precedence of ADHD over obesity is likely. We did not assess retrospectively a positive childhood diagnosis, although we assume it to be a disease of childhood onset which persists into adulthood. Another limitation is the use of self-report instruments which have a sensitivity and specificity of 75-88%, resulting in the possibility of identifying false-negative and false-positive cases. However, the assessment

methods used in this study have been validated extensively and have been used in other clinical and community-based samples.

The comorbidity between severe obesity and adult ADHD, alone or in combination with another psychiatric disorder, might have important clinical implications. As there is sufficient evidence for impaired weight loss of individuals with adult ADHD in non-surgical weight loss treatments, the assessment of adult ADHD in subjects presenting for bariatric surgery should be taken into account. The dietary regime after this type of surgery requires major changes in lifestyle and eating patterns to ensure proper weight loss and minimize the risk of nutritional deficiencies. Patients with adult ADHD may find difficulties in following severe dietary regimens, behavioral recommendations, medical treatment or programmed medical visits. Although it is mandatory to assess and help patients with psychiatric problems before surgery, it may be even more important to plan for prolonged follow-up and support after surgery, in order to improve clinical and psychological aspects. In this way, in order to offer successfully a proper and individualized follow-up after the intervention, we believe that adult ADHD should be ruled out before bariatric surgery as a part of the psychological evaluation.

In conclusion, this study showed that the prevalence of adult ADHD in a bariatric surgery sample is considerable enough to take into account its screening before surgery. A substantial number of patients with adult ADHD present with abnormal eating patterns as well as difficulties in following scheduled clinical visits; however, we could not find any differences in post-surgery clinical outcomes among patients with or without ADHD. On the other hand, we demonstrated higher levels of HDL cholesterol that could be related to the greater amount of mono and polyunsaturated lipids in the diet of patients with ADHD. More research regarding the effect of adult ADHD after bariatric surgery and the role of omega-3 PUFA on this type of psychiatric disorder is warranted.

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Conflict of interest

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Original/*Obesidad*

Biomarkers of the prothrombotic state in abdominal obesity

Marcela Montilla¹, María José Santi², María A. Carrozas³ and Félix A. Ruiz¹

¹Department of Biomedicine, Biotechnology and Public Health. University of Cádiz, Spain. ²Research Group on Nutrition: Molecular, pathophysiological and social issues. University of Cádiz, Spain. ³San Carlos Hospital, Cádiz, Spain.

Abstract

Introduction: Central obesity is specifically associated with cardiovascular disease. Nevertheless, the molecular events that promote these conditions remain incompletely defined and risk stratifying patients for cardiovascular disease continues a challenge.

Objective: The aim of this study was to assess some cost-efficient haemostatic markers, and its association with central obesity and traditional cardiovascular risk factors, in a cohort of middle aged subjects, without clinical cardiovascular disease, as basis for an improved prevention and intervention.

Methods: We studied 307 men, aged 45±7 years, which underwent medical history, physical examination, anthropometric measurements, plasmatic biochemical parameters, plasma concentrations of fibrinogen, prothrombin activity, activated partial thromboplastin time, platelet count and mean platelet volume.

Results: Prothrombin activity values were significantly higher in patients with central obesity (103 ± 16 % vs 111 ± 17 %, p<0.001). Across tertiles of fibrinogen (low and high), there was an increase in cholesterol, adjusted for age and body mass index (4.9±0.9 mmol/L vs 5.4±1.1 mmol/L, p< 0.01). High tertile of prothrombin activity showed higher levels of cholesterol (4.8±1.0 mmol/L vs 5.4±0.9 mmol/L, p<0.05), triglycerides (1.07±0.6 mmol/L vs 1.32±0.9 mmol/L, p< 0.05), and waist circumference (92.8±8.3 cm vs 96.5±8.8 cm, p= ns). Mean values of cholesterol were higher in low-activated partial thromboplastin time (5.3±0.9 mmol/L vs 4.9±1.1 mmol/L, p<0.01). Participants in the high-mean platelet volume tertile showed higher levels of glycemia (5.7±0.6 mmol/L vs 5.99±0.7 mmol/L, p<0.05). Significant positive correlations were observed between fibrinogen and cholesterol (r=0.198, p<0.001) and triglycerides (r=0.116, p<0.05). Prothrombin activity was positively correlated with waist circumference (r=0.156, p<0.05), glucose (r=0.227, p<0.001), cholesterol (r=0.270, p=0.001), triglycerides (r=0.187, p=0.001) and mean platelet volume (r=0.130, p=0.05). Activated partial thromboplastin time was inversely related cholesterol (r=-0.172, p<0.01) concentra-

BIOMARCADORES DE ESTADO PROTROMBÓTICO EN LA OBESIDAD ABDOMINAL

Resumen

Introducción: La obesidad central está especialmente asociada con la enfermedad cardiovascular. No obstante, los mecanismos moleculares que la promueven no están completamente definidos y la estratificación del riesgo de los pacientes para la enfermedad cardiovascular sigue siendo un reto.

Objetivo: Evaluar la asociación de la adiposidad central con marcadores hemostáticos coste-eficientes y con los factores de riesgo cardiovascular tradicionales en una cohorte de varones de mediana edad sin enfermedad cardiovascular clínica con objeto de mejorar la prevención y la intervención.

Métodos: Estudiamos 307 varones de 45±7 años, a los que se realizó historia clínica, examen físico, mediciones antropométricas y determinaciones plasmáticas bioquímicas y de fibrinógeno, actividad protrombina, tiempo de tromboplastina parcial activada, recuento de plaquetas y volumen plaquetario medio.

Resultados: Los valores de actividad protrombina fueron significativamente más elevados en pacientes con obesidad central (103 ± 16 % vs 111 ± 17 %, p<0.001). Los sujetos con cifras de fibrinógeno en el tercil alto presentaban un aumento en las concentraciones plasmáticas de colesterol (4.9±0.9 mmol/L vs 5.4±1.1 mmol/L, p< 0.01), ajustado por edad e índice de masa corporal. El tercil alto de actividad protrombina mostró concentraciones más elevadas de colesterol plasmático (4.8±1.0 mmol/L vs 5.4±0.9 mmol/L, p< 0.05), triglicéridos (1.07±0.6 mmol/L vs 1.32±0.9 mmol/L, p<0.05), and medida de la circunferencia de la cintura (92.8±8.3 cm vs 96.5±8.8 cm, p= ns). Las concentraciones medias de colesterol fueron más altas en el tercil bajo de tiempo de tromboplastina parcial activado (5.3±0.9 mmol/L vs 4.9±1.1 mmol/L, p<0.01). Los individuos en el tercil alto de volumen plaquetario medio presentaron glucemia más elevada (5.7±0.6 mmol/L vs 5.99±0.7 mmol/L, p<0.05). Se observaron correlaciones significativas positivas entre fibrinógeno y colesterol (r=0.198, p<0.001) and triglicéridos (r=0.116, p<0.05). La actividad protrombina estuvo positivamente correlacionada con la medida de la circunferencia de la cintura (r=0.156, p<0.05), glucemia (r=0.227, p<0.001), colesterol (r=0.270, p=0.001), triglicéridos (r=0.187, p=0.001) y volumen plaquetario medio (r=0.130, p=0.05). El tiempo de tromboplastina parcial activado estuvo inversamente relacionado con las concentraciones de colesterol (r=-0.172, p<0.01). El volumen plaquetario medio se correlacionó con las concentraciones de glucosa (r=0.170, p<0.01).

Correspondence: María José Santi.

Avda. Ana de Viya, 52,
11009-Cádiz, Spain.
E-mail: mariajose.santi@uca.es

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tions. Mean platelet volume rose with increasing glucose concentrations ($r=0.170$, $p<0.01$).

Conclusions: Haemostatic markers studied have shown association with abdominal adiposity and established cardiovascular risk factors. These markers are widely available, relatively inexpensive, and might allow risk stratifying patients for cardiovascular disease and the identification of hypercoagulable state in patients who might deserve preventive measures and are potential tools for assessing the impact of these measures.

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Key words: *Obesity. Cardiovascular diseases. Fibrinogen. Prothrombin.*

Abbreviations

PT: Prothrombin activity.

APTT: Activated partial thromboplastin time.

MPV: Mean platelet volume.

BMI: Body mass index.

WC: Waist circumference.

Introduction

Obesity has reached epidemic proportions in Western societies and is a strong risk factor for the development of cardiovascular disease. Central obesity is specifically associated with cardiovascular mortality and obesity is a significant risk factor for the development of arterial thrombosis and venous thromboembolism. Nevertheless, the molecular events that promote these conditions remain incompletely defined and risk stratifying patients for cardiovascular disease remains a challenge because many patients identified to be at low or intermediate risk experience a cardiovascular event^{1,2}.

For these reasons there has been considerable interest in identifying biomarkers that might improve the global risk prediction of cardiovascular disease. Among these, some haemostatic markers can be highlighted, such as fibrinogen, prothrombin activity (PT), activated partial thromboplastin time (APTT) and platelet activity measuring, like platelet count and mean platelet volume (MPV).

Fibrinogen, an acute phase reactant, is synthesized in the liver. It is an important component of the coagulation pathway and a major determinant of plasma viscosity³.

Clinical studies yield strong evidence that fibrinogen levels are increased in obese and overweight individuals with abdominal fat distribution. A positive correlation has been observed between body index mass (BMI), insulin resistance, metabolic syndrome and fibrinogen⁴.

The PT and APTT are globally accepted parameters for assessing the activity of extrinsic and intrinsic coagulation pathways⁵.

Conclusiones: Los marcadores hemostáticos estudiados se asocian con la adiposidad abdominal y con los factores de riesgo cardiovascular establecidos. Estos marcadores están disponibles en clínica, son asequibles y podrían ser de ayuda en la estratificación del riesgo cardiovascular de los pacientes y en la identificación del estado hipercoagulable en personas que podrían beneficiarse de medidas preventivas. Además de ser herramientas potenciales para evaluar el impacto de dichas medidas.

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Palabras Clave: *Obesidad. Enfermedad cardiovascular. Fibrinógeno. Protrombina.*

The clinical significance of short APTT has gained interest recently, since it might be considered as a marker for hypercoagulability. A shortened APTT has been related to an increase in thrombin generation, chest pain, acute myocardial infarction and risk of thrombosis⁶.

On the other hand, platelets play a pivotal role in atherothrombosis. Activation of platelets at the site of vascular injury is central to the pathogenesis of occlusive arterial disease. Studies on platelet function have aroused interest since the advent of novel treatment modalities such as antiplatelet drugs and stents⁷.

Platelet count and MPV are markers of platelet activation widely available in clinical practice. Mean platelet volume is a potential marker of platelet reactivity. Larger platelets are younger, more reactive and have greater prothrombotic potential. Furthermore, higher MPV is observed in patients with diabetes mellitus, hypertension, hypercholesterolemia, smoking and obesity⁸. Although measuring platelet activity has been reported to identify individuals at increased risk for cardiovascular events, it remains a research tool that yet to be included in routine clinical decisions-making.

Objective

The aim of this study was to assess some cost-efficient hemostatic markers, such as plasma levels of fibrinogen, PT, APTT, platelet count and MPV, and its association with central obesity and traditional cardiovascular risk factors, in a cohort of middle aged subjects, without clinical cardiovascular disease, as basis for an improved prevention and intervention.

Methods

Study Population

This is a cross-sectional study involving 307 men from San Carlos Hospital, Cádiz, that attend employment medical examination, undertaken from March

to October 2011. The sample size was set in order to provide a specific relative precision of 3%, a 95% confidence interval, taking into account 5% of MVP ≥ 11.7 fL prevalence. All subjects were free of clinical acute or chronic disease in the medical record.

Anthropometry, blood pressure, health behaviors, hematology and biochemistry

Measurements were performed as described: height was determined using a mobile stadiometer (model Seca 217, Hamburg, Germany), body weight was recorded by a digital scale (model Seca 876, Hamburg, Germany), both measures were used to calculate body mass index (kg/m^2). Waist circumference (WC) was measured in a standing position, midway between the lower costal margin and the iliac crest, using a 2-metre non-stretch fiberglass tape. Central obesity was defined as a waist circumference ≥ 94 cm.⁹ Resting blood pressure was measured on the right arm, at the end of the physical examination with the participant sitting, using mercury sphygmomanometer. Smoking status (number of cigarettes per day), alcohol intake (g/day) and physical activity (exercise: number of hours per day) were evaluated by structured interview. We used the SCORE chart for cardiovascular risk estimation⁹. The following parameters were measured in fasting blood samples: glucose (plasma), cholesterol, triglycerides, uric acid (serum), platelet count and MPV (whole blood, EDTA anticoagulant). Fibrinogen, PT and APTT were assessed by an analyzer (STA compact- Diagnostica Stago, Asnieres, France) using the appropriate reagents (Roche Diagnostics, Basel, Switzerland)^{10,11}.

Statistical Analysis

Data analysis was performed using SPSS v19.0 (SPSS Inc., Chicago, IL, USA). If variables were not normally distributed, they were logarithmically transformed. Associations between risk factors and fibrinogen, PT, APTT, platelet count and MPV were assessed by grouping participants into tertiles of fibrinogen, PT, APTT, platelet count and MPV ($\leq 33^{\text{th}}$, $34\text{--}65^{\text{th}}$ and $\geq 66^{\text{th}}$ percentile). Means were compared by an ANOVA test or by Kruskal-Wallis test depending on the distribution of the data. A value of $p < 0.05$ was considered statistically significant. Spearman's correlation test and partial correlation coefficients were performed to analyze the linear relationship between variables.

Ethics

The study was approved by the ethics committee of our university and informed consent was obtained. The investigation conforms with the principles outlined in the Declaration of Helsinki.

Results

Characteristics of participants and cardiovascular risks factors are presented in Table I. Prothrombotic biomarkers of the patients with and without abdominal obesity are presented in Table II. Prothrombin activity values were significantly higher in patients with central obesity ($103 \% \pm 16 \%$ vs $111 \% \pm 17 \%$, $p < 0.001$). There were no statistically significant differences between the two groups with respect to fibrinogen, APTT, platelet count and MPV. Across tertiles of fibrinogen (low and high), there was an increase in cholesterol (the difference remained significant after adjusting for age and BMI) (4.9 ± 0.9 mmol/L vs 5.4 ± 1.1 mmol/L, $p < 0.01$), PT activity ($100 \pm 22 \%$ vs $111 \pm 19 \%$, $p < 0.001$) and a decrease in APTT (35 ± 11 s vs 32 ± 5 s, $p < 0.01$) (Table III).

High tertile of PT showed higher levels of cholesterol (4.8 ± 1.0 mmol/L vs 5.4 ± 0.9 mmol/L, $p < 0.05$),

Table I
Characteristics of the study subjects

<i>N</i> = 307	<i>Mean</i> $\pm$ <i>SD</i>
Age (years)	45.2 $\pm$ 7
WC (cm)	94.8 $\pm$ 9.2
BMI (kg/m^2)	27.5 $\pm$ 3.5
SBP (mmHg)	124 $\pm$ 14
DBP (mmHg)	71 $\pm$ 10
Smoking (n°c/d)	4.0 $\pm$ 8.2
Smoking (%)	26 %
Exercise (n° h/week)	1.3 $\pm$ 1.4
Any alcohol intake (%)	68%
Any alcohol intake (g/d)	10 $\pm$ 10
Glucose (mmol/L)	5.83 $\pm$ 0.83
Cholesterol (mmol/L)	5.18 $\pm$ 1.06
Triglycerides (mmol/L)	1.22 $\pm$ 0.88
Uric acid ($\mu\text{mol}/\text{L}$)	333 $\pm$ 65
Fibrinogen (g/L)	3.1 $\pm$ 0.8
PT (%)	106 $\pm$ 20
PT (s)	13.2 $\pm$ 3.1
PT(INR)	1.04 $\pm$ 0.77
APTT (s)	34 $\pm$ 9
Platelets count (n° /mm ³)	226 $\pm$ 49
MPV (fL)	10.7 $\pm$ 0.8
SCORE (%)	0.91 $\pm$ 1.35

Waist circumference, WC; body mass index, BMI; Systolic blood pressure, SBP; Diastolic blood pressure, DBP; Prothrombin time, PT; activated partial thromboplastin, APTT; Mean platelet volume, MPV.

Table II
Hemostatic biomarkers in normal men and in men with abdominal obesity (WC ≥94)

Variable	WC < 94	WC ≥94
n	175	132
Fibrinogen	3.0±0.7	3.2±0.8
PT	103± 16	111± 17*
APTT	34±10	34±11
Platelet count	225±45	231±51
MPV	10,6±0,9	10,7±0,8

Results are expressed as mean ± standard deviation. Fibrinogen (g/L); Prothrombin, PT (activity %); Activated partial thromboplastin, APTT(s); Mean platelet volume, MPV (fL); Platelet count (n°/mm³). Statistically significant: ANOVA *p<0.001.

triglycerides (1.07±0.6 mmol/L vs 1.32±0.9 mmol/L, p<0.05) and fibrinogen (2.94±0.86 g/L vs 3.36±0.93 g/L, p<0.001), adjusted for age and BMI, and lower of APTT (p<0.001) and higher WC (92.8±8.3 cm vs 96.5±8.8 cm, p=ns).

Mean values of fibrinogen (3.24±0.77 g/L vs 3.00±0.84 g/L, p<0.001), cholesterol (5.3±0.9 mmol/L vs 4.9±1.1 mmol/L, p<0.01) and PT (113±14 % vs 100±27%, p<0.001), adjusted for age and BMI, were higher in low-APTT tertile.

Participants in the high-MPV tertile showed higher levels of glycemia (5.7±0.6 mmol/L vs 5.99±0.7 mmol/L, p<0.05) and lower platelet count (251 ± 53 / mm³ vs 196 ±36 /mm³, p<0.001), after adjusting for age and BMI (Table IV).

There were no statistically significant differences between tertiles of prothrombotic biomarkers with respect to BMI and WC, although WC was higher in high-PT tertile, as already mentioned.

Table III
Cardiovascular risk markers across tertiles of fibrinogen, PT and APTT

	Fibrinogen		PT		APTT	
	Low ≤267	High ≥332	Low ≤100	High ≥113	Low ≤31.4	High ≥34.3
n	103	103	105	102	102	103
Age	44±6	46±7	44±7	45±7	46±7	44±6
BMI	27.3±3.5	27.8±3.6	27.1±3.5	27.5±3.3	27.7±3.3	27.5±4.3
WC	94.2±9.0	96.3±8.9	92.8±8.3	96.5±8.8	95.2±8.3	95.3±11.7
SBP	125±13	123±14	123±13	125±14	124±15	124±12
DBP	72±11	71±10	71±10	73±10	70±11	72±9
Smoking	3.3±6.9	5.6±9.4	4.4±8.8	4.9±9.4	4.5±9.4	4.2±8.3
Exercise	1.2±1.4	1.1±1.4	1.4±1.6	1.0±1.2	1.4±1.5	1.0±1.3
Alcohol	12±11	9±9	9±9	11±10	10±10	9±11
Glucose	5.8±1	5.8±0.8	5.7±1.1	5.9±0.6	5.9±1.0	5.7±0.5
Cholesterol	4.9±0.9	5.4±1.1**	4.8±1.0	5.4±0.9*	5.3±0.9	4.9±1.1**
TG	1.13±0.8	1.28±1.1	1.07±0.6	1.32±0.9*	1.12±0.9	1.28±0.9
Uric acid	327±59	339±77	315±59	344±77	344±71	327±65
Fibrinogen	2.36±0.27	4.05±0.74	2.94±0.86	3.36±0.93***	3.24±0.77	3.00±0.84***
PT	100±22	111±19***	88±16	125±14	113±14	100±27***
APTT	35±11	32±5**	37±14	31±4***	29.3±1.4	40.3±14
Platelet	223±45	227±50	236±52	218±46	222±52	229±51
MPV	10.5±0.9	10.8±0.9	10.4±0.8	10.8±0.8**	10.7±0.9	10.7±0.9
SCORE	0.73±1.05	1.14±1.40	0.79±1.2	1.14±1.78	1.21±1.68	0.60±0.80

Results are expressed as mean ± standard deviation. Waist circumference, WC; Body mass index, BMI; Systolic blood pressure, SBP; Diastolic blood pressure, DBP; Smoking (n°c/d); Exercise (n° h/week); Alcohol intake (g/d); Glucose (mmol/L); Cholesterol (mmol/L); Triglycerides, TG (mmol/L); Uric acid (μmol/L); Fibrinogen (g/L); Prothrombin time, PT (activity %); Activated partial thromboplastin, APTT(s); Mean platelet volume, MPV (fL); Platelet count (n°/mm³); SCORE (%). Statistically significant: (ANOVA adjusted for age and BMI: Cholesterol, Triglycerides, Fibrinogen, MPV). (Kruskal-Wallis: PT, APTT). * p<0.05, **p<0.01, ***p<0.001.

Tabla IV
Cardiovascular risk markers across tertiles of platelet count and MPV

	Platelet count		MPV	
	Low	High	Low	High
	≤203	≥241	≤10.2	≥11
n	103	103	101	102
Age	44±7	45±7	45.4±7.4	45.4±7.4
BMI	27.3±3.5	27.7±3.9	27.5±3.8	27.1±3.1
WC	94.0±9.4	95.1±8.7	94.2±9.1	93.6±8.0
SBP	122±13	123±14	125±15	122±13
DBP	69±10	71±10	70±11	69±10
Smoking	3.7±6.9	5.8±10.7	5.1±9.4	4.0±8.1
Exercise	1.4±1.5	1.0±1.4	1.0±1.3	1.6±1.6 *
Alcohol	9±9	10±9	10±12	10±8
Glucose	5.8±0.5	5.8±1.0	5.7±0.6	5.99±0.7 *
Cholesterol	5.2±1.1	5.1±1.0	5.1±0.9	5.2±1.1
TG	1.24±1.0	1.2±0.8	1.12±0.6	1.38±1.0
Uric acid	327±59	344±71	321±59	327±65
Fibrinogen	3.11±0.78	3.18±0.95	3.01±0.83	3.20±0.87
PT	107±23	104±19	105±20	107±20
APTT	34±11	34±10	105±20	107±20
Platelet	176±18	280±35	251±53	196±36 ***
MPV	11.0±1.4	10.1±1.2 ***	9.7±0.3	11.7±0.5
SCORE	0.92±1.69	0.92±1.20	1.14±1.86	0.86±1.09

Results are expressed as mean ± standard deviation. Waist circumference, WC; Body mass index, BMI; Systolic blood pressure, SBP; Diastolic blood pressure, DBP; Smoking (n° h/week); Exercise (n° h/week); Alcohol intake (g/d); Glucose (mmol/L); Cholesterol (mmol/L); Triglycerides, TG (mmol/L); Uric acid (μmol/L); Fibrinogen (g/L); Prothrombin time, PT (activity %); Activated partial thromboplastin, APTT(s); Platelet count (n°/mm³); Mean platelet volume, MPV (fL); SCORE (%). Statistically significant (ANOVA adjusted for age and BMI: Glucose, Platelet count, MPV). (Kruskal-Wallis: exercise). * p<0.05, **p<0.01, ***p<0.001.

Significant positive correlations were observed between fibrinogen and age, cholesterol (r=0.198, p<0.001) and triglycerides (r=0.116, p<0.05). With respect to cholesterol concentrations, the correlation remained significant after controlling for age and BMI (r=0.193, p=0.01). PT was positively correlated with WC (r=0.156, p<0.05), glucose (r=0.227, p<0.001), cholesterol (r=0.270, p=0.001), triglycerides (r=0.187, p=0.001) and MPV (r=0.130, p=0.05). APTT was inversely related to age and cholesterol (r=-0.172, p<0.01) concentrations. MPV rose with increasing glucose concentrations, controlling for age and BMI, (r=0.170, p<0.01) and platelet count was inversely related to MPV (Table V). None of the outcomes was related to tobacco use or alcohol intake, except higher exercise in high MPV-tertile (1.0±1.3 vs 1.6±1.6 p<0.05).

Discussion

The current study analyzed the complex interactions between haemostatic markers, platelet activity indicators, obesity and established cardiovascular risks factors, trying to provide scientific and clinically relevant information, in order to establish novel strategies in the prevention and treatment of atherothrombosis.

Mean fibrinogen levels (3.1±0.8 g/L) were similar to those reported for subjects without clinical cardiovascular disease ¹² and lower than those found in high cardiovascular risk population or patients with diabetes type 2 ^{13,14}.

Fibrinogen concentration was not positively related to abdominal adiposity in our study. A recently published article showed fibrinogen association with overweight and trunk obesity ¹⁵, although this associa-

Tabla V
Correlation test between established cardiovascular risk factors and haemostatic biomarkers

<i>Variable</i>	<i>Significant correlations</i>
Fibrinogen	Age (r=0.148, p<0.05), cholesterol (r=0.198, p<0.001), triglycerides (r=0.116, p<0.05), PT % (r=0.271, p<0.001), APTT (r= -0.195, p<0.001). *Cholesterol (r=0.193, p<0.01).
PT %	WC (r=0.156, p<0.05), glucose (r=0.227, p<0.001), cholesterol (r=0.270, p<0.001), triglycerides (r=0.187, p<0.001), fibrinogen (r=0.271, p<0.001), APTT (r=-0.386, p<0.001), MPV (r=0.130, p<0.05).
APTT	Age (r=-0.154, p<0.05), cholesterol (r=-0.172, p<0.01), fibrinogen (r=-0.195, p<0.001), PT % (r=-0.386, p<0.001), SCORE (r=-0.177, p<0.01).
Platelet count	MPV (r=-0.458, p<0.001). *MPV (r=-0.529, p<0.001).
MPV	Exercise (r=0.176, p<0.01), glucose (r=0.177, p<0.01). *Glucose (r=0.170, p<0.01).

Spearman's correlation coefficients. * Partial correlation coefficients controlling for age and body mass index. Waist circumference, WC; Exercise (n° h/week); Glucose (mmol/L); Cholesterol (mmol/L); Triglycerides, TG (mmol/L); Fibrinogen (g/L); Prothrombin time, PT (activity %); Activated partial thromboplastin, APTT(s); Mean platelet volume, MPV (fL); Platelet count (n°/mm³); SCORE (%).

tion was higher in women¹⁶ and our participants were all men. Consistent with DRUID study cigarette smoking was not significantly associated with fibrinogen.¹³

Cholesterol rose with increasing fibrinogen levels (p=0.007) (Table III) and fibrinogen levels have been correlated with early atherosclerotic changes of the carotid artery in young healthy adults with mean fibrinogen concentrations about 2.6 ± 0.05 g/L.¹² These fibrinogen levels are lower than those found in our participants with mean age 45±7 years. It has been suggested that in subjects with very low cardiovascular risk, fibrinogen levels might serve as early and highly valid predictors for the development of atherosclerotic disease¹⁷.

Different mechanisms have been identified by which fibrinogen might promote atherosclerosis. Fibrinogen can bind to endothelial cell receptors (ICAM-1) and trigger the release of vasoactive mediators. Fibrinogen has been shown to modulate endothelial cell permeability and smooth muscle cell proliferation.¹⁸ We found relationship between high cholesterol levels and increased PT activity and shortened APTT (Table 3 and 5). Other studies attribute a potential role to shortened APTT as haemostatic marker of hypercoagulable state and it could be a useful screening test applicable to clinical conditions¹⁹.

In our work PT was associated with abdominal obesity, glucose concentrations and triglycerides; and APTT with age and cholesterol. Lippi et al. showed that APTT values below the reference range (< 25.5 s) were significantly more frequent in diabetics than in normal subjects. In contrast to their findings, our results showed higher mean values of APTT (34.1±9.3 s) and they were not associated with glycemia. This could be explained by the lower age of our participants (45±7 years) compared to those of Lippi et al. (61 years).⁶ However, since PT and APTT are relatively

inexpensive tests, it might allow the identification of a subset of patients at major risk of thromboembolic complications who deserve more aggressive anti-thrombotic preventive measures.

Previous studies have reported increased fibrinogen levels with aging^{12, 13} and we observed significant correlation between age and haemostatic markers, fibrinogen and APTT. Although, in a recent experimental study, no age-dependent alteration in PT and APTT was recorded, suggesting comparable function among young and old mice⁵. The authors of this study propose that aging per se does not affect arterial thrombosis and that age-dependent vascular dysfunction in the absence of additional risk factors does not alter arterial thrombus formation. These findings underscores the importance of controlling modifiable risk factors in aged individuals.

Regarding platelet activity, our findings of MPV values (10.7±0.8 fL) were similar to those of others authors in healthy subjects who suggest that patients having a MPV beyond 11.7 fL should be evaluated for occlusive arterial diseases²⁰. This was the average MPV value of the high tertile in our study, in which we observed elevated levels of glucose. Mean platelet volume is simple, inexpensive, easy to interpret and routinely measured by automated cell counters. As compared with other markers of platelet activity, which require specialized equipment, MPV is a practical and prognostically important biomarker of cardiovascular disease⁸.

Our findings did not show significant differences between tertiles of MPV with regard to BMI and abdominal adiposity. However, in contrast to our results others studies have reported this association. Furthermore, platelet function is modulated by several key regulators of body weight and metabolism. For example, platelet-dependent thrombosis is increased by leptin,

and is decreased by adiponectin. One explanation for this could be the presence of the leptin receptor on platelets, which acts synergistically with ADP to promote platelet aggregation²¹⁻²³.

Accordingly, obesity is associated with increased platelet activation, an event that has implications for both thrombosis and inflammation. The inflammatory response related to fat accumulation may influence cardiovascular risk through its involvement in coagulation and atherosclerosis. Thus, clinical markers of a prothrombotic state may indicate a risk for development of complications of insulin resistance or metabolic syndrome in obese or not obese^{24, 25}.

Although a significant amount of data has emerged demonstrating an association of MPV with myocardial infarction and death in patients with established coronary artery disease, there is much less data in patients without coronary artery disease. In a prospective cohort study of 25,923 apparently healthy men and women followed up for more than 10 years, subjects with an MPV ≥ 9.5 were 50% more likely to develop a venous thromboembolism as compared with those with MPV < 8.5 ²⁶. In line with these findings, a large majority of individuals in our study would be in the range of risk (mean: 10.7 ± 0.8 fL). Additionally, a study of more than 39,000 subjects from the Danish general population demonstrated that higher MPV was associated with incident myocardial infarction and all-cause mortality²⁷.

A recently published meta-analysis showed that MPV was higher in patients with acute myocardial infarction (MPV = 9.2 fL) than in those without acute myocardial infarction (MPV = 8.5 fL).⁸ This analysis supports the hypothesis that platelet size may play a role in both the development and consequences of cardiovascular disease. Moreover, prognostic value of MPV has been validated in patients with decompensated heart failure (MPV > 10.5 fL) and pulmonary embolism (MPV > 10.9 fL)^{28,29}. It is likely that an increased MPV predates an acute myocardial infarction rather than results from it. As the average platelet lifespan in blood is 7-10 days, the vast majority of platelets sampled at the time of hospital admission for an acute myocardial infarction would have been circulating before the event. Recent genome-wide studies have identified loci involved with MPV and it is being studied the relationship between genetic determinants of MPV and cardiovascular phenotype³⁰.

In clinical practice, increased MPV may be of value to detect high-risk patients for future cardiovascular events and can be used as a diagnostic or prognostic measurements. The assessment of MPV could be useful for identifying patients who would benefit from antiplatelet therapy and prediction of ischemic events. It is known that clopidogrel significantly inhibits the ADP-induced increase in MPV and aspirin has no effect on platelet size⁷. Also, obesity is thought to cause resistance to antiplatelet therapy²⁴.

Regarding platelet count, we observed an inverse association with MPV and consistent with other

reports, platelet count was not associated with cardiovascular risks factors^{31, 32}. However, both measures were inversely related and high tertile of MPV showed higher glucose concentrations (adjusted for age and BMI) suggesting that they could play a role as possible risk indicator independent of plasma lipids and adiposity.

Study limitations

There were certain limitations in this study: First, the cross-sectional design with healthy men. It will be interesting to follow up the participants and to examine aging-related effects on haemostatic system in future investigations. Second, preanalytical factors such as anticoagulant used, timing of blood sample preparation and calibration of particle counters, which may have an impact on the measurement of MPV. However, as sample preparations did not vary within the study because all sample were processed in the same laboratory, we do not believe that this limitation significantly altered our results or the conclusions that should be drawn from them.

Conclusions

In conclusion, haemostatic factors studied have shown association with abdominal adiposity and established cardiovascular risk factors such as, plasma cholesterol and triglycerides, indicating that could be markers of cardiovascular risk. Mean platelet volume was significantly higher in subjects with increased prothrombin activity, showing potential prothrombotic effect. Also, subjects grouped in the highest tertile of MPV presented values that are considered predictive of cardiovascular disease. Since MPV is routinely measured as a platelet standardized parameter, we suggest MPV is a potentially useful cardiovascular risk biomarker. Haemostatic tests studied are widely available, relatively inexpensive, and might allow risk stratifying patients for cardiovascular disease and the identification of hypercoagulable state in patients who might deserve preventive measures. Finally, there is evidence that the lifestyles that promote weight reduction, smoking cessation and physical exercise, decrease platelet reactivity and coagulability and stimulate fibrinolysis. This translates into improved cardiovascular prognosis and therefore, haemostatic parameters studied are potential tools for assessing the impact of these measures.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship and /or publication of this article.

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Original/*Obesidad*

Influence of age and religious fasting on the body composition of Muslim women living in a westernized context

Marta López-Bueno¹, Emilio González-Jiménez¹, Silvia Navarro-Prado¹, Miguel A. Montero-Alonso² and Jacqueline Schmidt-RioValle³

¹Department of Nursing, Faculty of Nursing, Campus of Melilla, University of Granada, Spain. ²Department of Statistics and O.I., Faculty of Social Sciences, Campus of Melilla, University of Granada, Spain. ³Department of Nursing, Faculty of Health Sciences, University of Granada, Spain.

Abstract

Introduction: Currently there is some controversy to whether Ramadan fasting leads to changes in the nutritional status and body composition of females who observe this practice. Furthermore, recent research suggest that age may be an important factor that affects anthropometric values and body composition just before and at the end of Ramadan. The aim of our study was to analyze the effects of Ramadan fasting, as modulated by age, on the nutritional status and body composition of a group of Muslim female subjects living in a westernized context.

Material and Methods: A longitudinal study was carried out of 62 Berber Muslim females of ages ranging from 18 to 61 in the North African city of Melilla (Spain). The nutritional status was evaluated by anthropometry and their body composition studied by means of bioimpedance scales. These evaluations were performed before fasting began and again in the last week of Ramadan.

Results: The intermittent fasting produced important changes in the nutritional status and body composition of the female subjects. More specifically, there was a significant reduction ($p=0.000$) in total body weight values, BMI, body fat percentage measured by bioimpedance, and hip circumference ($p=0.008$). Significant differences were found ($p=0.000$) in anthropometric values and body composition before and at the end of Ramadan, depending on age.

Conclusions: All the subjects experienced significant changes in nutritional status and body composition at the end of Ramada. These changes were more pronounced in the group of women over thirty years of age. .

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Key words: Ramadan. Woman. Anthropometry. Bioelectrical impedance. Body composition.

Correspondence: Emilio González-Jiménez.
Department of Nursing.
Faculty of Nursing (Campus of Melilla).
University of Granada. C/Santander 1.
52071 Melilla. Spain.
E-mail: emigoji@ugr.es

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INFLUENCIA DE LA EDAD Y EL AYUNO RELIGIOSO SOBRE LA COMPOSICIÓN CORPORAL, EN MUJERES MUSULMANAS, EN UN CONTEXTO OCCIDENTALIZADO

Resumen

Introducción: Actualmente existe controversia acerca de si la práctica del Ramadán implica, o no, cambios en el estado nutricional y composición corporal en las mujeres que lo practican. Asimismo, estudios recientes sugieren que la edad puede constituir un factor influyente en los valores antropométricos y de composición corporal antes y al final del Ramadán. El objetivo de nuestro estudio fue analizar los efectos del ayuno practicado durante el Ramadán sobre el estado nutricional y la composición corporal en un grupo de mujeres que viven en un contexto occidentalizado, así como el efecto de la variable edad.

Material y Métodos: Se llevó a cabo un estudio longitudinal con 62 mujeres, bereberes y musulmanas, de edades comprendidas entre los 18 a 61 en la ciudad norteafricana de Melilla (España). El estado nutricional se evaluó mediante antropometría y el estudio de la composición corporal, a través de bioimpedancia. Estas evaluaciones se realizaron antes del inicio del ayuno y la última semana de Ramadán.

Resultados: El ayuno intermitente produce cambios importantes en el estado nutricional y en la composición corporal de las mujeres. Observándose una reducción significativa ($p=0.000$) en los valores del peso corporal total, índice de masa corporal, porcentaje de grasa corporal medida por bioimpedancia, y circunferencia de la cadera ($p=0.008$). Se encontraron diferencias significativas ($p=0.000$) en los valores antropométricos y de composición corporal, antes y al final del Ramadán, en función de la edad.

Conclusiones: Se observaron cambios significativos en el estado nutricional y en la composición corporal en todas las mujeres al finalizar el Ramadán. Estos cambios fueron más acusados en el grupo de mujeres mayores de treinta años.

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Palabras clave: Ramadán. Mujer. Antropometría. Impedancia bioeléctrica. Composición corporal.

Introduction

The observance of Ramadan is regarded as one of the five pillars of Islam and corresponds to the ninth month of the Islamic calendar. During this sacred month from sunrise until sunset, Muslims are required to abstain from sexual relations, smoking, drinking and eating. On average, it lasts twelve hours each day. In fact, certain authors regard Ramadan as a unique model of intermittent fasting¹.

During Ramadan, eating habits are modified² as well as social activity³ and sleep patterns^{4,5}. Given this unique context, it is interesting to study the effects of intermittent fasting on different aspects of human health⁶. Until now, most of the research on this subject has been conducted in countries where the majority of the population is Muslim.

Currently, there are few studies on this subject that have been carried out in Western countries in which city life is not affected by Ramadan. Not surprisingly, this makes it more difficult to reconcile religious obligations with day-to-day responsibilities⁷. In a Muslim society, it is still customary for females to prepare the food served from the time when fasting is broken until when the sun rises. They are also responsible for taking care of family members who are not required to observe Ramadan, such as children, the sick, and the elderly⁸. Evidently, this cumulative work overload may make it even more difficult for women to observe the fasting period. For this reason, it is necessary to ascertain the impact that Ramadan has on the nutritional status of Muslim women who live in westernized contexts, based on anthropometric parameters and body composition.

Body mass index is the direct measurement most recommended by international health organizations to define overweight and obesity⁹ because of its reliability, simplicity, and accurate correlation with body fat mass¹⁰⁻¹². Another procedure used to determine modifications in body composition after fasting is the study of skinfolds. By evaluating skinfolds with the Siri and Brozek formulas, it is possible to calculate the body fat percentage^{13,14}.

Moreover, waist measurement is another extremely useful anthropometric variable since it provides data regarding the body composition of the subject and more specifically, the volume of intra-abdominal fat¹⁵. In fact, it can offer accurate information regarding any modification of the intra-abdominal fat deposit after the fasting periods^{16,17}. Other parameters of interest in anthropometry and body composition are the waist-to-hip ratio (WHR) and the waist-to-height ratio (WHtR). Both are excellent indicators of abdominal adiposity in an individual^{18,19}.

Based on the previous considerations, the objectives of this study were the following: to determine whether this period of intermittent fasting modified the anthropometric values and body composition of the female subjects; to analyze the impact of age as a modulating

factor in anthropometric values and body composition immediately before and at the end of the Ramadan fasting period.

Material and methods

Study design and population

This research involved a longitudinal study of 62 Berber Muslim females of ages ranging from 18 to 61 (33.6 ± 12.7 years) in the North African city of Melilla (Spain) during the months of July and August in 2012 and 2013. For this purpose, the nutritional status of the subjects was evaluated by anthropometry and their body composition studied by means of bioimpedance scales. These evaluations were performed before fasting began and again in the last week of Ramadan. It was decided to divide the subjects into two groups: (i) women under thirty years of age; (ii) women over thirty years of age. The age threshold was based on the mean age at first childbirth in Spain (30.2 years), according to data published by the National Institute of Statistics in Spain in December 2012²⁰. The inclusion criteria for the study were that all subjects had to be Muslim females of legal age. They also had to be non-smokers and willing to voluntarily observe the Ramadan religious fasting. Pregnant women were excluded from the study. All of the participants received detailed information regarding the objectives of the study and gave their written informed consent. The study had been previously approved by the Ethics Committee of the University of Granada. This research was performed in strict compliance with the international code of medical ethics established by the World Medical Association and the Declaration of Helsinki.

Anthropometric measurements

The nutritional status of the subjects was assessed by means of anthropometry. The variables used for this evaluation were weight, height, and body mass index (BMI). Also analyzed were the tricipital, bicipital, subscapular, and suprailiac skinfolds, body fat percentage (BF%), waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR). This assessment was performed before the beginning and in the last week of Ramadan. The subjects were asked to come with an empty stomach and empty bladder. They also had to wear comfortable clothes, not have any metallic objects in contact with their skin, and not have practiced any intense physical exercise in 12 hours previous to the measurements.

The calculation of the total body weight and body composition was carried out with a Whole Body Composition Monitor (TANITA SC-330), which is self-calibrating with an accuracy of 100 grams. Height was measured with a portable stadiometer (TANITA®). The

subjects were asked to stand on the center of the base plate, feet together, and heels against the rod. Facing forward, their head was oriented so that the Frankfort Plane was in a horizontal position. The subjects' back and pelvis were kept as straight as possible in contact with rod. Once in that position, the measuring arm of the stadiometer was applied to the crown of their head. The subjects' height and weight measurements were used to calculate their BMI and thus classify their nutritional status as normal weight, overweight, or obese, according to the references values of the World Health Organization²¹.

The evaluation of the skinfolds was performed with a Holtain® skinfold caliper with an accuracy of 0.1-0.2 mm, following the prediction equations of Durnin & Womersley²². Each skinfold was measured three times by the same observer and the mean value was calculated. The waist and hip circumferences were measured with a flexible, inextensible metric measuring tape with an accuracy of 1mm. Waist circumference was measured midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Hip circumference was taken around the widest portion of the buttocks. Each circumference was also measured three times by the same observer and the mean value was calculated. The waist-to-hip ratio (WHR) was calculated by dividing the waist circumference measured in centimeters by the hip circumference also measured in centimeters. Values regarded as normal were 0.8 for females and 1 for males. The waist-to-height ratio (WHtR) was calculated by dividing the waist circumference measured in centimeters by the height in centimeters. Values regarded as normal were 0.4-0.5.

Body density was calculated by means of the following formula:

$$1,1567 - 0,0717 \times \text{Lg}10 \Sigma$$

(Tricipital, Bicipital, Subscapular, and Suprailiac)

The equations used to calculate the body fat percentage were those formulated by Siri¹³ and Brozek¹⁴:

$$\text{Siri} = [(4,95/\text{Density}) - 4,50] \times 100$$

$$\text{Brozek} = [(4,57/\text{Density}) - 4,142] \times 100$$

This study was carried out in compliance with the ethical guidelines and principles for biomedical research involving human subjects established by the World Medical Assembly (WMA) in the Helsinki Declaration (Finland 1994) and periodically revised in subsequent assemblies (the most recent being the 59th WMA held in Seoul, Korea in October 2008). After being informed about the objectives and details of the study, all subjects gave their informed written con-

sent. Current Spanish legislation that regulates clinical research in humans (Royal Decree 561/1993 on clinical trials) and the Personal Data Protection Act 15/1999 of 13 December guaranteed the total confidentiality of the collected data, which were made anonymous by the use of codes and only used for scientific purposes.

Statistical analysis

The analysis of the data was performed with the SPSS statistical software package, version 20.0 (IBM, Chicago, IL, USA) for Windows. The normality of the data was calculated with the Kolmogorov-Smirnov test, which showed that the variables had a normal distribution. A descriptive analysis of all of the variables was also performed. In relation to the study of anthropometric characteristics and body composition before and at the end of Ramadan, and according to age, a contrast of hypotheses was carried out for each of the variables in order to ascertain whether the mean value of the responses before and after could be regarded as equal. Given the fact that the samples were in pairs, the Student *t*-test was applied. A result was considered to be statistically significant when $p < 0,05$. Data were expressed as the mean (SD).

Results

Table I shows the percentages of change in the variables in reference to the initial (baseline) values. Something worth highlighting is the change in the BMI, waist and hip circumferences, body fat percentage measured with bioimpedance, and the bicipital skinfold. There was thus a significant reduction ($p=0.000$) in their total body weight, BMI, body fat percentage measured with bioimpedance, and hip circumference ($p=0.008$) from the beginning until the end of Ramadan. In contrast, there were no statistically significant differences for this period for the following variables: tricipital skinfold ($p=0.613$); bicipital skinfold ($p=0.069$); subscapular skinfold ($p=0.787$); suprailiac skinfold ($p=0.748$); waist circumference ($p=0.106$); and the body fat percentage calculated with the Siri and Brozek equations, WHR ($p=0.633$), and WHtR ($p=0.104$).

In regards to the two groups of ages (table II), the results reflected statistically significant differences ($p=0.000$) for all anthropometric and body composition parameters, except the waist-to-hip ratio, both before and at the end of Ramadan as well as according to the age of the subjects. In regards to weight, the younger group of women (< 30 years) lost an average of half a kilogram from the beginning to the end of Ramadan. In contrast, the older group (>30 years) experienced a greater weight loss of approximately two kilograms during this same period.

Table I
Anthropometric and body composition characteristics before and at the end of Ramadan.

	Before Ramadan				After Ramadan				% Change for baseline				<i>p</i> ^a
	Mean	(SE)	Minimum	Maximum	Mean	(SD)	Minimum	Maximum	Mean	(SD)	Minimum	Maximum	
Weight (Kg)	67.2	(14.12)	40.6	106.1	66.1	(14.98)	39.0	104.0	-1.6	(2.8)	-2.1	19.4	0.000
Tricipital skinfold (mm)	22.6	(6.37)	7.3	35.0	22.7	(6.63)	7.7	37.3	0.4	(9.4)	-24.1	18.0	0.613
Bicipital skinfold (mm)	12.9	(4.89)	4.2	24.3	12.3	(5.18)	5.0	27.0	-4.7	(18.2)	-66.6	43.6	0.069
Subscapular skinfold (mm)	20.8	(8.93)	7.1	39.7	20.9	(8.69)	7.0	40.3	0.5	(12.7)	-52.0	29.9	0.787
Suprailiac skinfold (mm)	22.3	(7.92)	6.1	41.3	22.4	(7.58)	6.5	40.2	0.5	(14.4)	-43.9	31.3	0.748
Waist circumference (cm)	90.1	(12.42)	66.3	123.0	89.4	(12.40)	64.2	127.5	-0.8	(3.3)	-8.4	9.8	0.106
Hip circumference (cm)	99.0	(12.72)	76.4	134.8	98.1	(12.69)	74.4	134.8	-0.9	(3.3)	-8.4	9.8	0.008
Fat mass (%)	32.1	(9.39)	4.3	51.5	31.4	(9.50)	3.0	51.2	-2.2	(7.3)	-16.0	33.4	0.000
BMI	26.3	(5.77)	16.5	43.6	25.8	(5.59)	16.4	42.7	-1.9	(1.6)	-1.6	5.2	0.000
Body fat (%) Siri	34.1	(5.18)	18.4	42.54	34.1	(5.03)	19.30	43.38	0.0	(3.1)	-6.8	7.3	0.919
Body fat (%) Brozek	32.8	(4.78)	18.2	40.53	32.7	(4.64)	19.07	41.30	-0.6	(3.1)	-6.6	7.1	0.919
WHR	0.91	(0.04)	0.81	0.98	0.91	(0.04)	0.80	1.04	0.0	(3.7)	-6.9	13.3	0.633
WHtR	0.56	(0.08)	0.41	0.79	0.56	(0.08)	0.40	0.79	0.0	(3.3)	-8.4	9.8	0.104

BMI: body mass index; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio.

^aStatistical significance at <0.05.

Table II
Anthropometric characteristics and body composition before and after Ramadan.

	Age (y)	n	Before Ramadan				After Ramadan				p ^a
			Mean	(SD)	Minimum	Maximum	Mean	(SD)	Minimum	Maximum	
Weight (Kg)	≤30	29	59.9	(11.00)	40.6	84.6	59.4	(10.88)	39.0	85.2	0.000
	>30	33	73.7	(13.49)	50.8	106.1	71.9	(13.90)	47.7	104.0	
Tricipital skinfold (mm)	≤30	29	19.3	(5.37)	7.3	32.0	19.2	(5.13)	7.7	28.7	0.000
	>30	33	25.4	(5.87)	16.0	35.0	25.8	(6.32)	15.7	37.3	
Subscapular skinfold (mm)	≤30	29	13.8	(5.74)	7.1	30.3	14.2	(5.56)	7.0	31.3	0.000
	>30	33	27.0	(6.31)	11.8	39.7	26.8	(6.35)	12.7	40.3	
Bicipital skinfold (mm)	≤30	29	9.9	(3.50)	4.2	19.3	10.0	(4.01)	5.0	19.3	0.000
	>30	33	15.5	(4.48)	8.0	24.3	14.3	(5.30)	6.5	27.0	
Suprailiac skinfold (mm)	≤30	29	17.9	(6.77)	6.1	32.0	18.6	(6.06)	6.5	30.0	0.000
	>30	33	26.1	(6.85)	11.8	41.3	25.7	(7.26)	13.3	40.2	
Waist circumference (cm)	≤30	29	82.6	(9.43)	66.3	102.7	81.7	(9.00)	64.2	102.8	0.000
	>30	33	96.7	(10.94)	76.8	123.0	96.2	(10.96)	77.2	127.5	
Hip circumference (cm)	≤30	29	91.6	(8.77)	76.4	110.0	90.9	(8.37)	74.4	108.3	0.000
	>30	33	105.5	(12.11)	84.8	134.8	104.4	(12.54)	84.3	134.8	
Fat mass (%)	≤30	29	25.7	(8.31)	4.3	41.5	25.0	(8.44)	3.0	41.1	0.000
	>30	33	37.7	(6.11)	27.0	51.5	37.0	(6.37)	24.4	51.2	
BMI	≤30	29	22.8	(3.92)	16.5	33.9	22.6	(3.88)	16.4	34.1	0.000
	>30	33	29.3	(5.43)	20.9	43.6	28.7	(5.30)	20.3	42.7	
Body fat (%) (Siri)	≤30	29	30.53	-4.609	18.38	39.61	30.83	-4.395	19.30	38.47	0.000
	>30	33	37.25	-3.269	29.58	42.54	36.97	-3.619	29.05	43.38	
Body fat (%) Broeck	≤30	29	29.44	-4.255	18.22	37.82	29.72	-4.058	19.07	36.77	0.000
	>30	33	35.65	-3.018	28.57	40.53	35.38	-3.341	28.07	41.30	
WHR	≤30	29	0.90	(0.038)	0.81	0.96	0.90	(0.039)	0.80	0.96	0.085
	>30	33	0.92	(0.035)	0.85	0.98	0.92	(0.043)	0.80	1.04	
WHtR	≤30	29	0.51	(0.057)	0.41	0.65	0.50	(0.055)	0.40	0.65	0.000
	>30	33	0.61	(0.073)	0.49	0.79	0.61	(0.072)	0.49	0.79	

BMI: body mass index; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio. ^aStatistical significance at <0.05.

In reference to changes in skinfold values, the younger group of women experienced a slight reduction in the tricipital and bicipital skinfold values and a slight increase in the subscapular and suprailiac skinfolds during the period of intermittent fasting. The older group of women experienced a slight increase in the tricipital skinfold value and a reduction in the other skinfold values. The value that decreased the most was that of the bicipital skinfold.

Both groups also experienced a slight reduction in their waist and hip circumferences. However, the older group of women showed a somewhat greater decrease in hip circumference when the measurement was taken at the end of the religious fasting period. The waist circumference measurements before and at the end of Ramadan were greater than 80 cm in both groups of subjects. In relation to the ratios derived from both circumferences, the values for the waist-to-hip ratio (WHR) were higher than 0.8 before and after the fasting period. As for the waist-to-height ratio (WHtR), only the younger group of women (< 30 years) had higher values both before and after Ramadan.

Both the WHR and the WHtR remained stable in both groups of subjects before and at the end of Ramadan. The body fat percentage of the subjects, as calculated with bioimpedance and the Siri and Brozek equations, decreased slightly during the fasting period. Nevertheless, the bioimpedance data reflected a marginally greater fat loss than the values calculated by the equations. The subjects' BMI was also somewhat lower at the end of Ramadan although this decrease was slightly more accentuated in the older group of women.

Discussion

The results obtained in this study showed at the end of Ramadan, all of the female subjects had experienced significant changes in their anthropometric values and body composition. This result coincides with Norouzy et al.²³ who concluded that Ramadan fasting led to a reduction of fat-free mass and thus to changes in body composition. In this same line, our results showed important variations in anthropometric values and confirmed body composition changes in both groups of subjects. Moreover, significant modifications were observed in the tricipital, bicipital, subscapular, and suprailiac skinfold values as well as in the body fat percentage determined with the Siri¹³ and Brozek¹⁴ equations, which were not calculated in Norouzy et al.²³.

In the total sample, no statistically significant differences were found in skinfold values before and after Ramadan. In fact, the only change observed was a reduction in the bicipital skinfold and a slight increase in all of the others.

Furthermore, contradictory results were obtained for the body fat percentage at the end of Ramadan,

depending on the technique used. In this sense, our results coincide with those of Norouzy et al.²³, who also observed a significant reduction in the percentage of body fat when measured with bioimpedance. However, when body fat was calculated with the Siri¹³ and Brozek¹⁴ equations, the results did not reflect significant differences in the values before and at the end of Ramadan. These results are in consonance with those of Rohin et al.²⁴ According to Marradán et al.²⁵, this divergence in results for body fat percentage, depending on the technique used, could be due to the tendency of bioimpedance measuring devices to overestimate fat mass. This signifies that it is necessary to use both techniques in order to compare the data.

Regarding weight loss, the results of our study reflect statistically significant differences in the subjects' weight as well as BMI. Nevertheless, it is not clear whether this loss was caused by a reduction in the body fat percentage or was due to other circumstances. Rohin et al.²⁴ concluded that this weight loss could have been produced by the depletion of body fluids because of fasting and not to a reduction in body fat. According to other authors, the reduction of visceral (intra-abdominal) fat in both younger and older women (as compared to men) is a consequence of their higher level of physical activity during Ramadan²⁶.

When the two age groups were compared, the most significant changes in anthropometric values and body composition occurred in the older group of women (>30 years). This indicates that age had an impact on the other variables studied. Furthermore, given the fact that in this group of women, there was a greater prevalence of overweight and obesity at the beginning of the religious fasting period, it is necessary to consider the potential effect of nutritional status on the changes observed at the end of the fasting period.

One of the limitations of this study was the size of the sample. Another limitation could have been the effect of cigarette consumption as a confusing factor. Nevertheless, since this study was composed only of female non-smokers, we were able to avoid this pitfall that had been a problem in previous studies.²⁷

In summary, all the subjects experienced significant changes in nutritional status and body composition at the end of Ramadan. These changes were greater in the group of older women (> 30 years). In future research, we will explore which of the following variables most influenced the changes observed: the age of the subjects, their nutritional status, or a possible association between the two variables.

Conflict of interests

The authors declare that there are no conflicts of interest.

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Original/*Obesidad*

La obesidad infantil como consecuencia de la interacción entre firmicutes y el consumo de alimentos con alto contenido energético

Barbara Ixchel Estrada-Velasco¹, Miguel Cruz², Jaime García-Mena³, Adan Valladares Salgado², Jesus Peralta Romero², Maria de los Remedios Guna Serrano⁴, Vicente Madrid-Marina¹, Citlalli Orbe Orihuela¹, Claudia López Islas¹ y Ana Isabel Burguete-García¹

¹Centro de investigación sobre enfermedades infecciosas, Instituto Nacional de Salud Pública, Cuernavaca, Mor., México.

²Unidad de Investigación Médica en Bioquímica, Hospital de Especialidades, IMSS, CMN Siglo XXI, Ciudad de México, México.

³Departamento de Genética y Biología Molecular, Cinvestav-IPN, México, DF, Mexico. ⁴Servicio de Microbiología, Hospital General Universitario y Facultad de Medicina, Universidad de Valencia, Valencia, España.

Resumen

Introducción: La obesidad es un grave problema de salud pública en México, la Encuesta Nacional de Salud y Nutrición (ENSANUT 2012) reporta una prevalencia de sobrepeso y obesidad en niños de 5 a 11 años de 34.4%, siendo el país con mayor prevalencia a nivel mundial. Investigaciones recientes han sugerido que la microbiota intestinal puede ser factor de riesgo de la obesidad por su influencia en el metabolismo humano.

Objetivo: Evaluar si existe asociación entre el perfil de la microbiota intestinal y la obesidad infantil y si esta asociación se modifica dependiendo del patrón de alimentación de una muestra de niños de edad escolar de la Ciudad de México.

Metodología y Resultados: Estudio transversal en 1042 niños de 6 a 14 años, a todos se les aplicó cuestionario de actividad física, antecedentes patológicos personales y heredofamiliares de obesidad y diabetes tipo 2. La definición de los patrones de alimentación se realizó por análisis de componentes principales (ACP). La asociación entre microbiota intestinal y sobrepeso/obesidad dependiendo de la dieta se evaluó con modelos de regresión logística, ajustados por factores de confusión. Encontramos que un perfil de abundancia relativa alta de Firmicutes y una abundancia relativa baja de Bacteroidetes aunado a un consumo elevado de dietas ricas en carbohidratos y grasas saturadas se asocia con un mayor riesgo de obesidad.

Conclusión: La interacción entre la microbiota intestinal y la dieta, particularmente con alto contenido de grasas y carbohidratos simples incrementa las posibilidades de presentar obesidad.

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Palabras clave: Microbiota intestinal. Obesidad infantil. IMC. Patrones de alimentación. Firmicutes.

Correspondencia: AI. Burguete-García
Instituto Nacional de Salud Pública.
Av. Universidad 655, Santa María Ahuacatitlán Cuernavaca,
México. C.P.62508.
E-mail: aburguete@correo.insp.mx

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CHILDHOOD OBESITY IS ASSOCIATED TO THE INTERACTION BETWEEN FIRMICUTES AND HIGH ENERGY FOOD CONSUMPTION

Abstract

Introduction: Obesity is a serious public health problem in Mexico, the National Health and Nutrition Survey (ENSANUT 2012) reported a 34.4% prevalence of overweight, and obesity in children aged 5-11. Recent research has suggested that the gut microbiota may be a risk factor of obesity through its influence on human metabolism.

Aim of the study: To evaluate association between the intestinal microbiota profile and obesity among children and whether this association is modified depending on the feeding pattern of a sample of schoolchildren from Mexico City.

Methodology and Results: Cross-sectional study on 1042 children aged 6-14 years; physical activity questionnaire, personal medical history and heredofamilial of obesity and type 2 diabetes were administered to all the children. Eating patterns was performed by principal component analysis (PCA). The association between intestinal microbiota and overweight / obesity depending on diet was assessed with logistic regression models.

Conclusion: Our results shows that the interaction between the intestinal microbiota and diet, particularly high in fats and simple carbohydrates increases the chance of developing obesity.

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Key words: Gut Microbiota. Childhood obesity. BMI. Dietary patterns. Firmicutes.

Introducción

La obesidad se ha convertido en un problema de salud pública en todo el mundo considerada actualmente como pandemia^{1,2,3}. En México, la Encuesta Nacional de Salud y Nutrición (ENSANUT 2012)⁴ reporta una prevalencia de sobrepeso y obesidad en niños de 5 a 11 años de 34.4%, siendo el país con mayor prevalencia a nivel mundial. La obesidad es una enfermedad crónica y multifactorial, caracterizada por desórdenes metabólicos, inflamación de bajo grado y aumento de la grasa corporal, cuya magnitud y distribución condicionan la salud del individuo. Es el principal factor de riesgo para diferentes enfermedades crónicas, incluyendo diabetes, enfermedades cardiovasculares y cáncer⁵. Los factores de riesgo de la obesidad infantil incluyen la dieta, antecedentes de obesidad en padres, y disminución de la actividad física⁶. El papel de la dieta en la etiología de la mayoría de las enfermedades no transmisibles está bien establecido. Los patrones de alimentación varían considerablemente entre las poblaciones, los individuos, grupos de edad y las clases sociales y culturales⁷.

La microbiota humana consiste en alrededor de 10 a 100 billones de microorganismos, representando al menos 10 veces más el número de células humanas. La microbiota y su microbioma nos proveen de importantes funciones biológicas, inmunológicas y metabólicas que no pueden ser realizadas por el metabolismo humano como síntesis de aminoácidos esenciales y vitaminas y la digestión de componentes de la dieta como polisacáridos de estructurales^{8,9,10,11,12}. En el interior del intestino se han descrito alrededor de 70 divisiones de bacterias, siendo los más frecuentes dos filos bacterianos específicos: Bacterioidetes y Firmicutes, que incluyen cientos de filotipos⁹.

Investigaciones recientes han sugerido que la microbiota intestinal puede ser factor importante que participa como mediador de la obesidad ya que puede incrementar la habilidad del hospedero para conseguir calorías de la dieta mediante la estimulación de la absorción de grasas y su capacidad de digerir carbohidratos no digeribles por nuestro organismo^{13,14}. Así mismo se ha sugerido que interviene en la modulación de la inmunidad del hospedero, y a la inflamación asociada con la obesidad en ratones¹⁵. También se ha reportado que diferencias en el consumo de macronutrientes debido a dietas con alto contenido de proteínas y grasas o con bajo contenido de carbohidratos puede alterar la composición de la microbiota intestinal^{14,16,17}. Sin embargo aún no están totalmente claros los mecanismos mediante los cuales la microbiota intestinal humana interactúa con el hospedero y con su patrón de alimentación, y de esta manera estar asociado con la obesidad.

El objetivo de este estudio fue evaluar si existe asociación entre el perfil de la microbiota intestinal y la obesidad infantil y si esta asociación se modifica dependiendo del patrón de alimentación de una muestra de niños de edad escolar de la Ciudad de México.

Metodología

Diseño y población

Estudio transversal a partir del banco de muestras biológicas y base de datos generados en el proyecto “Genética de la obesidad en la infancia y la adolescencia” llevado a cabo en conjunto por el Instituto Nacional de Salud Pública (INSP) y la Unidad de Investigación Médica en Bioquímica del Hospital de Especialidades del Centro Médico Nacional Siglo XXI del IMSS, con registro 2006-785-072 por la Comisión Nacional de Investigación del IMSS.

Criterios de selección

Seleccionamos 1119 niños de 6 a 14 años de edad, no relacionados, residentes de 4 zonas geográficas de la Ciudad de México (Norte, Sur, Oriente y Poniente). Se excluyeron a los niños con diagnóstico de enfermedad infecciosa y/o desórdenes gastrointestinales al momento de la entrevista y a los que hubieran tomado antibióticos durante dos meses previos al estudio. Los niños y padres de familia que aceptaron participar firmaron un asentimiento y consentimiento informado respectivamente. Se aplicó un cuestionario de 18 preguntas a través del cual se obtuvieron datos socioeconómicos, demográficos, antecedentes patológicos personales y heredofamiliares. También contestaron un cuestionario de frecuencia de consumo de alimentos previamente validado compuesto por 107 preguntas y un cuestionario de actividad física y sedentarismo de 40 preguntas. Posteriormente se colectaron muestras de sangre venosa y muestras de heces. Se eliminaron del estudio a los niños que no cumplieran con todos los cuestionarios y/o muestras completas resultando una muestra final de 1042 niños.

Mediciones bioquímicas y antropométricas

Las muestras de sangre se tomaron en ayuno de 12h. Se midieron los niveles de glucosa, colesterol total, HDL, LDL, triglicéridos e insulina (Equipo Clinical Chemistry System ILAB 300 plus®). Los perfiles bioquímicos se determinaron de acuerdo con los criterios de la American Heart Association/National Heart, Lung and Blood Institute Scientific Statement (AHA/NHLBI)¹⁸.

Las medidas antropométricas evaluadas por personal estandarizado fueron: peso (kg) (báscula con precisión de 0.1kg, marca SECA, Alemania) talla (cm) medida con un estadímetro portátil SECA, índice de masa corporal (IMC, kg/m²) y circunferencia de cintura (cm). Se eliminaron 3 niños sin datos antropométricos. La clasificación de los niños en peso normal, sobrepeso y obesidad se realizó con base en el puntaje z de IMC para edad y sexo, de acuerdo con las referencias de la OMS¹⁹; con los siguientes puntos de corte:

Normal de -2 a 1 DE, Sobrepeso de 1 a 2 DE y Obesidad >2 DE. Las presiones sistólica y diastólica se midieron con esfigmomanómetros calibrados después de estar sentado en reposo durante al menos 5 minutos. Se realizaron dos mediciones para obtener un promedio.

Caracterización de la microbiota

La extracción de los ácidos nucleicos se llevó a cabo con el kit QIAamp® DNA Stool Mini Kit for human (Qiagen, Alemania), a partir de 200 mg de heces. Se determinó la concentración y pureza del DNA con un espectrofotómetro NanoDrop 1000 Thermo Scientific (Saveen Werner ApS, Dinamarca). El análisis del perfil de microbiota se realizó por qPCR utilizando primers universales y específicos para los filos Bacteroidetes y Firmicutes (Fig. 1)²⁰. Cada reacción de PCR tuvo 5 µl de Maxima SYBR Green/ROX qPCR Master Mix (2x) (Fermentas®), 1 µl de cada primer (concentración de 5pmol para Reverse y 10pmol para Forward), 1 µl del templado de DNA y 2 µl de agua libre de ácidos nucleicos (Fermentas®) teniendo un volumen final de 10 µl. Cada reacción se realizó por duplicado.

El análisis de las amplificaciones de PCR en tiempo real se llevó a cabo en el equipo Step One Plus realtime PCR system (Applied Biosystems, E.U.), las muestras se procesaron en placas de 96 pozos y con las siguientes condiciones de amplificación: un ciclado térmico de 5 minutos a 95°C, desnaturalización a 95°C por 15 segundos, 30 ciclos a 59°C por 15 segundos para alineamiento y por 20 segundos a 72°C para elongación; las condiciones fueron las mismas para los 3 pares de primers utilizados; Universal, Bacteroidetes y Firmicutes.

Los resultados de las reacciones se observaron en las gráficas de amplificación donde se expresa la cantidad de la fluorescencia obtenida en el eje de las ordenadas y el número de ciclos del PCR en el cual la fluorescencia alcanza el umbral fijado (CT) en el eje de las abscisas²¹; la cuantificación de la fluorescencia emitida durante cada ciclo de la PCR es proporcional a la cantidad de ADN amplificada. Se realizó la cuantificación de las unidades de abundancia relativa de Firmicutes y Bacteroidetes con la siguiente fórmula $UAR = 2^{-\Delta Ct}$ donde: UAR= Unidades de Abundancia

Relativa y $\Delta Ct = Ct \text{ primer específico} - Ct \text{ primer universal}$ ²². Las UAR de microbiota expresan un aproximado de unidades bacterianas de un filo con respecto a otro, y permite conocer la diferencia de distribución de la población bacteriana en determinada área.

Patrones de alimentación

Para identificar patrones de alimentación, se obtuvo información mediante un cuestionario de frecuencia de consumo de alimentos semicuantitativo (CFCA) que incluía un total de 107 preguntas con 10 opciones de respuesta de frecuencia que van desde “nunca” a “6 o más veces al día.” De acuerdo con la frecuencia reportada se calculó el consumo diario promedio en gramos de alimentos y obtuvimos el consumo de macronutrientes y la ingesta total de energía para cada niño en el estudio utilizando la base de datos de composición de alimentos ENSANUT 2012⁴.

Para la identificación de los patrones de alimentación se eliminaron 74 participantes que reportaron un consumo diario de energía total por encima de 6.388,83 kcal/d, según el método DE²³. Los alimentos y bebidas del CFCA se clasificaron en 22 grupos (Fig. 2) con base en la similitud en el contenido de nutrientes entre ellos. Los patrones de alimentación se caracterizaron por análisis de componentes principales (ACP),²⁴ utilizando una rotación ortogonal (varimax) y elegimos los factores con un autovalor mayor a 1.50. Bajo estos criterios, se identificaron 2 patrones, que en conjunto representan el 20% de la varianza total (12% del patrón 1 y 8% del patrón 2). Se predijo el valor de varianza en cada patrón para cada niño. Los valores más altos indican que el niño tiene mayor adherencia a una dieta particular o patrón de alimentación.

Cada patrón se definió por los grupos de alimentos con un factor de carga >0.30 (Cuadro 3); este valor se ha reportado en otros estudios como un valor apropiado para clasificar un factor significativo²⁵. Los dos patrones de alimentación identificados (Fig. 3) se describen de la siguiente manera: Patrón 1: No saludable (Antojitos mexicanos y comida rápida, y Alimentos con alto contenido de grasas saturadas.) y Patrón 2: Saludable (Frutas frescas, Verduras frescas y Pescado).

Grupo	Nombre	Secuencia	Concentración	TM
Universal	926Forward	5'AAACTCAAAGGAATTGACGG3'	343 pmol/µL	60
	1062Reverse	5'CTCACRRACGAGCTGAC3'	266 pmol/µL	68
Bacteroidetes	798cfbForward	5'CRAACAGGATTAGATACCT3'	393 pmol/µL	60
	Cfb967Reverse	5'GGTAAGGTTTCCTCGCGTAT3'	407 pmol/µL	62
Firmicutes	928F-Forward	5'TGAAACTYAAAGGAATTGACG3'	327 pmol/µL	62
	1040Reverse	5'ACCATGCACCACCTGTC3'	378 pmol/µL	64

Fig. 1.—Pares de primer utilizados en la qPCR.

<i>Grupos de alimentos</i>	<i>Alimentos que los constituyen</i>
1. Tortilla y alimentos a base de maíz	Tortilla de maíz, elote, pozole, palomitas de maíz, sope asado y tamales.
2. Antojitos mexicanos y comida rápida.	Tacos al pastor, sope frito, tortas, hamburguesas, nuggets, sándwiches, hot dogs, pizza, carnitas y barbacoa.
3. Pan de trigo y tortilla de harina y productos de panadería azucarados	Pan de caja blanco, pan de caja integral, bolillo, tortilla de harina, Pan de dulce, hot cakes, pastel, pastelillo relleno y galletas dulces.
4. Cereales listos para comer	Avena, cereal con fibra, cereales de caja sin azúcar, cereales azucarados y barras de cereal.
5. Papas, arroz y pasta	Papas, arroz, pasta seca y sopa de pasta caldosa
6. Leguminosas	Frijol y lentejas
7. Frutas frescas	Naranja, mandarina, manzana, pera, plátano, melón, mango, piña, papaya, sandía, fresa, durazno, uvas y ciruelas.
8. Verduras frescas	Jitomate, jícama, zanahoria, pepino, lechuga, nopal, calabacitas, brócoli y chicharos.
9. Picantes	Salsas picantes y chiles
10. Pollo	Pollo y hígado de pollo
11. Pescado	Pescado, atún y sardina
12. Carnes rojas	Carne de res, hígado de res y carne de cerdo
13. Embutidos	Jamón y salchichas
14. Agua	Agua natural
15. Lácteos con bajo contenido de grasa.	Leche descremada
16. Lácteos con alto contenido de grasa.	Leche entera, yogurt natural, yogurt activia flora, queso manchego, queso amarillo, malteadas, danonino, helado, leche con chocolate y queso crema, queso Oaxaca.
17. Huevos	Huevo.
18. Alimentos con grasa saturada	Chicharrón, chorizo y tocino.
19. Aderezos	Mayonesa, margarina y aderezos.
20. Dulces y azúcares	Agua fresca con azúcar, Yakult, agua con endulzante en polvo, jugo de naranja, dulces, chocolate, miel y dulce de chamoy.
21. Refrescos	Refresco de cola y de sabor, jugo industrializado y bebidas hidratantes.
22. Botanas saladas	Papas a la francesa, Frituras, galletas saladas y cacahuates japoneses.

Fig. 2.—Grupos de alimentos.

<i>Grupos de alimentos</i>	<i>Patrón 1: No Saludable</i>	<i>Patrón 2: Saludable</i>
Antojitos mexicanos y comida rápida.	0.34	-0.07
Frutas frescas	-0.10	0.45
Verduras frescas	0.02	0.46
Pescado	0.11	0.32
Alimentos con grasa saturada	0.32	0.08

Fig. 3.—Matriz de factores de carga de los patrones de alimentación

Análisis estadístico

Para la descripción de las variables relevantes la población de estudio fue estratificada por la adiposidad (según IMC) en peso normal y sobrepeso/obesidad, para la comparación de los grupos se utilizó la prueba de Kruskal-Wallis para las variables continuas y la prueba de chi-cuadrada (χ^2) para las variables categóricas.

Antes de evaluar el efecto de la dieta, los patrones de alimentación se dividieron en terciles (consumo bajo, medio y alto) con base en la distribución del consumo de los niños con peso normal. Para evaluar la asociación entre la abundancia relativa de microbiota y el riesgo de tener sobrepeso/obesidad la abundancia se categorizó en abundancia baja (menor al promedio) o alta (mayor al promedio) y se realizó un modelo de

regresión logística teniendo como grupo de referencia a los niños con peso normal. Para evaluar la modificación del efecto dependiendo del patrón de alimentación se realizó el mismo modelo de regresión pero se estratificó por los terciles de consumo bajo, medio y alto de cada patrón. Todos los modelos se ajustaron por el sexo, edad, antecedente heredofamiliar de obesidad y actividad física. El valor de *p* que consideramos para significancia estadística en los modelos de regresión fue de 0.008 después de corregir por el método de Bonferroni para evitar error por múltiples comparaciones²⁶. Para todos los análisis realizados se utilizó la versión 12.0 del software paquete estadístico STATA SE (College Station, TX).

Resultados

La tabla I muestra las características generales de la población de acuerdo con el grado de adiposidad (peso normal y sobrepeso/obesidad). Las presiones arteriales sistólica y diastólica aumentan con el grado de adiposidad ($p=0.0001$). Los niveles en sangre de glucosa,

colesterol total, triglicéridos y LDL son mayores para el grupo de obesos ($p=0.0002$, $p=0.001$, $p=0.0001$ y $p=0.0001$, respectivamente) y HDL fue menor para este grupo ($p=0.0001$). La historia familiar de obesidad y DT2 fue mayor en el grupo de obesos con 58.5% y 61.9% respectivamente ($p<0.0001$ y $p=0.02$). La abundancia relativa de Bacteroidetes es mayor en los niños con peso normal (1.19 ± 3.52 UAR, $p=0.03$) y la abundancia relativa de Firmicutes es mayor en los niños con sobrepeso/obesidad (1.64 ± 5.47 UAR, $p=0.0007$).

Cuando evaluamos la asociación entre la abundancia relativa de Bacteroidetes y de Firmicutes y el riesgo de tener sobrepeso/obesidad (Tabla II) observamos que los niños con un perfil de abundancia relativa alta de Bacteroidetes tienen 40% menos posibilidades de presentar sobrepeso u obesidad ($OR=0.62$, $p=0.001$) en comparación con los niños con un perfil de abundancia relativa baja; por otro lado encontramos que los niños con un perfil de abundancia relativa alta de Firmicutes tienen 1.5 veces más posibilidades de presentar sobrepeso/obesidad ($OR=1.53$, $p<0.003$) en comparación a los niños con un perfil de abundancia relativa baja. Dichas asociaciones son estadísticamente significativas.

Tabla I
Características generales de la población por IMC

		Normal (<i>n</i> =503)	SP/OB (<i>n</i> =539)	<i>p</i> ^a
Sexo	% F	50.3	49.7	0.212
	% M	46.4	53.6	
Edad (a)		8.98 ± 2.06	9.43 ± 2.01	0.0002
IMC (kg/m ²)		16.54 ± 1.83	22.88 ± 3.54	0.0001
C. cintura (cm)		58.39 ± 6.40	75.243 ± 10.27	0.0001
PAS (mmHg)		95.28 ± 9.54	100.76 ± 10.54	0.0001
PAD (mmHg)		64.29 ± 8.20	67.51 ± 8.79	0.0001
Glucosa (mg/dl)		80.12 ± 9.47	82.25 ± 8.85	0.0002
Col. total(mg/dl)		149.67 ± 31.89	159.64 ± 86.49	0.001
Triglicéridos (mg/dl)		74.19 ± 29.27	109.69 ± 55.32	0.0001
HDL (mg/dl)		51.90 ± 11.53	45.96 ± 11.79	0.0001
LDL (mg/dl)		95.59 ± 24.21	105.63 ± 26.93	0.0001
Energía total (kcal)		3239.70 ± 1038.34	3296.61 ± 1072.43	0.5631
Actividad Física (Mets/hora/sem)		485.88 ± 395.98	465.01 ± 416.30	0.1608
Antecedente Heredofamiliar de obesidad (%)		41.46	58.5	<0.0001
Antecedente Heredofamiliar de DT2 (%)		38.05	61.95	0.02
UAR Bacteroidetes		1.19 ± 3.52	0.76 ± 1.49	0.035
UAR Firmicutes		1.01 ± 2.24	1.64 ± 5.47	0.0007

Los valores están expresados en % para las variables categóricas y en media ± DE para las variables continuas. F: femenino, M: masculino, IMC: índice de masa corporal, C.C: circunferencia de la cintura, PAS: presión arterial sistólica, PAD: presión arterial diastólica, HDL: lipoproteínas de alta densidad, LDL: lipoproteínas de baja densidad, UAR: unidades de abundancia relativa, DT2: diabetes tipo 2. ^aValor de *p* de ji 2 para variables categóricas y prueba de *p*-valor de Kruskal Wallis para variables continuas.

Tabla II
Asociación entre la abundancia relativa de microbiota y el riesgo de tener sobrepeso/obesidad

	OR*	p	IC 95%
AR Bacteroidetes	0.62	0.001	0.47, 0.82
AR Firmicutes	1.53	0.003	1.16, 2.01

ARB: abundancia relativa de Bacteroidetes, ARF: abundancia relativa de Firmicutes *Ajustado por sexo, edad, actividad física y antecedente familiar de obesidad. Grupo de referencia: AR baja.

Para evaluar si la dieta modifica el efecto de la microbiota sobre el riesgo de tener sobrepeso/obesidad, realizamos una regresión logística estratificando los modelos por tercil de consumo de cada patrón de alimentación. Con respecto al consumo del patrón 1 o no saludable (Tabla III), observamos que los niños con abundancia relativa alta de Bacteroidetes y un alto consumo del patrón 1 tienen 51% menos posibilidades de presentar sobrepeso/obesidad ($OR=0.49$, $p=0.004$), en sentido contrario los niños con abundancia relativa alta de Firmicutes y un consumo alto de patrón 1 tienen 2 veces más posibilidades de tener sobrepeso/obesidad ($OR=1.98$, $p=0.006$). Al evaluar el consumo del patrón 2 o Saludable (Tabla IV), se observó que los niños con una abundancia relativa alta de Bacteroidetes y un consumo alto de este patrón tienen 55% menos posibilidades de tener sobrepeso/obesidad ($OR=0.45$, $p=0.001$). Finalmente observamos que los niños con un consumo bajo del patrón 2 y una abundancia relativa alta de Firmicutes tienen 2 veces más posibilidades de presentar sobrepeso/obesidad ($OR=2.00$, $p=0.005$). Todas las asociaciones son estadísticamente significativas.

Discusión

En este trabajo encontramos que en población infantil mexicana un perfil de abundancia relativa alta

de Firmicutes y una abundancia relativa baja de Bacteroidetes se asocia significativamente con el riesgo de tener sobrepeso y obesidad. Estos resultados coinciden con los primeros reportes que establecieron la hipótesis de que la microbiota intestinal favorece el almacén de grasa en el organismo. En un modelo animal, Bäckhed y cols., observaron que ratones libres de gérmenes tenían 40% menos grasa corporal en comparación a los ratones convencionales¹³. También se ha observado que la microbiota intestinal de ratones genéticamente obesos (ob/ob) tiene 50% mayor proporción de Firmicutes y menor proporción de Bacteroidetes, en comparación a los ratones de peso normal²⁷. En humanos un comportamiento similar se observó en el estudio de Ley y cols., quienes siguieron a voluntarios obesos que recibieron una dieta de reducción durante 52 semanas y observaron que a medida que perdían peso la abundancia relativa de Firmicutes disminuía mientras que la abundancia relativa de Bacteroidetes aumentaba¹⁴.

Aunado a lo anterior, encontramos que la interacción entre la microbiota intestinal y la dieta de los niños tiene un efecto importante tanto en protección como en el riesgo de obesidad. Por un lado observamos el fuerte papel de la microbiota en la protección contra sobrepeso y obesidad ya que el presentar una abundancia relativa alta de Bacteroidetes confiere a los niños menos riesgo de presentar obesidad si tienen un consumo alto de frutas, verduras y pescado. Por otro lado observamos el papel de la dieta ya que el efecto que confiere una abundancia relativa alta de Firmicutes sobre el riesgo de presentar obesidad depende del consumo alto de un patrón de alimentación no saludable caracterizado por alimentos con elevado contenido de carbohidratos complejos y grasas saturadas, y del consumo bajo de alimentos ricos en micronutrientes y fibra (patrón saludable). Dichos hallazgos coinciden con los encontrados por Cotillard y cols., quienes realizaron un estudio de intervención (dieta de reducción y mantenimiento de peso) para

Tabla III
Asociación entre la abundancia relativa de microbiota y el riesgo de tener sobrepeso/obesidad, estratificado por tercil de consumo del Patrón 1*

<i>Bacteroidetes</i>				<i>Firmicutes</i>			
	OR*	p**	IC 95%		OR*	p**	IC 95%
Consumo bajo				Consumo bajo			
AR Alta ^a	0.69	0.12	0.43, 1.10	AR Alta	1.34	0.23	0.83, 2.15
Consumo medio				Consumo medio			
AR Alta	0.66	0.10	0.40, 1.09	AR Alta	1.37	0.21	0.84, 2.24
Consumo alto				Consumo alto			
AR Alta	0.49	0.004	0.30, 0.80	AR Alta	1.98	0.006	1.21, 3.24

AR: abundancia relativa, ^aGrupo de referencia: AR baja.

*Ajustado por sexo, edad, actividad física, antecedente familiar de obesidad.

** Valor p ajustado por múltiples comparaciones <0.008 *Patrón 1: No saludable (Antojitos mexicanos y comida rápida, y Alimentos con alto contenido de grasas saturadas).

Tabla IV
Asociación entre la abundancia relativa de microbiota y el riesgo de tener sobrepeso/obesidad, estratificado por tercil de consumo del Patrón 2⁺

<i>Bacteroidetes</i>				<i>Firmicutes</i>			
	OR*	p**	IC 95%		OR*	p**	IC 95%
Consumo bajo				Consumo bajo			
AR Alta ^a	0.70	0.16	0.43, 1.14	AR Alta	2.00	0.005	1.23, 3.26
Consumo medio				Consumo medio			
AR Alta	0.80	0.37	0.48, 1.32	AR Alta	1.04	0.87	0.63, 1.72
Consumo alto				Consumo alto			
AR Alta	0.45	0.001	0.28, 0.71	AR Alta	1.57	0.05	0.99, 2.49

AR: abundancia relativa, ^aGrupo de referencia: AR baja.

*Ajustado por sexo, edad, actividad física, antecedente familiar de obesidad.

** Valor *p* ajustado por múltiples comparaciones <0.008 ⁺Patrón 2: Saludable (Frutas frescas, Verduras frescas y Pescado).

investigar la temporalidad de las asociaciones entre microbiota, dieta y los fenotipos asociados a obesidad e inflamación²⁸. Determinaron el perfil de frecuencia de genes de microbiota haciendo coincidir las lecturas de secuencia de cada muestra con un catálogo de referencia de genes de bacterias intestinales, para establecer el grado de diversidad. Clasificaron a los individuos de acuerdo a la riqueza (diversidad alta o baja) de genes de microbiota y observaron que la intervención dietética mejora la baja riqueza de genes de microbiota y los fenotipos clínicos. Antes de la intervención midieron los patrones de alimentación de los participantes y observaron que los sujetos con baja riqueza de microbiota parecían consumir menos frutas, verduras y pescado en comparación a los sujetos con alta riqueza de microbiota, por lo que sugieren la posibilidad de que los hábitos alimenticios a largo plazo pueden afectar a la riqueza de genes de microbiota y los fenotipos asociados²⁹. Dichos alimentos (frutas, verduras y pescado) son los mismos que integran nuestro patrón saludable, por lo que la promoción del aumento en el consumo de este patrón podría influir en forma positiva la prevención de la obesidad, no solo por el efecto de la dieta en el metabolismo humano sino por su fuerte influencia en la composición de la microbiota.

Es importante señalar que aun cuando nuestros resultados van en el mismo sentido que lo reportado en las primeras investigaciones, necesitamos explorar la microbiota a niveles más profundos, a nivel de especies particulares o incluso por abundancia de genes, ya que se ha encontrado que aquellos individuos con baja diversidad de microbiota presentan mayor grado de adiposidad. Este efecto puede deberse a la menor presencia de bacterias productoras de butirato (ácido graso de cadena corta que mejora la sensibilidad a la insulina y promueve el gasto de energía) favoreciendo la inflamación característica de la obesidad y las enfermedades crónicas asociadas³⁰.

Conclusión

En una muestra de niños mexicanos de la ciudad de México, un perfil de microbiota con abundancia relativa alta de Bacteroidetes confiere protección contra sobrepeso y obesidad, contrario a un perfil de microbiota con abundancia relativa alta de Firmicutes que confiere riesgo. Aún cuando la evidencia reciente señala a la microbiota como un fuerte factor de riesgo en el desarrollo de obesidad, su interacción con la dieta, particularmente un alto consumo de grasas saturadas y menor consumo de alimentos saludables incrementa las posibilidades de presentar obesidad. Por tal motivo la promoción del consumo de dietas saludables sigue siendo una estrategia fundamental en la prevención de obesidad.

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Conflictos de interés

Los autores declaran que no hay ningún conflicto de interés.

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Original/*Obesidad*

Satisfacción de la imagen corporal en adolescentes y adultos mexicanos y su relación con la autopercepción corporal y el índice de masa corporal real

Reyna Sámano¹, Ana Lilia Rodríguez-Ventura¹, Bernarda Sánchez-Jiménez¹, Estela Ytelina Godínez Martínez¹, Almudena Noriega², Rosa Zelonka¹, Marien Garza¹ y Javier Nieto²

¹Departamento de Nutrición y Bioprogramación, Subdirección de Intervenciones Comunitarias, Instituto Nacional de Perinatología Isidro Espinosa de los Reyes. ²Escuela de Dietética y Nutrición del ISSSTE, México.

Resumen

Introducción: La percepción que se tengan de la imagen corporal (IC) podría determinar la búsqueda de atención nutricia, aunque no siempre hay concordancia del índice de masa corporal (IMC) autopercebido con el real.

Objetivo: Correlacionar el IMC autopercebido con el real y su relación con la satisfacción de la IC en una muestra de adolescentes y adultos mexicanos.

Métodos: Estudio transversal analítico, con 556 participantes: 330 adolescentes y 217 adultos, con las siguientes evaluaciones: de autopercepción y de la satisfacción de la IC; asimismo, antropométrica.

Resultados: El IMC fue mayor entre adultos 23 ± 6 vs 29.3 ± 5 $p < 0.001$, quienes duplicaron la cifra de sobrepeso y obesidad de los adolescentes 79% vs 43%. La mitad de todos los participantes tuvo concordancia de su IMC percibido con el real ($p < 0.001$). De los adultos con sobrepeso u obesidad 68% estuvieron satisfechos con su IC, mientras que en los adolescentes esto correspondió a más del 80%. Las variables predictoras de insatisfacción de la IC fueron ser adulto, ser mujer y tener sobrepeso/obesidad ($p = 0.013$). Los que refirieron que su figura corporal les inspiraba un juicio positivo reportaron estar satisfechos con su IC y la mayoría presentaron un IMC real de normal o sobrepeso.

Conclusiones: En la mitad de los participantes hubo concordancia entre la IC autopercebida y el IMC real. La satisfacción con la IC fue más frecuente entre los de menor IMC real y autopercebido, pero una gran proporción de los de sobrepeso y obesidad también refirieron satisfacción con su IC, aunque sea una condición de riesgo.

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Palabras clave: Imagen corporal. Obesidad. Adolescente. Índice de masa corporal. Satisfacción.

BODY IMAGE SATISFACTION IN MEXICAN ADOLESCENTS AND ADULTS AND ITS RELATION WITH BODY SELFPERCEPTION AND REAL BODY MASS INDEX

Abstract

Introduction: Body Image (BI) perception could determine the nutritional care search, even though there is not always concordance between the real BMI and the self-perceived one.

Objective: To determine the correlation between self-perceived and real BMI, and their relation with body image (BI) satisfaction in a sample of Mexican adolescents and adults.

Subjects and methods: An cross-sectional and analytical study, conformed by 556 participants; of which 330 were adolescents and 217 were adults with anthropometric, self-perception and BI satisfaction assessment.

Results: The BMI was higher 23 ± 6 vs 29.3 ± 5 $p < 0.001$ in adults, which doubled the level of overweight and obesity present in the adolescents 79% vs 43%. About 50% of participants had concordance between their real BMI and their perceived one ($p < 0.001$). Of all adults with overweight and obesity 68% had satisfaction with their BI, whereas the prevalence of satisfaction with the BI in adolescents was 80%. The predictive variables of BI insatisfaction were being an adult, being a woman and having overweight/obesity ($p = 0.013$). Those ones who referred a positive judgment about their BI, they also reported being satisfied with their BI and presented a real normal or overweight BMI.

Conclusions: Half of the participants had concordance of their perceived BI with their real BMI. The satisfaction with BI was more frequent between the lower real and perceived BMI, but subjects with overweight and obesity also reported satisfaction with their BI even though it is considered a risk condition.

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Keys words: Body image. Obesity. Adolescent. Body mass index. Satisfaction.

Correspondencia: Estela Ytelina Godínez Martínez
eygodinez@hotmail.com

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Abreviaturas

IMC: Índice de masa corporal.

IC: Imagen corporal.

RM: Razón de momios.

OMS: Organización Mundial de la Salud.

Introducción

A nivel mundial el 65% de la población vive en países donde el sobrepeso y la obesidad tienen gran repercusión en la morbilidad y mortalidad¹, lo que implica grandes gastos a la salud a escala gubernamental y familiar por las complicaciones que representan como diabetes, hipertensión arterial y cáncer entre otras. Este problema de salud pública se ha incrementado en todos los grupos de edad, en EEUU como en México la prevalencia es mayor al 70%². Su origen es multifactorial, algunos de sus determinantes son el balance positivo en el consumo de energía, el sedentarismo y la influencia de los medios de comunicación.

También se ha postulado que la autopercepción que se tenga del peso corporal podría influir para mantener, aumentar o perder peso; por su relación sobre la práctica de conductas alimentarias que afectan la salud³. Por lo tanto, la autopercepción de la imagen corporal (IC) puede ser una limitante para la búsqueda de atención nutricional. La IC se define como un constructo que involucra las percepciones, pensamientos, sentimientos sobre el tamaño y forma del cuerpo⁴.

La autopercepción de la IC en la población adolescente⁵ y adulta⁶ ha sido evaluada en varias ocasiones, siendo constante la falta de concordancia de la autopercepción de la IC con el Índice de Masa Corporal (IMC) real^{7,8} donde el género, la raza y el nivel de escolaridad son determinantes de la precisión de la autopercepción del peso corporal con el real⁹.

Por otra parte, la autopercepción de la IC se asocia con los cambios en las conductas alimentarias¹⁰ sobre todo en adolescentes¹¹. También se ha demostrado que la autopercepción de la imagen corporal puede ser variable según la raza; al respecto se ha reportado que la población latina tiene tres veces mayor probabilidad de no reportar concordancia entre su peso real y la autopercepción de la IC¹².

Los conocimientos y percepciones que la gente tenga de su IC pueden ser determinantes para su manejo nutricional⁷; por ello el objetivo de esta investigación fue correlacionar el IMC autopercebido con el real y su relación con la satisfacción del peso real en una muestra de adolescentes y adultos mexicanos.

Material y métodos

Se realizó un estudio observacional, transversal y analítico durante junio de 2013 a mayo de 2014, con adolescentes de dos centros educativos públicos y un

grupo de adultos trabajadores de una institución de salud, ambos ubicados en el área metropolitana de la Ciudad de México. La selección fue consecutiva y a conveniencia, con personas aparentemente sanas.

De 600 sujetos incluidos, se eliminaron 44 por no contar con toda la información. La muestra quedó conformada por 556 participantes, de ellos fueron 330 adolescentes y 217 adultos, con predominio de mujeres en ambos grupos de edad (75%).

El presente trabajo deriva de una línea de investigación sobre hábitos alimentarios, registrada y financiada por el Instituto Nacional de Perinatología.

Sujetos. Todos los participantes fueron contactados e invitados a incorporarse en el estudio, previamente se les explicó en qué consistía el mismo, en el caso de los adolescentes, también se les explicó a sus padres o tutores. La investigación fue aprobada por los Comités de Investigación y de Ética Institucionales, es una investigación de riesgo mínimo de acuerdo con la Ley General de Salud en México, considerando los aspectos de la Declaración de Helsinki¹³. Al finalizar todos los procedimientos se ofreció tratamiento nutricional, el cual fue proporcionado por nutriólogas, una enfermera y una endocrinóloga del equipo de trabajo.

Procedimientos realizados:

Evaluación antropométrica. A los participantes se les midió el peso corporal con una báscula (Terraillon-Fitness Coach Premium 11328) con precisión de 100 g y se midió la estatura con un estadiómetro (SECA modelo 208), con una precisión 0.1 cm, con ambos datos se calculó el IMC y posteriormente en los(as) adolescentes se ubicaron los valores en las tablas percentilares de la OMS¹⁴ asignando la siguientes categorías: ≤ 14.99 bajo peso, 15 a 84.99 normal, 85 a 94.99 sobrepeso y ≥ 95 obesidad. Para los adultos los puntos correspondientes fueron directamente sobre los valores de IMC como sigue de bajo peso ≤ 18.49 , normal de 18.5-24.99, sobrepeso 25-29.99 y obesidad ≥ 30 ¹⁵, cuando la estatura fue baja (≤ 150 cm en mujeres y ≤ 160 cm en hombres) se clasificó de la siguiente manera: bajo peso ≤ 18.49 , normal de 18.5 a 22.99, sobrepeso de 23 a 24.99, obesidad ≥ 25 ¹⁶.

Autopercepción de la imagen corporal y satisfacción del cuerpo: Se aplicó la escala de nueve imágenes de Sorensen¹⁷ cada una con un número de identificación, utilizada previamente en población mexicana¹⁸, a los participantes se les indicó que marcaran la figura que ellos consideraran que más se acercaba a su IC. La clasificación fue como sigue: 1 bajo peso, 2-3 normal, 4-6 sobrepeso y 7-9 obesidad. Estos datos fueron validados previamente en hombres y mujeres con cálculo de sensibilidad y especificidad¹⁸, y validado en consistencia y contenido por expertos en el área de nutrición, tomando como contraste las categorías de IMC que establece la OMS.

Para conocer la satisfacción de su IC se realizó la siguiente pregunta *¿Está satisfecho con su imagen*

corporal? *sí* ___ *no* ___ y *¿por qué?* De acuerdo con el contenido de las respuestas que se obtuvieron, fue posible agruparlas en dos categorías para su análisis correspondiente: 1) *porque es saludable y me gusta como me veo*, y 2) *porque no es bueno para la salud y me siento pesada(o) para hacer las cosas*.

Aspectos sociodemográficos. Se aplicó una encuesta para obtener la edad, sexo, escolaridad, ocupación y el nivel socioeconómico de la muestra, este último fue medido a través del cuestionario de la AMAI 2008¹⁹.

Análisis estadístico. Se utilizó el programa estadístico SPSS (versión 12.0 para Windows, 200x, SPSS, Inc, Chicago). Para relacionar el IMC real y autopercebido, se recurrió a la Ji 2 de Pearson. Finalmente se realizó un modelo de regresión logística para identificar las variables que predijeran la insatisfacción de su IC.

Resultados

De los 217 adultos la edad predominante fue de 40 a 59 años, la mayoría fue personal administrativo y paramédico con una escolaridad de bachillerato y licenciatura. Por su parte, los 330 adolescentes fueron estudiantes de secundaria o bachillerato. De los adolescentes 82% correspondió a mujeres y en los adultos fue de 73%. Todos y todas las participantes se ubicaron en el nivel socioeconómico medio y medio bajo.

La edad en años de los adolescentes fue de 16±2 para mujeres y de 15±2 para hombres, mientras que en adultas esto correspondió a 52±11 y a 50±9 de los hombres. Los adolescentes tuvieron significativamente

menos peso (kg) con 57.9±12 en mujeres y en hombres 57.9±13, en tanto que en las adultas fue de 69.6±14 y en adultos 80.7±14 ($p<0.001$), lo que se reflejó en el IMC con cifras de 23±6 vs 29.7±6 en adolescentes y adultos respectivamente, (entre sujetos $p<0.001$, intra-sujetos y grupo $p<0.001$).

La mayoría de las adolescentes se percibieron con sobrepeso; no obstante el 43% de la población adolescente tuvo sobrepeso u obesidad, cuando entre la muestra de adultos esta característica fue de 83% en mujeres y 76% en hombres. En los adultos hubo una mayor autopercepción de obesidad, en contraste, su IMC real más frecuente fue de sobrepeso y en los adolescentes el IMC real predominante fue normal. En el caso de bajo peso, los adolescentes subestimaron y los adultos sobrestimaron su presencia. Además se observó que la mitad de adolescentes y adultos tuvo certeza de su verdadero IMC, el resto tendió a subestimar o sobreestimar su peso corporal (Tabla I).

En la figura 1, se ve que cerca de la mitad de los participantes que tenían obesidad se identificaron con sobrepeso, los de sobrepeso se identifican con peso normal y los de peso normal en mayor frecuencia (50% aproximadamente) con bajo peso en ambos grupos; mientras que la mayor parte los que se percibieron de bajo peso, tuvieron concordancia con el IMC real ($p\leq 0.001$).

En otros datos, se presentó una correlación directa entre la edad cronológica y puntaje de autopercepción de la imagen corporal con $r=0.315$ ($p\leq 0.001$); y entre el IMC real con el IMC percibido con $r=0.459$ ($p\leq 0.001$).

Tabla I
Frecuencia de autopercepción e IMC real según sexo y grupo de edad. $n=556$

IMC	Adolescentes ($n=339$)		Adultos ($n=217$)	
Percepción $p\leq 0.001$	Mujeres (82%)	Hombres (18%)	Mujeres (73%)	Hombres (27%)
Bajo peso	7 (2.5)	5 (8)	6 (3.8)	3 (5)
Normal	100 (36)	30 (48)	18 (11)	10 (17)
Sobrepeso	127 (46)	18 (30)	63 (40)	24 (41)
Obesidad	46 (16.5)	8 (13)	72 (45)	21 (36)
Real $p\leq 0.001$				
Bajo peso	15 (5)	8 (10)	1 (0.6)	0 (0)
Normal	143 (51)	28 (47)	26 (16)	14 (24)
Sobrepeso	46 (16)	11 (18)	72 (45)	29 (50)
Obesidad	75 (27)	15 (25)	60 (38)	15 (26)
Correlación del IMC autopercebido y real en 3 categorías $p\leq 0.001$				
Subestima	53 (19)	13 (22)	32 (20)	15 (26)
Igual	143 (51)	36 (60)	94 (59)	27 (47)
Sobreestima	85 (30)	11 (18)	33 (21)	16 (28)

Datos expresados en frecuencia (%).

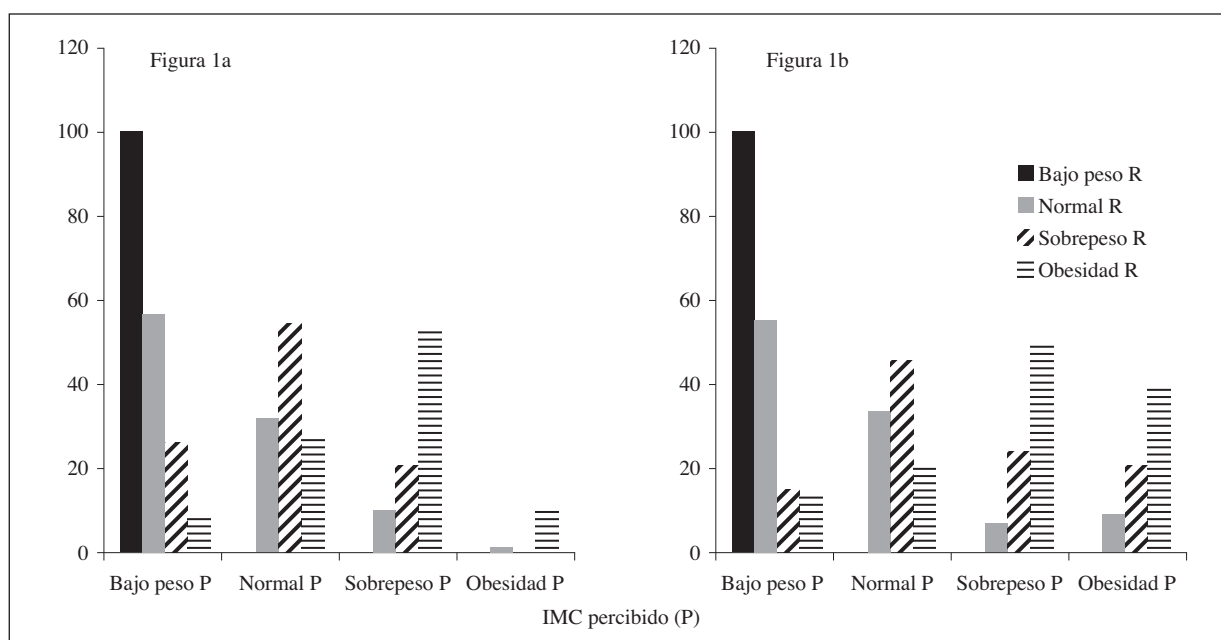


Fig. 1a.—Concordancia (%) de IMC real (R) con el IMC percibido (P) en adolescentes. $p \leq 0.001$.

Fig. 1b.—Concordancia (%) de IMC real (R) con el IMC percibido (P) en adultos. $p \leq 0.001$.

En la tabla II se visualiza una mayor frecuencia varones adolescentes satisfechos con su peso corporal. La satisfacción del peso corporal fue más común entre todos los que presentaron un IMC autopercebido y real de bajo peso y peso normal, en los individuos con

IMC real de sobrepeso y en los que subestimaron su IMC. Sin embargo, de la totalidad de los adultos con sobrepeso u obesidad 68% estuvo satisfecho con su imagen corporal, en tanto que en los adolescentes esto correspondió a más del 80% ($p \leq 0.010$). Por otra parte, la mayoría de los que subestima el peso están satisfechos con su imagen corporal. Además, de los que tuvieron concordancia en la autopercepción de la imagen corporal con el IMC real, se observó que 57% de los adolescentes y 23% de los adultos estaban satisfechos con su peso corporal ($p = 0.010$).

Se calculó un modelo de regresión logística para identificar las variables que podrían predecir el riesgo para la insatisfacción corporal, de acuerdo con él se vio que las variables predictoras para la insatisfacción corporal fueron ser adulto, mujer y tener sobrepeso y obesidad ($p = 0.013$), ver tabla III.

En la tabla IV se aprecia que la mayoría de los que: estaban satisfechos con su peso corporal; tenían IMC real normal o sobrepeso; una autopercepción de IMC de bajo peso, normal o sobrepeso y eran hombres adultos refiriendo que su IC les inspiraba un juicio positivo. En contraste, los que reportaron argumentos negativos de su imagen corporal fueron más frecuentes entre los que no estaban satisfechos con su IC y tenían obesidad autopercebida y real, población adulta y/o mujeres.

Discusión

En el presente estudio se observó un mayor IMC entre los adultos, a pesar de que fueron aparentemente sanos. La frecuencia del sobrepeso y la obesidad fue

Tabla II		
Frecuencia de satisfacción con la imagen corporal, según diferentes características		
Satisfacción con imagen corporal		
	Adultos (n=339)	Adolescentes (n=217)
Sexo ^a		
Mujer	52	62
Hombre	42	78
IMC percibido ^a		
Bajo peso	89	75
Normal	93	81
Sobrepeso	53	61
Obesidad	17	33
IMC real ^a		
Bajo peso	100	62
Normal	80	71
Sobrepeso	45	77
Obesidad	23	45
Concordancia del IMC real con el percibido ^a		
Subestima	59	70
Igual	23	57
Sobreestima	28	53

^a Ji² de Pearson $p \leq 0.010$. Datos expresados en porcentaje.

Tabla III
Modelo de regresión para la insatisfacción con el peso corporal y sus variables predictoras

	<i>Beta</i>	<i>RM</i>	<i>IC (95%)</i>	<i>p</i>
Ser adulto	0.680	1.975	1.332, 2.928	0.001
Tener sobrepeso/obesidad	0.574	1.775	1.200, 2.625	0.004
Ser mujer	0.616	1.852	1.218, 2.815	0.004
Sin correlación entre IMC real y autopercebido	-0.056	0.946	0.664, 1.346	0.746
Constante	-0.595	0.499		0.013

Regresión logística. RM. Razón de momios.

Tabla IV
Razones de los participantes para estar o no satisfechos con su imagen corporal, según IMC autopercebido y real

	<i>Razones por las que refirieron satisfacción con su peso corporal</i>		
	<i>Les gusta, es saludable, se ven bien (positivas)</i>	<i>Se sienten pesada(o)s, no es bueno (negativa)</i>	<i>No contestaron</i>
Están satisfechos con su peso corporal $p \leq 0.001$			
Sí	175 (56)	59 (19)	79 (25)
No	36 (15)	158 (67)	42 (18)
IMC real $p \leq 0.001$			
Bajo peso	7 (32)	8 (36)	7 (32)
Normal	91 (43)	62 (29)	58 (28)
Sobrepeso	70 (44)	57 (36)	31 (20)
Obesidad	43 (26)	90 (54)	32 (19)
IMC percibido $p \leq 0.001$			
Bajo peso	12 (57)	6 (29)	3 (14)
Normal	69 (44)	39 (25)	48 (31)
Sobrepeso	102 (44)	78 (33)	52 (22)
Obesidad	28 (19)	94 (64)	25 (17)
Correlaciona el IMC real con el autopercebido $p = 0.866$			
Sí	111 (37)	118 (39)	71 (24)
No	100 (39)	99 (39)	57 (22)
Edad $p \leq 0.001$			
Adulta	98 (45)	109 (50)	10 (5)
Adolescente	113 (33)	108 (32)	118 (34)
Sexo $p = 0.004$			
Hombre	60 (51)	39 (33)	19 (16)
Mujer	151 (34)	178 (41)	109 (25)

Ji² de Pearson. Datos expresados en casos (%).

más alta entre los adultos con 83% en mujeres y 76% en hombres, cifras superiores a las reportadas en población adulta en México (71%)²⁰, mientras que en los adolescentes se encontró el 43% con esta característica, de igual manera rebasó la prevalencia reportada

(35%);²¹ con lo anterior se reitera que estos padecimientos siguen incrementándose como se ha reportado a nivel mundial²² lo que puede conducir a serias consecuencias a la salud pública con gastos económicos importantes.

En esta investigación al igual que en otras con población adolescente⁵ y adulta^{23,24} hubo una tendencia a no identificar correctamente el IMC corporal, esto relacionado con el sexo y edad; donde cerca de la mitad de la muestra de la presente investigación tuvo concordancia entre el IMC real con el percibido, lo que significa que probablemente sólo buscarán resolver su problemática en la composición corporal a través de las estrategias de control de peso, aquellas personas que en primer lugar se identifican realmente en el IMC que tienen, y que además admitan que necesitan ayuda de un especialista en nutrición para mejorar su estilo de vida^{25,29}. Esta percepción errada de la IC en adolescentes y adultos puede ser la principal barrera para una pérdida o cambio de peso exitoso²⁶ por ello el manejo de metas debe hacerse de manera individual según la percepción del peso corporal que se tenga²⁷. De hecho Ramos et al, en su estudio con adolescentes concluyó que “la razón que mueve a los adolescentes a realizar dietas para adelgazar no es el peso corporal real, sino la percepción que tienen de su cuerpo y si están satisfechos con él”²⁸.

Se ha postulado que es necesario concientizar sobre el verdadero peso corporal a los adolescentes, para generar estrategias que mejoren sus hábitos alimentarios según su IMC real⁷, sin embargo, en esta investigación se observó que en las adultas también aplicaría dicho postulado, porque además de que fueron las que reportaron en mayor proporción no estar satisfechas con su peso, muchas de ellas también se autoperciben con menor peso, similar a otros estudios^{23,24}.

La cuarta parte de los que tuvieron bajo peso o peso normal se perciben con sobrepeso u obesidad, lo que podría llevarlos a practicar conductas no saludables como ayunos, consumo de píldoras, laxantes o la inducción del vómito²⁹.

Entre los que no tuvieron concordancia del IMC real con el autopercebido y que además están insatisfechos con su IC, deben contar con atención especializada porque podrían cursar con procesos depresivos que los puede conducir a una elección inadecuada de alimentos³⁰. En contraste, las mujeres que tendieron a sobreestimar el peso corporal estarían más comprometidas para seguir las instrucciones de los especialistas en nutrición, comparadas con los varones, quienes subestimaron su imagen corporal³¹.

¿Por qué hay mayor discordancia entre la imagen corporal percibida y el IMC real?

La discordancia entre el IMC real y el autopercebido en la mayoría de la población puede ser resultado de los juicios constantes que se reciben dentro del seno familiar, que conducen a la aceptación de un exceso de peso considerándolo como normal^{32,33} que no necesariamente es el saludable; lo preocupante es que aún

con el exceso de peso se sientan satisfechos y crean que es sano su peso corporal en ambos grupos de esta población, siendo más frecuente la satisfacción entre los adolescentes. Al respecto una limitante de este estudio es que probablemente los adolescentes estén utilizando mecanismos de defensa al referir satisfacción con la imagen corporal cuando realmente es todo lo contrario “formación reactiva”, de hecho Martínez-Aguilar reportó la presencia de estos mecanismos en su estudio con adolescentes obesos³⁴.

Entre los participantes del presente estudio se pudo observar que la insatisfacción de su IC fue más frecuente entre los adultos y los que tenían obesidad, aseverándose que podrían tener idea del peligro que representa el exceso de peso. Aún así se presentaron casos de adolescentes y adultos con IMC de sobrepeso y obesidad real y autopercebido que refirieron estar satisfechos con su IC y que además argumentaron sentirse y verse bien, aunque como ya se mencionó podrían estar presentes ciertos mecanismos de defensa que afectaron la veracidad de la información proporcionada.

La subestimación de la IC en los hombres puede estar relacionada a que una proporción de ellos también se preocupa por incrementar su masa muscular, que erróneamente se puede traducir en mayor peso corporal sin que necesariamente sea proveniente de músculo³⁵.

Conclusiones. Se presentó correlación del IMC real con el autopercebido en la mitad de los participantes; la satisfacción con la IC fue más frecuente entre los de menor IMC real y percibido, aún así la población con sobrepeso y obesidad también refirió satisfacción con su imagen, aunque sea una condición de riesgo. Además se observó que las mujeres de ambos grupos estudiados y los adultos mostraron una mayor insatisfacción con su IC.

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Original/*Obesidad*

Prevalence of underweight, overweight and obesity in university students from the region of Anhui (China)

Xiaohua Ren¹, Yan Chen¹, Lianping He¹, Yuelong Jin¹, Li Tian¹, Mi Lu², Wei Lu¹, Lingling Ding¹, Daoxia Guo¹, Linghong Wang¹, Zhonghua Nie¹ and Yingshui Yao¹

¹School of Public Health, Wannan Medical College, Wuhu 241002, Anhui, People's Republic of China. ²School of Medical Imaging and Inspection, Wannan Medical College, Wuhu 241002, Anhui, People's Republic of China.

Abstract

Background: Overweight and obesity are epidemic worldwide. Our previous study found that the prevalence of overweight and obesity in primary students is high.

Objective: we sought to estimate whether the prevalence of overweight and obesity among university students is still high in China.

Methods: A cross-sectional study was designed to collect the routine health screening data for university students in 2013. The height and weight of students were measured, and BMI was calculated with height and weight, we estimated the underweight and obesity prevalence of university students using by two references [Working Group on Obesity references in China (2004) and World Health Organization (WHO) criteria (2000)].

Results: Depending on the China references used, the overall prevalence of underweight, overweight (including obesity) and obesity in male university students were 14.2%, 14.7% and 4.2%, respectively; in female university students were 27.5%, 4.4% and 0.6%, respectively. Depending on the WHO references used, the overall prevalence of underweight, overweight (including obesity) and obesity in male university students were 14.2%, 11.5% and 2.5%, respectively, in female university students were 27.5%, 2.4% and 0.3%, respectively. An interesting observation made was that the underweight prevalence of university students has an increasing trend, especially in female.

Conclusion: The study showed that the prevalence of underweight in university students, especially in female students has become a critical health issue. Related department of school and government should pay more attention to student's physical health.

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Correspondence: Yingshui Yao,
School of Public Health, Wannan Medical College,
No.22 Road wenchangxi, Yijiang district, Wuhu city,
Anhui, 241002 China.
E-mail: yingshuiyao@163.com.

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Xiaohua Ren, Yan Chen and Lianping He contributed equally to this work

PREVALENCIA DE BAJO PESO, EL SOBREPESO Y LA OBESIDAD EN ESTUDIANTES UNIVERSITARIOS DE LA REGIÓN DE ANHUI (CHINA)

Resumen

Antecedentes: El sobrepeso y la obesidad son epidemia en todo el mundo. Nuestro estudio anterior halló que la prevalencia de sobrepeso y obesidad en estudiantes de primaria es alto.

Objetivo: Hemos tratado de estimar si la prevalencia del sobrepeso y la obesidad entre los estudiantes universitarios es todavía alta en China.

Métodos: Un estudio transversal fue diseñado para recoger los exámenes de salud de rutina datos para estudiantes universitarios en 2013. La altura y el peso de los estudiantes fueron medidos, y el IMC se calcula con la altura y el peso, así como para estimar la prevalencia de insuficiencia ponderal y obesidad de la Universidad los estudiantes utilizando dos referencias [Grupo de trabajo sobre la obesidad referencias en China (2004) y la Organización Mundial de la salud (OMS) criterios (2000)].

Resultados: Dependiendo de la China referencias utilizadas, la prevalencia global de bajo peso, sobrepeso (obesidad) y la obesidad en estudiantes universitarios masculinos fueron 14,2%, el 14,7% y 4,2%, respectivamente; en mujeres estudiantes universitarios fueron el 27,5%, 4,4% y 0,6%, respectivamente. Dependiendo de los que referencias utilizadas, la prevalencia global de bajo peso, sobrepeso (obesidad) y la obesidad en estudiantes universitarios masculinos fueron 14,2%, 11,5% y 2,5%, respectivamente, en mujeres estudiantes universitarios fueron el 27,5%, 2,4% y 0,3%, respectivamente. Una observación interesante es que la prevalencia de insuficiencia ponderal de los estudiantes universitarios tiene una tendencia al aumento, sobre todo en mujeres.

Conclusión: El estudio demostró que la prevalencia de la insuficiencia ponderal en estudiantes universitarios, especialmente en mujeres estudiantes se ha convertido en un problema de salud crítico. Related Departamento de la escuela y el Gobierno deben prestar más atención a la salud física del alumno.

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Palabras clave: *Bajo peso. Obesidad. Estudiantes universitarios.*

Introduction

Increasing number of reported that a high prevalence of obesity and overweight is common in developing countries undergoing nutritional transition¹⁻⁶. These are also a major emerging public health problem in China⁷. Thinness is an important overlooked phenomenon with wide variation in prevalence and trends across developed countries⁸. Some researcher found that the prevalence of underweight in university students is high⁹. Olearo B et al¹⁰ reported that 12, 5% university students are underweight. A random sample of university students from 22 universities in 22 low, middle income and emerging economy countries also reveled that the prevalence of underweight among women students was 17.6%¹¹. A study conducted in Malaysia reveals that 14.8% medical students were underweight (males 12.2% and females 17.0%)¹². Thus, underweight prevalence among university students also arouses our special attention.

In this study, we sought to evaluate the physical health of university students based on two references [Working Group on Obesity references in China (2004) and World Health Organization (WHO) criteria (2000)].

Subjects and methods

Participants

A school-based cross-sectional study was conducted in a university student who admitted routine health screening in 2013. This study contains a total of 2617 subjects (1131 male and 1486 female) was recruited in 2013, aged 19-23 years. All subjects agreed to provide their personal information regarding the purpose and the procedures of our study, and written informed consent. This study was approved by local ethics committee.

Anthropometric measurements

Height was measured to the nearest 0.1 cm with a standard stadiometer following study protocols, and weight in kilograms was measured in light clothing to the nearest 0.1 kg on an electronic scales. All anthropometric data were collected by trained staff and supervised by the school nurse. BMI was computed using the following standard equation: BMI = Weight in kg/height squared in meter.

Definitions

Overweight and obesity were defined on BMI cutoff points, which are gender and age specific. (1) Working Group on Obesity references in China, the BMI cut-off points are 24 and 28 for overweight and obesity, respectively; (2) the WHO reference is based on the BMI of 25 and 30 at the age of 18 for classification of childhood and adolescent overweight and obesity, respectively.

Statistical analysis

Excel software was performed to describe the prevalence of overweight/obesity among university students. A line graph was draw for the prevalence of overweight and obesity among university students by age.

Results

In this study, a total of 2617 subjects (1131 male and 1486 female) was recruited in 2013, aged 19-23 years. The mean values ($\pm$ SD) of weight, height, and calculated BMI are shown in table I.

Table I
Mean ($\pm$ SD) of height, weight and BMI of university students by age

	19	20	21	22	23
Male					
n	80	354	404	219	74
Height (m)	1.74 $\pm$ 0.04	1.74 $\pm$ 0.05	1.73 $\pm$ 0.06	1.73 $\pm$ 0.06	1.73 $\pm$ 0.05
Weight (kg)	62.88 $\pm$ 8.27	66.12 $\pm$ 11.32	63.87 $\pm$ 9.62	63.61 $\pm$ 9.71	62.36 $\pm$ 8.78
BMI (kg/m ²)	20.69	21.92	21.36	21.27	20.88
Female					
n	109	457	547	285	90
Height (m)	1.62 $\pm$ 0.06	1.62 $\pm$ 0.05	1.62 $\pm$ 0.05	1.62 $\pm$ 0.05	1.62 $\pm$ 0.05
Weight (kg)	52.95 $\pm$ 7.40	53.70 $\pm$ 24.50	52.04 $\pm$ 6.59	53.11 $\pm$ 25.51	51.86 $\pm$ 6.69
BMI (kg/m ²)	20.10	20.49	19.92	20.32	19.81

The prevalence of underweight, overweight and obesity for university students are shown in table II. Depending on the China references used, the overall prevalence of underweight, overweight (including obesity) and obesity in male university students were 14.2%, 14.7% and 4.2%, respectively; in female university students were 27.5%, 4.4% and 0.6%, respectively. Depending on the WHO references used, the overall prevalence of underweight, overweight (including obesity) and obesity in male university students were 14.2%, 11.5% and 2.5%, respectively, in female university students were 27.5%, 2.4% and 0.3%, respectively. Change of underweight, overweight and obesity prevalence are showed (Figs. 1-3). An interesting observation made was that the underweight prevalence of university students has an increase trend, especially in female. (Fig. 1).

Discussion

In the present study, we use two references [Working Group on Obesity references in China (2004) and World Health Organization (WHO) criteria (2000)] to evaluate the overweight and obesi-

ty among university students. The results based on China reference revealed that the overall prevalence of underweight, overweight (including obesity) and obesity in male university students were 14.2%, 14.7% and 4.2%, respectively; in female university students were 27.5%, 4.4% and 0.6%, respectively. Depending on the WHO references used, the overall prevalence of underweight, overweight (including obesity) and obesity in male university students were 14.2%, 11.5% and 2.5%, respectively, in female university students were 27.5%, 2.4% and 0.3%, respectively. The prevalence of underweight is similarly with the previous study¹³. An interesting observation made was that the prevalence of underweight was increase with age.

Previous study documented that the prevalence of thinness was higher than the prevalence of overweight and obesity, especially in students from high status families¹⁴. The possible reason maybe that university students have unhealthy eating behavior and inadequate nutrient intake, and a high prevalence of underweight among university students¹⁵. Thus, further investigation should be taken to confirm that whether there are a relationship between eating habits and underweight.

Table II
The prevalence of obesity for university students according to age

			Prevalence (%)					Total
reference								
Age (years)			19	20	21	22	23	
Male	n		80	354	404	219	74	1131
	underweight	China ^{##}	14 (17.5)	46 (13.0)	55 (13.6)	30 (13.7)	16 (21.9)	161 (14.2)
	Normal	China ^{##}	58 (72.5)	238 (67.2)	280 (69.3)	153 (69.9)	48 (65.8)	777 (68.8)
	Overweight ^a	China ^{##}	7 (8.8)	46 (13.0)	58 (14.4)	26 (11.9)	7 (9.6)	144 (12.7)
	Obesity	China ^{##}	1 (1.3)	24 (6.8)	11 (2.7)	10 (4.6)	2 (2.7)	48 (4.2)
	underweight	WHO [#]	14 (17.5)	46 (13.0)	55 (13.6)	30 (13.7)	16 (21.6)	161 (14.2)
	Normal	WHO [#]	60 (75)	258 (72.9)	305 (75.5)	164 (74.9)	53 (71.6)	840 (74.3)
	Overweight ^a	WHO [#]	6 (7.5)	32 (9.0)	37 (9.2)	22 (10.0)	5 (6.8)	130 (11.5)
Female	Obesity	WHO [#]	0 (0.0)	18 (5.1)	7 (1.7)	3 (1.4)	0 (0.0)	28 (2.5)
	n		109	457	547	285	90	1486
	underweight	China ^{##}	29 (26.6)	120 (26.3)	155 (28.3)	76 (26.7)	29 (32.2)	409 (27.5)
	Normal	China ^{##}	70 (64.2)	309 (67.8)	369 (67.5)	199 (69.8)	57 (63.3)	1004 (67.5)
	Overweight ^a	China ^{##}	9 (8.3)	22 (4.8)	21 (3.8)	9 (3.2)	4 (4.4)	65 (4.4)
	Obesity	China ^{##}	1 (0.9)	5 (1.1)	2 (0.4)	1 (0.4)	0 (0.0)	9 (0.6)
	underweight	WHO [#]	29 (26.6)	120 (26.3)	155 (28.3)	76 (26.7)	29 (32.6)	409 (27.5)
	Normal	WHO [#]	74 (67.9)	319 (70)	378 (69.1)	206 (72.3)	60 (67.4)	1037 (69.8)
	Overweight ^a	WHO [#]	6 (5.5)	14 (3.1)	13 (2.4)	2 (0.7)	0 (0.0)	35 (2.4)
	Obesity	WHO [#]	0 (0.0)	3 (0.7)	1 (0.2)	1 (0.4)	0 (0.0)	5 (0.3)

^{##} Working Group on Obesity references in China. [#] The WHO reference. Overweight^a: Overweight including obesity.

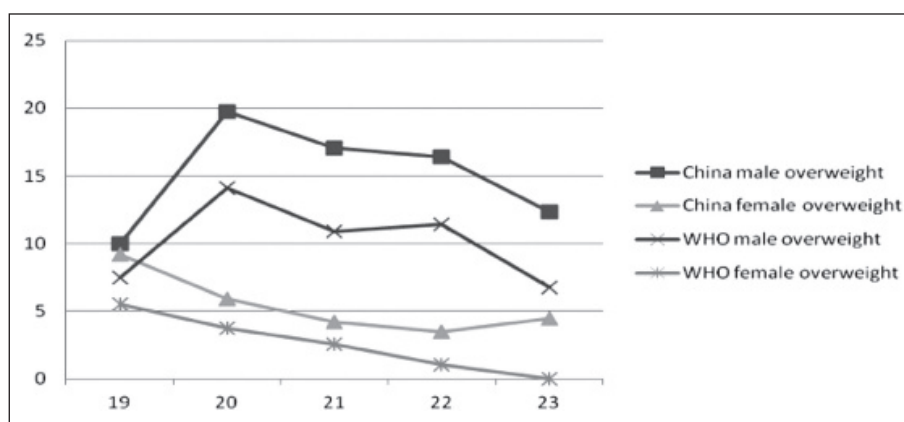


Fig. 1—The prevalence of overweight for university students by age(%).

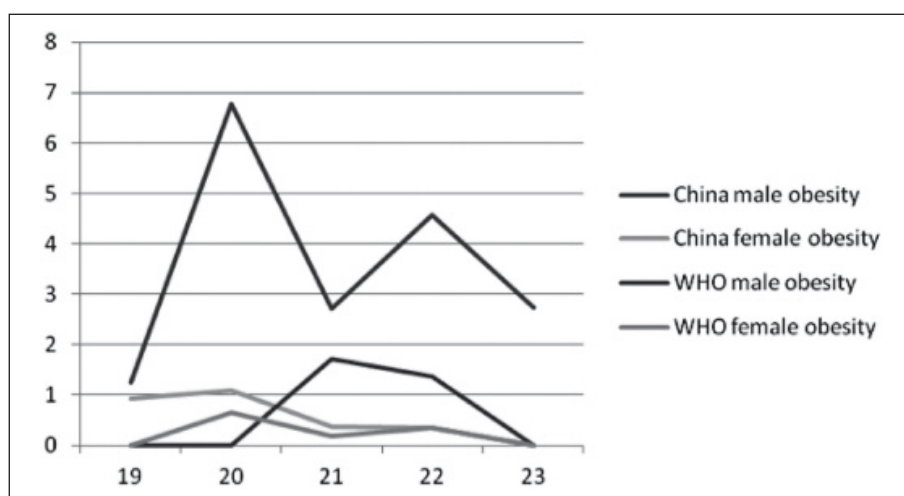


Fig. 2—The prevalence of obesity for university students by age(%).

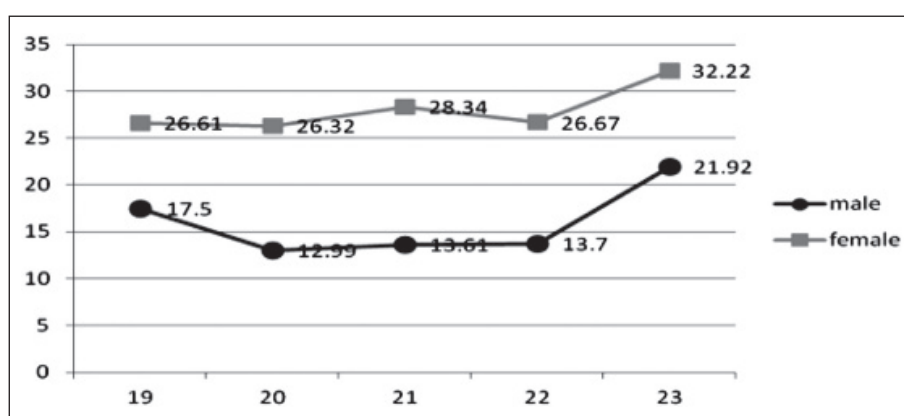


Fig. 3—The prevalence of underweight for university students by age(%).

Conclusions

The study showed that the prevalence of underweight in university students, especially in female students has become a critical health issue. Related department of school and government should pay more attention to student's physical health.

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Conflict of interest

None declared.

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Original/*Obesidad*

Prevalence of obesity among secondary school students from 2009 to 2014 in China: A Meta-analysis

Ning Dai, Li Tian, Tao Tao Tongda Li, Tianmiao Tang, Ying Sheng, Xiao Qian Lu, Xue Tang, Baozhen Peng, Wei Lu, Yuelong Jin, Lianping He and Yingshui Yao

School of Public Health, Wannan Medical College. Wuhu, Anhui 241002 China.

Abstract

Background: In recent years, obesity was a major public health problem in many countries. It was estimated that 8% of their children are obese. However, little is known about the overall prevalence of obesity among secondary students in China, the aim of this study was to evaluate the overall obesity prevalence of student from Chinese secondary school.

Methods: Publications from 2009 to 2014 on the obesity prevalence among secondary school students in China were retrieved from PubMed, online Chinese periodical full-text databases of VIP, CNKI and Wan fang. Meta Analyst was used analyze the total rates of obesity for Chinese secondary school.

Results: After evaluation of the quality of the articles, 32 papers were finally included in our study, and the total sample sizes on the obesity investigation were 218317 (107631 male and 110686 female), in which 27455(14865 male and 12590 female) were obesity. Meta-analyst findings showed that the pooled prevalence of obesity in secondary school students are 8.4 % (95% CI: 6.2%-11.3%) and 4.8 % (95% CI: 3.2%-7.2%) for boy and girl respectively.

Conclusion: Our results suggest that school and government related department should pay more attention to the obesity among secondary school students in China, and take some properly measures should to curve the trend growth of obesity.

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DOI:10.3305/nh.2015.31.3.8234

Key words: *Secondary school students. Obesity. Prevalence. Meta-analysis.*

LA PREVALENCIA DE LA OBESIDAD ENTRE LOS ALUMNOS DE SECUNDARIA A PARTIR DE 2009 A 2014 EN CHINA: UN META-ANÁLISIS

Resumen

Antecedentes: En los últimos años, la obesidad es un importante problema de salud pública en muchos países. Se calcula que el 8% de los niños son obesos. Sin embargo, poco se sabe acerca de la prevalencia de la obesidad entre los alumnos de secundaria en China, el objetivo de este estudio fue evaluar la prevalencia de la obesidad en general chino, estudiante de la escuela secundaria.

Métodos: Publicaciones de 2009 a 2014 en la prevalencia de obesidad entre los estudiantes de la escuela secundaria en China fueron recuperados de PubMed, Online Chinese periódico de bases de datos de texto completo de VIP, CNKI y Wan Fang. Analista del meta fue utilizado analizar el total de las tasas de obesidad para chinos de la escuela secundaria.

Resultados: Después de la evaluación de la calidad de los artículos, 33 papeles fueron finalmente incluidos en nuestro estudio, y el total de los tamaños de muestra sobre la obesidad investigación fueron 218317 (107631 macho y 110686 hembra), en la que 27455 (14863 macho y 12590 mujeres) fueron la obesidad. Los resultados mostraron que el analista del meta la prevalencia de la obesidad en estudiantes de secundaria son 8,4% (IC del 95%: 6,2% - 11,3%) y 4,8% (IC del 95%: 3,2% - 7,2%) para chico y chica, respectivamente.

Conclusión: Nuestros resultados sugieren que la escuela y Gobierno related Departamento debería prestar más atención a la obesidad entre los estudiantes de la escuela secundaria en China, y tomar algunas medidas adecuadamente a la curva de la tendencia de crecimiento de la obesidad.

(Nutr Hosp. 2015;31:1094-1101)

DOI:10.3305/nh.2015.31.3.8234

Palabras clave: *Estudiantes de secundaria. La obesidad. Prevalence. Meta-analysis.*

Correspondence: Yingshui Yao and Lianping He, School of Public Health, Wannan Medical College, No.22 Road Wenchangxi, Yijiang district, Wuhu, Anhui, 241002 China.
E-mail: yingshuiyao@163.com and Lianpinghe@126.com

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Ning Dai and Li Tian contributed equally to this work

Introduction

With the development of national economy and the improvement of people's living standard, there is rising prevalence of overweight and obesity in both developing countries and developed countries¹. The rate of obesity has tripled in developing countries over the past 20 years as they rapidly become more urbanized, with increased consumption of high calorie foods and adoption of a more sedentary lifestyle².

Some studies reported that obesity is associated with breast cancer³, asthma^{4,5}, diabetes mellitus^{6,7}, hypertension, coronary artery disease⁸, and dental caries⁹⁻¹¹. In addition, the obese suffer from social bias, prejudice and discrimination¹². It is known that the prevalence of obesity in Chinese children and adolescents was considered to be still relatively low¹³. However, there is a paucity of data on prevalence of overweight and obesity in Chinese secondary school student.

Thus, we performed the meta-analysis to assess the prevalence of obesity for secondary school students in recently, so as to provide a basis for intervention to children obesity.

Materials and methods

Literature retrieval

Related publications on obesity released from 2009 to 2014 were retrieved online from the PubMed. Chinese periodical full-text databases of VIP, Wan fang and CNKI in compliance with the key words "Obesity, students, children, adolescents and China" in Chinese for Chinese database and in English for Pub Med. Full-texts were eligible to retrieve manually from the previous data.

Criteria

The entry criteria for the literature was consisted of: 1) The papers on the obesity among college or university students in China published between January

2009 and June 2014; 2) Articles aimed at the discussion of the prevalence of obesity in the secondary school students of China. Exclusion criteria included: 1) The indicators described in the article were with fewer association or data being incomplete; 2) Repeated articles.

Literature screening and Quality assessment in process

Each study was assessed by two investigators independently, and the disagreements were resolved by expert assessment. Blind method was used to ensure quality. The related literatures were retrieved on the basis of the key words described previously, and initially selected through the title appraisal and scanning the abstracts. Full-text appreciation was carried out for the secondary selections. Data extraction was performed in papers verified eligibly. Evaluation of the article quality was made as meta-analysis of observational studies in epidemiology proposed Stroup DF, et al¹⁴.

Statistical analysis

Meta Analyst for Windows¹⁵ was used for performing meta-analysis. By heterogeneity test, the random-effect model was applied to merging sets of data and data analysis. The final data were subdivided into several groups for statistical analysis and chart description.

Results

Basic information and quality assessment of the articles

A total of 127 articles were retrieved from online Chinese periodical full-text databases of VIP, Wan fang database and CNKI well as Pub Med. Quality assessment was made by Meta-analysis of observatio-

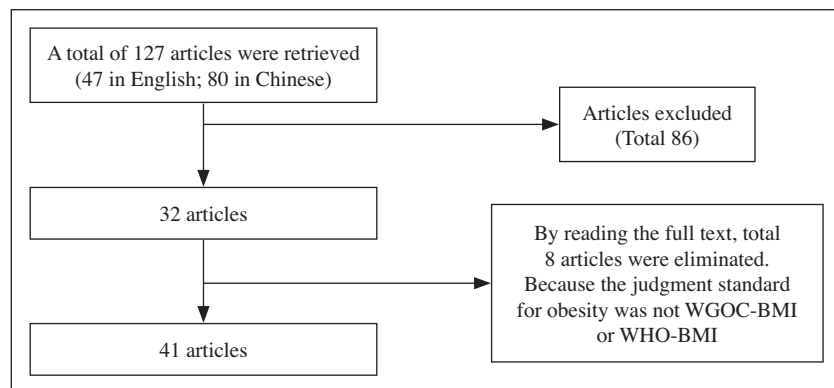


Fig. 1.—Flow Chart for the Literature Screening.

Table I
Main Characteristic of the Studies and the Detection Rate of Obesity among Secondary School Students in China

Author, year	Obesity			Sample size (n)			Age	Geographical distribution	Criterion
	Boys	Girls	Total	Boys	Girls	Total			
Xiaorong Hu, 2009 ¹⁶	248	189	437	5081	4898	9979	Junior high school	Jiangsu	WGOC-BMI
	155	54	209	5098	4878	9976	High school		
Juan Jin, 2009 ¹⁷	31	24	55	1656	1612	3268	Junior high school to university	Guangdong	WGOC-BMI
Xiaomin Zhang, 2010 ¹⁸	31	8	39	213	246	459	15~18	Shanghai	WGOC-BMI
Zhijie Xue, 2010 ¹⁹	49	35	84	584	513	1097	16~18	Neimenggu	WGOC-BMI
Weifeng Huang, 2010 ²⁰	62	90	152	92	101	193	15~20	Beijing	WGOC-BMI
Ying Yang, 2010 ²¹	163	84	247	2151	2847	4998	13~18	Jilin	WGOC-BMI
Qiuming Sheng, 2010 ²²	167	64	231	1737	1658	3395	13~15	Shanghai	WGOC-BMI
Yinghuan Xiong, 2010 ²³	18	12	30	771	887	1658	High school	Jilin	WGOC-BMI
Qing Tang, 2011 ²⁴	148	75	223	1459	1477	2936	13~18	Guangxi	WGOC-BMI
Xianghong Cao, 2011 ²⁵	67	32	99	1810	1709	3519	13~18	Gansu	WGOC-BMI
Shizhong Jia, 2011 ²⁶	23	10	33	747	653	1400	11~20	Gansu	WGOC-BMI
Yue Pan, 2011 ²⁷	258	105	363	454	187	641	12~15	Beijing	WGOC-BMI
Yinhua Jin, 2011 ²⁸	18	12	30	771	887	1658	17~19	Jilin	WGOC-BMI
Xia Peng, 2012 ²⁹	127	133	260	2630	3151	5781	13~18	Yunnan	WGOC-BMI
Bin Hong, 2012 ³⁰	125	66	191	1992	2183	4175	11~17	Shanghai	WGOC-BMI
Chunxia Hui, 2012 ³¹	275	205	480	1656	1792	3448	13~18	Neimenggu	WGOC-BMI
Jun Cui, 2012 ³²	17	3	20	617	611	1228	13~17	Zhejiang	WGOC-BMI
Dan Zhang, 2012 ³³	158	163	321	2657	2636	5293	13~17	Shanghai	WGOC-BMI
Yang Yang, 2012 ³⁴	186	83	269	3511	3416	6927	13~18	Shanghai	WGOC-BMI
Xiaojing Liu, 2012 ³⁵	54	16	70	600	600	1200	13~18	Xinjiang	WGOC-BMI
Ming Chang, 2012 ³⁶	152	148	300	3692	3778	7470	13~18	Shanxi	WGOC-BMI
Yi Song , 2012 ³⁷	10086	9809	19895	45511	47550	93061	12~18	China	WGOC-BMI WHO-BMI
Zhaocheng Zhang, 2012 ³⁸	490	215	705	2993	2737	5730	High school	Jiangsu	WGOC-BMI
Ping Li , 2012 ³⁹	31	8	39	1088	1019	2107	13~15	Sichuan	WHO-BMI (2007)
Meng Jia , 2012 ⁴⁰	73	39	112	322	380	702	12~15	Beijing	WGOC-BMI
Meilin Dong, 2013 ⁴¹	108	46	154	199	186	385	13~16	Shanghai	WGOC-BMI
Xueliang Zhang, 2013 ⁴²	33	31	64	407	408	815	14~18	Guangdong	WGOC-BMI
Xiaomei Lin, 2013 ⁴³	71	15	86	885	431	1316	13~18	Fujian	WGOC-BMI
Jing Sun, 2013 ⁴⁴	167	88	255	936	943	1879	12~13, 15~16	Beijing	WGOC-BMI
Ping Shi, 2013 ⁴⁵	48	51	99	583	649	1232	13~17	Beijing	WGOC-BMI
Jun Qiu, 2013 ⁴⁶	578	260	838	8149	8694	16843	12~18	Hunan	WHO-BMI
Shenglin Xia, 2014 ⁴⁷	42	33	75	916	926	1842	12~18	Guangdong	WGOC-BMI

nal studies in epidemiology¹⁴. Of the 32 articles, the total sample sizes on the obesity investigation were 27455 (14865 male and 12590 female). Figure 1 shows the process of literature screening and the basic information on the final articles are showed in table I.

Meta-analysis of the obesity prevalence among secondary school students in China

Heterogeneity test was carried out on the obesity detection rate, with a result of $I^2=0.499$, $Q=1.00$, sug-

gesting that the research results in the 34 article were heterogeneous. Random-effect model was used to meta-analysis. As is shown by the forest plots (Fig. 2), the results suggested that pooled prevalence of boy obesity in secondary school students is 8.4% (95% CI: 6.2%-11.3%).

Heterogeneity test was carried out on the obesity detection rate, with a result of $I^2=0.499$, $Q=1.00$, suggesting that the research results in the 34 article were heterogeneous. Random-effect model was used for meta-analysis. As is shown by the forest plots (Fig. 3), the results suggested that pooled prevalence of girl

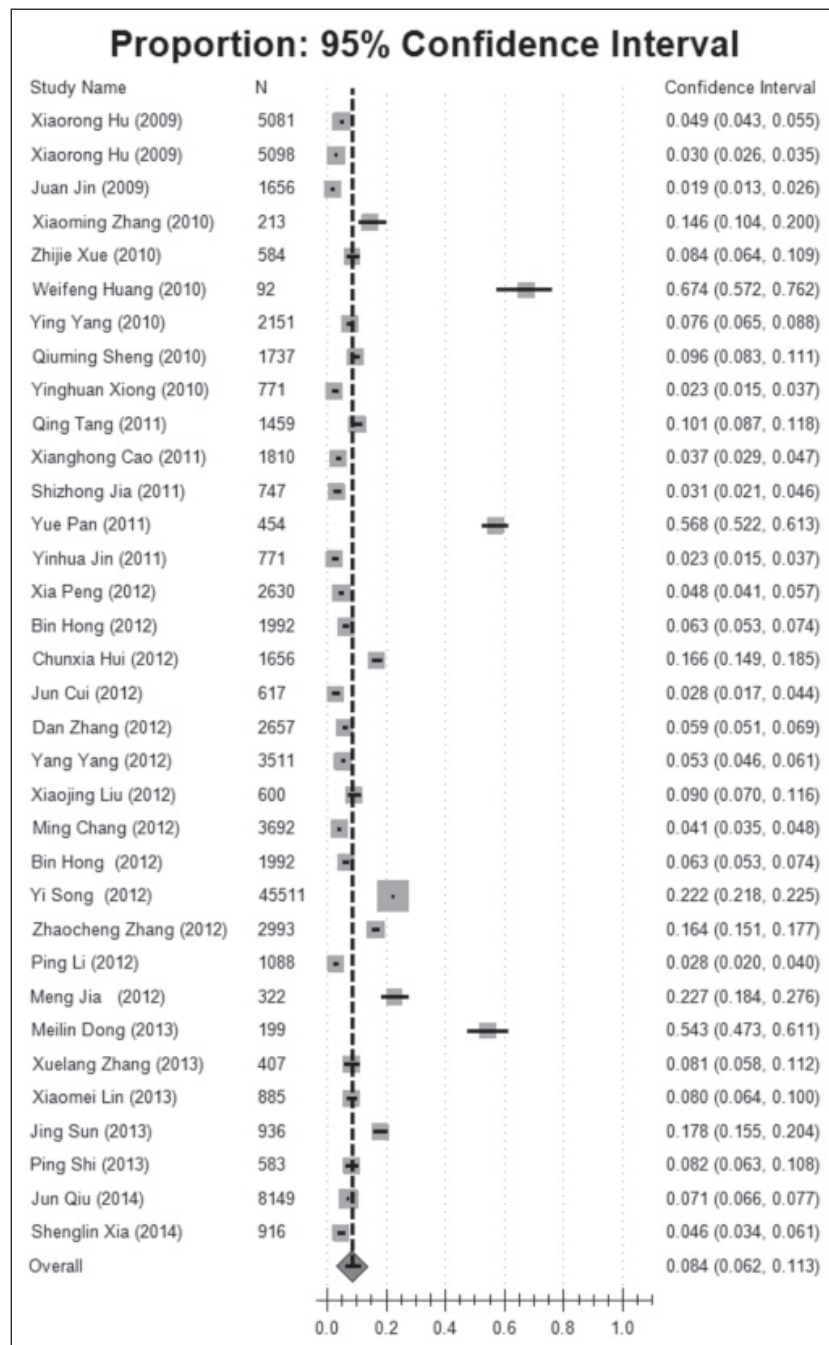


Fig. 2.—Forest plot of obesity rate for secondary students in boy.

obesity in secondary school students is 4.8 % (95% CI: 3.2%-7.2%).

Publication bias

Publication bias is a tendency on average to produce results that appear statistical significance on the part of investigator to submit, or the reviewers and editors, to accept manuscripts. Even though a potential threat in meta-analysis, it may be verified with funnel plots, which was applied to modifying the possible bias in

our literature selection. Verification by funnel plot (Figs. 4-5) shows that the literatures included were in better symmetry, suggesting less possibility of publication bias on the detection rate of obesity in China secondary school students.

Discussion

The results of presents Meta-analysis were based on 32 articles, which indicated that the obesity prevalence in China was still troublesome, the pooled prevalence

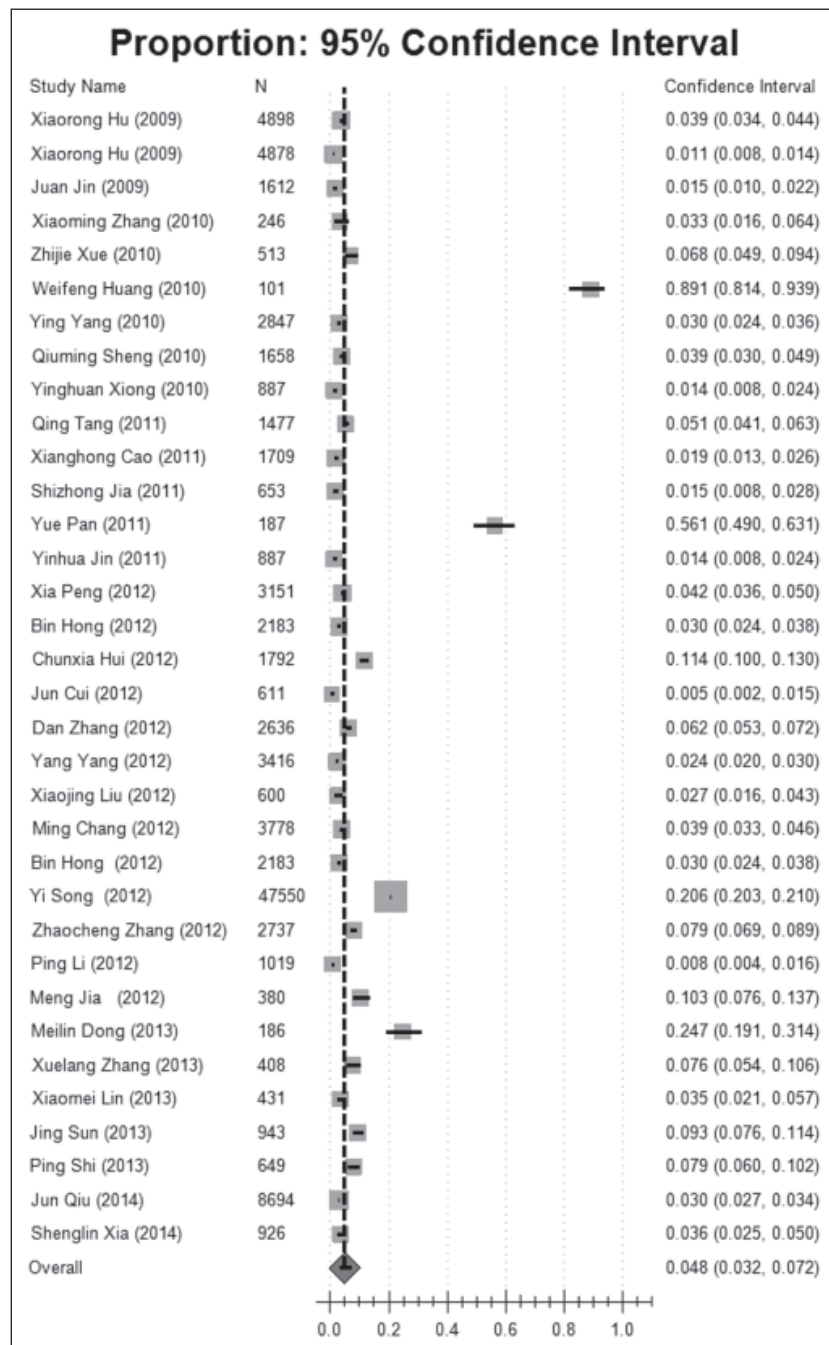


Fig. 3.—Forest plot of obesity rate for secondary school students in girl

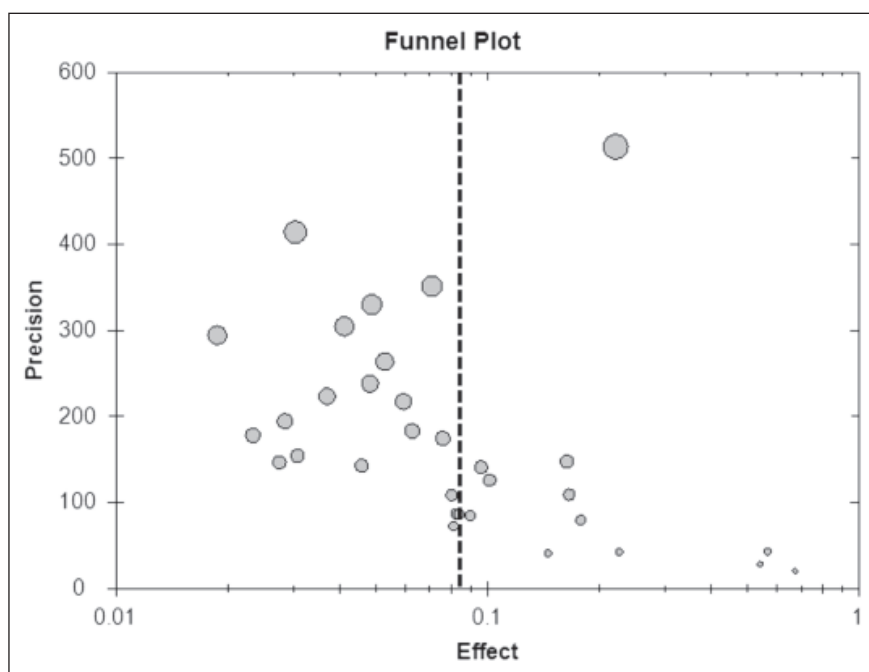


Fig. 4.—Funnel plot of obesity rate for secondary school students in boy.

of obesity in secondary school students is 8.4 % (95% CI: 6.2%-11.3%) and 4.8 % (95% CI: 3.2%-7.2%) for boy and girl respectively. boy obesity is twice times close to the rate of obese girls. The possible explanation maybe that boy is more important than girl in traditional Chinese thoughts, and parents pay more attention to health of boy. Lacking of knowledge for healthy lifestyle and healthy behavior, it is maybe another possible reason. Additionally, numerous modern vehicles were used in our daily life , which lead to re-

duce daily physical activities and a decrease in daily energy expenditure, and increase the prevalence of children obesity.

Although the figure by our study doesn't seem as high as previous reports in western nations, the prevalence of obesity in Mainland China is still arouse our attention. Obesity not only brings serious health problems but also huge financial burden to whole country. Our educational departments and health authorities should jointly take effective and practical measures,

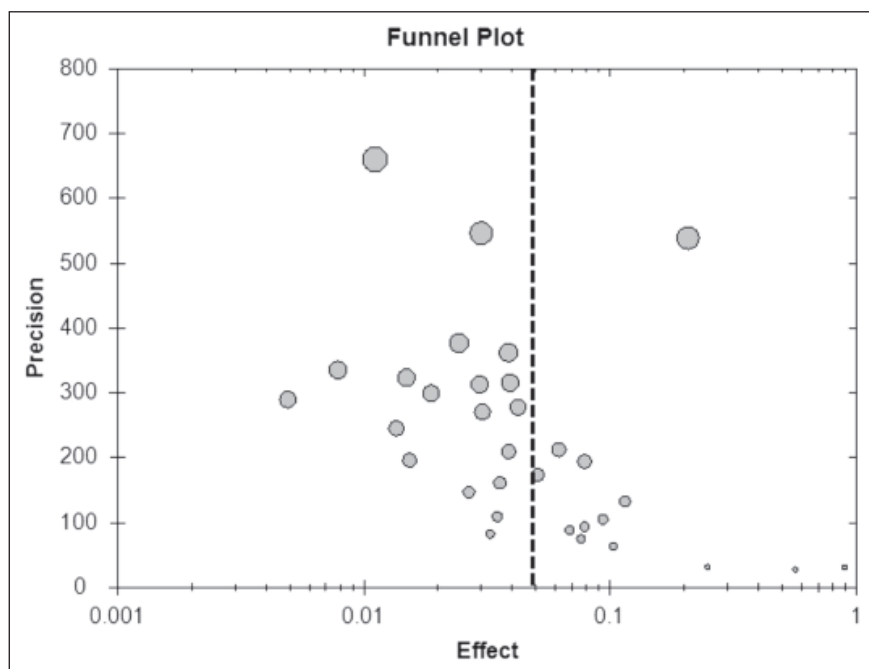


Fig. 5.—Funnel plot of obesity rate for secondary school students in girl.

such as health education and regular physical examination, to put it under control. Besides, parents should lead a healthy eating habit to the students, while students are encouraged to take more exercise and shape good living habits.

Limitations

This study provides a general situation of childhood obesity from 2009 to 2014 in China. The following limitations cannot be ignored: for example, we selected the article based on age range from 12 to 18 years, only published data are included, publication bias remains possible, relatively smaller sized samples from tends to weaken the validity of the results; and failure to exclude the genetic susceptibility as an important risk factor for childhood obesity in China. Therefore, more reliable obesity prevalence in secondary school students in China still needs further investigation.

Conclusion

Our results indicated that the obesity prevalence status in China was still troublesome, for the situation will be worse if we currently fail to take effective and practical measures.

Conflict of interest

None declared

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Disclosure of conflict of interest

The authors have no conflicts of interest to disclose.

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Original/*Pediatría*

Levels of eicosapentaenoic acid in obese schoolchildren with and without insulin resistance

Karina Sánchez Meza¹, Carlos Enrique Tene Pérez¹, Carmen Alicia Sánchez Ramírez¹, Roberto Muñoz Valencia² and Mario Del Toro Equihua¹

¹Universidad de Colima, Facultad de Medicina. Av. Universidad 333, Colonia Las Víboras, Colima, Col., México. CP 28010.

²Universidad de Colima, Facultad de Ciencias Químicas. Kilómetro 9 carretera Colima-Coquimatlán, Col. México. CP 28400. México.

Abstract

Background: Obesity in children is now an increasing health risk worldwide in which the insulin-resistance can be present. Studies have linked a diet rich in n-3 fatty acids with a lower prevalence of insulin-resistance.

Objective: To compare the levels of eicosapentaenoic acid among obese children with and without insulin-resistance.

Materials and Methods: In 56 randomly school-age children with obesity, insulin-resistance was determined by the homeostasis model assessment for insulin-resistance index and the serum levels of eicosapentaenoic acid were determined by gas chromatography. Insulin-resistance was established when the index was >6.0 , non-insulin-resistance when that index was <1.4 and as an intermediate group when the index was within the range of 1.4-5.9. The serum levels of eicosapentaenoic acid were compared with the Kruskal-Wallis and Mann-Whitney U tests, as needed.

Results: No differences in age or sex were identified among the groups studied. The anthropometric parameters were significantly higher in the group of children with insulin-resistance than in the other two groups. The children with insulin-resistance had significantly lower levels of eicosapentaenoic acid than the non-insulin-resistance group [12.4% area under the curve vs. 37.4%, $p = 0.031$], respectively.

Conclusion: Obese primary school-aged children with insulin-resistance had lower plasma levels of eicosapentaenoic acid.

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Key words: *Eicosapentaenoic acid. Insulin resistance. Obesity. Polyunsaturated fat. Schoolchildren.*

Correspondence: Ph. D. Carlos Enrique Tene Pérez.
Universidad de Colima. Facultad de Medicina.
Av. Universidad 333, Colonia Las Víboras,
Colima, Col., México. CP 28010.
E-mail: carlostene1@hotmail.com

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NIVELES DE ÁCIDO EICOSAPENTAENOICO EN ESCOLARES OBESOS CON Y SIN RESISTENCIA A LA INSULINA

Resumen

Introducción: La obesidad en los niños es un problema de salud pública en todo el mundo y la resistencia a la insulina puede estar presente. Existen estudios publicados que han relacionado una dieta rica en n-3 ácidos grasos con una menor prevalencia de resistencia a la insulina en sujetos obesos.

Objetivo: Comparar los niveles de ácido eicosapentaenoico en niños escolares obesos con y sin resistencia a la insulina.

Métodos: Se eligieron al azar 56 niños en edad escolar con obesidad, a los cuales se les determinó resistencia a la insulina mediante la evaluación del modelo de homeostasis para el índice de resistencia a la insulina y se determinaron los niveles séricos de ácido eicosapentaenoico por cromatografía de gases. La resistencia a la insulina se estableció cuando el índice fue >6.0 , no resistencia a la insulina cuando ese índice fue <1.4 y como un grupo intermedio cuando el índice estaba dentro del rango de 1.4 a 5.9. Los niveles séricos de ácido eicosapentaenoico se compararon entre los grupos estudiados con las pruebas de Kruskal-Wallis y Mann-Whitney U, según fue necesario.

Resultados: No hubo diferencias en la edad o el sexo entre los grupos estudiados. Los parámetros antropométricos fueron significativamente mayores en el grupo de niños con resistencia a la insulina que en los otros dos grupos. Los niños con resistencia a la insulina tenían niveles significativamente más bajos de ácido eicosapentaenoico que el grupo que no tenía resistencia a la insulina [área 12,4% bajo la curva frente a 37,4%, $p = 0,031$], respectivamente.

Conclusión: los niños en edad escolar obesos con resistencia a la insulina presentaron niveles plasmáticos más bajos de ácido eicosapentaenoico que los niños escolares obesos sin resistencia a la insulina.

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Palabras clave: *Acido eicosapentaenoico. Resistencia a insulina. Obesidad. Grasas poliinsaturados. Escolares.*

Introduction

Obesity in children is now an increasing health risk worldwide. In Mexico, the 2012 National Health and Nutritional Survey reported the prevalence of overweight and obesity in primary school-aged children (5-11 years old) at 34.4% (19.8 and 14.6%, respectively), according to the WHO criteria. It was 32% (20.2 and 11.8%, respectively) for girls and 36.9% (19.5 and 17.4%, respectively) for boys¹. Insulin resistance (IR), which can be identified in early childhood, is the common denominator found in the association of obesity with chronic degenerative diseases (CDD) such as type 2 diabetes mellitus, hypertension, dyslipidemia, and carotid-artery atherosclerosis^{2,3}. IR is characterized by an impaired response of insulin-sensitive organs to physiological circulating levels of the hormone insulin⁴. Insulin signaling has been described as being controlled by nutrient-sensitive pathways and proinflammatory signals. Recently, several published studies have linked a diet rich in n-3 fatty acids (FAs) with a lower prevalence of IR and diabetes, due to the anti-inflammatory properties that influence several key cardio-metabolic parameters; however, the results of the studies have been inconsistent^{5,6,7,8,9,10,11}. The n-3 FAs known as essential FAs are α -linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). These n-3 fatty acids are found mainly in fish, shellfish, sea mammals, plant oils, and several vegetables¹². The aim of the present study was to compare the levels of EPA in obese schoolchildren with and without IR.

Material and Methods

Protocol

Design: Cross-sectional. **Inclusion and setting:** The study was performed on children attending the obesity clinic at a primary care hospital of the *Instituto Mexicano del Seguro Social* in Colima, Mexico, during 2012. **Sampling:** The population was comprised of fifty-six randomly selected schoolchildren presenting with obesity. The mean age was 109.2 months (22.2 SD); 21/56 (37.5%) were girls. Children that presented with diabetes or other chronic diseases, or whose anthropometrical data were missing, were excluded from the study.

Anthropometric and body composition assessments

All measurements were carried out by trained technicians. Before the data were collected, the main author and two collaborators performed an anthropometrical standardization trial evaluating consistency (intra-group individual measurements) and validity (inter-group comparison with a gold standard) through

Pearson's bivariate correlations; when the "r" was below 0.8, the anthropometrical technique was reviewed and corrected until the desired intra and inter-group correlations were achieved. For weight and height measurements a digital scale with a 64-214 cm long stadiometer (Brand TANITA WB-3000) was used. The children were measured according to standard procedures, wearing lightweight clothing and without shoes¹³. BMI was calculated as weight (kg) divided by height squared (m²). The definition of obesity for the children was based on the age-specific BMI Z scores established by the WHO and those children that presented with standard deviations $\geq +2$ were classified as obese¹⁴. Waist circumference (WC) was measured using a fiberglass tape placed above the uppermost lateral border of the right ilium, at the end of a normal expiration, and was recorded to the nearest millimeter. This measurement was taken with the child standing upright, feet together, and arms hanging freely at the sides¹⁵.

IR determination

A 5 mL fasting blood sample was collected in tubes containing EDTA sodium. Plasma was immediately separated by centrifugation at 3000 rpm at 4 °C for 10 min, and serum was collected by centrifugation at 1000 rpm at room temperature for 10 min. The tubes were labeled and stored at -20 °C; they were stored at -75 °C for fatty acid measurement.

Plasma glucose was determined by the glucose oxidase method (Spinreact, SPAIN) and plasma insulin was determined by the enzyme-linked immunosorbent assay (ELISA) (Alpco^{MR} USA). IR was estimated by the homeostasis model assessment for insulin resistance (HOMA-IR) index as $\text{HOMA-IR} = (\text{fasting insulin } (\mu\text{U/L}) \times \text{fasting plasma glucose (mg/dL)}) / 22.5$. IR was established by a HOMA-IR index above 6.0 and non-IR by a HOMA-IR index below 1.4. A third group was the intermediate group (IG) and was made up of children with a HOMA-IR index in the range of 1.4-5.9.

EPA determination

Total plasma lipids and FAs were extracted applying the Folch method¹⁶, using a chloroform:methanol solution (2:1, vol:vol). The extracts were analyzed by means of coupled gas chromatography-mass spectrometry, employing a Varian 3900 gas chromatograph equipped with a Saturn 2100T mass spectrometer detector (Varian, Palo Alto, CA, USA.). The Omegawax 320 capillary column (30m x 0.32 mm x 0.25 μm) was used. FAs were identified by comparison with a FA standard mixture (Sigma-Aldrich, USA). Results were expressed as % of total FA in plasma. Areas under the curve (AUC) of the EPA chromatographic peaks were calculated for each child.

Sports was defined as any form of physical activity, whether casual or organized, that was aimed at expressing or improving physical fitness and mental well-being, at forming social relationships, or at obtaining results in competitions at all levels¹⁷. It was assessed through a questionnaire by answering “yes” or “no” and classified into 2 groups: fewer than 3 times a week or more than 3 times a week.

N-3 fatty acid consumption was determined by a food frequency questionnaire, in which the schoolchildren and their parents were the respondents. Trained interviewers conducted the food-frequency questionnaire, asking subjects to recall “average intake over the last six months”; the answers were: never, once a month or less, 2-3 times a month, once a week, 2-3 times a week, 4-7 times a week, once a day, and 2-3 times a day. The list of foods included eggs, oils, avocados, almonds, walnuts, fish oil, cod-liver oil, fish (anchovy, sardine, salmon, and herring), flax seeds, and soy. The intake of any of these food items at least 4 times a week was regarded as adequate.

Statistical analysis

The data were analyzed using the SPSS software, version 20. The variables studied were described as frequencies and percentages or as medians and interquartile ranges; inferential statistics were addressed by the Mann-Whitney U, Kruskal-Wallis, and chi-square tests. Statistical significance was set at a p value < 0.05.

Informed consent was obtained from the children’s parents or guardians. The study protocol was approved by the Ethics Committee of the *Instituto Mexicano del Seguro Social* (# R-2011-601-26), which conforms to the guidelines of the Declaration of Helsinki in regard to the principles of beneficence, non-maleficence, justice, and autonomy of decision. (Ethical Principles for Medical Research Involving Human Subjects. 52nd release, October 2000).

Results

Demographic and anthropometric characteristics. As shown in table I, no differences in age or sex were found among the three groups. When comparing the IR group of children, the intermediate group and the non-IR group of children, the anthropometric parameters of height, weight, BMI, and waist circumference were significantly higher in the IR group than in the other two groups. The comparison of age, height, weight, BMI, and WC between girls and boys showed no significant differences (Table II).

Biochemical characteristics. As shown in table III, the serum glucose levels were higher in the IR group of children, without being significant. However, the comparison of the glucose level of the IR children with the non-IR group was significant (p=0.012). In the three groups the glucose levels remained within normal values. Of the total series, 8/56 (14.3%) of the children were diagnosed

Table I
Comparison of demographic and anthropometric characteristics in three groups of children (non-IR group, intermediate group (IG) and IR group¹

	Insulin resistance ²			P-value*
	non-IR (n=8)	IG (n=36)	IR (n=12)	
Age (Months)	124.0 (121-133)	110.5 (94-125)	101.5 (81-114)	0.080*
Sex (Girls/Boys)	5/3	14/22	3/9	0.227**
Height (m)	1.50 (1.4-1.6)	1.43 (1.3-1.5)	1.39 (1.3-1.5)	0.187*
Weight (Kg)	65.0 (61-75)	52.1 (40-60)	46.0 (36-52)	0.010*
Waist circumference (cm)	95.50 (92-98)	86.00 (78-91)	78.50 (72-86)	0.011*
BMI*** (kg/m ²)	29.4 (27-32)	25.9 (24-29)	23.4 (22-24)	0.002*

¹Data are reported as median and interquartile range.

²The presence or absence of IR was determined by HOMA-IR (homeostasis model assessment for insulin resistance) as IR >6.0 and non-IR <1.4, respectively).

*The p values were calculated with the Kruskal-Wallis and ** Chi-square tests.

***BMI (body mass index).

Table II
Comparison of demographic and anthropometric characteristics between girls and boys

	<i>Girls</i> (<i>n</i> =21)	<i>Boys</i> (<i>n</i> =35)	<i>P-value*</i>
Age (Months)	112.0 (88-123)	113.0 (99-128)	0.330
Height (m)	1.45 (1.3-1.5)	1.44 (1.3-1.5)	0.953
Weight (Kg)	49.2 (38-66)	52.4 (43-61)	0.710
Waist circumference (cm)	86.00 (77-90)	87.0 (80-92)	0.330
BMI** (kg/m ²)	24.4 (22-29)	27.1 (24-28)	0.330

¹Data are reported as median and interquartile range

²*The p values were calculated with the Mann-Whitney U test.

**BMI: body mass index.

Table III
Comparison of biochemical characteristics and serum levels of EPA between girls and boys¹

	<i>Girls</i> (<i>n</i> =21)	<i>Boys</i> (<i>n</i> =35)	<i>P-value³</i>
Glucose (mg/dl)	84.7 (79-92)	85.6 (82-90)	0.678
Insulin (μUI/ml)	16.0 (10-28)	10.7 (6-19)	0.053
Homa-IR²	3.559 (2.07-6.58)	2.360 (1.39-3.87)	0.077
Eicosapentaenoic acid (% AUC)*	29.82 (6.3-57.5)	23.75 (8.0-48.7)	0.939

¹Data are reported as median and interquartile range.

²The presence or absence of IR was determined by HOMA-IR (homeostasis model assessment for insulin resistance) as IR >6.0 and non-IR <1.4, respectively).

³The p values were calculated with the Mann-Whitney U test.

*%AUC: % of area under the curve.

with IR and the serum levels of insulin were significantly higher in this group compared with the non-IR group or the IG. Insulin levels in the non-IR group of children were within normal values. When comparing the serum biochemical parameters between girls and boys, we identified higher levels of insulin in girls that almost reached statistical significance, as well as a trend towards a higher HOMA-IR index in girls (Table III).

EPA serum levels. When comparing the serum levels of EPA among the three study groups, children with IR had significantly lower levels of this FA than the non-IR group (Table IV and Fig. 1).

Dietary intake and physical activity. When analyzing other variables such as sports and n-3-FA intake, we found that 16/56 (28.6%) of the children played a sport more than 3 times a week. Ninety-one percent (51/56) of the study children consumed n-3-FAs more than 4

times a week. The comparison of these two variables between the IR group vs. the non-IR group showed no significant difference ($p=0.701$) in relation to sports and ($p=0.213$) n-3 FA intake. When comparing the EPA serum levels with the dietary intake of n-3 fatty acids, we found that the levels were statistically higher in the children with an adequate intake ($p=0.008$)

Discussion

One fourth of the obese children enrolled in the present study had IR. When we compared the plasma levels of EPA among the three study groups, the IR group had significantly lower levels. The results of studies conducted on children and adults associating n-3 FAs and IR are inconsistent, and in addition, the

Table IV
Comparison of biochemical characteristics and serum levels of EPA in three groups of children (non-IR group, intermediate group (IG) and IR group)¹

	Insulin Resistance ²			P-value ³
	IR (n=8)	IG (n=36)	non-IR (n=12)	
Glucose (mg/dL)	93.4 (86-102)	85.3 (82 - 89)	84.2 (79-89)	0.188
Insulin (μUI/mL)	35.6 (31-45)	14.3 (10-18)	5.1 (3-6)	<0.0001
Homa-IR²	8.240 (6.86-10.23)	2.770 (2.25-3.84)	1.005 (0.61-1.27)	<0.0001
Eicosapentaenoic acid (% Area under the curve)	12.4 (4-26)	24.8 (8-48)	37.4*** (23-53)	0.044**

¹Data are reported as median and interquartile range.

²The presence or absence of IR was determined by HOMA-IR (homeostasis model assessment for insulin resistance) as IR >6.0 and non-IR <1.4, respectively).

³The p values were calculated with the Kruskal-Wallis test**.

***p=0.031 when comparing the IR and non-IR groups (Mann-Whitney U test).

number of studies involving children is much lower. A study done by Saito *et al.* on 32 obese children (12 ± 2.6 years of age) that aimed to identify the relationships between DHA content and the components of metabolic syndrome, among others, found that the DHA content in plasma phospholipids was lower in children with metabolic syndrome than in those that did not present with the disorder; however, the difference was not significant (p=0.076)¹⁸. Baur *et al.* investigated the interrelationships between the type of infant feeding, skeletal muscle biopsies, and fasting blood samples in children under 2 years of age in whom the muscle phospholipid FA composition was analyzed and found significant inverse correlations between fasting

plasma glucose and the percentage of DHA (r=0.47, p<0.003) and the total levels of polyunsaturated FAs (r=0.38, p<0.05). They concluded that early changes in skeletal muscle membrane phospholipid FA saturation may play a role in the subsequent development of diseases associated with IR¹⁹.

A randomized controlled trial of DHA supplementation vs. placebo in 60 children with biopsy-confirmed non-alcoholic fatty liver disease (NAFLD) identified the odds of more severe versus less severe liver steatosis after treatment as being lower in children treated with DHA compared with placebo. They also found that the insulin sensitivity index increased and triglycerides decreased to a similar degree in the groups that received DHA as compared with placebo²⁰.

A group of researchers in Denmark studied n-3 FAs in children and adolescents that presented with signs of metabolic syndrome and found the interesting phenomenon of beneficial associations between n-3 FAs and HDL. However, DHA was unexpectedly associated with higher mean arterial pressure²¹. A previous study carried out on adolescents by the same Danish group found that DHA status was significantly correlated with higher blood pressure and increased fasting insulin²². Another study performed by Rump *et al.* determined the FA concentrations in umbilical cord blood; when those children were seven years old, fasting glucose, insulin, proinsulin, and leptin levels were measured (n=259). The n-3 FA concentrations were negatively related to insulin concentrations, HOMA-IR values, body fat, and proinsulin and leptin levels. The highest insulin concentrations were found in children with a low birth weight and a low gamma-linolenic acid concentration at birth²³.

Studies conducted on adults have also produced controversial results. Zhu *et al.* determined the rela-

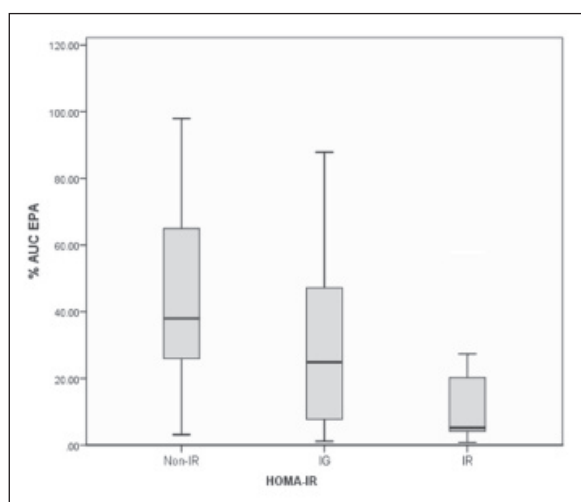


Fig. 1.—Percentage of area under the curve (% AUC) of eicosapentaenoic acid in non-IR (HOMA <1.4), IG (HOMA 1.5-5.9), and IR (HOMA >6.0) obese children.

tionship between serum omega-3 PUFAs (polyunsaturated fatty acids) and IR in 51 patients with type 2 diabetes mellitus and NAFLD and found a modest negative correlation between HOMA-IR values and n-3-FA serum levels ($r = -0.491$, $p < 0.05$). In an Inuit population of individuals 18 years of age or older (452 participants)²⁴, Thorseng *et al.* determined the contents of n-3 FAs and the n-3/n-6 ratio in erythrocyte membrane phospholipids and found a significant inverse association between n-3 FAs and the n-3/n-6 ratio and HOMA-IR values. Other authors have found the contrary; in a randomized trial of 258 subjects 45-70 years of age²⁵, Griffin *et al.* compared the effects on insulin sensitivity of modifying the dietary n-3 and n-6 fatty acid ratio and found that dietary intervention had no effect on insulin sensitivity⁷. Another study performed on 162 healthy adults that were fed two different iso-energetic diets supplemented with 3.6 g/d of n-3 FA or olive oil (placebo) for 3 months, found no improvement in insulin sensitivity, insulin secretion, beta cell function, or glucose tolerance⁸.

Various methods have been established to define insulin sensitivity. The euglycemic clamp and modified minimal model are considered the gold standards, but they are complex and invasive tests and are applied mainly for research purposes²⁶. The HOMA-IR index is another method for determining insulin resistance and is frequently used in the field of clinical research²⁷. In addition, there is no consensus in the literature on the definition of IR in children. The cut-off values of the HOMA-IR index and plasma insulin levels in children vary according to the authors. In the present series, IR in children was defined as a HOMA-IR value above 6. Previous studies conducted on Mexican schoolchildren have defined IR as a HOMA-IR value higher than 3.88²⁸. Juarez *et al.* carried out a study on 466 obese children between the ages of 11 and 13 years in Campeche, Mexico, and defined IR using the HOMA-IR with a cut-off point above 3.4. When classifying four categories for HOMA-IR values, they also found that a cut-off point higher than 5.5, which is above the 75th percentile, increased the risk of metabolic syndrome, compared with the lowest HOMA-IR percentile, which was a cut-off point below 2.4²⁹. Kurtoglu *et al.* defined IR values according to a HOMA-IR value of 2.7 in boys and 2.2 in girls in the pre-pubertal period, and 5.2 in boys and 3.8 in girls in the pubertal period. Other criteria that can be considered are the fasting insulin levels; at above 15 $\mu\text{U/mL}$ in the pre-pubertal period, 30 $\mu\text{U/mL}$ in the pubertal period, and 20 $\mu\text{U/mL}$ in the post-pubertal period, they are regarded as hyperinsulinism and consequently, IR. According to these latter criteria, in the present study, 23/56 (41.1%) of the children could be regarded as presenting with IR, which is a higher frequency than the one we reported with the HOMA-IR index cut-off point above 6³⁰.

To the best of our knowledge, this study is the first to assess the association between serum levels of EPA in plasma and IR determined by the HOMA-IR index

in Mexican schoolchildren. Our study has two weak points: the first is that the EPA was measured in serum, and previous studies have reported that n-3 FA determination in serum reflects the intake of the past two weeks, whereas the measurement of n-3 FA in adipose tissue and erythrocyte membranes enables the intake over the past weeks and months to be estimated^{31,32}. The second weak point is that the Tanner stage was not evaluated and even though the study was only conducted on primary school-aged children, it is well known that transient insulin resistance develops in children during puberty, a condition that is accepted to be physiological³⁰.

The data of the present study suggest the significant roles that the n-3 FAs play, specifically the relation of EPA serum levels to insulin sensitivity. These findings highlight the importance of the nutrient intake goal of representing 1-2% of the total energy intake, within a n6/n3 ratio from 5-10 to 1³³, in order to reduce the development of IR and all its associated co-morbidities^{34,35,36}. Further studies on children are required to determine the role that variables such as energy intake, dietary habits, and socio-economic status, among others, play in the association of n-3 FAs with IR.

In conclusion, the results of the present series showed that obese schoolchildren with IR had lower plasma levels of EPA, and therefore nutritional intervention should encourage the consumption of n-3 FAs in the diet of both obese and non-obese children as a preventive care measure.

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Original/Pediatría

Características del síndrome de intestino corto y del fracaso intestinal en nuestra comunidad

Jose Carlos Salazar Quero¹, Javier Blasco Alonso², Aurora Pérez Parras³, María del Carmen Rivero de la Rosa⁴, Juan José Gilbert Pérez⁵, José Antonio Blanca García⁶ y Beatriz Espín Jaime¹

¹Unidad de Gastroenterología, Hepatología y Nutrición Pediátricas. HHUU Virgen del Rocío. ²Unidad de Gastroenterología, Hepatología y Nutrición Pediátricas. Hospital Carlos Haya, Málaga. ³Unidad de Gastroenterología, Hepatología y Nutrición Pediátricas. Hospital de Jaén. ⁴Unidad de Gastroenterología, Hepatología y Nutrición Pediátricas. HHUU Virgen Macarena. ⁵Unidad de Gastroenterología, Hepatología y Nutrición Pediátricas. Hospital Reina Sofía, Córdoba. ⁶Unidad de Gastroenterología, Hepatología y Nutrición Pediátricas. Hospital Puerta del Mar. Cádiz. España.

Resumen

Introducción: El Fracaso intestinal está siendo una entidad con mayor prevalencia dentro de la edad pediátrica, en especial debido a resecciones importantes de intestino que terminan provocando la aparición de un Síndrome de Intestino Corto.

Objetivos: Conocer la prevalencia y etiología de los casos de Síndrome de Intestino Corto (SIC) y Fracaso Intestinal (FI) existentes en la comunidad andaluza. Analizar los factores relacionados en su evolución, el número de pacientes trasplantados y conocer el tiempo necesario para lograr la autonomía enteral, estudiando si existen diferencias en el manejo entre los diferentes participantes.

Métodos: Estudio observacional descriptivo retrospectivo multicéntrico en el cual se recogen los datos de los pacientes diagnosticados de Síndrome de Intestino corto o Fracaso intestinal en 6 centros hospitalarios de Andalucía en el periodo comprendido entre el 1 de enero de 2.008 y el 31 de Enero de 2.014.

Resultados: 25 pacientes. Edad media al diagnóstico: 7,4 meses. Longitud media de intestino remanente 113,8 cm; 64% pacientes con <75 cm de longitud de intestino remanente. Se demuestra que: la introducción precoz de nutrición enteral es un factor favorecedor de la suspensión de la NP ($p = 0'033$); y que la prevención de la enfermedad hepática asociada a nutrición parenteral (EHANP) se favorece por: el uso de cifras de lípidos más bajas en la Nutrición Parenteral ($p = 0'008$), una mayor longitud de intestino remanente ($p = 0'049$), la introducción precoz de nutrición enteral ($p = 0'009$) y una menor edad gestacional ($p = 0'006$).

Discusión: La Introducción precoz de NE es un factor esencial para lograr la adaptación intestinal, el destete de la NP y evitar la aparición de EHANP. Para prevenir la

SHORT BOWEL SYNDROME AND FAILURE INTESTINAL FEATURES IN OUR COMMUNITY

Abstract

Introduction: Intestinal failure is being an entity with higher prevalence in the pediatric age, especially due to bowel resections causing the appearance of a short bowel syndrome.

Objectives: To determine the prevalence and etiology of cases of short bowel syndrome (SIC) and Intestinal Failure (FI) existing in Andalusia. Analyze factors involved in evolution, the number of transplant patients and to know the time required to achieve enteral autonomy, studying whether there are differences in management between different participants.

Methods: Multicenter retrospective descriptive observational study in which are collected data of patients diagnosed with short bowel syndrome or intestinal failure in 6 hospitals in Andalusia in the period from 1 January 2008 to 31 January 2014.

Results: 25 patients. Average age at diagnosis 7.4 months. Average length of remnant intestine: 113.8 cm; 64% of patients with <75 cm length remaining intestine. We show that: the early introduction of enteral nutrition is a factor favoring the suspension of the NP ($p = 0'033$); and that the prevention of liver disease associated with parenteral nutrition (EHANP) is favored by: the use of fewer lipid Parenteral Nutrition ($p = 0'008$), a greater length of remaining intestine ($p = 0'049$), the early introduction of enteral nutrition ($p = 0'009$) and a lower gestational age ($p = 0'006$).

Correspondencia: Jose Carlos Salazar Quero.
Unidad de Gastroenterología, Hepatología y Nutrición
Pediátricas. HHUU Virgen del Rocío. Sevilla.
Av. Voltaire, 1 -blq 2-2º A.
Jerez de la Frontera. (Cádiz). CP: 11405
E-mail: josesolrac@hotmail.com

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aparición de EHANP además de instaurar la NE lo antes posible, el manejo de los lípidos en la NP debe ser lo más exhaustivo posible, intentando ajustar su aporte a las cifras más baja posibles.

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Palabras clave: *Síndrome de intestino corto. Nutrición parenteral. Nutrición enteral.*

Abreviaturas

FI: Fracaso intestinal.
NP: Nutrición Parenteral.
SIC: Síndrome de intestino corto.
EHANP: Enfermedad hepática asociada a nutrición parenteral.
CVCp: Catéter venoso central permanente.
RNPT: Recién nacido pretérmino.
RNT: Recién nacido término.
BD: Bilirrubina directa.
GPT: Guanosin-5-fosfato.
NE: Nutrición enteral.

Introducción

El Fracaso Intestinal (FI) se define como la reducción crítica de la masa intestinal funcionante por debajo de la cantidad mínima necesaria para lograr una adecuada digestión y absorción de nutrientes y fluidos, requiriendo el uso de nutrición parenteral (NP). Puede deberse a diferentes causas: dismotilidad, obstrucción intestinal, resecciones quirúrgicas, defectos congénitos o enfermedades asociadas a una pérdida de absorción. La causa más importante de FI es el Síndrome de Intestino Corto (SIC), el cual se caracteriza por la existencia de un FI secundario a una resección intestinal importante o un defecto congénito intestinal, que provoca una reducción de la superficie digestiva y absorptiva del intestino¹⁻⁴.

La incidencia del SIC no se conoce con exactitud. Existen series que la estiman en 24,5/100.000 recién nacidos vivos en Canadá, o en 2-3 casos/1.000.000 habitantes/año en Reino Unido, siendo la mitad de ellos en niños¹.

Las manifestaciones clínicas del SIC vienen determinadas por la longitud del intestino residual, el segmento de intestino funcionante, la existencia de válvula ileocecal y colon y la asociación con otras patologías¹⁻⁴.

El abordaje de los casos de FI y de SIC se basa en intentar lograr una adaptación intestinal lo más precoz posible, la cual se define como los cambios anatómicos, histológicos y funcionales que se producen en el intestino, maximizando su capacidad digestiva y de absorción en el contexto de la pérdida de función intestinal por resección o enfermedad. Entre estos cambios se incluyen el aumento de la circunferencia

Discussion: Early Introduction of NE is essential for intestinal adaptation, weaning from PN and avoid the appearance of EHANP. The use of low amounts of lipids prevents development of EHANP.

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Key words: *Short bowel syndrome. Parenteral nutrition. Enteral nutrition.*

intestinal, el grosor de la pared, la longitud intestinal total, la altura de las vellosidades, la profundidad de las criptas y la proliferación intestinal. Mientras ocurre este proceso, el uso de NP (Nutrición Parenteral) es inevitable por un tiempo variable, existiendo pacientes que la precisan de forma irreversible. Muchos de ellos sufren complicaciones derivadas del uso prolongado de la NP, como la Enfermedad Asociada a Nutrición Parenteral (EHANP), la cual puede presentarse en diferente grado entre un 30-60% de los pacientes que reciben NP. Otras complicaciones son derivadas del uso de catéteres centrales permanentes (CVCp) como son las infecciones relacionadas con el catéter o la trombosis de vasos venosos¹⁻⁴.

El manejo desde el punto de vista de la nutrición enteral (NE) de estos pacientes sigue siendo un factor esencial para lograr la adaptación intestinal y evitar muchas de las complicaciones del uso de la NP. Aspectos como el tiempo de introducción de la NE, su composición (polimérica, oligomérica o elemental), el ritmo, o el momento de introducción de la nutrición oral son temas de debate en la literatura^{1-3,5}.

Objetivos

Conocer la prevalencia y etiología de los casos de Síndrome de Intestino Corto (SIC) y Fracaso Intestinal (FI) existentes en la comunidad andaluza. Analizar los factores relacionados en su evolución, el número de pacientes trasplantados y conocer el tiempo necesario para lograr la autonomía enteral, estudiando si existen diferencias en el manejo entre los diferentes participantes.

Material y métodos

Estudio observacional descriptivo retrospectivo multicéntrico en el cual se recogen los datos de los pacientes diagnosticados de Síndrome de Intestino corto o Fracaso intestinal en 6 centros hospitalarios de Andalucía en el periodo comprendido entre el 1 de enero de 2008 y el 31 de enero de 2014. Se define SIC o FI como: Resección de >70% del intestino delgado; o Nutrición Parenteral (NP) durante más de 42 días; o longitud del intestino residual, distal al ligamento de Treitz, de 50 cm para recién nacido pretérmino (RNPT) (24-36 semanas) o < 75 cm en

el recién nacido término (RNT). Se definió la presencia de Enfermedad hepática asociada a NP (EHANP) por el desarrollo de cifras de Bilirrubina directa (BD) mayores de 2 mg/dl ó de GTP (guanosin-5-trifosfato) > x2 de los valores normales de corte del laboratorio que realizara la determinación. La población de estudio son niños entre 0-13 años diagnosticados de SIC o FI desde el 1 de enero de 2008, en seguimiento en la consulta de digestivo infantil en algún hospital de Andalucía. Se recogieron las siguientes variables: Edad gestacional (semanas gestación); Edad al diagnóstico (meses); Sexo; raza; peso (kg) y longitud (cm) al nacimiento (se expresan también en forma de desviación estándar para la edad gestacional y el sexo según las tablas de Carrascosa et al de 2010)⁶; causa del FI/SIC; longitud de intestino delgado remanente en cm; presencia o no de válvula ileocecal; presencia o no de colon, indicando en los casos de resección si ésta es parcial o total; Cifras de citrulina y el tiempo de evolución en meses en el que se realiza la determinación; número intervenciones realizadas; cirugías de incremento longitud: Bianchi, STEP, u otras; así como la Longitud de intestino delgado (ID) tras estas cirugías; nº de CVC permanentes (CVCp) colocados y la causa de los posibles cambios de CVCp; nº de infecciones relacionadas con CVCp (indicadas en forma de nº de infecciones/1.000 días de catéter); sustancia usada en el sellado del CVCp; si se ha logrado la suspensión de la NP; duración (en meses) de la NP. En los casos en los que no se ha logrado se indica el tiempo de evolución hasta el momento de la recogida de los datos, en meses; peso y longitud (en forma de DE para la edad y sexo) a la suspensión de NP (si se ha logrado) o en el momento de recogida de los datos; fuente de los lípidos en la NP: intralipid®, SMOF®, Omegaven®, Clinoleic®; Dosis de lípidos en la NP en la fase de mantenimiento (en gr/kg/día); existencia de EHANP; el tiempo de evolución en el cual aparece en meses; cifras más elevadas de BD alcanzadas (mg/dl), así como el tratamiento o medidas tomadas; tiempo de comienzo de NE (días); Fórmula NE usada inicialmente: materna, polimérica, hidrolizada, elemental; Fórmula NE en la actualidad: materna, polimérica, hidrolizada, elemental, ninguna; Tipo de alimentación en la actualidad: Nutrición Parenteral Total, Nutrición parenteral + Nutrición enteral, Nutrición Parenteral+Nutrición Enteral+oral, Nutrición Enteral + oral, oral; nº de ingresos hospitalarios; Tiempo de estancia hospitalaria (Días/año) en los sucesivos años de seguimiento; existencia de sobrecrecimiento bacteriano y su tratamiento; la presencia de D-acidosis; el uso de probióticos, indicando que tipo; el uso de Antiperistálticos, indicando cual o cuales se han usado; si se ha realizado tratamiento con hormona de crecimiento o con teduglutide; el uso de glutamina oral; si el paciente ha sido éxito, indicando el tiempo de evolución y la causa; si se ha realizado trasplante intestinal, indicando el tiempo de evolución y la causa.

Las fuentes fueron la revisión de las historias clínicas de los paciente diagnosticados de FI o SIC en los diferentes hospitales participantes en el estudio.

Se realizó un estudio estadístico con el programa IBM SPSS 19.01, analizando los cambios en los valores medios mediante test de Mann-Whitney con una significación positiva para una $p < 0.05$.

Como sesgos mencionar que al ser un estudio retrospectivo, pueden que por un lado exista una pérdida de los datos y parámetros recogidos, y por otro que la precisión de los datos recogida no sea exacta.

Resultados

Se obtuvieron 25 pacientes. Edad gestacional media 34,6 meses con una desviación estándar (DE) de 3,84 meses. La etiología fue: 20% atresia intestinal, 20% enterocolitis 16% gastrosquisis, 12% enfermedad de Hirschprung; 8% obstrucción intestinal; 8% vólvulo; 16% otras causas (2 casos de inmunodeficiencia con afectación intestinal, 1 síndrome de Berdon, 1 displasia intestinal). Edad al diagnóstico: 7,4 meses (DE 20,38). 69,5% hombres y 30,5% mujeres. Raza: caucásica 82%, árabe 8,6%; gitana 4,3%; hispana 4,3%. Longitud de intestino media de 113,8 cm (DE 86,75), presentando un 64% una longitud <75 cm. En este grupo de pacientes la longitud media del intestino fue de 49 cm (DE 19,95). El 56% presentaban válvula ileocecal y 68% colon. Número de intervenciones media: 2,66 por paciente. A un sólo paciente se le realizó un enteroplastia tipo Bianchi. En 4 pacientes se determinó las cifras de citrulina con unos valores medios de 5,5 mcmol/l, presentando todos una longitud de intestino <65 cm. El 100% de los pacientes requirieron Nutrición Parenteral (NP) durante el primer año tras el diagnóstico, con una duración media de 13,32 meses. Un 25% de los pacientes no suspenden NP, de los cuales 42,8% fueron éxitos. El tiempo medio de evolución de los pacientes que no suspenden la NP es de 13,7 meses, en el momento de realizar el estudio (Tabla I).

Tabla I
Características de los pacientes.

Edad gestacional (semanas) (DE)	34,66 (3,84)
Edad al diagnóstico (meses) (DE)	7,4 (20,38)
Sexo	69,5% H / 30,5% M
Longitud intestino (cm) (DE)	113,8 (86,75)
Pacientes con <75 cm / longitud media (cm)	64% / 49
Presencia de válvula ileocecal	56%
Presencia de colon	68%

DE: Desviación estándar

H: Hombres

M: Mujeres

Factores implicados en la suspensión de la NP

Se estudió la existencia de relación entre la suspensión de la NP con otros factores (Tabla II) como longitud del intestino, cifras de Bilirrubina total, presencia de válvula ileocecal, edad gestacional sin encontrar significación estadística. Si se encontró relación entre la introducción precoz de NE (2 días vs 25 días) y la suspensión de la NP ($p=0.033$). La fuente de lípidos usada fue SMOF en un 52%; Intra-lipid 36%; Clinoleic 9%; y Clinoleic+Omegaven en un 4%. Con una cifra media de 2,1 g/kg/día de lípidos administrados en la NP.

Manejo del CVCp

El 50% de los pacientes precisaron el uso de un Catéter Venoso Central permanente (tipo Hickman® o Broviac®). Se usaron una media de 2,4 catéteres por paciente, siendo las causas más importantes de recambio del catéter las infecciones del mismo (6 pacientes) y la pérdida accidental (6 pacientes). El 100% de los pacientes sufren infecciones relacionadas con el CVCp el primer año. La tasa de infecciones en el primer año de administración de NP a través de CVCp es de 2,6 infecciones/año (7,1 infecciones/1.000 días de catéter). La sustancia usada para el sellado es principalmente Heparina (75%), seguida de antibiótico (16%) y combinación de antibiótico y heparina (8%). En un paciente se cambio el sellado del CVCp

de heparina por etanol 70% debido a una alta tasa de infecciones relacionadas con el catéter, pasando de presentar una tasa de 22,9 infecciones/1.000 días de catéter a 2,7 infecciones/1.000 días, sin describirse efectos secundarios.

Parámetros relacionados con la EHANP

Se encontró una prevalencia de EHANP del 63%, a los 1,9 meses de evolución del proceso de media. La cifra media de BD alcanzada fue de 10,9 gr/dl (DE 6,7). Se encontró relación estadística entre el desarrollo de EHANP y las siguientes variables: uso de cifras más elevadas de lípidos en la NP ($p=0.008$) (1,68 g/kg/día vs 2,28 g/kg/día); menor longitud de intestino remanente ($p=0.049$) (83 cm vs 168 cm); menor edad gestacional ($p=0.006$) (33,2 semanas vs 27,8 semanas); y una introducción más tardía de la NE ($p=0.009$) (4,5 días vs 29,26 días). (Tabla III)

Manejo de la NE

El tiempo medio de comienzo de la NE fue de 22,5 días (DE 30,55). La fórmula usada fue: elemental (48%), hidrolizada (20,6%), polimérica (16%), materna (16%). El tipo de alimentación que reciben en la actualidad estos pacientes es oral en exclusiva en 45%, NE+oral en 40% y NP+NE+Oral en un 15%, siendo la fórmula usada por los pacientes con NE, polimérica

Tabla II
Variables asociadas a la suspensión de la NPs

	Persiste NP (DE)	Suspenden NP	Significación
Longitud de intestino (cm)	82,5 (83,71)	128,61 (87,29)	0,227
Cifras de Bilirrubina total (mg/dl)	11,14 (6,39)	5,15 (6,00)	0,054
Presencia de válvula ileocecal	66,7%	33,3%	0,061
Edad gestacional (meses)	33,94 (3,85)	38,60 (2,88)	0,056
Introducción de NE (días)	25,61 (32,98)	2,7 (0'95)	0,033

NP: Nutrición Parenteral; NE: Nutrición Enteral; DE: Desviación estándar

Tabla III
Factores relacionados con el desarrollo de EHANP

	Suspenden NP	Mantienen NP	Significación
Cifras lípidos en la NP (g/kg/día)	1,68 (0'34)	2,28 (0'54)	0,008
Longitud intestino cm (DE)	83,12 (62,95)	168,61 (99,59)	0,049
Tiempo introducción NE (días)	4,5 (4,17)	29,26 (35,06)	0,009
Infecciones CVCp/año	1,8 (1,30)	3,00 (2,44)	0,47
Edad gestacional (semanas) (DE)	37,87 (1,88)	33,25 (3,66)	0,006

DE: Desviación estándar

en un 82% y oligomérica en un 18%. El tiempo medio de estancia hospitalaria tras el diagnóstico de estos pacientes fue: 127 días el primer año; 19,2 días el segundo año; 19,85 días el tercer año; 11,66 días el cuarto año; y 7 días el quinto año. No se encontró relación entre una mayor estancia y una longitud de intestino menor, la existencia de EHANP o el tiempo de introducción de la alimentación. Existe sobrecrecimiento en un 48% de los pacientes, siendo éste más frecuente entre los que no tienen colon ($p=0'003$), mientras que no se encontró relación con la presencia de válvula o la longitud del intestino.

Manejo farmacológico

En ningún paciente se usó hormona de crecimiento ni teduglutide. Un 17% recibieron probióticos en algún momento de la evolución (50% *S. boulardi*, 50% *L. GG*). Un 30% de los pacientes recibieron antiperistálticos (71% loperamida, 20% loperamida/codeína). La glutamina fue usada en un 30% de los pacientes.

Causas de éxitus

Fueron éxitus un 16% de los pacientes a los 12,6 meses de evolución como media. Las causas de muerte fueron 3 cuadros de sepsis y 1 un cuadro de coagulopatía secundaria de EHANP. No se encontró relación estadística con otras variables, aunque algunos factores se aproximaron a presentar significación: longitud intestino menor (48,7 cm vs 126,19): $p=0,12$; cifras de BD: $p=0'24$; ausencia de válvula: $p=0'28$; dosis mayor de lípidos en la NP: $p=0'23$. Sólo se encontró un paciente trasplantado. Corresponde a un paciente con un SIC con 10 cm de intestino remanente tras enterocolitis. El trasplante se realizó a los 7,5 meses de edad debido a que había cursado con varias sepsis de repetición y la existencia de EHALD.

Tiempo de estancia

El tiempo de estancia medio durante el primer año, fue de 127 días/año, para disminuir a partir del 2º año de evolución (Fig. 1). En nuestra serie no se encontró relación entre un mayor tiempo de estancia con una menor longitud de intestino, la presencia de EHANP o el tiempo de introducción de la alimentación.

Discusión

Presentamos la primera revisión multicéntrica del manejo y de los factores asociados con la morbilidad en el FI elaborada en nuestra comunidad. Queremos destacar que todos los hospitales colaboradores son centros de tercer nivel de referencia en sus respec-

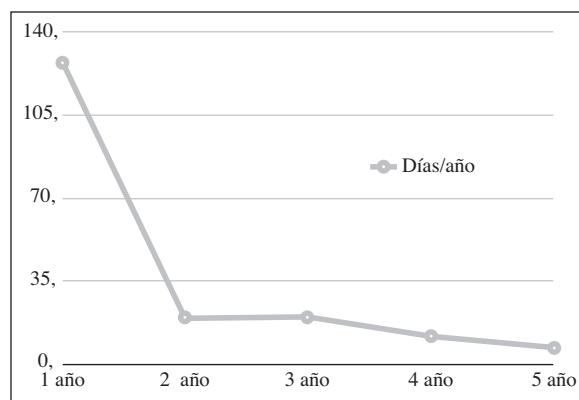


Fig. 1.—Tiempo de estancia media.

tivas provincias para la patología digestiva y nutricional pediátrica, pero que ninguno de ellos es centro de referencia para el trasplante de intestino, por lo que los datos que presentamos creemos que reflejan las peculiaridades del manejo de este grupo de pacientes en este tipo de centros no trasplantadores.

En nuestra serie la causa del FI es principalmente un SIC (64% de los pacientes), el cual a su vez presenta una etiología similar a otras series publicadas^{2,7}. Todos los pacientes precisaron del uso de NP desde el momento del diagnóstico, con una duración media de 13,32 meses. La mayoría de los pacientes que continúan vivos han logrado retirar la NP (85%), lo cual habla del buen pronóstico que en general pueden tener estos pacientes. El único factor que se demuestra relacionado con la suspensión de la NP, es la introducción precoz de la NE, lo que demuestra la importancia de este hecho para comenzar y potenciar la adaptación intestinal. No se encontró relación entre el tipo de fórmula usada en el inicio de la NE y la suspensión de la NP, aunque cabe destacar que en la mayoría de los casos se usó fórmula elemental o hidrolizada, a pesar de que no se haya demostrado beneficio del uso de este tipo de fórmulas sobre las poliméricas, siempre en el caso de no poder usar leche materna¹. Otros factores que clásicamente se han postulado como relacionados con la suspensión de la NP^{8,9}, como la longitud de intestino remanente, la edad gestacional, la presencia de válvula o las cifras máximas de bilirrubina alcanzadas, no logran significación pero probablemente se alcanzaría la significación si se dispusieran de más pacientes.

La EHANP se describe en el 63% de los pacientes, evidenciando que el uso de aportes elevados de lípidos en la NP, la existencia de un intestino remanente más corto, una edad gestacional al nacimiento menor y una introducción más tardía de la NE, son factores relacionados con su aparición de forma similar a la publicada por otros autores^{10,11}. Un factor importante relacionado con el desarrollo de la EHANP es la fuente de lípidos usados en la NP. En nuestra serie se basa en fórmulas basadas en aceites vegetales ricos en omega 6, o en mezcla de estos aceites con aceite de oliva, triglicé-

ridos de cadena media y aceite de pescado (SMOF). Sólo en un caso se evidenció el uso de lípidos de origen de aceite de pescado (Omegaven). Dicha fuente lipídica se ha propuesto en publicaciones recientes como tratamiento de la EHANP¹²⁻¹⁵, al evidenciarse unas tasas de recuperación superiores a las existentes con el uso de lípidos de origen vegetal. Si bien existen dudas acerca de su seguridad a largo plazo, principalmente debido a la posibilidad de generar un déficit en ácidos grasos esenciales omega 6.

Uno de los mayores problemas que presentan este tipo de pacientes es el desarrollo de infecciones relacionadas con el CVCp, las cuales obligan al ingreso del paciente para tratamiento antibiótico intravenoso y en muchas ocasiones al recambio del catéter venoso. En nuestra serie este problema queda de manifiesto en que tres de los casos de éxitus de se deban a complicaciones infecciosas y que en el único trasplantado una de las causas del trasplante fueran la repetición de sepsis relacionadas con el CVCp, que también potencian el desarrollo de la EHANP. Además 6 pacientes requirieron en algún momento un recambio de catéter por problemas infecciosos. De hecho, la tasa de infecciones que presentamos puede considerarse elevada (7,1 infecciones/1.000 días catéter) con respecto a otras series publicadas^{16,17}. La existencia de esta tasa de infecciones puede deberse a diversos factores: uno de ellos es la baja edad media de los pacientes (7,4 meses), lo cuales suelen presentar más tasa de infecciones. Otra causa y probablemente la más importante, sea la falta de especialización del equipo de profesionales encargado de la enseñanza del manejo del CVCp a la familia, lo que hace que la curva de aprendizaje sea más lenta y con mayor tasa de complicaciones. Una causa de esta falta de especialización puede que ser que este tipo de pacientes era infrecuente hace unos años, pero el incremento en su incidencia y la gravedad de las complicaciones justifica claramente la necesidad de mejora en este campo, siendo necesarios la creación de equipos multidisciplinarios que incluyan pediatras, enfermería, psicólogos, trabajadores sociales, en el cual la familia pueda ser educada de forma correcta en el manejo de los CVCp. Aquí cabe destacar la buena evolución de una paciente en la que se realizó un cambio en la sustancia del sellado del catéter, pasando de heparina a alcohol 70°, lo que permitió un descenso de la tasa de infecciones de 22,9 infecciones/1.000 días de catéter a 2,7 infecciones/1.000 días de catéter. El uso del etanol, así como la taurolidina se han propuesto como herramientas útiles en este tipo de casos, al ser sustancias que han demostrado disminuir significativamente la tasa de infecciones relacionadas con el catéter y además poseer actividad antifibrinolítica¹⁶⁻²⁰.

En el manejo médico de estos pacientes se usan gran variedad de fármacos (omeprazol, ácido ursodeoxicólico, etc.) encaminados a corregir o prevenir complicaciones existentes. En nuestra serie cabe destacar la baja tasa de uso de los probióticos (17%) (50% S. Boulardii y 50% Lactobacillus GG), probablemente reflejo de la escasa utilidad que se ha demostrado de su uso en

los casos de FI^{20,22}. La baja tasa de uso y la brevedad de la muestra no permiten obtener datos acerca de su eficacia en nuestra serie. Dentro de las complicaciones, una de la más prevalentes descritas en la literatura es el desarrollo de sobrecrecimiento bacteriano. En nuestra serie se presenta casi en la mitad de los pacientes, favoreciendo su aparición la ausencia de colon.

En el análisis de los posibles factores relacionados con los éxitus no encontramos relación significativa con factores descritos en otras series^{3,8} relacionados con la supervivencia como la longitud del intestino, cifras de bilirrubina directa, presencia de válvula ileocecal, o dosis de lípidos en la NP. Esta falta de relación probablemente se deba a la brevedad de la serie ya que los datos obtenidos se acercan bastante a la significación.

Aunque este estudio sea multicéntrico, el manejo de estos pacientes es en general bastante similar en los distintos hospitales como lo reflejan los siguientes datos: la fórmula enteral usada al inicio de la nutrición enteral es fórmula elemental o hidrolizada en el 68% de los casos; salvo en un caso, no se ha realizado cirugía de incremento de longitud; el uso de preparados de lípidos en la NP ricos en omega 3 sólo se ha realizado en un centro; la cifra de infecciones relacionadas con el catéter es similar en todos los hospitales; el sellado del CVCp se suele realizar con heparina, existiendo un único caso de sellado con etanol y ninguno con taurolidina; el uso de probióticos es bastante bajo, así como inexistente el empleo de hormona de crecimiento o teduglutide.

Por último comentar la alta tasa de hospitalización que presentan este tipo de pacientes, especialmente durante el primer año de evolución (Fig. 1). Olieman et al²³, realizó un estudio analizando los costes que presentaban estos pacientes, obteniendo una estancia media de 174 días el primer año con un gasto medio por paciente de 269.700 euros. Este hecho refleja la complejidad de este proceso y el alto consumo de recursos sanitarios que conllevan estos pacientes.

Conclusiones

La causa principal del FI es el SIC, el cual presenta una etiología similar a otras series publicadas. No parecen existir grandes diferencias en el manejo de este tipo de pacientes dentro nuestra comunidad, presentando en general un buen pronóstico de supervivencia y de adaptación intestinal.

La Introducción precoz de NE es un factor esencial para lograr la adaptación intestinal, el destete de la NP y evitar la aparición de EHANP. En relación con la EHANP además de instaurar la NE lo antes posible, el manejo de los lípidos en la NP debe ser lo más exhaustivo posible, intentando ajustar su aporte a las cifras más baja posibles que no interfieran en el adecuado aporte calórico. Por último, destacar la alta tasa de infecciones relacionadas con el CVCp existente, lo cual indica que este es uno de los factores más importantes a mejorar en el manejo de estos

pacientes. Para ello probablemente sea necesario mejorar en el abordaje multidisciplinar, pero en especial por parte de enfermería, para un correcto aprendizaje de los padres.

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Original/*Pediatría*

Reorganization of nutritional therapy can markedly reduce the rate of catheter-related blood stream infections in pediatric patients receiving parenteral nutrition – a 7-year prospective follow-up study

Agnieszka Szlagatys-Sidorkiewicz¹, Anna Borkowska¹, Agnieszka Jankowska¹, Mariusz Sroka^{2†}, Maciej Zagierski¹, Anna Gosk¹, Magdalena Słomińska-Frączek¹, Grzegorz Bogowski³, Katarzyna Plata-Nazar¹, Katarzyna Sznurkowska¹, Grzegorz Krzykowski⁴ and Barbara Kamińska¹

¹Department of Pediatrics, Pediatric Gastroenterology, Hepatology and Nutrition, Medical University of Gdansk. ²Department of Surgery and Urology for Children and Adolescents, Medical University of Gdansk. ³Copernicus PL, Gdansk. ⁴Institute of Mathematics, University of Gdansk. Poland.

Abstract

Background: Implementation of hygienic measures and simple changes in the structure of medical team may considerably reduce the rate of catheter-related bloodstream infections (CRBSIs) in parenterally nourished patients.

Aim: To analyze the effects of organizational changes in parenteral nutrition services on the CRBSI rates in pediatric patients.

Methods: We compared the CRBSI rates documented prior to, during and after the implementation of the organizational changes (introduction of a nutritional support team and related procedures, medical staff training).

Findings: A total of 260 courses of parenteral nutrition were offered to 141 pediatric patients during the analyzed period. Thirty CRBSIs were documented during this period. The most frequent etiological factors were staphylococci (21/30), followed by *Klebsiella pneumoniae*, *Escherichia coli* and *Candida albicans* (2/30 each). The reorganization was reflected by more than 8-fold reduction of the CRBSI incidence rate: from the initial value of 10.14 to 6.89 per 1000 catheter days and 1.17 per 1000 catheter days during and after the reorganization, respectively.

Conclusion: Introduction of a nutritional support team, accompanied by extensive training of medical staff,

CAMBIO DE LA ORGANIZACIÓN DEL TRATAMIENTO NUTRICIONAL PUEDE REDUCIR CONSIDERABLEMENTE LA TASA DE BACTERIEMIA ASOCIADA AL CATÉTER (BAC) EN PACIENTES PEDIÁTRICOS QUE RECIBEN NUTRICIÓN PARENTERAL, UN ESTUDIO PROSPECTIVO DE SEGUIMIENTO DE 7 AÑOS DE DURACIÓN

Resumen

Antecedentes: La implementación de medidas higiénicas y cambios sencillos en la estructura del personal médico puede reducir considerablemente la tasa de bacteriemia asociada al catéter (BAC) en pacientes que reciben nutrición parenteral.

Objetivo: Analizar el impacto de los cambios organizacionales dentro de los servicios de nutrición parenteral sobre las tasas de BAC en pacientes pediátricos.

Métodos: Hemos comparado las tasas de BAC documentadas antes, durante y después de la implementación de los cambios organizacionales (introducción de un grupo de apoyo nutricional y los procedimientos relacionados, formación del personal médico).

Descubrimientos: Un total de 260 series de nutrición parenteral fueron ofrecidos a 141 pacientes pediátricos durante el periodo analizado. Se documentaron treinta BAC durante este periodo. Los factores etiológicos más frecuentes eran staphylococci (21/30), seguidos por *Klebsiella pneumoniae*, *Escherichia coli* y *Candida albicans* (2/30 cada uno). Los cambios organizacionales fueron reflejados en una reducción de la incidencia de BAC en más de 8 veces: el valor inicial disminuyó desde 10.14 hasta 6.89 por 1000 días-catéter y hasta 1.17 por 1000 días-catéter durante y después de la reorganización, respectivamente.

Conclusión: La introducción de un grupo de apoyo nutricional, acompañada de una extensa formación del personal médico puede resultar en una reducción considera-

Correspondence: Agnieszka Szlagatys-Sidorkiewicz, MD PhD
Department of Pediatrics, Pediatric Gastroenterology,
Hepatology and Nutrition, Medical University of Gdansk,
ul. Nowe Ogrody 1-6, 80-803 Gdansk, Poland.
E-mail: aga1@gumed.edu.pl.

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can result in a marked reduction of CRBSI rate in pediatric patients nourished parenterally in a hospital setting.

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Key words: *Catheter-related blood stream infection. Nutritional support team. Parenteral nutrition. Pediatric gastroenterology.*

Introduction

Parenteral nutrition is an option of treatment of both acute and chronic intestinal failure. Although beneficial, it is associated with a relatively wide range of complications, such as central catheter thrombosis, catheter occlusion, mechanical problems, liver disease and infections^{1,2}. Catheter-related blood stream infections (CRBSIs) are the most common complication observed in patients receiving parenteral nutrition³. The infection may originate from two sources: extraluminal –when microbes migrate from the skin to the catheter insertion site, and intraluminal– with the catheter hub, infusion set connectors or nutritional admixture as a portal of entry⁴.

Connector-related infections result from manipulations associated with drawing blood, exchanging sets and drug administration. Furthermore, improper management of catheter insertion site can lead to its colonization with microorganisms and further microbial migration along the catheters' wall into the lumen of a blood vessel^{5,6}.

Due to a relatively high probability for the development of central catheter-related infection during parenteral nutrition, numerous previous studies have investigated the potential risk factors for this complication. The risk for infection was found to increase proportionally to the duration of catheterization, frequency of catheter-associated manipulations and catheter use for parenteral nutrition administration^{7,8}. Furthermore, bloodstream infections were more likely to develop in *Staphylococcus aureus* carriers⁹.

Appropriate management of the catheter insertion site is vital for the prevention of CRBSIs. Chlorhexidine proved to be the most effective of all disinfectants used in the prevention of catheter-related infections^{10,11}. Also octenidine, used for disinfection of the skin prior to the insertion, and for insertion-site care, was found to reduce the risk of catheter-related colonization in a recently published randomized trial¹². The strategies to prevent infectious catheter complications were studied extensively during last years. Antibiotic, 70% alcohol and tauridine locks were shown to reduce the CRBSI rates¹³⁻¹⁷.

Nevertheless, it is sterility during catheter-related manipulations which plays a vital role in CRBSI prevention^{4,18}. Although further studies of novel protective modalities are still required, introduction of simple changes in the structure of the medical team, as well as implementation of hygienic measures, e.g. wearing sterile gloves, masks and coats during central catheter insertion and manipulation, disinfecting patient's skin with chlor-

ble de la tasa de BAC en pacientes pediátricos que reciben nutrición parenteral en un entorno hospitalario.

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Palabras clave: *Bacteriemia asociada al catéter. Grupo de apoyo nutricional. Nutrición parenteral. Gastroenterología pediátrica.*

hexidine and avoiding the femoral catheter placement, can considerably reduce the infection rates¹⁹.

In pediatric parenteral nutrition, CRBSI rate is a sensitive marker of the quality of care. According to the ESPGHAN/ESPEN/ESPR guidelines, the incidence of infectious complications in hospitalized patients should not exceed 0.45 to 1.00 per year²⁰. In our previous study, we showed that the number of CRBSIs associated with parenteral nutrition may decrease considerably shortly after implementation of simple organizational changes²¹. The aim of this study was to analyze the long-term effects of the changes implemented at our clinic; we compared the CRBSIs rates in children receiving parenteral nutrition throughout a 7-year follow-up period prior to, during and after the reorganization.

Material and Methods

Organizational changes

Beginning in 2007, we started to reorganize nutritional therapy services offered at our pediatric gastroenterology department. The reorganization program was based on: 1) creating a nutritional support team comprised of pediatricians, nutrition nurse specialists and pharmacists, 2) providing training for team members at a reference center (Nutritional Ward of the Pediatric Clinic, The Children's Memorial Health Institute in Warsaw), 3) implementation of nutritional therapy and central catheter placement procedures, 4) documentation of all central catheterizations, 5) limiting central-catheter-associated manipulations to a necessary minimum, 6) authorization of staff involved in central catheter manipulation, 7) providing education and motivation to medical personnel, and 8) monitoring complications associated with nutritional therapy. Our program of nutritional therapy reorganization followed current recommendations and standards of care²⁰⁻²³.

Study design

This analysis included three periods: 1) prior to the reorganization, i.e. between April 1st, 2005 and December 31st, 2006, 2) during the reorganization, i.e. between January 1st 2007 and September 30th, 2007, and 3) after the reorganization, i.e. between October 1st, 2007 and September 30th, 2014. In the case of period 1, a retrospective analysis of medical documentation was

conducted, whereas the data concerning periods 2 and 3 were examined prospectively.

We analyzed the rates of CRBSIs documented during these three periods in patients nourished parenterally at our clinic. The inclusion criteria were as follows: patient's age between 2 and 48 months of life, at least four consecutive days of parenteral nutrition, and infusion of nutritional admixture through the central catheter.

The protocol of this study was approved by the Local Ethics Committee of the Medical University in Gdansk.

Diagnostic criteria of CRBSI

CRBSI was diagnosed whenever clinical symptoms of infection (poor general condition and body temperature above 38.5°C) co-existed with elevated levels of inflammatory markers (CRP and peripheral leukocyte count) and leukocyte left shift. Furthermore, the criteria required that the same microorganism was isolated simultaneously from the blood obtained from the catheter and from peripheral blood, in absence of other sites of infection^{18,20,24}.

Microbiological verification

Catheter and peripheral blood samples (2-5 ml) were analyzed using the automated incubation system BacT/Alert (BioMerieux, France). Initially, the blood was cultured in the PediBacT medium (i.e. non-selective growth medium for aerobic microflora isolated from pediatric patients). If the culture was positive, the samples were passaged onto specific media for testing bacterial and fungal growth (BioMerieux, France). The material was incubated at 35°C under aerobic conditions or 5-10% CO₂. Species identification was performed by means of routine microbiological methods and with an aid of VITEK2 system (BioMerieux, France). Antibiotic susceptibility of isolates was tested with disk-diffusion method in Mueller-Hinton II medium in accordance with the CLSI standards and with an aid of VITEK2 system.

Statistical analysis

Normal distribution of continuous variables (patients' age and the duration of nutritional therapy) was verified with the Kolmogorow-Smirnov test. The results were presented as arithmetic means and their standard deviations (SD) and compared with ANOVA and Tukey post-hoc test. The distributions of categorical variables were compared with the Pearson's chi-square test or Fischer's exact test. All calculations were performed using Statistica 10 (StatSoft®, Tulsa OK, USA) software, and statistical significance was defined as $p \leq 0.05$.

Results

A total of 260 courses of parenteral nutrition lasting at least 4 consecutive days were offered to 141 patients during the period covered by this study (Table I). This corresponded to 7 715 procedures of parenteral nutrition (one procedure defined as one day of parenteral nutrition offered to a single patient). Mean age of patients who received parenteral nutrition prior to and during the reorganization was significantly lower than the age of patients treated nutritionally after the reorganization ($p=0.028$). Also mean duration of parenteral nutrition decreased significantly, from 76 days per course prior to the reorganization to 20 days per course thereafter ($p<0.001$).

Short bowel syndrome was the main indication for parenteral nutrition in the vast majority of cases. Nevertheless, the frequency of this indication decreased gradually with time: from 68% during period 1, to 59% and 55% during periods 2 and 3, respectively. However, this tendency did not prove significant on statistical analysis.

A total number of 30 CRBSIs were documented throughout the analyzed period. The reorganization was reflected by more than 8-fold reduction in the CRBSI incidence rate: from initial value of 10.14 to 6.89 per 1000 catheter days and 1.17 per 1000 catheter days during and after the reorganization, respectively (Table II). Staphylococci: *S. aureus* ($n=4$) and *S. epidermidis* ($n=17$) were identified as etiological factor of infection in 21 out of the 30 cases. The remaining CRBSIs resulted from infection with *Enterococcus faecalis* ($n=1$), Gram-negative bacteria ($n=6$) and *Candida albicans* ($n=2$).

Discussion

Parenteral nutrition is associated with a number of complications^{1,2}, and the rate of infectious complications constitutes a sensitive quality marker of nutritional therapy²⁰. Therefore, the aim of this study was to verify if simple organizational changes implemented at our department exerted sustained effect on the CRBSI rate. Organization of a nutritional support team and reorganization of nutritional therapy was shown to result in more than 8-fold reduction of the CRBSI rate (from 10.14 to 1.17 per 1000 catheter days) throughout a 7-year follow-up period. As a result, the incidence of infections approximated the safety limit stated in the ESPGHAN/ESPEN/ESPR guidelines²⁰. Majority of previous studies dealing with the problem in question analyzed only the short-term effects of organizational changes on the CRBSI rates. A number of these studies confirmed that organization of nutritional support is reflected by lower number of catheter-related infections. Pronovost *et al.*¹⁹ observed a dramatic decrease in the mean CRBSI rate, from 7.7 at baseline to 1.4 per 1000 catheter days at 16-18 months after implementation of organizational changes similar to those proposed in our study. Also other authors documented marked reduction of infection rates, resulting from implementation of training programs and

Table I
Clinical characteristics of patients receiving parenteral nutrition during the period of this study

Parameter	Prior to the reorganization (1)	During the reorganization (2)	After the reorganization (3)	p-value		
				1 vs. 2	2 vs. 3	1 vs. 3
Patients (n)	8	10	123	-	-	-
Patients' gender (F/M)	5/3	5/5	55/68		0.600*	
Patients' age in months (mean±SD)	7.2±4.4	11.9±6.0	21.4±31.0	0.590	0.138	0.028
Parenteral nutrition courses (n)	22	22	216	-	-	-
Total days of parenteral nutrition (n)	1675	1162	4278	-	-	-
Days per course of nutrition (mean±SD)	76±108	53±75	20±28	0.092	0.001	<0.001
Indications to parenteral nutrition (n)						
Short bowel syndrome:	15/22	13/22	120/216		0.754*	
- agangliosis	2	1	14		-	
- intestinal atresia	4	3	35		-	
- ileus	6	4	1		-	
- NEC	1	1	30		-	
- gastroschisis	1	1	33		-	
- others	1	3	7		-	
Mitochondrial cytopathy	0	0	3/216		-	
Crohn disease	0	0	6/216		-	
Motility disorders	6/22	9/22	41/216	0.526	0.026	0.250
Severe malnutrition	1/22	0/22	13/216		0.484*	
Other	0/22	0/22	33/216	-	0.036	0.036

*no post-hoc testing.

Table II
Characteristics of catheter-related blood stream infections (CRBSIs) documented in parenterally nourished patients during the period of this study

Parameter	Total (4)	Prior to the reorganization (5)	During the reorganization (6)	After the reorganization (7)	p-value		
					5 vs. 6	6 vs. 7	5 vs. 7
Number of CRBSIs	30/7115	17/1675	8/1162	5/4278	-	-	-
CRBSI rate per 1000 catheter days	4.2	10.14	6.89	1.17	0.043	<0.001	<0.001
Etiological factor (n)							
<i>Staphylococcus aureus</i>	4/30	0	3	1	0.028	0.196	-
<i>Staph. epidermidis</i>	17/30	12	2	3	0.032	0.086	0.662
<i>Enterococcus faecalis</i>	1/30	0	1	0		0.257*	
<i>Klebsiella pneumoniae</i>	2/30	2	0	0		0.418*	
<i>Escherichia coli</i>	2/30	2	0	0		0.418*	
<i>Haemophilus influenzae</i>	1/30	0	1	0		0.257*	
<i>Pseudomonas aeruginosa</i>	1/30	0	0	1		0.083*	
<i>Candida albicans</i>	2/30	1	1	0		0.680*	

*no post-hoc testing.

organizing nutritional support teams. However, the reduced rates were not as low as in our study. Costello *et al.*²⁵ reported more than a three-fold decrease in the infection rate of children hospitalized at intensive care units (from 7.8 to 2.3 per 1000 days), resulting from organization of central catheter team and a system for monitoring and analyzing all CRBSI cases. In turn, Warren *et al.*^{26,27} analyzed the effectiveness of the obligatory training of

medical personnel, and showed that this approach resulted in more than two-fold decrease in the infection rate. Also, Coopersmith *et al.*²⁸ revealed similar effectiveness of the training program for medical personnel (a decrease in the incidence of septic complications from 11.6 to 2.4 per 1000 days of parenteral nutrition).

Contrary to the studies mentioned above, the principal aim of our research was to analyze the long-term effects

of organizational changes on the incidence of catheter-related infections. To the best of our knowledge, only few similar long-term observations have been published to date. The authors of one of these studies analyzed two 18-month periods after the implementation of CRBSI prevention program at intensive care units. They showed that the initial reduction of CRBSI rate observed during the first period sustained for another 18 months, and thus concluded that the program was integrated well into routine clinical practice²⁹. In another study, the CRBSI rate at an intensive care unit decreased from 3.38 to 0.46 per 1 000 catheter days during a 4-year follow-up period after reorganization³⁰. The sustained reduction of CRBSI rate was also documented in a multicenter study conducted at another intensive care unit³¹, as well as in a 6-year follow-up one-center study including all units using central venous catheters³². In our study, we documented sustained reduction of CRBSI rate at the pediatric gastroenterology unit of a tertiary hospital, thus showing that a relatively simple reorganization accompanied by educational activities may efficiently improve the quality of care. Our findings are consistent with the results of another study conducted at non-intensive care units of a tertiary hospital, which showed that educational intervention among nurses may reduce the risk for peripheral venous catheter infections³³.

Undoubtedly, one potential limitation of this study stems from the combined retrospective/prospective character of our analysis. During the period covered by this study, the status of our clinic was changed to a reference center for nutritional therapy. Continuous increase in the experience of our medical team was reflected by changes in patients' profile, as shown by greater number of children qualified to parenteral nutrition therapy at the clinic³⁴. Moreover, mean age of patients who received parenteral nutrition prior to and during the reorganization was significantly lower than the age of children treated nutritionally after the reorganization ($p=0.028$). Also this phenomenon may be explained by greater heterogeneity of patients referred for nutritional therapy at a reference center. Importantly, the reorganization resulted in a significant decrease in the mean duration of nutritional therapy, from initial 76 days to no more than 20 days ($p<0.001$). Also this might contribute to the lower CRBSI rates. Even taking a potential confounding effect of the abovementioned factors into account, our study confirmed that implementation of simple organizational changes may be reflected by a considerable decrease in the incidence of catheter-related infections. It is noteworthy that the changes implemented at our clinic generated relatively low costs (mostly associated with training of the personnel) and considerable financial savings (data not shown), inherent to lower CRBSI rates^{35,36}. The most frequent etiological factors of CRBSIs documented in parenterally nourished children treated at our clinic were staphylococci (21/30), followed by *Klebsiella pneumoniae*, *Escherichia coli* and *Candida albicans* (2/30 each). This distribution of etiological factors of CRBSIs is similar to those reported previously^{9,37}.

Aside from the risk for infection, parenteral nutrition may also result in mechanical and metabolic complications, and nutritional disorders. According to literature, the risk for mechanical complications, such as pneumothorax, air embolism or displacement of a catheter inside the vessel, is markedly lower in centers having nutritional support teams³⁸. Some authors suggested that organization of the nutritional support team may be reflected by 3.6% to 24% reduction of mechanical complication rates^{39,40}, and Png *et al.*⁴¹ claimed even on a complete elimination thereof. However, the period covered by the latter study (initial 6 months after nutritional support team implementation) seems too short for such radical conclusion. Nevertheless, parenterally nourished patients supervised by a nutritional support team were shown to be characterized by lower incidence of metabolic disorders, such as hyper- or hypoglycemia, abnormal levels of sodium, phosphorus and magnesium ions^{39,40,42}. Also, energy and protein deficiencies are less frequently reported from patients receiving parenteral nutrition at centers having dedicated nutritional support teams^{39,40,43}.

Appropriate qualification to nutritional therapy represents a crucial task of the nutritional support team. According to literature, the fraction of patients qualified to nutritional treatment by such teams is markedly lower than the fraction qualified by regular medical personnel. Png *et al.*⁴¹ showed that as many as 41% of patients who were initially prescribed parenteral nutrition, were re-qualified to enteral nutrition following a consultation with nutritional support team, and this switch was associated with marked reduction in morbidity rates. Also, Gurgueira *et al.*⁴⁴ reported that the nutritional support team introduced to an intensive care unit qualified patients to enteral feeding rather than to parenteral nutrition. As a result, the fraction of patients receiving enteral nutrition increased from 25% to 67% following the introduction of nutritional support team⁴⁴. This is consistent with Saalwachter *et al.*'s⁴⁵ findings; these authors observed that the nutritional support team may reduce the fraction of patients who were inappropriately qualified to parenteral nutrition from 32% to 7.9%.

According to modern standards, efficient parenteral nutrition requires multidisciplinary approach and involvement of various medical specialists. This goal can be achieved by the introduction of nutritional support teams. Our study confirmed that such reorganization, supported by extensive training and education of medical staff, may result in sustained reduction of CRBSI rates of pediatric patients nourished parenterally in a hospital setting. This leads to the conclusion that even relatively simple and inexpensive changes may constitute a key for marked improvement of medical care.

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Original/*Pediatría*

Prevalence of factors related to the bone mass formation of children from a cohort in Southern Brazil

Alessandra Doumid Borges Pretto¹, Cristina Correa Kaufmann², Gisele Ferreira Dutra³ and Elaine Pinto Albernaz⁴

¹PhD Student Behavior and Health of the Catholic University of Pelotas (UCPEL), Pelotas, RS, Brazil. ²PhD by the Health and Behavior of the Catholic University of Pelotas (UCPEL), Adjunct Professor, School of Nutrition, Federal University of Pelotas (UFPEL), Pelotas, RS, Brazil. ³PhD Student Behavior and Health of the Catholic University of Pelotas (UCPEL), Pelotas, RS, Brazil. ⁴PhD in Epidemiology, Federal University of Pelotas, Adjunct Professor of Pediatrics, Graduate Program in Health and Behavior of the Catholic University of Pelotas and Adjunct Professor, Faculty of Medicine, Federal University of Pelotas, RS, Brazil. Scholarship Productivity CNPQ.

Abstract

Introduction: The amount of bone mass acquired in the early stages of life is an important determinant of its peak and future risk of osteoporosis and fractures.

Objective: To describe the prevalence of factors that contributes to the formation of bone mass in children of a Southern Brazil cohort.

Methods: A retrospective cohort study with hospital screening of all births (2741) occurred from September/2002 to May/2003 and monitoring of a random sample of 30.0% of these (one, three and six months and eight years old). During the eight years old visit, a questionnaire containing questions related to food and physical activity was applied.

Results e Discussion: Of the 616 children studied, 51.3% were male, 70.3% Caucasian, about half belonged to economic class C, 20.5% were overweight, 16.9% were obese and 71.2% were sedentary. As for food intake low consumption of fruits, vegetables, dairy products, meat, cereals and tubers was noticed. Vitamin D administration in the first six months of life was followed by 14.1% of premature, 16.1% of infants with low birth weight, 24.2% of weaned in the first month and only 16.4% at three months.

Conclusion: The evaluated children have low nutrients consumption, including calcium, inappropriate vitamin D administration in the first semester of life, little regular physical activity and high prevalence of overweight and obesity are factors that can impair the formation of bone mass.

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Key words: Bone mass. Childhood. Physical activity.

Correspondence: Alessandra Doumid Borges Pretto.
645 General Teles St. Apt 302 - Zip Code: 96010-310
Pelotas, RS, Brazil.
Email: alidoumid@yahoo.com.br

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PREVALENCIA DE LOS FACTORES RELACIONADOS CON LA FORMACIÓN DE LA MASA ÓSEA DE LOS NIÑOS EN UNA COHORTE EN EL SUR DE BRASIL

Resumen

Introducción: La cantidad de masa ósea adquirida en las primeras etapas de la vida es un importante factor determinante de su pico y el riesgo futuro de osteoporosis y fracturas.

Objetivo: Describir la prevalencia de factores que contribuye a la formación de la masa ósea en niños de una cohorte del sur de Brasil.

Métodos: Estudio de cohorte retrospectiva con el hospital de todos los nacimientos (2741) se produjo en septiembre / 2002 a mayo / 2003 y el seguimiento de una muestra aleatoria de un 30,0% de los mismos (uno, tres y seis meses y ocho años de edad). En una visita a los ocho años de edad, aplicó un cuestionario con preguntas relacionadas con la alimentación y la actividad física.

Resultados y Discusión: De los 616 niños, el 51,3% eran hombres, el 70,3% de raza caucásica, cerca de la mitad pertenecían a la clase económica C, 20,5% tenían sobrepeso, el 16,9% eran obesos y 71,2% sedentarios. La ingesta de alimentos es bajo consumo de frutas, verduras, productos lácteos, carne, los cereales y los tubérculos. La administración de vitamina D en los primeros seis meses de vida fue seguido por 14,1% de los prematuros, el 16,1% de los recién nacidos con bajo peso al nacer, el 24,2% de destete en el primer mes y sólo el 16,4% a los tres meses.

Conclusión: Los niños evaluados tienen un bajo consumo de nutrientes, entre ellos el calcio, deficiente administración de vitamina D en el primer semestre de vida, poca actividad física regular y la alta prevalencia del sobrepeso y la obesidad son factores que pueden afectar a la formación de masa ósea.

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Palabras clave: Masa ósea. Infancia. Actividad física.

Abbreviations

BM: Bone mass.
HIV: Human immunodeficiency virus.
RR: Relative risk.
ICU: Intensive care unit.
BMI: Body mass index.
PTH: Parathyroid hormone.
WHO: World Health Organization.
PAQ-C: Physical Activity Questionnaire for Older Children.
UCPEL: Catholic University of Pelotas.
ABEP: Brazilian Association of Research Companies.

Introduction

In recent years there has been increasing interest in determining which factors influence bone mineralization in children, since the amount of bone mass (BM) acquired in the early stages of life is an important determinant of its peak and future risk of osteoporosis and fractures¹. So it is essential that children intensify their BM before and during periods of growth to ensure full development of their genetic potential¹.

Osteoporosis is a systemic skeletal disease characterized by low bone mass and deterioration of bone tissue micro architecture, with consequent increase in bone fragility and susceptibility to fracture². According to International Foundation of osteoporosis study, the number of hip fracture cases in Brazil, currently 121,700 a year, will increase 32.0% by 2050³. Osteopenia and osteoporosis do not represent an exclusive concern for elders and adults, once the bone mineral density of these age groups depends on the BM peak acquired by the end of the second decade of life⁴.

The BM peak can be defined as the maximum amount of bone mass that an individual accumulates from birth until skeletal maturity, therefore a key mark in skeletal health throughout life⁵. Thus, childhood and adolescence are the highest increase period on bone mineral capital¹. Approximately 80.0% of the BM peak is determined by genetic factors and the rest is influenced by environmental factors, such as exercise, smoking, medications and nutrition².

Physical activity during different stages of life has been suggested as osteoporosis protection factor and represents an essential element in building and maintaining BM⁶. Studies point out that more physically active people are those with the highest BM^{5,6}.

A nutritionally adequate feed corresponded to a major modifiable factor in the development/maintenance of bone mass and preventing osteoporosis⁷. Thus, throughout childhood adequate calcium, phosphorus, vitamin A, D and K and protein intake is required, since these lead to reduced bone remodeling, increased calcium retention and fracture risk reduction⁷.

As for factors related to birth, we can point out the gestational time and birth weight. Preterm infants are

at increased risk of lower growth and bone mineralization compared to children born at term⁸. Bone development of preterm infants is complex and the restriction of intrauterine and postnatal growth may lead to repercussions in adulthood⁸. Just as premature, those born with low weight must be supplemented with iron and vitamins A and D to ensure their genetic growth potential⁹.

The identification of factors that contribute for children bone mass formation represents an important strategy for preventing the occurrence of future bone disease⁸. Regarding nutritional status, the studies differ because obese and less active children have lower BM¹⁰. It is unclear whether this reduction in BM in obese children is a direct effect of fat on the bone or due to decreased muscle mass or reduced levels of activity or a combination of both¹⁰. In contrast, other studies claim that obesity acts as a protective factor against risk of fractures and osteoporosis, given that obese individuals have a higher BM in other eutrophic¹⁰.

Taking into consideration that the influence of interactions between nutritional factors, environment, lifestyle and heredity supports the development of osteoporosis and consequent fractures⁷, the assessment of BM formation predictors' prevalence in children and adolescents is important not only for the development of intervention programs, but also to play an important factor in prevention of bone diseases in adulthood⁸. Therefore, this article aims to describe the prevalence of factors that contribute to the BM formation, such as birth weight, gestational age, early weaning, childhood feed intake, physical activity and nutritional status of children in a cohort of Southern Brazil.

Methods

This is a retrospective cohort study, which had two components: perinatal (hospital screening) and monitoring (home visits with one, three and six months and eight years old). During the study period, there were 3449 births, and 81.0% (2799) of infants residing in the urban area of Pelotas. Among them, 29 were born outside the hospital, but were included in the study because they were sent there soon after birth. Ten children had early hospital discharge and were not subsequently located. We excluded 26 mothers for being human immunodeficiency virus (HIV) positive, since the main objective of the cohort study was to study aspects related to breastfeeding and 22 refused to participate. Therefore, in hospital screening the final population interviewed was 2741 mothers, representing 98.0% of all births in the target population. From this sample, 30.0% (973) were selected at random, by means of statistical program for home care in the first, third and sixth month and eight years of life.

The sample was calculated aiming for analyzes based on a 95.0% confidence level and 80.0% statistical

power for data, ranging from 15 to 80.0% and estimating a relative risk (RR) of 2.0 and 15.0% increase to the initial calculation for losses and control of confounding factors. In first month monitoring 951 questionnaires were completed, 940 in the third month, 931 in the sixth month, with 2.3%, 3.4% and 4.4% losses, respectively. In eight years old monitoring, 616 children were visited (63.0% of the initial sample). There were five refusals, 17 deaths, 93 children moved to other states or cities and 242 did not have their new addresses located.

Those with hospitalization of 24 hours or higher after birth either in nursery or intensive care unit (ICU) were not included in the study. Were eligible for inclusion in the study, all newborns from mothers living in the urban area of Pelotas and not presenting serious problems that contraindicated breastfeeding. For monitoring at eight years old, all children who were visited at six months and lived in the city of Pelotas were included in the cohort.

Data on the methodology of the cohort and accompaniments in the 1st semester of life are published¹¹. For the eight years old visit, we used a standardized questionnaire which was applied to the mothers or caregivers with questions about health and eating habits.

The variables studied were: gestational age at birth, birth weight, body mass index (BMI) at eight years old, physical activity, socioeconomic factors (family income, maternal education and economic class according to Brazilian Association of Research Companies, ABEP), breastfeeding duration, and vitamin D administration in the first three months of age and food intake at eight years old.

To evaluate the eating habits we used as basis the "Food Guide- Ten Steps to Healthy Eating", created by the Ministry of Health¹². Simple and easy to answer questions were designed for parents or legal guardians.

For the anthropometric measurements at age of eight, the child was weighed and measured with portable and precision equipment. The weight was measured with scale Tanita brand, model UM-080 Body Fat Monitor/Scale and the height with wooden stadiometer. Overweight and obesity were classified according to the curves of the World Health Organization (WHO) from 2007¹³. From them, we calculated the BMI as a diagnostic criterion for overweight and obesity, being considered overweight children with BMI-for-age $\geq$ score $z+1$ and $<$ score $z+2$ and for obesity $\geq$ score $z+2$.

In the evaluation of physical activity, we used the instrument Physical Activity Questionnaire for Older Children (PAQ-C)¹⁴, on which the classification is given according to physical activity scores from 1 (very sedentary) to 5 (very active). Anthropometric data (weight, height and waist circumference) were analyzed by gender and age on the assessment day.

Quality control was conducted through questionnaires and pre-tested instruments and questions repetition in a synthesized questionnaires in a random sample of 10.0% of all children. The questionnaires were entered

into a database built through the program Epi Info 6.0 d[®]. We calculated the variables of interest's frequency after a bivariate analysis between the independent variables and the outcome, using the chi-square test. After the analysis, only the variables with $p < 0,05$ were considered to be linked to the outcome as statistically significant.

Table I
Studied sample's characteristics, Pelotas, Rio Grande do Sul, Brazil, 2011. (n=616)

Variable	N	%
Child sex		
Male	316	51,3
Femamle	300	48,7
Child color		
Caucasian	433	70,3
Not Caucasian	183	29,7
Family income ^a		
≤ 1	85	13,8
1,01-3	308	50,0
3,01-6	144	23,4
>6	66	10,7
Ignored	13	2,1
Economic Class		
A1 e A2	24	3,9
B1 e B2	202	32,8
C1 e C2	325	52,8
D e E	65	10,5
Maternal education level		
Illiterate / 3rd graders	34	5,5
4th graders	176	28,6
Elementary education	133	21,6
High school education	213	34,6
University graduated	53	8,6
Ignored ^b	7	1,1
Gestational age at birth		
< 37 weeks	66	10,7
≥ 37 weeks	550	89,3
Birth weight		
$< 2500g$	49	8,0
$\geq 2500g$	567	92,0
Breastfeeding until six months		
Yes	324	52,6
No	292	47,4
BMI classification		
Low weight	11	1,8
Adequate weight	375	60,8
Overweight	126	20,5
Obesity	104	16,9
Level of physical activity		
Very sedentary	103	16,7%
Sedentary	336	54,5%
Moderately active	160	26,0%
Active	17	2,8%
Total	616	100,0

^aIn minimum wages. ^bChildren who do not live with the mother.

The research project was approved by the Ethics Committee of Catholic University of Pelotas (UCPEL) with mothers or legal guardians having signed a new Terms of Informed Consent, since the age of eight visit was not contemplated in the original cohort design. On this visit, a printed copy of "Food Guide for the Brazilian population"¹² had been delivered to the mothers and children who were identified as having health problems were referred for care.

Results

On follow-up to age of eight, 616 children were interviewed, being 51.3% boys; 70.3% Caucasian; 92.0% were born weighing more than 2500 g and 10.7% with gestational age of less than 37 weeks. As for maternal education, 34.6% had completed high school (Table I).

The anthropometric nutritional assessment identified 20.5% of overweight children, occurring in 19.6% of boys and 21.7% of girls. While obesity was observed in 16.9% of the sample with 19.9% of boys and 14.0% of girls. Therefore, the prevalence of overweight in the sample was 37.4%. As for physical activity, less than 30% of children were considered active (Table I).

Table II shows food consumption according to the frequency of adherence to the Ten Steps to Healthy Eating. As to the factors associated with BM, children avoided the salt increase in food but had low intake of foods rich in calcium, fiber, vitamins and phosphorus.

When comparing food intake with socioeconomic factors, it can be seen that the lower the economic class, a greater beans consumption, good source of phosphorus, and a higher sweets, soft drinks and goodies consumption, while with a higher maternal education level, a lesser bean consumption, and a higher fats, sweets and treats consumption. (Table III).

Regarding the use of vitamin D according to the gestational period, birth weight and early weaning, its administration in the first three months of life was followed by 14.1% of premature, 16.1% of low birth weight infants, 24.2% of weaned in the first month and 16.4% of weaned at three months (data not shown in table).

Discussion

A bone health is directly dependent on the intake of certain nutrients, including calcium, which with regular consumption in childhood and adolescence would increase the BM peak and reduce the risk of osteoporosis in later decades¹⁵. In addition, adequate levels of calcium intake can maximize the positive effects of physical activity on bone health during the period of growth in children¹⁶. In this study, only 25.0% of children followed the daily recommendation of three servings of dairy products¹², a similar result to studies with schoolchildren¹⁸.

Research shows high protein intake from schoolchildren, contrary to the results of this study, which showed that only 32.8% of children consume the recommended

Table II
Studied children's food intake, Pelotas, Rio Grande do Sul, Brazil, 2011. (n=616)

<i>Food consumption</i>	<i>n</i>	<i>%</i>
At least three meals and two light lunches a day	463	75,2
Daily consumption of six grain group portions	241	39,1
Daily consumption of six tubers and roots group portions	41	6,7
Whole grain consumption	17	2,8
Daily consumption of at least three vegetable portions	43	7,0
Daily consumption of at least three fruit portions	56	9,1
Daily consumption of beans	449	72,9
Daily consumption of three milk and dairy products portion	154	25,0
Daily consumption of one meat, fish, chicken or eggs portion	202	32,8
Maximum daily intake of a vegetable oils, olive oil or butter or margarine portion	352	57,1
Avoid soft drink consumption	475	77,1
Avoid processed juices consumption	385	62,5
Maximum daily intake of sweet biscuits, stuffed and other goodies portion	493	80,0
Not adding salt to ready meals	521	84,6
Consumption of at least two liters of water per day	55	8,9

Table III
Food consumption according to socioeconomic factors of the studied sample. Pelotas, Rio Grande do Sul, Brazil, 2011. (n=616)

Variable	Daily consumption of six tubers and roots group portions and Whole grain consumption (%)	Daily consumption of three vegetable and three fruit portions (%)	Daily consumption of beans (%)	Daily consumption of three milk and dairy products portion and maximum consumption of 1 meats and/or egg portion (%)	Maximum consumption of 1 fat portion (%)	Avoid soft drinks/ juices and candies consumption (%)	Sodium addition in ready meals (%)
Economic Class (ABEP)^a p value*							
A	0.24	0.97	0.03	0.98	0.10	0.000	0.30
B	75.00	0.00	58.33	4.17	62.50	70.83	83.33
C	76.73	2.97	73.76	5.94	64.36	50.50	87.13
D e E	76.00	1.54	78.77	6.46	51.38	37.23	83.69
	66.15	3.08	80.00	4.62	61.54	40.00	81.54
Maternal education level pvalue**							
Illiterate/ 3rd graders	0.22	0.51	0.000	0.82	0.02	0.000	0.95
4th graders	88.24	5.88	82.35	2.94	50.00	20.59	85.29
Elementary education	72.73	1.70	83.52	5.68	51.70	37.50	82.95
High school education	70.68	2.26	78.20	9.02	57.89	36.09	86.47
University graduated	76.53	1.88	70.89	5.16	60.56	49.30	85.45
	79.25	1.89	64.15	3.77	66.04	71.70	81.13

^aRanked by the Brazilian Association of Research Companies. A economy class comprises people with higher purchasing power and E economic class those with less purchasing power. *Chi-square test for linear trend. **Chi-square test for heterogeneity.

daily portion¹⁹⁻²⁰. A study performed with elderly men and women, higher protein intake in the diet was associated with a lower rate of age-related bone loss²¹.

Fruits and vegetables intake is very important for children, as well as the positively contribution to growth and development, it can assist in body weight maintenance and chronic diseases²². In children evaluated in this study the low vegetables (7.0%) and fruits (9.1%) intake is impressive. A similar result to a study conducted by Conceição et al. 2010, with 570 schoolchildren aged 9 to 16 years of public and private school systems in Brazil, who found low fruits and vegetables consumption²⁴. These results raise concerns, as these foods are good sources of potassium that can positively influence bone health markers, thus contributing to osteoporosis reduction²³.

Phosphorus is another essential nutrient and acts as a regulator of bone formation and resorption inhibitor, however, there is an agreement that high amounts could be detrimental to the bone, since they produce transient drop in plasma calcium resulting in increased parathyroid hormone (PTH) secretion and potentially bone resorption²⁵. Cereals as well as the legumes represent good sources of serum phosphorus and in studied children there were low consumption of cereals (39.1%), tubers and roots (6.7%) and a good amount of legume consumption (72.9%).

A favorable aspect on the food intake, 77.1% of children avoided the consumption of soft drinks, which acts as a positive aspect; because cola based beverages contain caffeine and phosphoric acid, which can adversely affect bone health through generation of acid load in the body⁷. Another positive aspect was that the majority of children (84.6%) did not add salt to ready meals, which is positive since the dietary sodium chloride represents potential damage to the BM as its increased ingestion, elevates urinary calcium excretion²⁶. It is noteworthy that the information on consumption of soft drinks and salt may not reflect the actual habit of children, but a false positive due to omission.

The increase in chronic diseases new cases in recent decades is due in part to lifestyle habits acquired over a lifetime²⁷. Physical activity is important as preventive and curative factor, and when practiced regularly and early, prevents the loss of BM and consequently osteoporosis. This practice should occur from childhood because it is the stage of life in which the maximum bone mass is reached. Alarming was the fact that 71.2% of children in this study had one and two scores in the PAQ-C¹⁴, related to physical activity, demonstrating that the vast majority is sedentary or less active.

The anthropometric nutritional assessment identified 20.5% of overweight and obesity was observed in 16.9% of the sample. Therefore, the prevalence of overweight in the sample was 37.4%. On the influence of body weight and other compartments of body composition on the BM, there is controversy about what is the meaning of the association between excessive body weight and BM²⁸.

Vitamin D administration in the first six months of life was followed by 14.1% of premature, 16.1% of low birth weight infants, 24.2% of weaned in the first month and 16.4% of weaned at three months. Alarming results since early weaned babies born with low birth weight or premature infants need vitamin D supplementation, so that the development/normal maintenance of skeletal structures occur through improved quality and/or bone strength⁷. The recommendation of 200 IU of vitamin D up to 18 months is required for breastfeeding infants who do not have regular sun exposure and for infants who do not receive 500 ml per day of infant formula, and for babies born with low birth weight and premature²⁹. Importantly, in addition to the impact on bone metabolism, the level of vitamin D may influence the further development of some chronic diseases such as type 1 diabetes, hypertension and cancer³⁰.

This study had as limitations the fact of being a retrospective study, in which the information were only analyzed during the cohort visits, a food frequency questionnaire was not applied to verify the consumption of foods rich in bone formation related nutrients and also the sun exposure has not been evaluated.

Of the studied children, low consumption of dairy products, fruits and vegetables, cereals, legumes, low exercise frequency, high overweight prevalence and inadequacies of vitamin D administration in the first months of life was perceived. Knowing that the BM peak is reached in late adolescence and early adulthood, it is necessary to optimize modifiable factors that can affect bone mass, including vitamin D administration. Thus, it is evident the importance of early intervention during the first years of life, promoting better quality of life in childhood to prevent the emergence of many diseases, including bone diseases.

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Original/Síndrome metabólico

Glycemic Control and Oxidative Stress Markers and their relationship with the Thioredoxin Interacting Protein (TXNIP) gene in Type 2 Diabetic patients

Mónica Andrews Guzmán¹, Miguel Arredondo Olguín¹ and Manuel Olivares Gronhert¹

¹Laboratorio de Micronutriente. INTA. Universidad de Chile. Universidad Autónoma de Chile, Escuela de Nutrición y Dietética. Chile.

Abstract

Objective: To investigate the relationship between oxidative stress and biochemical parameters and the expression of TXNIP, IL-6, IL-1 β and TNF- α in peripheral mononuclear cells (PMCs) from type-2 diabetic patients.

Methods: We studied 60 males: 20 normal-weight type-2 diabetic patients (NW), 20 obese diabetic patients (OB) and 20 controls (C). Biochemical and oxidative stress parameters were evaluated. PMCs were isolated and total RNA was extracted in order to determine the expression of TXNIP, IL-6, IL-1 β and TNF- α by qRT-PCR.

Results: OB had higher weight, BMI and abdominal circumference (One way ANOVA, $p < 0.0001$). NW had higher fasting glycemia (One way ANOVA, $p = 0.0034$) however OB had higher HbA1c (One way ANOVA, $p < 0.0001$). OB also had higher hsCRP (One way ANOVA, $p = 0.0158$). TBARS and AGES were elevated in both NW and OB (One way ANOVA, $p < 0.0001$ and $p = 0.0008$, respectively). Compared to OB and C participants, the expression of TXNIP was significantly higher in NW (Kruskal Wallis, $p = 0.0074$); IL-1 β , IL-6 and TNF- α transcripts were higher in NW and OB (Kruskal Wallis, $p < 0.0001$, for all). In NW patients, the expression of TXNIP was positively correlated with fasting glycemia and AGES and negatively correlated with HOMA- β ($r = 0.72$; $r = 0.59$; $r = -0.44$, respectively, for all $p < 0.05$), in OB there was correlation only with 8-Isoprostanes ($r = 0.42$, $p = 0.046$).

Conclusions: Our results suggest that fasting glycemic control, independent of adiposity and nutritional status, represents a risk factor for β -cell dysfunction, increases oxidative stress markers and it is related with an elevation of TXNIP expression.

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Correspondence: Dra. Mónica Andrews Guzmán.
Dirección El Líbano 5524, Macul, Santiago, Chile.
Institución INTA, Universidad de Chile.
E-mail: monica.andrews@gmail.com.

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CONTROL GLICÉMICO Y MARCADORES DE ESTRÉS OXIDATIVO Y SU RELACIÓN CON EL GEN DE LA PROTEÍNA INTERACTUANTE CON LA TIOREDOXINA (TXNIP) EN SUJETOS DIABÉTICOS TIPO 2

Resumen

Objetivo: Investigar la relación existente entre parámetros bioquímicos y de estrés oxidativo y la expresión de TXNIP, IL-6, IL-1 β y TNF- α en células mononucleares periféricas (CMPs) de sujetos diabéticos.

Material y métodos: Se estudió 60 sujetos hombres: 20 con peso normal y diabetes tipo 2 (NW), 20 sujetos obesos con diabetes (OB) y 20 sujetos controles (C). Se evaluaron parámetros bioquímicos y de estrés oxidativo. Además se aislaron CMPs para la extracción de RNA total y se determinó la expresión de los genes TXNIP, IL-6, IL-1 β y TNF- α mediante PCR de tiempo real cuantitativo.

Resultados: Los OB presentaron mayor IMC y circunferencia abdominal que los NW y los C (ANOVA de una vía, $p < 0.0001$). Los NW tuvieron mayor glicemia en ayuna (ANOVA de una vía, $p = 0.0034$) sin embargo, los OB presentaron mayor HbA1c (ANOVA de una vía, $p < 0.0001$). Los OB además presentaron mayores niveles de PCRus (ANOVA de una vía, $p = 0.0158$). Los TBARS y los AGES se observaron elevados tanto en OB como en NW (ANOVA de una vía, $p < 0.0001$ y $p = 0.0008$, respectivamente). Comparado con los OB y C la expresión de TXNIP fue significativamente más alta en los NW (Kruskal Wallis, $p = 0.0074$); la expresión de IL-1 β , IL-6 y TNF- α se observó más elevada en los NW y OB (Kruskal Wallis, $p < 0.0001$). En los NW la expresión de TXNIP se correlacionó positivamente con la glicemia en ayunas y con los AGES y negativamente con HOMA- β ($r = 0.72$; $r = 0.59$; $r = -0.44$, respectivamente, $p < 0.05$), en los OB hubo correlación solamente con los 8-isoprostanos ($r = 0.42$, $p = 0.046$).

Conclusiones: Nuestros resultados sugieren que la alteración de la glicemia en ayunas, independiente de la adiposidad y del estado nutricional, representa un factor de riesgo para la disfunción de la célula beta, aumenta los marcadores de estrés oxidativo y se relaciona con el aumento de la expresión de TXNIP.

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Palabras Claves: TXNIP. Célula beta. Inflamación. AGES. Control glicémico.

Abbreviations

TXNIP: Thioredoxin interacting protein.
IL-6: Interleukin-6.
IL-1 β : Interleukin-1beta.
TNF- α : Tumor Necrosis Factor-alpha.
hs CRP: High sensitivity-C-reactive protein.
HOMA- β : Homeostasis model assessment-beta.

Introduction

Type-2 diabetes (T2D) is a chronic disease that is characterized by defects in insulin secretion, failure to suppress hepatic glucose output, and impaired glucose uptake in target tissues, such skeletal muscle and fat¹. Hyperglycemia results in oxidative stress and inflammation and it is considered a risk factor for cardiovascular disease.

Thioredoxin interacting protein (TXNIP) is a pro-apoptotic and pro-oxidant protein, which is elevated in insulin resistance and diabetes. It has been demonstrated that glucose stimulates TXNIP transcription through a carbohydrate response element in the TXNIP promoter, resulting in elevated TXNIP mRNA expression². TXNIP through a reactive oxygen species sensitive manner links NLRP3 which activates the inflammasome that allows the increased expression of IL-1 β ³. In turn this cytokine triggers the raising of IL-6 and TNF- α , these cytokines are recognized risk factors for insulin resistance and diabetes development, especially when accompanied by obesity⁴. Therefore, glucose may trigger a cycle between oxidative stress and inflammation induced by TXNIP and for the increasing of circulating cytokines.

Since it was discovered this top glucose-induced gene in a human pancreatic islet, is that TXNIP has emerged as a key player in beta cell biology⁵. The overexpression of TXNIP induces beta cell apoptosis, and is essential for glucotoxicity-induced beta cell death². Even more, TXNIP has been implicated in important cellular process including redox state⁶, apoptosis⁷, inflammation³ and endoplasmic reticulum stress⁸.

TXNIP is found increased in type 2 diabetes, and its down-regulation is related to the protection in the development of type 2 and 1 diabetes^{2,9}, but also in type 2 diabetes accompanied for obesity is found high levels of circulating glucose and fatty acids, nutrients that could exacerbate the expression of TXNIP and the inflammation markers.

Type 2 diabetes is more frequent in obese subjects; the obesity especially the abdominal obesity is characterized for a mild chronic inflammation with increased levels of markers such as: IL6, TNF α , IL-1 β between others. The obesity, the inflammation and the lack of glycemic control could be in part, related to TXNIP.

Since there is no evidence that shows that TXNIP expression may be modified for nutritional status, in

this study, we explore the relationship between the expression of TXNIP in PMCs from normal weight and obese type-2 diabetic patients, compared to healthy controls, with respect to β -cell functioning, oxidative, biochemical and inflammatory markers.

Methods

Study Subjects

We studied 20 diabetic subjects with normal nutritional status (NW); 20 obese with T2D (OB) and 20 controls (C). All participants were male and > 35 years. The inclusion criteria for T2D participants included: <10 years since diagnosis, not currently being treated with insulin, and BMI <27 kg/m² for NW and C and > 30 kg/m² for OB. Exclusion criteria included having any chronic disease or inflammatory condition other than T2D. The protocol was approved by the ethical committee of the Institute of Nutrition and Food Technology (INTA), and an informed consent was obtained from all participants.

Anthropometrics were measured in all patients (weight, height, and waist circumference). A blood sample (35 ml) was obtained after overnight fasting, of which 20 ml was used for biochemical determinations. Fasting glycemia was evaluated by glucose oxidase reaction (Dialab, Austria), HbA1c by turbidimetry, high-sensitivity C-reactive protein (hsCRP) by liquid-phase immunoprecipitation (Orion Diagnostica, Espoo, Finland), lipid profile by colorimetric method, insulin by radioimmunoassay (Coat-A-Count Insulin Kit, Siemens, USA), advanced glycation end products (AGES) by ELISA (OxiselectTM, Cell Biolabs, USA), TBARS (OxiSelectTM TBARS Assay Kit, Cell Biolabs, San Diego, CA) and 8-Isoprostanes (ELISA kit, Cayman Chemical Com, Michigan, USA). The HOMA- β index was calculated according to Wallace et al.¹⁰

Peripheral Mononuclear Cells (PMCs) Isolation

Fifteen mls of the blood sample was collected with EDTA anticoagulant and processed within 1-2 hrs. PMCs were separated by Ficoll-Histopaque gradient sedimentation (density 1.119, Sigma, St. Louis, MO). The mononuclear layer was removed and washed twice with PBS, an aliquot was used for determination of heme oxygenase (HO) activity according to Arredondo et al.¹¹ and total RNA was extracted and stored at -80° C.

RNA from PMCs was isolated using Trizol Reagent according to manufacturer protocol (Invitrogen). RNA (1.5 μ g) was reverse transcribed using the AffinityScript cDNA synthesis kit (Stratagene). qRT-PCR was performed using Fast SYBR[®]Green Master Mix (Applied Biosystems, USA) on StepOne equipment

(Applied Biosystem, USA). As housekeeping gene was used Beta-2 microglobulin (B2M). The studied genes were TXNIP, IL-6, IL-1 β and TNF- α . The primer list is available upon request.

Statistical Analysis

Anthropometric, biochemical and oxidative stress parameters are presented as means $\pm$ SD. The differences were evaluated using one-way ANOVA and the the Dunnett post-hoc test. Gene expression is presented as geometric mean and range ($\pm$ 1SD), and differences were evaluated using Kruskal Wallis and Dunn's post-hoc tests. Relationships between TXNIP and anthropometry, biochemical and oxidative stress parameters were evaluated using Spearman correlation. Statistical significance was assigned as $p < 0.05$. GraphPad Prism 6 (USA) was used for statistical analysis.

Results

As we expected OB had higher weight, BMI and abdominal circumference, compared to NW and C participants (Table I). However, NW subjects had higher fasting glycemia than OB and C, but OB had increased HbA1c than NW and also hsCRP (Table I). β -cell functioning, measured by HOMA- β , was significantly lower in NW, compared to OB and C, subjects (Table I).

Respect to the oxidative stress markers, TBARS and AGES were increased in both OB and NW, but HO activity was higher just in NW (Table I).

In the expression of genes, TXNIP was significantly higher in NW, compared to the other two groups (Table II). IL-1 β , IL-6 and TNF- α expression were increased in both NW and OB, compared to C subjects, but IL6 and IL-1 β were especially increased in OB (Table II).

Table I
Sample characteristics, Biochemical and Oxidative Stress Parameters

Parameters	C n=20	NW n=20	OB n=20	p
Age (years)	43.9 $\pm$ 6.4	64.9 $\pm$ 7.6	56.9 $\pm$ 8.9	<0.05
Weight (Kg)	66.9 $\pm$ 11.3	73.9 $\pm$ 7.8	92.9 $\pm$ 16.3***	<0.0001
BMI (kg/mt ²)	23.6 $\pm$ 2.9	25.7 $\pm$ 2.1	32.4 $\pm$ 5.9***	<0.0001
Waist Circumference(cm)	84.4 $\pm$ 6.7	95.6 $\pm$ 5.9*	109.8 $\pm$ 13.1***	<0.0001
SBP (mmHg)	128.4 $\pm$ 16.7	132.8 $\pm$ 20.4	137.8 $\pm$ 12.7	NS
DBP (mmHg)	81.3 $\pm$ 8.9	78.5 $\pm$ 12.4	83.1 $\pm$ 11.8	NS
<i>Biochemical Parameters</i>				
Fasting Glycemia (mg/dl)	105.4 $\pm$ 9.3	189.0 $\pm$ 72.9***	156.0 $\pm$ 63.2*	0.0034
Fasting Insulin (μ UI/mL) ¹	11.2 (7.2-12.4)	21.6 (5.7-34.9)	14.4 (9.0-15.4)	NS
Homa- β ¹	101.3 (62.3-109.1)	66.1 (18.4-92.9)*	80.3 (37.6-81.2)	0.0153
Hb1Ac (%) ¹	0.9 (0.5-1.6)	2.4 (1.3-4.3)	5.3 (3.9-7.2)***	<0.0001
hsCRP ¹	2.1 (1.1-4.2)	2.3 (1.3-4.1)	5.6 (3.9-8.2)*	0.0158
Total Cholesterol (mg/dl)	200.6 $\pm$ 37.9	197.6 $\pm$ 53.9	195 $\pm$ 59.9	NS
LDL (mg/dl)	136.3 $\pm$ 3.1	122.4 $\pm$ 37.7	115.0 $\pm$ 42.0	NS
HDL (mg/dl)	35.0 $\pm$ 10.3	35.3 $\pm$ 7.6	34.0 $\pm$ 7.7	NS
Tryglycerides (mg/dl) ¹	134.1 (109.2-164.8)	163.2 (115.3-231.1)	165.6 (116.0-236.5)	NS
<i>Oxidative Stress Parameters</i>				
HO ¹ (nmole bilirubin/mg protein/h)	2.7 (2.1-3.1)	8.6 (4.7-15.7)**	5.3 (3.0-9.3)	0.0024
TBARS ¹ (nmoles/mL)	1.0 (0.8-1.2)	1.6 (1.2-2.0)**	1.3 (1.2-1.4)**	<0.0001
AGES (μ g/mL)	12.2 $\pm$ 0.9	13.7 $\pm$ 1.5**	13.3 $\pm$ 1.3**	0.0008
8-isoprostanes (pg/mL)	6.6 $\pm$ 1.4	6.8 $\pm$ 1.6	6.9 $\pm$ 2.5	NS

Results are expressed as mean $\pm$ SD; ¹Geometric mean ($\pm$ 1SD).

One way ANOVA, post-hoc Dunnett's: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

BMI: Body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HbA1c: glycosylated hemoglobin; hsCRP: high-sensitive C-reactive protein; HO: Heme oxygenase; TBARS: Thiobarbituric acid reactive species; AGES: Advanced glycation end products.

Table II
Expression of TXNIP, IL-1 β , IL-6 and TNF- α in PMCs from diabetic patients

<i>Gen</i>	<i>C</i> <i>n= 20</i>	<i>NW</i> <i>n=20</i>	<i>OB</i> <i>n= 20</i>	<i>p</i>
TXNIP	0.6 (0.4-1.1)	6.2 (0.6-6.6)***	3.3 (1.2-3.6)**	0.0074
IL-1 β	0.7 (0.4-1.4)	7.2 (0.4-14.8)***	21.5 (2.3-45.4)***	<0.0001
IL-6	0.4 (0.4-1.4)	7.4 (6.2-21.3)*	34.9 (10.8-79.8)***	<0.0001
TNF- α	0.8 (0.3-2.6)	3.6 (1.1-8.4)*	6.2 (0.6-12.0)***	<0.0001

Results are expressed as geometric means ($\pm$ 1SD).
Kruskal Wallis, post-hoc Dunn's: * p <0.05, ** p <0.01, *** p <0.001.

TXNIP expression was positively correlated with fasting glycemia and AGES in NW patients (r =0.72; r = 0.59, respectively, both p <0.05), and negatively correlated with HOMA- β (r =-0.44, p = 0.0386). In OB subjects we found a positive correlation with 8-isprostanes (r = 0.42, p = 0.046) (Table III).

Table III
Correlations between TXNIP expression, anthropometric, biochemical and oxidative stress parameters

<i>Parameters</i>	<i>NW</i> <i>n=20</i>	<i>OB</i> <i>n=20</i>
Weight	r = 0.27 p = 0.147	r = -0.13 p = 0.275
BMI	r = 0.35 p = 0.086	r = -0.046 p = 0.4202
Abdominal Cir	r = 0.04 p = 0.4326	r = -0.12 p = 0.2939
Fasting glycemia	r= 0.72 p= 0.006	r = 0.13 p = 0.2713
Fasting insulin	r = -0.31 p = 0.1127	r = -0.062 p = 0.3913
HbA1c	r = -0.3 p = 0.121	r = 0.2742 p = 0.1145
hsPCR	r = -0.2889 p = 0.1304	r = 0.2621 p = 0.1193
HOMA- β	r= -0.44 p= 0.0386	r = -0.06 p = 0.3943
HO	r = 0.004 p = 0.4944	r = 0.3854 p = 0.0516
TBARS	r = 0.2218 p = 0.1961	r = 0.2120 p = 0.1718
AGES	r= 0.59 p= 0.0067	r = 0.2928 p = 0.0067
8-Isoprostanes	r = 0.2132 p = 0.2056	r= 0.4240 p= 0.246

Discussion

Hyperglycemia in diabetes is considered a major risk factor for the development of diabetes complications and for cardiovascular disease in absence of diabetes¹². It has been recently discovered that TXNIP, under hyperglycemic environment, migrates from the nucleus to mitochondria where it activates apoptosis signaling in β -cells¹³. Thus, TXNIP overexpression in pancreatic β -cells in hyperglycemic conditions has profound effects in diabetes and its complications¹³.

In this study, we evaluated the expression of TXNIP, inflammatory cytokines and their relationship with oxidative stress, biochemical, anthropometric, and inflammatory parameters. Our findings were unexpected. We observed that diabetic patients with normal nutritional status had less metabolic control of their fasting glycemia, had oxidative markers comparable to obese diabetic patients, and TXNIP expression was higher in these participants. HsCRP levels were comparable between NW and C, and the expression of IL-1 β , TNF- α and IL-6 were lower compared to OB participants. In NW participants only, we found a significant correlation between TXNIP expression and AGES, fasting glycemia and HOMA- β . These results suggest that fasting glycemia is a better predictor of β -cell functionality than a chronic marker (i.e. HbA1c).

Also, we intended to elucidate if nutritional status had an impact over TXNIP expression. Our NW patients that had lesser adiposity (measured by abdominal circumference) than OB *but* they did not have less visceral adiposity than C subjects, and NW also had the highest expression of TXNIP, therefore our data also suggest that the expression of this gene is independent of the adiposity and nutritional status.

AGES are produced under hyperglycemic conditions, but are also produced by diet. AGES bind to specific cell surface receptors (RAGE) and lead to post-receptor signaling and further generation of

ROS¹⁴. AGES also may activate intracellular transcription factors such as NF- κ B, which in turn could activate the inflammatory pathway through the increasing of pro-inflammatory cytokines⁴. Besides the formation of AGES, hyperglycemia also activates TXNIP, which is the endogenous inhibitor of thioredoxin protein—one of the major intracellular thiol-reducing mechanisms. Thioredoxin reduces ROS through reversible oxidation of thioredoxin at two cysteine residues¹⁵. The relationship found in this study with fasting hyperglycemia and the expression of TXNIP could be explained because intermittent high glucose is able to induce overproduction of ROS and both high glucose and ROS trigger the expression of TXNIP initiating an inflammatory pathway that can persist even after glycemia is normalized¹². We could observe that NW patients had higher HO activity, which could suggest that this group had higher oxidative stress, thus explaining the elevated expression of TXNIP and alteration in fasting glycemia.

In this study, we showed that alteration in fasting glycemia is a risk factor for β -cell dysfunction and is related to the TXNIP expression, independent of adiposity and nutritional status. Findings could be explained, in part, by the oxidative stress in this group, but further study is necessary to replicate these findings in a bigger sample and to explain the differences found between obese and normal-weight patients.

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Statement of Authorship

Andrews M designed the study, performed the statistical analysis and interpreted the data.

Arredondo M and Olivares M participated in data interpretation and provided helpful comments about the manuscript.

Conflict of Interest

The authors declare do not have any conflict of interest.

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Original/Síndrome metabólico

Central obesity and not age increases skeletal muscle lipids, without influencing lean body mass and strength

María Pía de la Maza¹, Sandra Hirsch¹, Natalia Jara¹, Laura Leiva¹, Gladys Barrera¹, Silva Claudio², Loreto Pañella¹, Sandra Henríquez¹ y Daniel Bunout¹

¹Institute of Nutrition and Food Technology, University of Chile. ²Radiology Department, Faculty of Medicine, Clínica Alemana and Universidad del Desarrollo, Santiago de Chile. Chile.

Abstract

Background/Aims: To measure skeletal muscle lipid infiltration, its association with insulin resistance (IR) lean mass and function, in Chilean men differing in age and body composition. Our hypothesis was that muscle lipid accumulation would be higher among older and heavier individuals and this would deteriorate insulin sensitivity (IS) and decrease muscle mass and function, both features of the ageing process.

Methods: Healthy men (38 < 55 and 18 > 65 years), underwent anthropometric measurements, body composition assessment through radiologic densitometry, Nuclear Magnetic Resonance spectroscopy at the tibialis anterioris muscle to measure intra (IMCL) and extramyocellular lipids (EMCL), quadriceps and handgrip strength, 12 minute walking distance and serum biochemistry (haemoglobin, lipoproteins, creatinine, ultrasensitive C Reactive Protein, fasting and post glucose insulin and glucose concentrations, to assess IS). Physical activity was estimated by actigraphy.

Results: 23 men were eutrophic, 26 were overweight and 7 were obese and mostly sedentary, independent of age. Both IMCL and EMCL were higher in overweight/obese men. Abdominal fat was negatively associated with IS and positively correlated with muscle lipid accretion (both IMCL and EMCL), but not with age. As expected, older individuals had lower muscle mass and strength, but not more adipose tissue nor intramyocellular lipids, yet were more glucose intolerant.

Conclusions: central obesity was associated with IMCL and EMCL infiltration and IR. This type of lipid accretion was not related with ageing nor age-related sarcopenia. Older individuals were more glucose intolerant, which was explained by a decrease of insulin secretion more than adiposity-related IR.

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Key words: Intramyocellular lipids (IMCL). Extramyocellular lipids (EMCL). Insulin resistance. Central adiposity. Ageing. Skeletal muscle lipid depots.

Correspondence: María Pía de la Maza.
Institute of Nutrition and Food Technology, University of Chile.
El Libano 5524, Santiago, Chile.
E-mail: mpmaza@inta.uchile.cl

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LA OBESIDAD CENTRAL Y NO LA EDAD AUMENTA LA GRASA INTRAMIOCELULAR, SIN AFECTAR LA MASA Y FUNCION MUSCULAR

Resumen

Introducción/Objetivos: medir la infiltración grasa en el músculo esquelético, su asociación con resistencia a la insulina (RI) y con masa y función muscular, en hombres chilenos de diferente edad y composición corporal. Nuestra hipótesis era que habría más acumulación de grasa en el tejido muscular entre las personas de mayor edad y peso, lo cual deterioraría la sensibilidad a la insulina (SI) y afectaría negativamente la masa y la función muscular, ambas características del proceso de envejecimiento.

Métodos: se estudiaron hombres sanos (38 < 55 años y 18 > 65 años), que fueron sometidos a mediciones antropométricas, evaluación de la composición corporal mediante densitometría radiológica (DEXA), espectroscopia de resonancia nuclear magnética en el músculo tibial anterior para medir lípidos intra (LIM) y extramiocelulares (LEM), fuerza de mano y cuádriceps, test de 12 minutos y bioquímica sérica (glicemia, hemoglobina, lipoproteínas, creatinina y proteína C reactiva ultrasensible en ayunas, además de glucosa e insulina post carga de glucosa para evaluar SI). La actividad física se estimó mediante actigrafía.

Resultados: 23 hombres eran eutróficos, 26 tenían sobrepeso y 7 eran obesos, todos eran sedentarios según el registro actigráfico, independiente de la edad. Tanto LIM como LEM resultaron más altos entre los hombres con sobrepeso / obesidad. La grasa abdominal se asoció negativamente con la SI y se correlacionó positivamente con la acumulación de grasa en el músculo (tanto LIM como LEM), pero no con la edad. Como era de esperar, las personas mayores tenían menor masa magra y fuerza, pero no más tejido adiposo ni lípidos intramiocelulares, aunque eran más intolerantes a la glucosa.

Conclusiones: La obesidad central se asoció con infiltración de grasa intramuscular y con RI. Esta distribución adiposa no se relacionó con edad ni con sarcopenia asociada al envejecimiento. Las personas mayores resultaron más intolerantes a la glucosa, explicable por una disminución de la secreción de insulina más que por RI relacionada con mayor adiposidad.

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Palabras clave: Lípidos Intramiocelulares (LIM), lípidos extramiocelulares (LEM), Resistencia a la insulina, Obesidad central. Envejecimiento.

Abbreviations

IR = Insulin Resistance.
BMI = Body mass index.
IS = Insulin Sensitivity.
DEXA = Double beam densitometry.
IMCL = Intramyocellular lipids.
NMR = Nuclear magnetic resonance.
EMCL = Extramyocellular lipids.
TA = Tibialis anterioris.
TAG = Triacylglycerol.
AEE = Average energy expenditure.
DAG = Diacylglycerol.
MEEE = Maximal exercise energy expenditure.

Introduction

Ageing induces well known changes in body composition, characterized by progressive building of fat mass and decline of skeletal muscle, which becomes gradually infiltrated with lipids^{1,2}. Other age-induced changes of muscle tissue are accumulation reactive oxygen species (ROS) and byproducts of oxidative damage^{3,4}, altered mitochondrial function⁵, loss and shift towards type-II fibers⁶, telomere shortening⁷ and increased expression of inflammatory cytokines^{8,9}. At a functional level, ageing is manifested by a decline of muscle strength and endurance¹⁰. This tissue is also critical for glucose homeostasis, accounting for up to 80 % of insulin mediated, glucose uptake¹¹. The relationship between central obesity and insulin resistance (IR) is well known but, more than total body fat mass, it has been proposed that muscle tissue accretion of triacylglycerol (TAG) and lipid intermediates are the major contributors for development of IR among overweight/obese subjects^{12,13}. The underlying hypothesis states that when IR is no longer able to protect from lipid overload, lipids are accumulated ectopically in muscle, abdominal visceral and hepatic fat depots, along with macrophage infiltration and inflammation¹⁴, leading to further IR¹⁵ and oxidative stress. However, exercise improves insulin sensitivity (IS) together with an increase of intramyocellular lipid (IMCL) content¹⁶, a phenomenon called the training paradox, because insulin resistant, untrained obese and diabetic patients exhibit an IMCL accumulation comparable to that of the most insulin sensitive, lean and trained individuals¹⁷. Consequently it has been postulated that, apart from TAG, certain metabolites (specifically ceramide (CER) and diacylglycerol (DAG)), might be responsible for altering IS^{1,18}. Moreover, deterioration of muscle quality by lipid infiltration is related with sarcopenia among elderly and diabetics^{2,19}. Muscle lipid deposition assessed through nuclear magnetic resonance (NMR) spectroscopy, allows to precisely assess whether lipids gather inside muscle cells (IMCL) or surrounding them, as extramyocellular lipids (EMCL). The predominance of EMCL over IMCL depends on

body composition, gender, ethnicity and endocrine environment. In tissue samples, only electron microscopy permits to assess localization of lipids in muscle cytosol (IMCL) or in adipocytes located between fibers (EMCL) or its proximity to mitochondria. Computed tomography technology identifies attenuation in the muscle area as an indicator of lipid infiltration, but is considered less accurate in defining its exact localization, due to inconsistency in cutoff Hounsfield units²⁰.

Most studies employing NMR have been performed in subjects from American-European or African American ethnic origin in soleus and/or tibialis anterioris muscles and have detected inverse correlations between insulin sensitivity (IS) and intramuscular lipids, predominantly among subjects from European origin²¹. African Americans are more insulin resistant and prone to diabetes in spite of lower visceral and hepatic fat depots. Also, at comparable IMCL muscle lipids are neither correlated with visceral fat nor with IS among African Americans, while these associations are evident among European Americans. None of the mentioned studies report relation with muscle function and customary physical activity.

Because of discrepancies between studies concerning the pathophysiologic relationship between IR, muscle function and lipid accretion in muscle, it is important to add information, and also include other ethnic groups. Our hypothesis was that skeletal muscle lipid accumulation would be higher both among heavier and older individuals, in association with a decline of lean mass and muscle function (strength and walking capacity) and decrease of IS, and that overweight/obese men would behave similar to elderly. Thus the aims of the present study were first to investigate factors associated with muscle lipid accumulation (age, body composition, fat distribution, metabolic parameters), and second the possible metabolic and functional consequences of muscle deposition of lipids and its localization within the tissue (IMCL or EMCL), in healthy adult and elderly men from Latin America, where scarce information has been gathered. In trying to study relatively healthy individuals we excluded those with extreme body weights, and included only men because we have detected better associations between lean mass and muscle function in this gender²².

Methods

After signing an informed consent, we selected healthy adult male subjects, below 55 years (YA) or over 65 years (OA). Other requisites were moderate alcohol intake (less than 30 g/day), smoking less than 5 cigarettes/day, performing less than 5 hours/week of physical activity, body mass index (BMI) > 20 and < 35 kg/m², and absence of chronic diseases or intake of steroids. The study followed guidelines for human stu-

dies and was approved by our local ethics committee. Volunteers were instructed to restrain from performing physical activity the day before the study. Each subject underwent the following assessments:

- 1) Anthropometry: weight and height for calculation of body mass index (BMI), waist and hip circumferences.
- 2) 1H Magnetic Resonance (NMR) Spectroscopy at the Radiology Unit of Clínica Alemana de Santiago, in the tibialis anterior (TA) muscle of the right calf using the STEAM (Stimulated Echo Acquisition Mode) technique, with water suppression on a GE 1.5 Signa HDxt MR unit. Measurements were acquired with the volunteer lying in the supine position with right leg positioned inside a commercially made radiofrequency extremity coil with knee configuration, with the knee in extension and ankle in a neutral position. The voxel box was placed in the most prominent muscle area, with prior identification of no lipid stranding adjacent or inside the planned zone. Peak positions and areas of interest were determined by time domain fitting using Java-based magnetic resonance user interface (SAGE®). Peak positions of IMCL and EMCL lipids were recorded, as also area under the curve (AUC) for a fixed region between 1 and 2 ppm. Results were expressed as arbitrary units (AU), reflecting the height of the peaks for extra and intra myocellular lipids. Results were not corrected by the creatine peak, since this can lead to errors when calf muscles are assessed²³.
- 3) Body composition measurement by DEXA with Lunar Encore equipment. Central abdominal fat was calculated according to Carey²⁴, as a better indicator of visceral fat, comparable to that measured by MRI.
- 4) Fasting blood samples were obtained for blood chemistry (hemoglobin, lipoproteins, us C Reactive Protein and creatinine). Three fasting samples were taken prior to the glucose challenge and then blood samples were taken at 30, 60, 90 and 120 min following the glucose challenge to determine insulin sensitivity using both the Homeostasis Model Assessment (HOMA-IR)²⁵ and Matsuda formula²⁶, and estimate insulin secretion through the corrected insulin response 30 minutes post glucose ingestion²⁷. Samples were immediately transported to Vida Integra Lab, Santiago Chile where biochemistry and insulin levels were measured by automated methods the same day.
- 5) As indicators of muscle function, we measured hand grip strength using a handgrip dynamometer, isometric quadriceps strength in a quadriceps table and twelve-minute walk, as previously described²⁸.

- 6) Placement of an Actiheart® actigraph, to record heart rate and movements during 24 hours. Activity energy expenditure was calculated through the software of the equipment, which uses a previously reported branched model algorithm²⁹. Results were expressed as average energy expenditure (AEE) and maximal exercise energy expenditure (MEEE), in METS (Metabolic Equivalent of Task).

Sample sized was estimated based on comparison of tibialis anterioris IMCL between normal weight and obese women³⁰, since data concerning the effects of age on IMCL are less conclusive. All statistical analysis were performed in STATA 12.0. Groups were compared through Students T test, ANOVA or Kruskal Wallis according to number of groups and normality of its distribution. Associations were analyzed using Pearson or Spearman correlation coefficients depending on distribution of the variables. We also performed a multiple linear regression analysis, using 120 min. serum glucose as the dependent variable and those significantly associated on univariate analysis as independent variables. In addition, to assess factors associated with muscle strength decline, we performed a multiple regression analysis using quadriceps muscle strength as the dependent variable and age, lean body mass, central body fat and intramyocellular lipids as independent variables. Data are presented as mean $\pm$ SD for normal distribution, or as median (range) otherwise.

Results

We included 56 men, 38 YA and 18 OA, representative of Santiago's genetic blend (mostly European-Amerindian)³¹. Among YA, 15 were normal weight (BMI < 25 kg/ m²), 18 overweight (BMI > 25 and < 30 kg/ m²) and 5 obese (BMI > 30 kg/ m²). Using the same cutoff values among OA, 8 were normal weight, 8 overweight and 2 obese. Maximal BMI reached 33.8 kg/m².

Table I depicts comparison of anthropometry, body composition, metabolic parameters and muscle tissue lipids and function between both age groups. It is noteworthy that, although OA had less lean body mass, muscle strength and endurance than YA, no differences were observed between age groups in total, trunk nor central abdominal fat, intra and extramyocellular lipids and insulin sensitivity, measured through HOMA-IR or Matsuda index. Only a weak correlation was detected between EMCL and age (Table III). However OA were more glucose intolerant, suggesting a predominant defect in β cell insulin secretion, as calculated by the corrected insulin response at 30 min (0.005[0.001- 0.037] in YA versus 0.004 [0.001-0.011] in OA, $p = 0.03$). Serum glucose levels 120 min post glucose load correlated with age, body fat and EMCL,

Table I
Distribution of study variables according to age groups

	YOUNGER ADULTS (YA) (n = 38)	OLDER ADULTS (OA) (n = 18)	P
AGE (years)	45 (27-52)	72 (66-80)	
BODY MASS INDEX (kg/m ²)	26.1 ± 3	25.4 ± 3	0.415
WAIST CIRCUMFERENCE(cm)	93.2 ± 7	94.5 ± 8	0.547
WAIST/ HIP RATIO	0.95 ± 0.4	0.98 ± 0.6	0.050
*TOTAL BODY FAT (k)	21.1 ± 6	19.3 ± 5	0.295
*TOTAL LEAN BODY MASS (kg)	53.4 ± 6	48.0 ± 5	0.002
*TRUNK FAT (kg)	13.2 ± 4	11.7 ± 3	0.175
#CENTRAL ABDOMINAL FAT (kg)	2.1 (0.9 – 5.1)	2.1 (0.7- 4.0)	0.539
#CENTRAL ABDOMINAL FAT (%)	10.9 ± 2.1	10.8 ± 2.6	0.826
TOTAL CHOLESTEROL (mg/dL)	190 ± 40	197 ± 43	0.536
HDL CHOLESTEROL (mg/dL)	47 ± 12	49 ± 14	0.626
TRYGLICERYDES (mg/dL)	158 ± 89	114 ± 45	0.053
FASTING GLUCOSE (mg/dL)	89.3 ± 6.5	93.4 ± 10.3	0.081
SERUM CREATININE (g/dL)	0.82 ± 0.1	0.93 ± 0.2	0.004
C REACTIVE PROTEIN (mg/L)	2.0(0.5-9.2)	1.8 (0.3-8.6)	0.773
SERUM GLUCOSE 120 MIN (POST 75g GLUCOSE LOAD) (mg/dL)	118 ± 41	148 ± 44	0.015
FASTING INSULIN (U/dL)	6.8 (3-26)	8.2 (3-19)	0.914
MATSUDA	4.3 (1.3 -11.8)	3.8 (1.3-11.8)	0.628
*HANDGRIP STRENGTH (kg)	39.9 ± 7	31.1 ± 5.4	0.000
*QUADRICEPS STRENGTH (kg)	44.7 ± 7.3	34.4 ± 5.7	0.000
12 MIN WALK (min)	1087 ± 164	977 ± 123	0.014
INTRAMYOCYLLULAR LIPIDS (IMCL) (AU)	0.12 (0.08-0.45)	0.1 (0.03-0.3)	0.063
EXTRAMYOCYLLULAR LIPIDS (EMCL) (AU)	0.32 (0.03-2.3)	0.42 (0.09-1.9)	0.358

*Total body fat, total lean body mass and trunk fat assessed automatically by DEXA,

#Central abdominal fat calculated manually from DEXA, according to Carey et.al. [21]

*Mean values between muscle strength in right and left extremities.

but not with IMCL. The linear multiple regression analysis, using 120 min serum glucose as the dependent variable and age, abdominal fat, EMCL and 120 min insulin levels as independent variables, showed that only age and post glucose insulin levels remained as significant factors.

When dividing the total sample according to BMI categories (below or over 25 kg/m²), IMCL and EMCL were significantly higher in overweight compared with normal weight subjects (IMCL = 0.11 [0.03-0.28] versus 0.167 [0.07 – 0.45] AU, p = 0.034 and EMCL= 0.31 [0.08 - 0.64] versus 0.56 [0.03 - 2.3] AU p= 0.027). There was a significant correlation between abdominal and trunk fat accumulation with IMCL and EMCL (Table II). Insulin sensitivity assessed through HOMA-IR and Matsuda correlated significantly with

IMCL but not with EMCL. Insulin secretion was negatively associated with EMCL (rho = - 0.38, p= 0.005). We found no association between total fat, abdominal fat nor muscle lipids with subclinical inflammation assessed by C reactive Protein serum levels. Muscle strength was associated with age, lean body mass and IMCL but no correlations were found with EMCL and abdominal fat. However, only age and lean body mass remained as significant predictors of muscle strength in the multiple regression analysis performed.

Twenty-three volunteers (12 YA and 11 OA) were classified as glucose intolerant, defined as a fasting serum glucose > 100 mg/dL or 2-hour glucose > 140 and ≤ 200 mg/dL. HDL cholesterol was higher among old glucose tolerant subjects and triacylglycerol levels were higher among glucose intolerant participants

Table II
Correlation matrix between muscle lipid deposition, insulin sensitivity, body composition and muscle function

	<i>IMCL</i> <i>Rho</i> <i>(p)</i>	<i>EMCL</i> <i>Rho</i> <i>(p)</i>
AGE (years)	-0.18 (0.18)	0.28 (0.04)
B.M.I. (kg/m ²)	0.3 (0.02)	0.20 (0.14)
TOTAL BODY FAT (%)	0.10 (0.44)	0.11 (0.43)
TRUNK FAT (%)	0.35 (0.009)	0.41 (0.002)
CENTRAL ABDOMINAL FAT (g)	0.27 (0.04)	0.27 (0.04)
PHYSICAL ACTIVITY ENERGY EXPENDITURE (METS/day)	-0.06 (0.68)	-0.13 (0.36)
LEAN BODY MASS (kg)	0.37 (0.006)	-0.008 (0.96)
MATSUDA INDEX	-0.29 (0.035)	-0.183 (0.19)
HOMA	0.31 (0.025)	0.132 (0.34)
HANDGRIP MUSCLE STRENGTH (kg)	0.25 (0.07)	-0.06 (0.67)
QUADRICEPS MUSCLE STRENGTH (kg)	0.34 (0.01)	-0.11 (0.43)

Central abdominal fat calculated manually from DEXA, according to Carey et.al. [21].

IMCL = Intramyocellular lipids EMCL = Extramyocellular lipids.

young volunteers. No differences in other parameters between glucose tolerant and intolerant participants were observed within age groups (Table III).

According to actigraphic readings, both groups of men were mostly sedentary; mean activity energy expenditure was similarly low among OA (0.21[0.1 – 0.72]) and YA (0.35[0.1 - 0.9]) METS/day ($p = 0.24$); likewise, maximal exercise energy expenditure was not different (5.4[2.9–10.5] in OA versus 4.9[2.9–14.6]) METS/day in YA) ($p = 0.60$). No association was found between actigraphically estimated energy expenditure and muscle lipids.

Discussion

In this study performed in healthy Hispanic men with weights ranging from normal to mild obesity, we confirmed that intramyocellular lipid accretion increases at higher body weight, especially when fat accrues at the trunk, but did not confirm an association with ageing as found by Crane et al, using electron microscopy³² or Nakagawa et al through 1H-MRS³³.

Noteworthy, our elder individuals were more glucose intolerant but not heavier than young volunteers, suggesting that the predominating mechanism is age-related β cell failure and probably not peripheral IR linked to abdominal obesity.

In our sample we found that abdominal and skeletal muscle lipid accretion coincided with IR and glucose intolerance as expected, but fat accretion was not associated with sarcopenia (age related decrease of lean body mass and strength), as occurs during the ageing process. Indeed our data show that these older but healthy men had less lean mass and muscle strength as expected, but this was not associated with growth of abdominal fat and accumulation of lipids at the tibialis anterioris (TA) muscle. Inversely, in the younger individuals, IR was associated with abdominal fat and muscle lipid deposit, but the latter did not alter muscle mass and function.

Based on these data we can suggest that muscle lipid infiltration at the TA is not a consequence of ageing, because it ensued in younger men with central obesity and IR. It is possible that muscles of these YA with central obesity in the future will deteriorate more than those from the elders included in this study, because our OA group represents the healthy survivors that lived their youth in a different nutritional environment, where the metabolic syndrome was less prevalent. However the answer to this would require long-term follow up studies.

Previous investigations attributed IR³⁴ predominantly to accumulation of IMCL, and more specifically lipid toxic moieties such as CER and DAG^{9,35}, but most of these studies have been performed in heavier subjects from different ethnic origin, and IR has been assessed by hyperinsulinemic clamps^{36,37}. Actually in these same volunteers we found significantly higher concentrations of certain CER and DAG species in biopsies obtained from the abdominal oblique muscle among men with abdominal obesity and glucose intolerance, independent of age³⁸. However, not all studies coincide in considering IMCL, as indicator of lipid overflow that cannot be sustained within adipose tissue as the cause of IR and glucose intolerance. As mentioned, some discrepancies can depend on characteristics of the studied population (age, nutritional status, fitness, ethnic background, etc), the muscle analyzed (soleus or tibialis anterioris) and the experimental model employed (infusion of lipid emulsions, cross-sectional analysis of muscle lipid content or analysis of IMCL after caloric restriction or exercise)^{5,39,40}. Our results are in accordance with those that highlight the relevance of lipid depots located within (IMCL and EMCL) and not between muscle fibers; the latter is another fat depot located under the muscle fascia, which tends to increase with weight gain and ageing, especially among African Americans⁴¹, but has not been studied among Hispanics. We are aware of only one study including Latin Americans, describing increased IMCL and hepatic lipid accretion among obese Hispanic adolescents⁴².

Tabla III
Comparisons between glucose tolerant versus glucose intolerant men

	GLUCOSE TOLERANT YOUNG (GROUP A) (n = 26)	GLUCOSE INTOLERANT YOUNG (GROUP B) (n = 12)	GLUCOSE TOLERANT OLD (GROUP C) (n=7)	GLUCOSE INTOLERANT OLD (GROUP D) (n = 11)	p
AGE (years)	41 (27-52)	45.5 (27-52)	72 (66-74)	72 (68-80)	
BODY MASS INDEX (kg/m ²)	25.8 ± 2.8	26.8 ± 4.1	24.7 ± 2.0	25.9 ± 3.4	0.577
WAIST CIRCUMFERENCE (cm)	92.4 ± 5.6	94.3 ± 10.1	92.3 ± 9.5	96.0 ± 7.5	0.599
WAIST/ HIP RATIO	0.95 ± 0.04	0.95 ± 0.05	0.97 ± 0.06	0.98 ± 0.05	0.241
*TOTAL BODY FAT (kg)	20.8 ± 5.3	21.2 ± 7.8	18.3 ± 4.6	19.9 ± 4.8	0.728
*TOTAL LEAN BODY MASS (kg)	52.9 ± 6.1	54.8 ± 6.0	46.4 ± 5.8	49.0 ± 4.0	0.009 (A ≠ C, B ≠ C)
*TRUNK FAT (kg)	12.8 ± 3.4	13.9 ± 5.5	10.6 ± 3.1	12.4 ± 3.3	0.362
# CENTRAL ABDOMINAL FAT (kg)	2.0 (0.9 – 4.3)	2.6 (0.9 – 5.1)	1.6 (0.7 – 2.7)	2.2 (1.0- 4.0)	0.549
# CENTRAL ABDOMINAL FAT (%)	10.4 ± 2.0	12.0 ± 2.0	10.0 ± 2.7	11.3 ± 2.3	0.107
TOTAL CHOLESTEROL (mg/dL)	195.3 ± 37.0	178.2 ± 46.9	204.6 ± 27.3	192.5 ± 51.6	0.552
HDL CHOLESTEROL (mg/dL)	49.2 ± 12.4	40.7 ± 7.5	57.0 ± 14.9	43.3 ± 10.0	0.017 (B ≠ C)
TRYGLICERYDES (mg/dL)	139.2 ± 53.8	201.4 ± 130.9	106.3 ± 20.1	119.7 ± 55.8	0.028 (A ≠ B)
FASTING GLUCOSE (mg/dL)	87.2 ± 5.7	93.9 ± 5.8	92.1 ± 7.6	94.2 ± 12.0	0.026
SERUM CREATININE (g/dL)	0.82 ± 0.1	0.85 ± 0.1	0.99 ± 0.2	0.88 ± 0.2	0.007
C REACTIVE PROTEIN (mg/L)	1.45(0.5-6.4)	2.8(0.5- 9.2)	2.0(0.5-4.6)	1.9(0.3-9.2)	0.186
SERUM GLUCOSE 120 MIN (POST 75g GLUCOSE LOAD) (mg/dL)	105.2 ± 24.6	154.9 ± 33.7	105.9 ± 27.2	175 ± 28.9	0.000
FASTING INSULIN (U/dL)	5.9 (2.1 – 30.4)	9.7 (3.3- 44.5)	7.0 (1.8 – 8.6)	8.6 (2.9- 16.5)	0.411
MATSUDA	4.3 (1.3 -12.7)	4.2 (1.8 – 9.3)	4.5 (2.4– 11.8)	3.6 (1.3- 8.2)	0.840
ADIPONECTIN (ug/mL)	6.5 (2.9-14.9)	5.6 (3.2-12.0)			0.276
INTRAMYOCYLLULAR LIPIDS (AU)	0.13 (0.08-0. 45)	0.10 (0.01-0.4)	0.07 (0.04-0.15)	0.10 (0.03-0.3)	0.095
EXTRAMYOCYLLULAR LIPIDS (AU)	0.32 (0.03-1)	0.37 (0.18-2.3)	0.29 (0.09-0.8)	0.59 (0.19-1.9)	0.432
*HANDGRIP STRENGTH (kg)	41.1 ± 6.5	38.8 ± 6.3	32 ± 4.2	30.5 ± 6.0	0.000 (A ≠ C,D B ≠ C)
*QUADRICEPS STRENGTH (kg)	45.6 ± 6.6	43.1 ± 8.8	33.9 ± 7.4	34.7 ± 4.6	0.000 (A ≠ C,D B ≠ C,D)
12 MIN WALK (min)	1100 ± 180	1045 ± 121	995 ± 60	966 ± 151	0.0875

* Total body fat, total lean body mass and trunk fat assessed automatically by DEXA.

#Central abdominal fat calculated manually from DEXA, according to Carey et.al. [21].

*Mean values between muscle strength in right and left extremities.

We must point out that even though our subjects were only slightly overweight on average, their trunk adiposity was significantly higher compared to other studies, performed in elderly subjects, nonetheless were more insulin sensitive⁴³, highlighting the relevance of confounding factors such as ethnicity, age, phy-

sical activity and body composition, when comparing results and drawing conclusions.

Apart from IR and sarcopenia⁴⁴ myosteatorsis has also been linked with cancer cachexia^{45,46}, and can be modified by resistance training⁴⁷. However evidences to support this premise are based on histologic analysis

of muscle tissue in animals, or muscle attenuation by computed tomography, but have not been confirmed by NMR spectroscopy. This is the first study to discard the association between muscle fat accumulation and sarcopenia.

In this study we were especially careful in the selection criteria, in order to avoid confounding factors. The sample size was comparable to other published studies and we chose only men with similar body weights and physical activity levels which was assessed by actigraphy, a reliable methodology, to evade the training effect on muscle lipid deposition. And even though we employed the best available techniques for assessment of body composition and lipid deposition within muscle tissue, our study has several limitations. First of all, it intended to study the relevance of muscle lipid accumulation through a cross sectional analysis, but it is impossible to precisely control all other possibly influencing factors, such as dietary habits and previous physical activity, since information obtained from dietary recalls or physical activity questionnaires are not reliable enough. We ensured though that volunteers were mostly sedentary through actigraphic readings, performed during 2 days and after obtaining blood samples and performing MRIs. Other approaches have evaluated the changes in these variables after interventions that reduce muscle lipid deposition through energy restriction, exercise, or drugs, and so are not comparable. Additionally, for better NMR acquisition, muscular lipids were measured at the tibialis anterioris muscle. Whether IMCL in soleus (a predominantly oxidative muscle) is more related with IS compared with tibialis anterioris is a matter of debate, and probably depends on multiple factors, as previously mentioned^{20,48}. In relation to quadriceps strength and walking capacity, it must be mentioned that accurate NMR peaks (intra and extramyocellular) cannot be adequately identified in this muscle (CS personal communication), and thus attenuation (indicating lipid accretion) in rectus femoralis is usually assessed only through CT scans⁴⁹; however even though this method is less precise, it could potentially show better associations with this muscle's function.

In summary, in healthy moderately active or sedentary men, we found an association between abdominal lipid accretion and TA lipid infiltration, predominantly inside muscle fibers (IMCL), in concomitance with IR. Muscle lipid infiltration starts at young ages, but it is not associated with the deterioration of muscle mass and strength observed among elderly men.

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Original/Síndrome metabólico

Estudio longitudinal del síndrome metabólico tras el trasplante renal

Rafael Fernández Castillo¹, Ruth Fernández Gallegos² y Gloria María Zaragoza Fernández².

¹Universidad de Granada. Facultad de Ciencias de la Salud. Departamento de Enfermería. ²Servicio de Nefrología Unidad de Hemodiálisis. Hospital Universitario Virgen de las Nieves. Granada. España.

Resumen

Introducción: La aparición del síndrome metabólico (SM) entre los receptores renales es una de la mayores complicaciones postrasplante y se asocia con un mayor riesgo de fracaso del injerto y altas tasas de obesidad y diabetes de nueva aparición.

Objetivos: Este estudio tiene como objetivo investigar la prevalencia y factores de riesgo asociados al desarrollo del SM y evaluar la asociación del mismo con la disfunción del injerto.

Métodos: La muestra estuvo formada por 138 pacientes trasplantados renales, 83 hombres y 55 mujeres, trasplantados renales, que asistieron durante cinco años a la consulta postrasplante. Se analizaron como posibles factores de riesgo para DMPT: edad, sexo, índice de masa corporal (IMC), peso, hipertensión, diabetes, LDL, HDL, triglicéridos en suero y terapia inmunosupresora (Ciclosporina, tacrolimus, micofenolato mofetil), también se evaluó la prevalencia de episodios de rechazo agudo y función renal.

Resultados: La prevalencia de SM fue del 39,85%. Como factores de riesgo estadísticamente significativos se obtuvieron el IMC, sobrepeso, niveles colesterol HDL, triglicéridos y LDL así como la hipertensión y la diabetes. Se obtuvieron altas tasas de rechazo agudo y diferencias en cuanto a la tasa de filtración glomerular.

Conclusiones: Existe una alta prevalencia del SM que compromete gravemente la función renal y la supervivencia del injerto en pacientes trasplantados renales. Es importantísimo el control y seguimiento estricto de todos los factores de riesgo identificados.

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Palabras clave: Trasplante renal. Obesidad. Dislipemia. Síndrome Metabólico. Índice de Masa Corporal.

LONGITUDINAL STUDY OF THE METABOLIC SYNDROME AFTER KIDNEY TRANSPLANTATION

Abstract

Background: The occurrence of the metabolic syndrome (MS) between the renal receptors is one of the major complications after transplantation and is associated with an increased risk of graft failure and high rates of obesity and diabetes new appearance.

Aims: This study aims to investigate the prevalence and risk factors associated with the development of the MS and to evaluate the association between the same with the allograft dysfunction.

Methods: The samples consisted of 138 renal transplant patients, 83 men and 55 women, kidney transplant, which was attended by over five years for the transplant consultation. Were analyzed as potential risk factors for MS: age, sex, body mass index (BMI), weight, hypertension, diabetes, LDL, HDL, triglycerides in serum and immunosuppressive therapy (cyclosporine, tacrolimus, mycophenolate mofetil), was also assessed the prevalence of acute rejection episodes and renal function.

Results: The prevalence of MS was 39.85 %. As statistically significant risk factors were obtained the BMI, overweight, HDL cholesterol levels, triglycerides and LDL as well as hypertension and diabetes. There were high rates of acute rejection and differences in story to the glomerular filtration rate.

Conclusions: There is a high prevalence of the MS that severely compromised renal function and graft survival in renal transplant patients, it is very important the control and strict monitoring of all risk factors identified.

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Key words: Kidney transplantation. Obesity. Dyslipidemia. Metabolic Syndrome. Body Mass Index.

Correspondencia:

Dr. Rafael Fernández Castillo.
Universidad de Granada.
Facultad de Ciencias de la Salud Campus de Ceuta
C/ Cortadura del Valle SN. C.P. 51001, Ceuta, Spain.
E-mail: rafaelfernandez@ugr.es

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Introducción

El Síndrome Metabólico (SM) esta formado por un conjunto de alteraciones clínicas y bioquímicas tales como obesidad, alteraciones de la glucemia, disminución de los niveles de lipoproteínas de alta densidad (HDL), triglicéridos elevados (TG) e hipertensión (HTA)¹.

Actualmente el aumento de la incidencia de la obesidad registrado en las últimas décadas ha provocado un aumento en la prevalencia del síndrome metabólico (SM) en la población general², pero la presencia de SM no solo aumenta el riesgo cardiovascular en la población general sino también en los pacientes receptores de trasplante renal^{3,4}.

La población de pacientes sometidos a trasplante renal esta considerada de alto riesgo para el desarrollo de la obesidad y los cambios en el metabolismo de los lípidos y la glucosa, debido a la utilización de fármacos inmunosupresores y el aumento de la ingesta de alimentos permitidos en el periodo postrasplante^{5,6}. Pero además existen otros factores de riesgo más específicos para los receptores de trasplante incluyen la duración de la diálisis pretrasplante y postrasplante⁷. El síndrome metabólico está estrechamente asociado con la resistencia a la insulina, trastorno metabólico caracterizado por alteración de la capacidad de respuesta tisular a la acción normal de la insulina que ha sido considerado como una de las causas subyacentes de la diabetes mellitus^{8,9}. El desarrollo de la diabetes de nuevo inicio después del trasplante renal (NODAT) representa una de las principales complicaciones postrasplante que pueda afectar negativamente a la supervivencia del injerto de los pacientes aumentando la tasa de rechazo agudo entre estos¹⁰. Por otra parte se han identificado algunos eventos cardiovasculares relacionados directamente con el desarrollo de NODAT, algunos de estos factores son potencialmente modificables¹¹, entre estos factores podemos mencionar la infección por citomegalovirus, virus de la hepatitis C, proteinuria, el tratamiento inmunosupresor, la presión arterial y el tratamiento antihipertensivo, sobrepeso y obesidad, niveles elevados de triglicéridos y glucosa en la sangre. Algunos de estos factores definen el síndrome metabólico, y aunque la función específica del SM en el desarrollo de la diabetes no ha sido completamente aclarado todavía, estudios recientes han arrojado algo de luz sobre este asunto y que muestran que el diagnóstico del SM después del trasplante renal se asocia con un mayor riesgo de NODAT^{12,13,14}. Este estudio tiene como objetivo investigar la prevalencia y factores de riesgo asociados al desarrollo del SM y evaluar la asociación del mismo con la disfunción del injerto.

Material y Métodos

Se recogieron datos de 138 pacientes trasplantados renales de ambos sexos que acuden de forma periódica

a la consulta de Trasplante Renal en el Hospital Universitario Virgen de las Nieves de Granada. No fueron seleccionados mediante procedimientos de muestreo aleatorio y su participación en el estudio viene determinada por la asistencia a la consulta para su seguimiento y control. Se incluyeron todos los receptores de trasplante renal de cadáver realizados del 1 de Enero de 2008 y el 31 de Diciembre de 2013. Los pacientes cumplieron los siguientes criterios de inclusión: (a) ausencia de diabetes mellitus antes del trasplante; (b) función renal estable al año después del trasplante; (c) 5 años de seguimiento. De los 138 trasplantados renales de trasplante que cumplían los criterios de inclusión, 83 fueron hombres y 55 mujeres, cuyas edades medias estaban entre 56.4 (10.8) para hombres y 5.2 (11.8) para mujeres.

A todos los pacientes se realizaron mediciones coincidiendo con los controles analíticos establecidos en nuestra unidad (desde el 1º año hasta el 5º año) de: colesterol total, lipoproteínas de baja densidad (LDL), lipoproteínas de alta densidad (HDL) y concentración de triglicéridos. Las muestras de sangre periférica se extrajeron entre las 8.30 y las 9 de la mañana: bioquímica: 6 ml de sangre en tubo Venojet® II (Terumo; autosep®). Las determinaciones de bioquímica se realizaron a 37°, se empleó el analizador automático de química clínica Roche/Hitachi 747, y los reactivos correspondientes, todos ellos suministrados por la compañía Roche. Todas las determinaciones se realizaron en laboratorio general del Hospital General Virgen de las Nieves de Granada.

Los hipotensores utilizados fueron betabloqueantes, diuréticos, IECAS y antagonistas del calcio. El protocolo inmunosupresor consistió en una triple terapia a base de prednisona, Ciclosporina (CsA) o Tacrólimus y Micofenolato Mofetilo (MMF) o Azatioprina (AZA). La dosis de inmunosupresores se estableció según protocolo de nuestro centro. De los pacientes, el 80% habían utilizado agentes antilipemiantes: rosuvastatina, atorvastatina y simvastatina.

Además se les efectuaron mediciones antropométricas de peso y altura a los 6, 12, 24, 36, 48 y 60 meses. El peso se midió por una balanza tallímetro Perperson 113481 en kilogramos y la altura en centímetros. El índice de masa corporal fue calculado mediante la fórmula: $\text{peso}/\text{talla}^2$, (Kg) / (m)², y agrupada según la clasificación de la OMS en IMC < 18,50 infrapeso, 18,50 a 25 normal, 25 a 30 sobrepeso y >30 del IMC s/OMS.

La estimación de la función renal se realizó mediante: MDRD (Modification of Diet in Renal Disease)¹⁵. La fórmula MDRD utilizada para estimar el filtrado glomerular fue: $\text{Filtrado glomerular (ml/min/1,73 m}^2\text{)} = 170 \times [\text{creatinina sérica, mg/dl}]^{-0,999} \times [\text{Edad, años}]^{-0,176} \times [0,762 \text{ si sexo femenino}] \times [\text{nitrogeno ureico sérico, mg/dl}]^{-0,170} \times [\text{albumina sérica, g/dl}]^{+0,318}$.

El Síndrome Metabólico se definió según el National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP-III)¹⁶, que establece el diagnóstico por la presencia de al menos tres de los siguientes

criterios: obesidad usando el IMC ≥ 30 kg/m²; triglicéridos (TG) ≥ 150 mg/dL o en tratamiento; colesterol HDL < 40 mg/dL para hombres o < 50 mg/dL para mujeres; Presión arterial sistólica ≥ 130 mm Hg, y diastólica ≥ 85 mm Hg, y/o tratamiento antihipertensivo y determinación de glucemia en ayunas ≥ 100 mg/dL o en tratamiento diabético. De los 138 pacientes 55 padecían Síndrome Metabólico frente a 83 que no.

Análisis estadístico

El análisis se realizó mediante el paquete estadístico IBM SPSS Statics 20, Los resultados se expresan como frecuencias, porcentajes y media $\pm$ desviación estándar. Para valorar las diferencias entre grupos, se utilizó el análisis de varianza (ANOVA), Las variables categóricas se compararon mediante la prueba de chi cuadrado. Además se usó el análisis de Kaplan Meier

para valorar la supervivencia del injerto. Todos los datos se expresan en valor medio + desviación estándar ($X \pm DS$), considerándose significación estadística con valores de $p < 0,05$.

Resultados

Los datos de laboratorio y demográficos de ambos grupos de pacientes se muestran en la Tabla 1. No se encontraron diferencias en las edades medias de los dos grupos, pero sí hubo un mayor porcentaje de pacientes hombres con SM que sin SM. El peso y el IMC fueron mayores en los pacientes con SM que en los pacientes sin SM, pero no se registraron diferencias en los pesos e IMC en la periodo pretrasplante. Se encontraron diferencias significativas entre los dos grupos en los niveles de colesterol HDL siendo mayores en los pacientes sin SM, en cambio los niveles de triglicé-ri-

Tabla I
Comparación entre pacientes con síndrome metabólico (SM) y sin SM

<i>Características</i>	<i>Pacientes con SM n = 55</i>	<i>Pacientes sin SM n = 83</i>	<i>Resultados</i>
Age	55,57 $\pm$ 12,12	55,58 $\pm$ 10,4	NA
Sexo: Hombre/Mujer %	56,4 / 43,6	67,8 / 32,2	NS
Peso	78 $\pm$ 13,10	71,06 $\pm$ 15,26	0,017
IMC	28,58 $\pm$ 4,79	23,9 $\pm$ 3,55	0,000
HDL	46,64 $\pm$ 3,27	61,33 $\pm$ 14,18	0,000
TG	158,69 $\pm$ 64,69	140 $\pm$ 32	0,000
LDL	112,45 $\pm$ 31,86	126,67 $\pm$ 46,65	NS
Hipertensión %	90,9	87,5	0,000
Diabetes %	25,9	20,8	0,000
Creatinina	1,59 $\pm$ 0,52	1,82 $\pm$ 0,85	NS
Creatinina Primer mes	1,86 $\pm$ 0,88	2,34 $\pm$ 1,80	NS
Tiempo en Hd Pre Meses	31,38 $\pm$ 29,75	47,72 $\pm$ 53,22	0.048
Hemodiálisis Post. Meses	1,69 $\pm$ 0,23	4,78 $\pm$ 0,62	NS
Peso Pre	68,14 $\pm$ 11,51	68,72 $\pm$ 12,58	NS
IMC Pre	25,57 $\pm$ 4	25,17 $\pm$ 4,46	NS
Función Renal MDRD	45,78 $\pm$ 15,97	137,90 $\pm$ 16,87	0,000
Rechazo Agudo %	83,3	50,4	0,001
Dosis de Tacrolimus mg/día	2,85 $\pm$ 1,59	2,25 $\pm$ 0,86	NS
Niveles de Tacrolimus ng/mg	6,91 $\pm$ 2,18	9,17 $\pm$ 3,27	NS
Dosis de Ciclosporina mg/día	153,33 $\pm$ 33,89	175	NS
Niveles de Ciclosporina ng/mg	126 $\pm$ 43,48	107	NS
Dosis de Micofenolato mg/día	1016,98 $\pm$ 462,14	906,25 $\pm$ 653,80	NS
Niveles de Micofenolato ng/mg	2,33 $\pm$ 1,46	3,28 $\pm$ 2,14	NS
Uso de Betabloqueantes %	71,4	57,4	NS

dos fueron mayores en los pacientes con SM. Las cifras de colesterol LDL fueron mayores en el grupo sin SM. Así mismo hubo un mayor porcentaje de pacientes con hipertensión y diabetes en los pacientes con SM. No se encontraron diferencias estadísticamente significativas en los niveles de creatinina aunque fueron ligeramente mayores en los pacientes sin SM, pero si fue significativo que estos estuvieron mas tiempo en tratamiento en hemodiálisis que los pacientes con SM y que una vez trasplantados tuvieran mayor media en el número de diálisis requeridas. Si hubo diferencias significativas en la medida de la función renal siendo menor en los pacientes con SM que sin SM así mismo la tasa de rechazo del injerto en bastante mayor en los pacientes con SM (83,3%) que en los pacientes con SM (50,4%). No hubo diferencias significativas e el uso de medicamentos inmunosupresores (ciclosporina, micofenolato, tacrolimus) entre los dos grupos pero si hubo un mayor uso de betabloqueantes y calcioantagonistas.

En cuanto a la supervivencia del injerto, tras 5 años de seguimiento, se observaron 26 casos de fracaso del injerto. Trece fueron en el grupo de SM, las causas de fracaso del injerto fueron: nefropatía crónica 5, muerte con injerto funcionante 5, y 3 por trombosis vascular.

El análisis de supervivencia de Kaplan Meier (Fig. 1), muestra la supervivencia en meses de del injerto en ambos grupos.

Discusión

Como hemos visto el SM es altamente prevalente entre los pacientes trasplantados renales, esta prevalencia varía ampliamente desde un mínimo de 20% hasta un máximo de 65%¹⁷⁻¹⁸, en nuestro estudio hemos obtenido una prevalencia dentro de este rango siendo del 39,85% entre la población estudiada. Nuestro es-

tudio revela que el SM es mas prevalente en hombres que en mujeres, este hecho no coincide con algunos estudios donde se produce una mayor prevalencia en mujeres sobre todo en estudios asiáticos¹⁹⁻²², en cambio si coincide con otros estudios realizados en Australia y USA²³⁻²⁶, lo que parece indicar una predisposición de género del SM difiriendo mucho entre grupos étnicos en los receptores de trasplante renal.

La obesidad es común en pacientes trasplantados renales y se asocia con el empeoramiento de los parámetros cardiovasculares y la progresión de la proteinuria²⁷. En nuestro estudio las diferencias en el peso de los pacientes son significativamente mayores en el grupo de MS al igual que los niveles elevados de triglicéridos y bajos de colesterol HDL, esto demuestra que la obesidad y la dislipemia son componentes muy importantes del SM en los pacientes receptores de trasplante renal. Varios estudios señalan al SM como factor de riesgo importante para la diabetes mellitus de nueva aparición²⁸⁻²⁹, de hecho en nuestro estudio se han obtenido un 25,9% de pacientes con diabetes de nueva aparición en el grupo con SM.

Por otra parte el SM es un factor de riesgo para la disfunción renal en la población general y un factor de riesgo importante para la disfunción crónica del injerto en pacientes trasplantados renales³⁰. Nuestro estudio no mostró diferencias significativas en los niveles de creatinina sérica entre pacientes con SM y los no SM, pero si se observo una disminución importante y estadísticamente significativa en la medida de la función renal, tasa y supervivencia del injerto en los pacientes con SM, confirmando el hecho de que el SM compromete seriamente la vida del trasplante renal.

La hipertensión representa el factor más común de riesgo cardiovascular y renal³¹, y se encontró en 90,9 y 87,5% de nuestros receptores de trasplante renal con y sin MS, respectivamente. Los betabloqueantes se han usado para tratar la hipertensión y aunque en nuestro estudio no hemos obtenido diferencias significativas muchos estudio lo asocian como factor de riesgo del SM.

La mayoría de los receptores de trasplante renal reciben combinaciones de medicamentos inmunosupresores, ciclosporina o tacrolimus, sirolimus o everolimus, micofenolato mofetil y azatioprina, y corticosteroides³². La ciclosporina y tacrolimus pueden inducir intolerancia a la glucosa, la hipertensión y la hiperlipidemia³³. Sirolimus puede inducir hiperlipidemia. Los corticosteroides pueden inducir intolerancia a la glucosa, hipertensión, hiperlipidemia y aumento de peso. Por lo tanto, utilizados solos o en combinación, estos medicamentos probablemente contribuyen al SM en receptores de trasplante renal³⁴⁻³⁵. En este estudio no se ha encontrado asociación entre el uso de medicamentos inmunosupresores y el SM.

En conclusión nuestros resultados ponen de manifiesto la importancia del SM como alteración clínica y metabólica que compromete gravemente la función renal y la supervivencia del injerto en pacientes trasplantados renales donde podemos apreciar una alta pre-

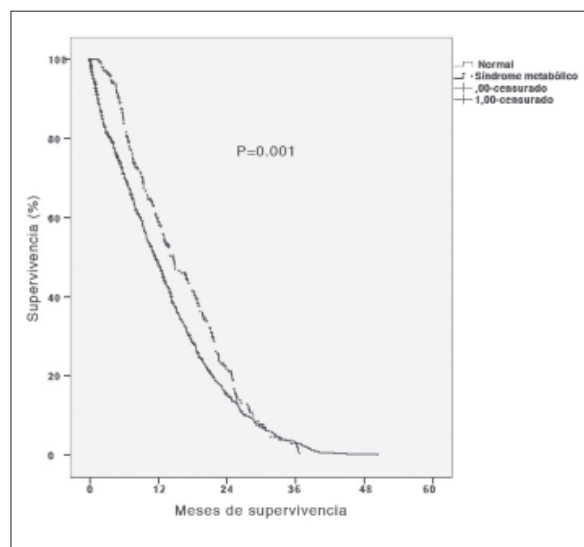


Fig. 1.—Supervivencia del injerto en pacientes con y sin SM.

valecía del SM. Los factores de riesgo fundamenteles para prevenir el SM son la vigilancia del peso, IMC, triglicéridos y colesterol HDL, hipertensión y diabetes.

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Original/Síndrome metabólico

Nutritional adequacy in subjects with metabolic syndrome

Cláudia Mesquita de Carvalho^{1,5}, Dayana Dias Mendonça^{1,5}, Carla Haas Piovesan^{2,5}, Fabrício Edler Macagnan^{3,6} and Ana Maria Pandolfo Feoli^{4,6}

¹Nutritionist, Pontifícia Universidade Católica do Rio Grande do Sul. ²Nutritionist, Master in Medicine and Health Sciences, Professor of the Nutrition of the Pontifícia Universidade Católica do Rio Grande do Sul. ³Physiotherapist, PhD in Medicine and Health Sciences, Professor at the Physiotherapy Department of the Universidade Federal de Ciências da Saúde de Porto Alegre, Rio Grande do Sul, Brazil. ⁴Nutritionist, PhD in Biological Sciences - Biochemistry, Professor and Coordinator of the Nutrition of the Pontifícia Universidade Católica do Rio Grande do Sul. ⁵Participated in conception and design of the study, generation, data collection, analysis and interpretation of data, drafting and revision of the manuscript. ⁶Participated in the overall coordination of the study, conception and design of the study, analysis and interpretation of data, drafting, revision and orientation of the manuscript.

Abstract

Introduction: The nutritional approach in the treatment of metabolic syndrome is a fundamental factor. It is important to raise awareness to patients about the benefits of following the treatments when you want to promote changes in lifestyle.

Objective: The aim of this study was to assess nutritional adequacy in subjects with metabolic syndrome according to the dietary recommendations prescribed.

Methods: Quasi-experimental research with 72 subjects with metabolic syndrome, held in southern Brazil. A nutritional orientation was conducted, related or not with physical exercise for three months. A 24-hour recall and two-day food record, were the reference method of dietary intake assessment. Nutritional adequacy was determined by the energy and nutrient intakes as defined by the Brazilian Food Guide Pyramid groups.

Results: Volunteers reached on average 80% of the energy consumption recommended. Protein and lipid intake was higher, and carbohydrate consumption was lower than recommended levels. There was a low intake of cereals, vegetables, dairy product and beans ($p < 0.001$) as compared with the recommended servings. A high consumption of meat ($p < 0.001$) and an adequate intake of fruit ($p = 0.149$) were observed.

Conclusion: The dietary intake was insufficient to meet the recommendation of energy, although the goal for weight loss was achieved. Still, the results show the need for a balance in food intake and quality of the diet to achieve nutritional adequacy.

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Correspondence: Ana Maria Feoli.

Faculdade de Enfermagem, Nutrição e Fisioterapia/PUCRS; Avenida Ipiranga 6681, prédio 12, 90619-900; Porto Alegre, RS, Brazil.
E-mail: anamariafeoli@hotmail.com

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LA ADECUACIÓN NUTRICIONAL EN SUJETOS CON SÍNDROME METABÓLICO

Resumen

Introducción: La terapia nutricional en el tratamiento del síndrome metabólico es un factor clave. Es importante educar los pacientes sobre los beneficios de seguir el tratamiento cuando se quiere promover cambios nel estilo de vida.

Objetivo: El objetivo fue evaluar la adecuación nutricional en individuos con síndrome metabólico de acuerdo con las recomendaciones dietéticas prescritas.

Métodos: Un ensayo clínico con 72 sujetos con síndrome metabólico, llevados a cabo en el sur de Brasil. Asesoramiento nutricional se llevó a cabo, asociada o no con el ejercicio físico durante tres meses. Un retiro de alimentos de 24 horas, y un registro de alimentos de dos días fueron los métodos de referencia para el consumo de alimentos. La adecuación nutricional se determinó mediante la ingesta de energía y nutrientes, grupos de alimentos definidos por la Pirámide de Alimentos del Brasil.

Results: Los voluntarios alcanzado un promedio del 80% del consumo de energía se recomienda. La ingestión de proteínas y lípidos fue mayor de lo esperado, y la ingesta de hidratos de carbono fue inferior a los niveles recomendados. Hubo una baja ingesta de cereales, verduras, productos lácteos y frijoles ($p < 0.001$) en comparación con las porciones recomendadas. Se observaron un alto consumo de carne ($p < 0.001$) y la ingesta de fruta adecuada ($p = 0.149$).

Conclusión: El consumo dietético fue insuficiente para cumplir con las recomendaciones de la energía, aunque se logró la meta de pérdida de peso. Aún así, los resultados muestran la necesidad de un equilibrio de la ingesta de alimentos y calidad de la dieta para lograr la adecuación nutricional.

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Palabras clave: Síndrome metabólico X. Terapia nutricional. Terapia de dieta. Factores de riesgo. Necesidades nutricionales.

Abbreviations

NCD; Non-communicable chronic diseases
AHA/NHLBI; American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement
HDL; HDL-cholesterol
PUCRS; Pontifícia Universidade Católica do Rio Grande do Sul
IMC; Body mass index
SPSS; Statistical Package for Social Sciences
ANOVA; One-way analysis of variance

Introduction

In the western world, shifts in lifestyle observed over the years include changes in eating habits and intensity of physical activity in the population. These changes have contributed to the increase in non-communicable chronic diseases (NCD) such as obesity, diabetes mellitus, hypertension, dyslipidemia and cardiovascular diseases^{1,2}. It is estimated that there are currently at least 400 million obese people in the world³. In this scenario, in Brazil about 49% of adults are overweight and approximately 14,8% of the population has obesity⁴.

The excess weight associated with other chronic diseases or NCD gives rise to a clinical condition known as metabolic syndrome, which is represented by a set of cardiovascular risk factors present in a single individual⁵ and can raise mortality due to cardiovascular disease⁶. Around 17 million deaths are caused by cardiovascular diseases, especially heart attack and stroke¹.

Specifically concerning the Brazilian population, there is a lack of data representative on the prevalence of metabolic syndrome. According to the American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement (AHA/NHLBI)⁵, the diagnosis of metabolic syndrome is determined by the presence of three or more of the following factors: increased waist circumference, high blood pressure, impaired glucose tolerance, hypertriglyceridemia and low blood concentrations of HDL-cholesterol (HDL).

The nutritional approach used in the treatment of metabolic syndrome is a fundamental factor whose main goals are weight loss and, consequently, the mitigation of associated risk factors such as blood pressure, glucose, cholesterol, and triglycerides. The nutritional treatment must be individual and must be adjusted according to each subject, and provides a 7% to 10% reduction in the current body weight during a period of 6 to 12 months⁵. To achieve these goals, the individual should be directed towards adopting a balanced diet avoiding simple carbohydrates and choosing foods that are high in fiber like fruits, vegetables, legumes and whole grains, since these are sources of minerals and vitamins. Also, a balanced diet includes the decreased intakes of saturated fatty acids. At the same time, monosaturated fatty acids present in vegetable

sources like plant oils and nuts as well as polyunsaturated fats found in fish (salmon, sardines and tuna) and vegetable oils should be more consistently consumed^{5,7}. To assist in the alimentary recommendations are used dietary guidelines that should favoring nutrition education using terms which are reasonable, simple and clear for most consumers, indicating the necessary modifications in food patterns⁸. The Brazilian Food Guide Pyramid is an example of these guides.

Studies have found that awareness of unhealthy lifestyle and perceptions of susceptibility to chronic diseases lead individuals to have greater participation in programs to change eating habits and physical activity^{9,10,11}. It is important to raise awareness to patients with chronic diseases about the benefits of following the treatments when you want to promote changes in lifestyle¹¹.

Therefore, the objective of this study was to assess nutritional adequacy in subjects with metabolic syndrome according to the dietary recommendations prescribed.

Methods

A quasi-experimental research was performed at Rehabilitation Center of Hospital São Lucas of the Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, Brazil. Including criteria were age between 30 and 59 years and diagnosis of metabolic syndrome according to criteria defined by AHA/NHLBI⁵, which is determined by the presence of at least three of the following factors: waist circumference ≥ 102 cm for men and ≥ 88 cm for women, systolic and diastolic blood pressure ≥ 130 mmHg ≥ 85 mmHg, respectively, fasting glucose ≥ 100 mg/dL, triglycerides ≥ 150 mg/dL, HDL < 40 mg/dL for men and < 50 mg/dL for women. We considered the following exclusion criteria: use of medications for weight reduction and/or lipid-lowering drugs, history of cardiovascular event, body mass index > 40 kg/m² (BMI calculated as kg/height²)¹². Data were collected between May 2006 and July 2009. Initially this study included 98 adult volunteers. Throughout the study, 26 subjects dropped out, with 72 participants (48 females) remaining until the end.

The nutritional intervention was performed by the nutrition team, and physical exercise sessions were supervised by the team of physiotherapists, all properly trained. Monitoring occurred individually and lasted three months. The initial assessment comprised food record, a 24-hour recall, and measurement of weight, height and waist circumference. Also, subjects were asked to record their food intake for two days (one week day and one weekend day) to be brought in the initial of study. After the evaluation, individualized diet plans were presented to each patient. Follow-up visits occurred every two weeks to discuss changes in eating habits, nutrition guidelines, and the importance of compliance with the diet to promote weight loss and to improve the quality of health. The dietary in-

intervention included written and oral instructions given as a lecture, visually aided using a series of posters. The achievement of goals and mainly difficulties to adhere to diet were verified in all consultations. The physical exercise sessions included walking on a treadmill uninterruptedly for 30 min, three times a week, totaling 36 sessions. Allowing speed and incline to maintain a range of 65 to 75% of maximum heart rate predicted for age.

The body weight of individuals was measured using a mechanical balance (Cauduro™) with maximum capacity of 160 kg. Participants were required to wear the minimum possible clothing and no shoes. Height was obtained using a stadiometer, with two meters of height and a half centimeters accuracy level. Waist circumference was measured two centimeters over the umbilical scar¹³, using a common tape measure inextensible and inelastic with 150 cm in length.

The recommended diet plan was based on calorie equivalents. The food groups and serving sizes of each food group were established in accordance with the Brazilian Food Guide Pyramid¹⁴. Four groups of calorie levels were established, in accordance with the recommendation of 20 to 25 kcal/kg^{15, 16}, aiming at the weight loss of 5% of initial weight within three months⁵. The four groups of calorie levels established were: 1.600, 1.900, 2.200 and 2.500 kcal per day, distributed as 50-60% carbohydrates (predominantly from foods rich in complex carbohydrates, especially whole grains), 20-30% of lipids (preferably polyunsaturated and monounsaturated fats) and 10-15% protein (animal sources and dairy products provide smaller amounts of fat). Adherence to diet was analyzed by assessing the nutritional recommendations through the caloric levels and servings of the food groups of the Brazilian Food Guide Pyramid prescribed and ingested, for every calorie level. The 24-hour recall and two-day food record (obtained at the end of three months) were used to calculate nutritional adequacy. The energy consumption of macronutrients and servings of food groups were classified as below the recommended value, adequate and above the recommended value.

The Brazilian Food Composition Table was used in the nutritional analysis of dietary surveys¹⁷. The data were tabulated and submitted to statistical analysis with the aid of software Excel® 2007 and Statistical Package for Social Sciences (SPSS®) version 17.0. To compare food consumption in each group of energy level the one-way analysis of variance (ANOVA) was used, supplemented by the Scheffe post-test. The chi-square test was used to measure the association between categorical variables, and the Student's t-test was employed to verify differences between the recommended and ingested values of energy and food servings in each group of calorie level. For the purpose of analysis we used a significance level of 5% ($p < 0.05$). The groups of calorie level 2.200 and 2.500 kcal were pooled for a proper statistical analysis, because of the limited number of volunteers in the 2.500 kcal group ($n = 7$).

The research protocol was started after approval by the Ethics in Research Committee of PUCRS (process of number 159/06) and written informed consent was obtained from all the volunteers.

Results

The mean age of the subjects was 50 ± 6 years, BMI of 33.3 ± 4 kg/m² classified as obese level I and average criteria of metabolic syndrome are presented of table I. The table II show the percentage of food intake in relation to the calorie level recommended. We observed the following number of volunteers: 18, 30, 17 and seven for groups of calorie level 1.600, 1.900, 2.200 and 2.500 kcal, respectively. The groups were not quantitatively homogeneous because the volunteers were allocated in

Table I
Characteristics of individuals. Porto Alegre (RS), 2009

Variable	Value
Age (years)	50.9±6.6
Weight (kg)	88.1±13.9
Height (m)	1.6±0.1
BMI (kg/m ²)	33.3±4.2
Waist circumference (cm)	106.6±9.2
Total cholesterol (mg/dL)	228.7±51.0
Fasting glucose (mg/dL)	107.2±37.6
Triglycerides (mg/dL)	212.4±112.2
HDL cholesterol (mg/dL)	44.4±10.2
LDL cholesterol (mg/dL)	139.7±43.1
Systolic blood pressure (mmHg)	131.1±15.5
Diastolic blood pressure (mmHg)	82.8±11.0
Fasting insulin (μUI/mL)	18.9±10.5

The results represent mean ± SD.

Table II
Percentage of food consumption in relation to the calorie level recommended. Porto Alegre (RS), 2009

Groups of calorie level (kcal)	Energy consumption (%)
1.600 (n=18)	93±16 ^a
1.900 (n=30)	82± 16 ^{a,b}
2.200 (n=17)	69 ±14 ^b
2.500 (n=07)	68±21 ^b
All (n=72)	80±18

The results represent mean ± SD. Different letters indicate means statistically different between the groups of calorie level (ANOVA $p < 0.05$ Scheffe post-test).

groups according to initial body weight in the study. It was possible to observe that the 72 volunteers managed to ingest, on average, 80% of the calories in the diet prescribed. On average, 93, 82, 69 and 68% of the recommended calorie level was reached in groups 1.600, 1.900, 2.200 and 2.500 kcal, respectively. No statistically significant difference was observed in average consumption between groups of 1.900, 2.200 and 2.500 kcal and between groups of 1.600 kcal and 1.900 kcal.

Table III presents the energy consumption and macronutrients. The overall sample and groups of 1.900 kcal and 2.200/2.500 kcal had a significant reduction in caloric intake ($p < 0.001$) when compared to the values that were recommended in the diet. The average calorie intake of 1.600 kcal group was not statistically different ($p = 0.076$); however, there was a reduction of 7% over the recommended calorie level. In the analysis of the consumption of macronutrients, the overall sample and the four groups of calorie levels had mean carbohydrate intake below the recommended range. The average intake of lipids and protein was shown to be higher than the values prescribed in the diet for the overall sample and all groups.

Table IV shows the adequacy of macronutrient intake in groups of calorie level in relation to the recommended range. Considering carbohydrates intake, most of the volunteers (70.8%) had an intake below the required values in food. For lipids was found that 66.7% of the volunteers ate more than the recommended range. In the analysis of protein intake, 95.8% of participants had an intake above the recommended values. The results of the intra-group analysis of the adequacy of the macronutrients were similar to those of the total sample analysis. The chi-square test indicated no statistically significant difference between groups of calorie level 1.600, 1.900 and 2.200/2.500 kcal for the adequacy of macronutrients ($p = 0.299$, $p = 0.733$ and $p = 0.781$ for carbohydrates, lipids and proteins, respectively).

The recommended values and intake of servings from the pyramid food groups are shown in table V. For most volunteers, inadequacies were observed in main food groups, except the fruit group, in which appropriate levels were consumed (mean intake: 3.7 servings/day; $p = 0.149$). Each group consumed on average 3.1, 3.6 and 4.2 servings of fruit a day, when 3 servings were recommended for groups 1.600 and 1.900 kcal and 4 servings were indicated for groups 2.200 and 2.500 kcal. No significant difference was observed between the recommendations of this food group ($p = 0.765$, $p = 0.089$, $p = 0.704$). A significantly lower intake was observed for the group of cereals, vegetables and dairy groups, as compared to the recommended values ($p < 0.001$). In the meat group, a significantly increased consumption was observed in the three groups at intake: the volunteers ingested 1.9 servings of meat a day, when the recommended serving is one for 1.600 and 1.900 kcal groups ($p < 0.001$), and two servings per day in the group of 2.200/2.500 kcal (recommended value: 1.5 servings per day; $p = 0.024$). In the beans group the daily

Table III
Consumption of energy and macronutrients in the respective groups of calorie level

Groups of calorie level (kcal)	Energy consumption (kcal)	p*	Carbohydrate recommended (%)	Carbohydrate intake (%)	Lipids recommended (%)	Lipids intake (%)	Protein recommended (%)	Protein intake (%)	g protein/kg body weight
1.600	1.490.2±255.1	0.076	50-60	46.1±5.2	20-30	32.1±5.3	10-15	21.6±3.3	1.2
1.900	1.566.5±314.6	<0.001	50-60	46.2±8	20-30	32.9±6.3	10-15	21.3±3.6	1.0
2.200/2.500	1.579.6±382.7	<0.001	50-60	46.4±6.7	20-30	30.9±4.6	10-15	22.5±4.4	0.9
All	1.551±323	<0.001	50-60	46.2±6.9	20-30	32±5.6	10-15	21.8±3.8	1.0

The results represent the mean ± SD of consumption of calories and macronutrients. *The p value refers to the Student's t-test used for comparison between calories and recommended intake ($p < 0.05$).

Table IV
Adequate intake of macronutrients in groups of calorie level

Groups of calorie level (kcal)	Carbohydrates (Recommended 50-60%)			Lipids (Recommended 20-30%)			Proteins (Recommended 10-15%)		
	Below (%)	Adequate (%)	Above (%)	Below (%)	Adequate (%)	Above (%)	Below (%)	Adequate (%)	Above (%)
1.600	77.8	22.2	0.0	0.0	33.3	66.7	0	0.0	100
1.900	73.3	20.0	6.7	3.3	26.7	70.0	0	6.7	93.3
2.200/2.500	62.5	37.5	0.0	0.0	37.5	62.5	0	4.2	95.8
All	70.8	26.4	2.8	1.4	31.9	66.7	0	4.2	95.8

The chi-square test indicated no statistically significant difference between groups of calorie level in 1.600, 2.200/2.500 and 1.900 kcal for the adequacy of macronutrients (p=0.299, p=0.733 and p=0.781 for carbohydrates, lipids and proteins respectively).

recommendation is one serving, regardless of the calorie level recommended. An adequate daily intake of this food group was recorded for the 1.600 and 1.900 kcal groups, 0.7 servings per day (p=0.145 and p=0.144, respectively), while in the 2.200/2.500 kcal group intake was not adequate, with 0.5 part per day (p<0.001).

Discussion

In this study a low energy and carbohydrates consumption and an elevated lipids and proteins intake can be observed. High amounts of lipids and proteins and insufficient carbohydrates consumption have been reported in the diet of the population in general^{18, 19}. This dietary pattern can lead to different consequences on the health of individuals, such as the development of NCD¹.

When the amount of protein per kilogram of body weight was analyzed, the protein consumption was also above the recommended value of 0.8 g/kg²⁰. The high percentage of protein intake may be related to low carbohydrate intake, showing an imbalance in the proportion of macronutrients consumed. This low carbohydrate consumption can be associated with energy deficit reported by the participants.

In a survey conducted in patients with cardiovascular disease, the results were similar to those of the present study. The authors observed that overweight or obese individuals tend to have an unbalanced diet, with inadequate intake of macronutrients, with the prevalence of low carbohydrate diet for both men and women²¹. The present study showed a carbohydrate intake below recommended levels, but Ackermann et al. observed that high consumption of carbohydrates, particularly those that are digested rapidly, contribute to increased risk of central obesity and development of metabolic syndrome²². This inadequacy in carbohydrate intake may be related to low cereals intake (3.3 servings) — all groups of calorie levels ingested about half the recommended amount for this food group. The low consumption of this group of the pyramid can be attributed to the influence of the media as manifested

in magazines, television programs, newspapers and the internet, which generally recommend a diet with low carbohydrate intake for rapid weight loss^{5, 18}. This reduction in cereal consumption accounts for a deficit of approximately 405 kcal in the caloric intake recommended. The average of servings of dairy products reached half the recommended value in general (1.5 servings). A multicenter study showed that an increased dairy consumption have a strong inverse association with insulin resistance syndrome among overweight adults and may reduce risk of type 2 diabetes and cardiovascular disease²³. There was a low consumption of vegetables, about half the recommended portion (2.3 servings), though fruit consumption was adequate (3.7 servings). Adequate fruit and vegetable intake have been shown to contribute for the prevention of cardiovascular diseases¹. Studies show that consumption of vegetables and fiber is inversely associated with overweight^{19, 24, 25}, and fruits contribute for body weight management²⁶. These foods are rich in antioxidants and the dietary antioxidant capacity may be inversely related to characteristics of metabolic syndrome²⁷.

The volunteers that participated in the present study had an insufficient intake in the group of beans, with 0.6 servings a day. A high consumption of the meat group was observed — the volunteers ingested about twice the recommended amount in the diet (two servings). Maskarinec et al. observed that individuals with overweight tend to have a high consumption of meat²⁴. Overweight is also associated with low levels of HDL, so high consumption of meat poses a risk factor for cardiovascular disease²⁵.

The direct questioning the patient and the subjective evaluation of individual behavior are used for establish dietary adequacy⁹. It is known that the rates of non-adherence to various therapeutic treatments are high²⁸, showing that the patients find many it difficult to follow guidelines and requirements^{21, 28}. The main difficulties mentioned by patients who are in attendance for weight reduction are: following a meal plan on weekends, holidays and special occasions, lack of understanding of the nutritional guidelines, drastic chan-

Table V
Comparison between the recommended servings and intakes of food groups of the food pyramid

Food Groups	1.600 kcal			1.900 kcal			2.200/2.500 kcal			All		
	Recommended serving	Intake serving	p	Recommended serving	Intake serving	p	Recommended serving	Intake serving	p	Recommended serving	Intake serving	p
Cereals	5	3	<0.001	6	3.2	<0.001	7.3	3.5	<0.001	6.2	3.3	<0.001
Vegetables	4	2.3	<0.001	4	2.3	<0.001	4.5	2.2	<0.001	4.2	2.3	<0.001
Dairies	3	1.6	<0.001	3	1.5	<0.001	3	1.4	<0.001	3	1.5	<0.001
Fruits	3	3.1	0.765	3	3.7	0.089	4	4.2	0.704	3.3	3.7	0.149
Meats	1	1.9	0.001	1	1.9	<0.001	1.5	2	0.024	1.2	2	<0.001
Beans	1	0.7	0.145	1	0.7	0.144	1	0.5	<0.001	1	0.6	0.001

The results represent the average of the servings of their food groups. * The p value refers to the Student's t-test used for comparison between recommended servings and ingested (p < 0.05).

ge in eating habits, slow results and anxiety²⁸. The consequences of poor adherence include worsening health problems and rising costs⁹.

Linck et al.¹¹ verified that the patient's perception about the disease situation influences their adherence to treatment. Because chronic diseases initially do not produce symptoms, some patients fail to recognize their current health status and therefore need care. In the present study, participants had biweekly appointments to promote a good adherence to dietary treatment, when issues about how to obtain a healthy diet so as to reduce the presence of the criteria for metabolic syndrome were discussed. Thus, there was an awareness of the consequences of cardiovascular risk factors in terms of future health. On each return appointment, a conversation on the major difficulties that the participants encountered in connection to following the diet plan, which constituted another strategy to help them join the counseling.

The participants reduced their weight as expected (5%; p<0.001; initial weight: 88.1 kg and final weight: 83.7 kg) as recommended by AHA/NHLBI, which corresponds to a reduction of 7% to 10% in body weight during a period of 6 to 12 months⁵. When the general sample is analyzed, we can observe the reduction of 5% in body weight in three months, that is, the recommended target was met in a short period of time. In a systematic review, Heymsfield et al.²⁹ found that different protocols of low-calorie diets lead to a loss of less than 50% of the expected value. It is assumed that the energy deficit reported by the individuals who participated in that study may have contributed to the reduction in weight, which was below the recommended threshold.

Some limitations in this study should be cited. Studies have shown a tendency to underreport food intake by female subjects^{30, 31}, overweight individuals^{24, 30} as well as by people who are undergoing treatment for weight loss³⁰. In this study, most of the sample consisted of female subjects, and all participants were overweight or obese in the process of reducing weight. These characteristics may indicate a possible underreporting of actual intake. Alternatively, the participants may have actually reduced caloric intake and intake of some food groups. In addition, factors such as emotional and moral judgments can influence the reporting of food intake²⁵. Another limitation in this study is linked to the methods of dietary surveys used. It is known that the information collected in the 24-hour recall and food record depend of memory and the cooperation of the patient. However, these methods are a widely used to collect data on eating behaviors and measuring energy intake in adults^{32, 33, 34}.

Conclusion

It is important to instruct individuals with metabolic syndrome about the ways a healthy diet can help to modify risk factors for developing cardiovascular disease [26]. In the population studied the dietary in-

take was insufficient to meet the recommendation of energy, although the goal for weight loss was achieved — a fundamental result in the treatment of metabolic syndrome. Still, the results show the need for a balance in food intake and quality of the diet to achieve nutritional adequacy. Therefore, nutritional education strategies and motivational aspects to dietary treatment should be improved.

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Original/Síndrome metabólico

Vitamina D sérica y factores de riesgo metabólico en un grupo de escolares españoles

Alexia De Piero Belmonte¹, Elena Rodríguez-Rodríguez^{2,3}, Liliana Guadalupe González-Rodríguez^{3,4}, Rosa María Ortega Anta^{3,5} y Ana María López-Sobaler^{3,5}

¹Instituto Superior de Investigaciones Biológicas (INSIBIO), Facultad de Bioquímica, Química y Farmacia, Universidad Nacional de Tucumán, Argentina. ²Sección Departamental de Química Analítica, Facultad de Farmacia, Universidad Complutense de Madrid. Ciudad Universitaria, Madrid, España. ³Grupo de Investigación VALORNUT-UCM (920030). Universidad Complutense de Madrid. Madrid, España. ⁴Departamento de Nutrición Humana y Dietética. Facultad de Ciencias de la Salud. Universidad Alfonso X El Sabio. Villanueva de la Cañada, Madrid, España. ⁵Departamento de Nutrición, Facultad de Farmacia, Universidad Complutense de Madrid, Ciudad Universitaria. Madrid. España.

Resumen

Objetivo: Analizar la situación nutricional en vitamina D y su relación con diferentes factores de riesgo asociados al síndrome metabólico (SM) en un grupo de escolares españoles.

Materiales y métodos: Se ha estudiado un colectivo de 314 escolares con edades comprendidas entre 8 y 13 años, residentes en A Coruña, Barcelona, Madrid, Sevilla y Valencia. Se recogieron datos antropométricos de peso, talla, circunferencias de cintura y cadera y pliegue tri-cipital, datos de tensión arterial, y en suero se valoraron los niveles de glucosa, triglicéridos, HDL-c y 25-hidroxico-alciferol (25(OH)D). Teniendo en cuenta el criterio de Cook se ha establecido la presencia de los siguientes factores de riesgo de SM: glucosa ≥ 100 mg/dL; perímetro de cintura $\geq P90$; triglicéridos $> P90$, HDL $\leq P10$; y presión arterial sistólica o diastólica $> P90$.

Resultados: Los niveles séricos de 25(OH)D medios fueron de 23.0 ± 8.6 ng/mL. Un 47.1% tuvo niveles indicadores de hipovitaminosis (20-30 ng/mL) y el 35% tuvo deficiencia de la vitamina (< 20 ng/mL). Comparado con los escolares del primer cuartil, los del segundo tienen un menor riesgo de tener triglicéridos elevados (OR=0.50 [CI=0.25-0.99] y los del tercero, menor riesgo de tener triglicéridos y tensión arterial elevada (0.60 [CI=0.42-0.86] y 0.50 [CI=0.32-0.79], respectivamente).

Conclusión: La prevalencia de deficiencia de vitamina D es elevada en este colectivo de escolares españoles. Bajos niveles de vitamina D sérica se asocian con un mayor riesgo de presentar triglicéridos y tensión arterial elevada.

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Palabras clave: Vitamina D sérica. Síndrome metabólico. Escolares. España.

Correspondencia: Ana María López Sobaler.
Departamento de Nutrición y Bromatología I (Nutrición)
Facultad de Farmacia, Universidad Complutense de Madrid.
Ciudad Universitaria s/n, 28040 Madrid, España.
E-mail: asobaler@ucm.es

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SERUM VITAMIN D AND METABOLIC RISK FACTORS IN A GROUP OF SPANISH SCHOOLCHILDREN

Abstract

Objective: To analyze the vitamin D status and its relationship with metabolic syndrome (MS) risk factors in a group of Spanish schoolchildren.

Material and methods: A group of 314 Spanish schoolchildren (8-13 years old) from A Coruña, Barcelona, Madrid, Seville and Valencia were studied. Anthropometric data on weight, height, waist and hip circumferences, and triceps skinfold, as well as blood pressure data were collected. Serum levels of glucose, triglycerides, HDL-c and 25-hydroxycholecalciferol (25 (OH) D) were assessed. Following Cook criterion, the following MS risk factors were defined: glucose ≥ 100 mg/dL; $\geq P90$ waist circumference; triglycerides $> P90$, HDL $\leq P10$; and systolic and/or diastolic blood pressure $> P90$.

Results: Mean serum 25(OH)D were 23.0 ± 8.6 ng/mL. Forty seven percent of children had hypovitaminosis (20-30 ng/mL) and 35% had vitamin deficiency (< 20 ng/mL). Compared to the first tertile, children in the second tertile have a lower risk of elevated triglycerides (OR = 0.50 [CI = 0.25 to 0.99]; those in the the third tertile had lower risk of high blood pressure and triglycerides (0.60 [CI = 0.42 -0.86] and 0.50 [CI = 0.32 to 0.79], respectively).

Conclusion: The prevalence of vitamin D deficiency is high in this group of Spanish schoolchildren. Low serum levels of vitamin D are associated with an increased risk of elevated triglycerides and blood pressure.

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Key words: Serum vitamin D. Metabolic syndrome. Schoolchildren. Spain.

Introducción

La deficiencia de vitamina D es uno de los problemas de salud más común en todo el mundo, su deficiencia suele ser usual en niños debido a una inadecuada ingesta, y una insuficiente exposición solar¹. Diversos estudios han utilizado la concentración en suero de 25-52 hidroxicolecalciferol (25(OH)D) como indicador del estado nutricional en vitamina D²⁻³, aunque no hay un claro consenso sobre cuáles son los niveles óptimos de 25(OH)D en suero. Cuando los niveles de calcidiol o 25(OH)D son bajos, disminuyen los niveles de paratohormona (PTH) y calcitriol [1,25(OH)2D]⁴, lo que incrementa la lipólisis en los adipocitos y la oxidación de lípidos en el músculo y en el hígado¹. Esta situación puede favorecer el aumento del peso corporal y por lo tanto la aparición de sobrepeso/obesidad, diabetes mellitus y síndrome metabólico⁵, y enfermedades cardiovasculares⁶. Aunque diversos estudios han evaluado la asociación entre el estado de vitamina D y síndrome metabólico (SM), las conclusiones hasta el momento no son consistentes⁷⁻¹⁰.

El objetivo del presente trabajo es analizar la situación nutricional en vitamina D, valorando los niveles séricos de 25(OH)D en un grupo de escolares españoles, y su relación con diversos factores de riesgo asociados al síndrome metabólico.

Material y métodos

Sujetos

La muestra del presente estudio pertenece a una más amplia, de conveniencia, de 505 niños y niñas españoles, de 8 a 13 años de edad, estudiantes de Educación Primaria (EP) de colegios públicos de 5 localidades españolas (A Coruña, Barcelona, Madrid, Sevilla y Valencia). En cada una de las ciudades se seleccionaron 2 centros públicos de EP, localizados en las zonas residenciales con el fin de que el nivel socioeconómico de los escolares fuera similar. Este estudio se ofertó a los escolares de los niveles de 4º a 6º curso, y consistió en el estudio de valoración de la situación nutricional, mediante el estudio de la dieta, valoración bioquímica de muestras sanguíneas y estudio de la composición corporal mediante antropometría. Los escolares participantes debían de cumplir los siguientes criterios de inclusión: edad comprendida entre 8 y 13 años de edad, estar libres de enfermedades (endocrinas, metabólicas) y no estar tomando habitualmente fármacos que pudieran modificar la ingesta o utilización de los nutrientes. Se solicitó el consentimiento escrito de los padres o tutores legales de los escolares para participar en el estudio. El protocolo del presente estudio ha sido aprobado por el Comité Ético de Investigación de la Facultad de Farmacia, de la Universidad Complutense de Madrid. De

los 505 escolares participantes en el estudio inicial, solo se pudo realizarse el estudio sanguíneo en 491, y de éstos solo se pudieron determinar los niveles de 25(OH)D en 314 escolares, que son los que constituyen la muestra del presente trabajo.

Métodos

Se concertó con el centro escolar y con los padres de los escolares los días en los que se llevarían a cabo los distintos estudios y se les explicaron los requisitos necesarios para la realización de los mismos. A los escolares que aceptaron participar del estudio se les aplicaron diferentes cuestionarios.

Estudio antropométrico

El peso y la talla fueron determinados con una báscula digital electrónica (modelo Seca Alpha; rango: 0.1-150 kg; precisión 100 g) y un estadiómetro digital Harpenden (Pfitter, Carlstadt, NJ, USA; rango 70-250 cm; precisión 1 mm), respectivamente. Todos los datos se registraron siguiendo las normas de la OMS¹¹.

El Índice de Masa Corporal (IMC) se calculó a partir de las medidas de peso y talla ($IMC = \text{peso [kg]} / \text{talla [m}^2\text{]}$) y se clasificó a la población según su estado ponderal estableciéndose los siguientes criterios de Hernández para la población de referencia¹² (Delgadez <P25; Normopeso >P25 y <P85; Sobrepeso >P85 y <P97; Obesidad >P97).

A partir del IMC se calculó:

- Porcentaje de desviación del IMC (%IMC) respecto al percentil 50 de la población de referencia¹³.
- Puntuación Z del IMC¹³, calculado a partir de la media y desviaciones estándar de la población de referencia

Se midieron las circunferencias de brazo, cintura y cadera mediante una cinta métrica inextensible de acero marca Holtain (rango: 0-150 cm; precisión de 1 mm). Se consideró la presencia de obesidad central cuando la circunferencia de la cintura superaba el percentil 90 de la población de referencia¹⁴. También se han calculado las relaciones Índice cintura/cadera (IC/Ca) e Índice cintura/altura (ICA).

Se midió el pliegue cutáneo tricipital (PT) en el brazo derecho mediante un lipocalibre (marca HOLTAIN LTD. CRYMYCH UK), de presión constante y de 10 g/mm² de superficie de contacto [rango 0-39 mm; precisión 0.2 mm]. A partir de este parámetro se ha calculado el área grasa del brazo (AGB) y área muscular del brazo (AMB) mediante las fórmulas:

$AMB = [\text{Circunferencia del brazo (cm)} - \pi PT \text{ (cm)}]^2 / (4\pi)$

$AGB = [\text{Circunferencia del brazo (cm)}^2 / 4\pi] - AMB$.

Medida de la Tensión arterial

Se realizó siguiendo las indicaciones de la OMS¹⁵. Se utilizó esfigmomanómetro digital Boso Compact 2 (Bosch + Sohn GMBH U. CO. Jungingen Germany). La medida se realizó con el escolar sentado y en el brazo derecho, que debía estar situado a la altura del corazón. El dato final corresponde al promedio de tres mediciones, que se realizaron con un intervalo de al menos 5 minutos.

A partir de las cifras de tensión arterial sistólica (PAS) y diastólica (PAD), y teniendo en cuenta la edad, sexo y estatura, se establecieron las siguientes situaciones^{16, 17}

- Tensión arterial normal: PAS y PAD $\leq$ P90.
- Prehipertensión: PAS o PAD $\geq$ P90 y $\leq$ P95.
- Hipertensión arterial: PAS o PAD $\geq$ P95.

Estudio bioquímico

Se recogieron muestras de sangre en las propias instalaciones de los centros educativos en los que se llevó a cabo el estudio, a primera hora de la mañana, con el niño en ayunas de entre 10 y 12 horas. Las determinaciones realizadas fueron las siguientes:

- Glucosa sérica: fue valorada por método enzimático basado en la conversión de glucosa en presencia de adenosintrifosfato (ATP) y la acción de la hexocinasa en glucosa-6-fosfato esta a su vez por la adición de fosfato de dinucleótido de nicotinamida y adenina (NADP) en presencia de glucosa-6-fosfato deshidrogenasa se obtiene 6-fosfogluconato y NADPH. La formación de NADPH es monitorizada a la longitud de onda de 340 nm y es directamente proporcional a la glucosa en la muestra. (CV= 2.1%)¹⁸.
- Triglicéridos: Se determinó utilizando una prueba enzimática para cuantificar este parámetro bioquímico. Los triglicéridos de la muestra se hidrolizaron, combinando lipasas microbianas para obtener glicerol y ácidos grasos. El glicerol se fosforila con trifosfato de adenosina (ATP) en presencia de glicerol cinasa (GK) para producir glicerol-3-fosfato. Este glicerol-3-fosfato se oxida mediante oxígeno molecular en presencia de glicerolfosfato oxidasa (GPO) para producir peróxido de hidrógeno (H₂O₂) y fosfato de dihidroxiacetona. El H₂O₂ generado reacciona con 4-aminofenol, N, N-bis (4-sulfobutil)-3,5-dimetilanilina y sal sódica (MADB) en presencia de peroxidasa (POD) para producir un cromóforo, la absorbancia obtenida es proporcional a los triglicéridos contenidos en la muestra problema (CV= 1.46%)¹⁹.
- HDL-c: Se determinaron por medio de un método enzimático. Las lipoproteínas diferentes a

las HDL-c (es decir, LDL-c, VLDL-c y quílo-micrones son eliminados en primera instancia mediante precipitación al añadir como reactivo precipitante sulfato de dextrano y una solución de MgCl₂ que permite que las HDL-c restantes puedan recogerse después de centrifugar reaccionen específicamente con la colesterol esterasa y la colesterol oxidasa. En presencia de peroxidasa el peróxido reacciona ahora con la 4-aminoantipirina y N (2-hidroxi-3-sulfopropil)-3,5-dimetilanilina (HDAOS) para formar un colorante quinona. La absorbancia medida a 600 nm, es proporcional a la concentración de HDL-c en la muestra (CV= 2.4%)²⁰.

- Vitamina D (25(OH)D: Se determinó en plasma mediante inmunoquimioluminiscencia. Durante la primera incubación, la 25 OH Vitamina D se separa de su proteína y se une al anticuerpo específico en la fase sólida. A continuación se agregó luminol como trazador. Después de una segunda incubación, el material libre se elimina en un ciclo de lavado. Se continuó agregando los reactivos derivatizantes para dar lugar a la reacción quimioluminiscente rápida. La intensidad de fluorescencia emitida y medida es inversamente proporcional a la concentración de 25(OH)D presente en la muestra problema²¹. No hay un consenso sobre los valores óptimos de vitamina D en suero. En este estudio se han considerado los siguientes: déficit severo, 25(OH)D <10 ng/mL; déficit moderado, 25(OH)D <20 ng/mL, hipovitaminosis, 25(OH)D <30 ng/mL, valores normales 25(OH)D $\geq$ 30 ng/mL²²⁻²⁵.

Factores asociados a síndrome metabólico (SM)

Se aplicó el criterio de Cook y col.²⁶ adaptado a valores de referencias españoles, y que establece la presencia de SM cuando se cumplen al menos tres de los cinco criterios siguientes: glucosa $\geq$ 100 mg/dL, circunferencia de cintura $\geq$ P90¹⁴, triglicéridos >P90, HDL $\leq$ P10¹⁰, PAS o PAD >P90¹⁶.

Análisis estadístico

Para el estudio estadístico, los datos se procesaron utilizando el software Rsigma Babel (Horus Hardward, Madrid). Se ha dividido a la población en función de los tertiles de vitamina D sérica. Se ha calculado los valores medios, desviación estándar (DS), de cada uno de los parámetros estudiados (datos personales, antropométricos, tensión arterial y factores de riesgo asociados al SM), así como porcentajes en el caso de las variables cualitativas. Para analizar las diferencias entre medias en las distribuciones homogéneas, y dependiendo del número de muestras a analizar, se ha

aplicado el test de la T de Student o un Se han realizado análisis de varianza con y se ha aplicado el Test de Neuuman-Keuls. En el caso de que la distribución de los resultados fuera no homogénea, se aplicaron test no paramétricos como el Test de Mann-Whitney y de Kruskal-Wallis. Para analizar la relación lineal entre dos variables numéricas, se han realizado análisis de regresión lineal simple y se han calculado los coeficientes de correlación. Se consideraron significativas las diferencias con $p < 0.05$. Se ha realizado un análisis de regresión logística para analizar el riesgo de presentar alguno de los factores asociados a SM en función de los tertiles de 25(OH)D sérica. Se consideran significativas las diferencias con $p < 0.05$.

Resultados

En la tabla I se presentan los datos personales y antropométricos de los niños objeto de estudio. La muestra final fue de 314 escolares, de los cuales 158 fueron niños y 156 niñas, con edades entre los 8 y 13 años con una media de 10.7 ± 1.0 años. No se observan diferencias estadísticamente significativas en cuanto a edad, peso, talla o IMC en función del sexo, pero si una mayor prevalencia de sobrepeso en las niñas y de obesidad en los varones. En relación a la tensión arterial, se observa un mayor porcentaje de varones con prehipertensión (tabla I). Los valores medios de glucosa sérica se encontraron dentro de la normalidad, aunque fueron significativamente inferiores en las niñas. En cuanto al resto de parámetros bioquímicos valorados, solo se observaron niveles más elevados de triglicéridos en las niñas.

En relación a los niveles de 25(OH)D, los valores medios fueron de 23.0 ± 8.6 ng/mL. Un 6% de los escolares presentaron valores inferiores a 10 ng/mL, indicadores de deficiencia severa de la vitamina, y un 29% tuvieron niveles entre 10 y 20 ng/mL, indicadores de deficiencia moderada. La mayoría de los escolares estudiados tuvieron valores entre 20 y 30 ng/mL (indicadores de hipovitaminosis) y solo el 17,8% tuvieron niveles por encima de 30 ng/mL.

En la tabla II se presentan los datos de los escolares en función de los tertiles de vitamina D sérica. Al aumentar los niveles de 25(OH)D, los valores de el peso y la talla son menores ($p < 0.05$). Al realizar un análisis de correlación se observó que los niveles de vitamina D sérica se asociaron inversamente con el peso ($r = -0.1371$, $p < 0.05$) y la talla de los niños ($r = -0.1473$, $p < 0.01$). En cuanto a las cifras de tensión arterial, se observó una asociación significativa con los tertiles de 25(OH)D ($p < 0.05$, test de Chi2) siendo inferior la prevalencia de prehipertensión e hipertensión en el tercil superior. Igualmente, se observó una asociación negativa y significativa entre los niveles de vitamina D y las cifras de presión arterial sistólica ($\beta = -0.194 \pm 0.0918$, $p < 0.05$) después de corregir por la edad y el sexo ($R^2 = 0.0351$ $p < 0.05$). Los niveles de glucosa sérica son sig-

nificativamente menores en el segundo y tercer tercil de vitamina D sérica (tabla II), y el resto de parámetros bioquímicos analizados no muestra diferencias en los tres grupos establecidos.

La tabla III presenta el riesgo de presentar parámetros alterados y que son factores de riesgo de SM. Se observa un menor riesgo de presentar triglicéridos elevados en el segundo (OR=0.50 [CI=0.25-0.99], $p < 0.05$) y tercer tercil de de niveles séricos de 25(OH)D (OR=0.60 [CI=0.42-0.86], $p < 0.01$). También los escolares del tercer tercil presentan un menor riesgo de tener cifras de tensión arterial elevadas (0.50 [CI=0.32-0.79], $p < 0.01$).

Discusión

El presente estudio aporta datos sobre la situación nutricional y los factores de riesgo asociados al síndrome metabólico en escolares y su asociación con los niveles séricos de vitamina D.

Los niveles séricos de vitamina D sérica observados en este colectivo de escolares son similares a los encontrados en otros colectivos de escolares españoles²⁷ y de otros países^{24, 28-29} y confirman que la deficiencia en vitamina D es un problema prevalente en niños y adolescentes. El 35% de los escolares de nuestro estudio presentan valores inferiores a 20 ng/mL, lo que indica que presentan deficiencia entre moderada y severa, y casi la mitad de la población (el 47.1%) presentan hipovitaminosis.

En cuanto a las características antropométricas de los niños de nuestro estudio, solo se observaron valores menores de peso y talla al aumentar los niveles séricos de 25(OH)D, sin ninguna otra diferencia en el resto de parámetros indicadores de composición corporal. Tampoco se observa un menor riesgo de presentar obesidad abdominal (valorado mediante el perímetro de la cintura) en los niños con niveles más elevados de la vitamina en suero. Estudios realizados en adultos si han observado que el padecimiento de sobrepeso/obesidad se asocia a menores niveles séricos de vitamina D, posiblemente como consecuencia de la adiposidad más que por la baja ingesta de la vitamina³⁰. Los resultados de otras investigaciones en niños sugieren que la deficiencia de vitamina D podría ser un factor de riesgo de obesidad en la infancia³¹⁻³², y que tanto el IMC como la obesidad central son un factor de riesgo de insuficiencia de vitamina D en escolares³³. La deficiencia de vitamina D se ha asociado negativamente con cambios del IMC durante el crecimiento³⁴⁻³⁶ y en estudios longitudinales se ha descrito un mayor grosor del pliegue subescapular y tricipital en niños con deficiencia de vitamina D, y mayor aumento del perímetro de la cintura³⁷. Este hecho podría ser un factor de riesgo para la obesidad, debido a que la vitamina D es capaz de inhibir la diferenciación de los adipocitos a través de su interacción con el receptor de vitamina D (VDR) presente en estas células³⁸.

Tabla I
Datos personales, antropométricos y bioquímicos de la población en función del sexo

	<i>Total</i> (n=314)	<i>Varones</i> (n=158)	<i>Mujeres</i> (n=156)
Edad (años)	10.7±1.0	10.7±1.0	10.7±1.0
Peso (kg)	40.8±9.9	40.6±9.9	40.9±9.8
Talla (cm)	144.2±8.9	143.9±8.7	144.4±9.1
IMC (kg/m ²)	19.4±3.2	19.4±3.2	19.4±3.1
IMC%	109.9±17.7	111.4±18.7	108.5±16.7
z-IMC	0.7±1.3	0.9±1.5	0.6±1.2
Valoración Ponderal (%)			
Delgadez	26.2	28.0	24.4
Normal	28.0	35.7	40.4
Sobrepeso	15.0	7.0	23.1***
Obesidad	20.8	29.3	12.2***
Circ. de cintura (cm)	68.0±9.2	68.3±9.6	67.7±8.8
Circ. de cadera (cm)	79.3±9.0	78.5±9.0	80.1±8.9
IC/Ca	0.9±0.1	0.9±0.1	0.8±0.1
ICA	0.5±0.1	0.5±0.1	0.5±0.1
AGB (cm ²)	16.1±7.8	15.4±8.4	16.8±7.0
AGB (%)	35.4±9.1	33.5±10.1	37.3±7.5***
AMB (cm ²)	27.4±6.4	27.9±6.5	26.9±6.2
Tensión Arterial			
Sistólica (mm Hg)	106.1±14.0	106.6±13.9	105.6±14.1
Diastólica (mm Hg)	63.7±10.6	64.1±10.4	63.4±10.9
Hipertensión Arterial (%)			
Tensión arterial Normal	86.6	81.8	91.4*
Prehipertensión	4.3	7.1	1.3*
Hipertensión	9.2	11.0	7.3
Bioquímica			
Glucosa (mg/dL)	84.2±7.8	85.4±7.8	83.0±7.7**
Triglicéridos (mg/dL)	69.1±29.2	64.6±27.9	73.7±29.9**
HDL-c (mg/dL)	60.2±13.0	61.5±13.3	58.9±12.5
25-hidroxicolecalciferol (ng/mL)	23.0±8.6	23.4±9.1	22.6±8.2

*p<0.05

** p<0.01, diferencias significativas en función del sexo

z-IMC: puntuación z del IMC

IC/Ca: Índice cintura/Cadera;

ICA= Índice Cintura/altura

AGB: 447 Área grasa del brazo

AMB: Área muscular del brazo

Tabla II
Características antropométricas de los niños. Diferencias en función de los tertiles de la vitamina D sérica (ng/mL)

	T1 (n= 104) (4.0-19.4 ng/mL)	T2 (n= 103) (19.5-25.3 ng/mL)	T3 (n= 107) (25.4-55.5 ng/mL)	P#
% niñas	50.9	49.5	48.6	
Edad (años)	10.8±1.0	10.7±1.0	10.5±1.0	
Peso (kg)	42.0±9.9 ^a	41.8±9.5 ^a	38.6±9.9 ^b	<0.05
Talla (cm)	145.5±8.2 ^a	144.7±8.9 ^{ab}	142.3±9.3 ^b	<0.05
IMC (kg/m ²)	19.6±3.3	19.7±3.0	18.8±3.1	
IMC%	110.8±19.0	111.8±17.1	107.2±16.8	
z-IMC	0.8±1.4	0.9±1.3	0.5±1.3	
Valoración Ponderal (%)				
Delgadez	26.0	18.4	34.0	
Normal	38.5	39.8	35.9	
Sobrepeso	14.4	16.5	14.2	
Obesidad	21.2	25.2	16.0	
Circ. de cintura (cm)	68.8±9.6	68.9±8.8	66.3±9.0	>p90
Circ. de cadera (cm)	80.0±9.5	80.2±8.3	77.6±8.9	
IC/Ca	0.9±0.1	0.9±0.1	0.8±0.1	
ICA	0.5±0.1	0.5±0.1	0.5±0.1	
AGB (cm ²)	16.1±8.1	17.1±7.5	15.2±7.6	
AGB (%)	35.6±9.6	36.3±8.4	34.3±9.2	
AMB (cm ²)	27.0±6.3	28.2±5.8	27.1±6.9	
Tensión Arterial				
Sistólica (mm Hg)	108.2±14.4	106.2±13.9	103.8±13.2	
Diastólica (mm Hg)	65.2±10.4	62.1±10.2	63.8±11.0	
Hipertensión Arterial (%)				<0.05##
Tensión arterial Normal	79.8	85.7	94.2	
Prehipertensión	6.7	5.1	1.0	
Hipertensión	13.5	9.2	4.9	
Bioquímica				
Glucosa (mg/dL)	86.3±7.0 ^a	84.0±7.2 ^b	82.3±8.7 ^b	<0.01
Triglicéridos (mg/dL)	74.4±32.0	68.0±29.1	65.1±25.9	
HDL-c (mg/dL)	59.7±12.2	59.4±11.3	61.4±15.1	
25-hidroxicolecalciferol (ng/mL)	14.2±4.0 ^a	22.3±1.6 ^b	32.2±6.5 ^c	<0.001

ANOVA de 1 factor

test de Chi2

a,b: Letras diferentes indican diferencias significativas entre las medias

z-IMC: puntuación z del IMC

IC/Ca: Índice cintura/Cadera

ICA= Índice Cintura/altura

AGB: Área grasa del brazo

AMB: Área muscular del brazo

Tabla III
Riesgo de presentar valores alterados de los factores de riesgo de SM en función de los tertiles de vitamina D sérica

	OR (CI95%)#	OR (CI95%) ##
Glucosa ≥ 100 mg/dL		
T1	1	1
T2	3,03 (0,30-29,6)	2,98 (0,30-29,2)
T3	0,98 (0,24-3,94)	0,95 (0,10-9,4)
Perímetro de cintura $\geq P90$	210	5
T1	1	1
T2	1,15 (0,65-2,07)	1,14 (0,63-2,05)
T3	0,76 (0,56-1,05)	0,77 (0,56-1,07)
Triglicéridos $> P90$		
T1	1	1
T2	0,50 (0,26-0,99)*	0,50 (0,25-0,99) *
T3	0,62 (0,44-0,88)**	0,60 (0,42-0,86) **
HDL $\leq P10$		
T1	1	1
T2	1,18 (0,62-2,23)	1,17 (0,61-2,22)
T3	1,08 (0,79-1,49)	1,10 (0,80-1,52)
PAS ó PAD $\geq P90$		
T1	1	1
T2	0,64 (0,31-1,31)	0,59 (0,28-1,24)
T3	0,54 (0,35-0,84)**	0,50 (0,32-0,79) **

valores de OR sin ajustar

valores de OR ajustando con edad y sexo

* $p < 0.05$

** $p < 0.01$

PAS: tensión arterial sistólica; PAD: tensión arterial diastólica

Nuestros resultados muestran que los escolares en el segundo y tercer tercil de niveles séricos de la vitamina tienen un menor riesgo de presentar triglicéridos elevados. Estos resultados confirman los observados en otros colectivos de escolares madrileños³⁹, en adolescentes⁴⁰ y en adultos⁴¹⁻⁴². También en estudios de intervención, que observan que el uso de suplementos de vitamina D se asocia a una mayor reducción en los niveles séricos de triglicéridos en adultos⁴³ y en escolares⁴⁴⁻⁴⁵. Es bien sabido que una mayor ingesta de calcio puede reducir los niveles de triglicéridos al disminuir la formación hepática de triglicéridos y su secreción al modificar el calcio hepatocelular⁴⁶, y la vitamina D aumenta la absorción de calcio⁴⁷. También la vitamina D disminuye los niveles de paratohormona, aumentando la actividad lipolítica postheparínica y aumentando la movilización de triglicéridos⁴⁸.

Los escolares del tercil superior de niveles séricos de la vitamina tienen menor riesgo de presentar cifras elevadas de tensión arterial. Estos resultados coinciden otros estudios realizados en adultos⁴⁹⁻⁵⁰ y niños³⁵ que

observan que la deficiencia de vitamina D se asocia a un mayor riesgo de tensión arterial elevada, así como mayor riesgo de enfermedades cardiovasculares. En adultos se ha observado esta asociación entre deficiencia de la vitamina y aumento de la presión arterial incluso en individuos normotensos⁵¹. Sin embargo, otros estudios en adolescentes no observan asociación entre la deficiencia de la vitamina e hipertensión⁵². Este efecto positivo de la vitamina D en la tensión arterial podría deberse al efecto de la vitamina activando receptores celulares del endotelio vascular y disminuyendo la expresión de moléculas de adhesión, a su efecto inhibiendo la vasoconstricción, por su capacidad para modular el sistema renina-angiotensina-al-dosterona, y por su papel dificultando la proliferación de células del músculo liso vascular y la activación de macrófagos⁵³⁻⁵⁸.

En resumen, los resultados del presente estudio ponen de relieve que la prevalencia de deficiencia de vitamina D en la población escolar es elevada, y que los niños y niñas con niveles séricos más bajos de la

vitamina, aunque tengan datos antropométricos similares a los de niveles más elevados, presentan un mayor riesgo de presentar cifras elevadas de triglicéridos y tensión arterial. Vigilar y mejorar la situación en esta vitamina, independientemente de la situación ponderal del escolar, puede contribuir a prevenir ya desde edades tempranas el inicio y desarrollo de enfermedades cardiovasculares y SM.

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Original/*Alimentos funcionales*

Antioxidant capacity of leaf extracts from two *Stevia rebaudiana* Bertoni varieties adapted to cultivation in Mexico

Jorge Carlos Ruiz Ruiz¹, Yolanda Beatriz Moguel Ordoñez², Ángel Matus Basto³ y Maira Rubi Segura Campos³

¹Departamento de Ingeniería Química-Bioquímica, Instituto Tecnológico de Mérida. Yucatán, México. ²Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. Campo Experimental Mocochá. Yucatán, México. ³Facultad de Ingeniería Química, Universidad Autónoma de Yucatán. Mérida, Yucatán, México.

Abstract

The recent introduction of the cultivation of *Stevia rebaudiana* Bertoni in Mexico has gained interest for its potential use as a non-caloric sweetener, but some other properties of this plant require studies. Extracts from two varieties of *S. rebaudiana* Bertoni adapted to cultivation in Mexico were screened for their content of some phytochemicals and antioxidant properties. Total pigments, total phenolic and flavonoids contents of the extracts ranged between 17.7-24.3 mg/g, 28.7-28.4 mg/g, and 39.3-36.7 mg/g, respectively. The variety “Criolla” exhibited higher contents of pigments and flavonoids. Trolox equivalent antioxidant capacity ranged between 618.5-623.7 mM/mg and DPPH decolorization assay ranged between 86.4-84.3%, no significant differences were observed between varieties. Inhibition of β -carotene bleaching ranged between 62.3-77.9%, with higher activity in the variety “Criolla”. Reducing power ranged between 85.2-86% and the chelating activity ranged between 57.3-59.4% for Cu^{2+} and between 52.2-54.4% for Fe^{2+} , no significant differences were observed between varieties. In conclusion, the results of this study showed that polar compounds obtained during the extraction like chlorophylls, carotenoids, phenolic compounds and flavonoids contribute to the antioxidative activity measured. The leaves of *S. rebaudiana* Bertoni could be used not only as a source of non-caloric sweeteners but also naturally occurring antioxidants..

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Key words: *Stevia rebaudiana* Bertoni. Leaves extracts. Phytochemicals. Antioxidant properties.

CAPACIDAD ANTIOXIDANTE DE EXTRACTOS FOLIARES DE DOS VARIEDADES DE *STEVIA REBAUDIANA* BERTONI ADAPTADAS AL CULTIVO EN MÉXICO

Resumen

La reciente introducción del cultivo de *Stevia rebaudiana* Bertoni en México ha ganado interés debido a su potencial uso como fuente de edulcorantes no calóricos, pero otras propiedades de esta planta aun requieren de estudios. Extractos de hojas de dos variedades de *S. rebaudiana* Bertoni adaptadas al cultivo en México fueron evaluados en cuanto a su contenido de algunos fitoquímicos y sus propiedades antioxidantes. El contenido de pigmentos, fenoles totales y flavonoides en los extractos, osciló entre 17.7-24.3 mg/g, 28.7-28.4 mg/g, y 39.3-36.7 mg/g, respectivamente. La variedad “Criolla” exhibió los mayores contenidos de pigmentos y flavonoides. La capacidad antioxidante equivalente de Trolox osciló entre 618.5-623.7 mM/mg y el ensayo de decoloración del radical DPPH osciló entre 86.4-84.3%, no observándose diferencias significativas entre ambas variedades. La inhibición de la decoloración del β -caroteno osciló entre 62.3-77.9%, siendo mayor en la variedad “Criolla”. El poder reductor osciló entre 85.2-86%, las capacidades quelantes de cobre y hierro oscilaron entre 57.3-59.4% y 52.2-54.4%, respectivamente, no observándose diferencias significativas entre ambas variedades. En conclusión, los resultados de este estudio demuestran que los compuestos de naturaleza polar obtenidos durante la extracción, tales como pigmentos clorofílicos, carotenoides, compuestos fenólicos y flavonoides contribuyen a la actividad antioxidante. Las hojas de *S. rebaudiana* Bertoni podrían ser empleadas no solo como fuente de edulcorantes no calóricos, sino también como fuente de antioxidantes de origen natural.

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Palabras clave: *Stevia rebaudiana* Bertoni. Extractos foliares. Fitoquímicos. Propiedades antioxidantes.

Correspondence: Maira Rubi Segura Campos.
Facultad de Ingeniería Química, Universidad Autónoma de Yucatán. Periférico Norte. Km. 33.5, Tablaje catastral 13615, Col. Chuburná de Hidalgo Inn, Mérida, Yucatán, México. C.P. 97203.
E-mail: maira.segura@uady.mx

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Introduction

The role of Reactive Oxygen Species (ROS) has been determined in many human degenerative diseases, including ageing, cancer, arthritis, and Parkinson's disease¹. For example, Hydrogen Peroxide (H_2O_2), a prominent ROS, caused lipid peroxidation and DNA damage in cells². The antioxidant action of some natural compounds, such as vitamins, minerals, polyphenols and other non-nutrient compounds of plants, inhibit the generation of reactive oxygen species or the scavenging of free radicals, was believed to be beneficial for human health³. Indeed, natural antioxidants have displayed a wide range of pharmacological activity, such as anticancer, anti-inflammatory and anti-ageing actions⁴. To counteract this threat to their integrity, cells have evolved a variety of defense systems based on both water-soluble and lipid-soluble antioxidant species, and on antioxidant enzymes. A high proportion of the antioxidant systems of the human body are dependent on dietary constituents⁵. Synthetic antioxidants such as butylhydroxyanisole (BHA) or butylhydroxytoluene (BHT) are used to decelerate these processes. However, due to their unstable and highly volatile nature, they have frequently brought some questions about their safety and efficiency ever since their first introduction to the food industry⁶. Consequently, the need to identify alternative natural and safe sources of antioxidant, and the search for safe and natural antioxidants, especially of plant origin, has notably increased in recent years⁷.

The genus *Stevia* belongs to the Asteraceae family, a tribe of the Eupatorieae, and comprises 240 species, growing mostly at the altitude of 500-3000 m in semidry mountainous terrain. Different species of *Stevia* contain several potential sweetening compounds, with *Stevia rebaudiana* (Bertoni) being the sweetest of all⁸. *Stevia* (*Stevia rebaudiana*, Bertoni) is a perennial shrub indigenous to Paraguay and Brazil. Nowadays the extraction of sweeteners from stevia leaves is a growing industrial and commercial worldwide sector; more than 750 tons of stevia leaves are used as crude extract for consumption and extraction of glycosides per year⁹. The sweetening property is associated with their contents of several glycosides, stevioside, steviobioside, rebaudiosides A to F, dulcoside A and steviol. These glycosides and their derivatives are known to account for 4-20% of the dry weight of stevia leaves¹⁰.

Stevia and its extract have been studied widely from the sweetener point of view however, a search through literature shows no information on the non-sweetening components, which make up 80- 90% dry weight of this plant. The non-sweet constituents identified in the *S. rebaudiana* leaves are diterpenes, triterpenes, sterols, flavonoids, volatile oil constituents, pigments and inorganic matters¹¹. *S. rebaudiana* leaves can be a potential source of natural antioxidants. The bioactivity of any plant products greatly varies with the change

of geographical conditions such as soil, water cultivation process etc. So far, the antioxidant capacity of *Stevia rebaudiana* cultivated in Yucatan, Mexico has not been evaluated.

The objective of the present study was to evaluate the content of chlorophyll and carotenoids pigments, phytochemical compounds and antioxidant capacities of the leaves' extracts of *Stevia rebaudiana* varieties from Yucatan, Mexico.

Materials

Raw material and chemicals

Stevia rebaudiana Bertoni variety Morita II and criolla were obtained from plots in the Yucatan State in México. The crop was managed according to the production technology established parameters for Mexico¹². Samples were obtained from the first cut of the plot at an age of three months; samples consisted on branches of leaves. All chemicals were reagent grade or better and purchased from Sigma Chemical Co. (St. Louis, MO, USA).

Methods

Drying treatment and extracts preparation

Stevia rebaudiana leaves were subjected to convection drying at 60 °C for 24 h. The vegetal material was distributed in aluminum trays and drying was stop until there was no significant weight loss; this is until vegetal material reached equilibrium in moist content. The leaves were milled in a Wiley equipment to obtain particles of 1.0 mm in size. Samples were stored at room temperature in polyethylene bags until extract preparation. The uniform particle-sized powder (50 g) was packed in thimble and extracted in Soxhlet apparatus with methanol (200 mL) till the solution in the thimble becomes clear⁸. The extract so obtained was then filtered through Whatman filter paper no. 40. All the filtrate together was concentrated with rotary vacuum evaporator at bath temperature not exceeding 40 °C and then freeze dried. Finally the extract was resuspended in 5 mL of distilled water and stored at 10 °C for further use.

Determination of chlorophylls (a and b), carotenoids and total pigments contents

The weighed samples, having been put separately in 90% acetone (1 ml for each 50 mg), were homogenized at 1000 rpm for one minute. The homogenate was filtered and centrifuged at 2500 rpm for ten min. The supernatant was separated and the absorbances were read at 665, 645, 630 and 444 nm. The amount of chlo-

rophylls and carotenoids were calculated according to the formulas¹³:

$$\text{Chlorophyll A (mg/g)} = 11.6 * A_{665} - 1.31 * A_{645} - 0.14 * A_{630}$$

$$\text{Chlorophyll B (mg/g)} = -4.34 * A_{664} + 20.7 * A_{645} - 4.42 * A_{630}$$

$$\text{Total carotenoids (mg/g)} = 0.0051 * A_{444} + 0.00003$$

Determination of total phenolic content

The phenolic compounds were determined using the Folin-Ciocalteu method, based on the reduction of phosphor-wolframate-phosphomolybdate complex by phenolics to a blue reaction product¹⁴. One g of sample was suspended in 40 mL of 80% methanol (v/v) in a beaker. The dispersion was stirred on a magnetic plate at room temperature for 3 h. After the extraction the dispersion was centrifuged at 2500 rpm for 20 min at 10 °C. The supernatant was filtered, refrigerated at 4 °C and protected from light until analysis. A volume of 0.2 mL from the methanol extract was placed in a plastic cell for spectrophotometer and 0.2 mL of Folin-Ciocalteu reagent were added and homogenized. Then 2 mL of distilled water were added and the cell was kept in dark at room temperature for 1 h. Absorbance was measured at 765 nm. The data was calculated by comparison between a standard curve (0 - 500 µg/mL of gallic acid) and the absorbance of each sample. The analysis was performed on three replicates. The total amount of phenolic compounds was determined in micrograms of gallic acid equivalents/mg of sample.

Determination of total flavonoids content

The flavonoids content was determined using the aluminum chloride method¹⁵. Briefly, 0.5 mL from the ethanol extract was placed in a plastic cell for spectrophotometer, then 1.5 mL of ethanol 95%, 0.1 mL AlCl₃ 10%, 0.1 mL of potassium acetate 1.0 M and 2.8 mL of distilled water were added and the cell was kept in dark at room temperature for 30 min. Absorbance was measured at 415 nm. The data was calculated by comparison between a standard curve (0 - 100 µg/mL of quercetin) and the absorbance of each sample. The analysis was performed on three replicates. The total amount of flavonoid compounds was determined in micrograms of quercetin equivalents/mg of sample.

Trolox equivalent antioxidant capacity

The ABTS^{•+} radical cation was produced by reacting 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid (ABTS) with potassium persulfate¹⁶. To prepare the stock solution, ABTS was dissolved at a 2 mM concentration in 50 mL phosphate-buffered saline. The ABTS radical cation was produced by reacting 10 mL

ABTS stock solution with 40 µL K₂S₂O₈ 70 mM solution and allowing the mixture to stand in darkness at room temperature for 16-17 h before use. The radical was stable in this form for more than 2 days when stored in darkness at room temperature. Antioxidant compound content in the stevia extracts was analyzed by diluting the ABTS^{•+} solution with PBS to an absorbance of 0.800 ± 0.030 AU at 734 nm. After adding 990 µL diluted ABTS^{•+} solution (A 734 nm= 0.800 ± 0.030) to 10 µL of 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (TROLOX) standard (final concentration 0.5-3.5 mM) in PBS, absorbance was read at room temperature exactly 6 min after initial mixing. All analyses were run in triplicate. The percentage decrease in absorbance at 734 nm was calculated and plotted as a function of the antioxidant concentration of Trolox for the standard reference data. To calculate the Trolox equivalent antioxidant capacity (TEAC), the slope of the absorbance inhibition percentage vs. antioxidant concentration plot was divided by the slope of the Trolox plot. This produces the TEAC at a specific point in time.

DPPH free radical-scavenging assay

The scavenging effect on α,α-diphenyl- β-picrylhydrazyl (DPPH) free radical was measured at 517¹⁷. With some modifications, a sample solution (1.5 mL) with 20 mg was added to 1.5 mL of 0.1 mM DPPH in 95% ethanol. The mixture was shaken and left for 30 min at room temperature. Absorbance was measured at 517 nm. Measurement was performed at least in triplicate. The percentage of the DPPH scavenging effect was calculated using the following equation:

$$\text{DPPH scavenging effect (\%)} = (A_0 - A_1) / A_0 \times 100.$$

Where A₀ was the absorbance of the control and A₁ was the absorbance in the presence of the *Stevia rebaudiana*. The IC₅₀ (concentration providing 50% inhibition) values were calculated using the dose inhibition curve in linear range by plotting the extract concentration versus the corresponding scavenging effect. Samples were tested in a range of concentrations from 0.5 to 3.0 mg/mL.

β-carotene bleaching assay

This method evaluates the capacity of the leaf extracts to reduce the oxidative loss of β-carotene in the presence of CuSO₄¹⁸. β-Carotene (10 mg) was dissolved in 1 mL of chloroform (CHCl₃) and 1 mL of Tween 80. The chloroform was removed using nitrogen and resuspended in phosphate buffer (100 mM, pH 7). The absorbance was immediately measured at 470 nm. Distilled water was used as the positive control. In the negative control, the distilled water was substituted with an equal volume of CuSO₄ (50 µM). The antioxidant activity (%) of the leaf extracts was evaluated in

terms of the bleaching of the β -carotene using the following formula: % inhibition = $[(At-Ct)/CO] \times 100$.

Where, At and Ct are the absorbances measured for the leaf extract and positive control, respectively, after reaction, and CO is the absorbance values for the negative control measured.

Ferric reducing power assay

This method is based on the reduction of Potassium Ferricyanide (Fe^{+3}) to (Fe^{2+}) in the presence of an antioxidant, KFeIII forming the blue complex $[FeI(CN)_6]$, which absorbing a 700 nm¹⁹. First, 200 μ L of sample (containing 1 mg of protein), 500 μ L of phosphate buffer (0.2 M, pH 6.6), and 500 μ L of potassium ferricyanide (1%) were mixed in a test tube. The test tube was then incubated at 50 °C for 20 min. Subsequently, 500 μ L of trichloroacetic acid (10%) were added, and the tube was centrifuged at 3000 g for 10 min. An aliquot of 500 μ L of the supernatant, which is dissolved in an equal amount of distilled water, immediately 500 μ L of ferric chloride (0.1%) were added. Absorbance was determined at 700 nm. Samples were tested in a range of concentrations from 200 to 1000 mg/mL. Butylated hydroxytoluene was used as control in the same range of concentrations.

Chelating of metal ions Cu^{2+} and Fe^{2+}

Cu^{2+} -chelating activity was determined using the pyrocatechol violet reagent²⁰. Briefly, 1.0 mL of sodium acetate buffer (100 mM, pH 4.9), 100 mL of Cu (II) standard solution (1.0 mg/mL), and 100 mL of sample (containing 200 mg) were mixed in a test tube. The mixture was allowed to react for 5 min at room temperature and 25 mL of a pyrocatechol violet solution (4.0 mM) was then added. Absorbance was determined at 632 nm. Copper chelating activity was calculated as follows: Chelating activity (%) = $(1 - \text{sample absorbance/control absorbance}) \times 100$.

Fe^{2+} -chelating activity was determined by measuring the formation of the Fe^{2+} -ferrozine complex²¹. Briefly,

1.0 mL of sodium acetate buffer (100 mM, pH 4.9), 100 mL of Fe(II) standard solution (1.0 mg/mL), and 100 mL of sample (containing 200 mg) were mixed in a test tube. The mixture was allowed to react for 5 min at room temperature and 50 mL of a ferrozine solution (40 mM) was then added. Absorbance was determined at 562 nm. Iron chelating activity was calculated as follows: Chelating activity (%) = $(1 - \text{sample absorbance/control absorbance}) \times 100$.

Statistical analysis

All results were analyzed using descriptive statistics with a central tendency and dispersion measures. One-way ANOVAs were run to evaluate proximate composition and *in vitro* antioxidant activities. The Least Significant Difference (LSD) multiple range test was used to determine differences among drying treatments. All analyses were done according to Montgomery²² and processed with the Statgraphics Plus version 5.1 software.

Results and Discussion

Determination of chlorophylls (a and b), carotenoids and total pigments contents

Extracts from two varieties of Stevia were analyzed for chlorophyll (A and B), carotenoids and total pigments content (table 1). It was found that Criolla extract showed higher contents of carotenoids and total pigments than the Morita II extract. Abou-Arab et al.²³, quantified the content of chlorophylls (A and B), carotenoids and total pigments in fresh leaves of Stevia reporting values of 10.1, 6.6, 3.9 and 20.1 g/g of chlorophylls A, B, carotenoids and total pigments, respectively.

The same authors reported reductions of 47.4, 41.3, 74.8, and 50.9% with final values of 4.7, 2.7, 0.76 and 7.5 g/g of chlorophylls A, B, carotenoids and total pigments, respectively after sun-drying them and using the extraction with methanol-water at room tempera-

Table I
Chlorophylls, carotenoids, and phytochemicals of Stevia rebaudiana Bertonii leaf extracts

<i>Parameter</i>	<i>Criolla</i>	<i>Morita II</i>
Chlorophyll a (mg/g)	4.0 ^a	3.0 ^a
Chlorophyll b (mg/g)	4.0 ^a	4.0 ^a
Carotenoids (mg/g)	16.3 ^a	10.7 ^b
Total pigments	24.3 ^a	17.7 ^b
Total phenolic compounds (mg gallic acid equivalents/g)	28.7 ^a	28.4 ^a
Total flavonoids compounds (mg quercetin equivalents/g)	39.3 ^a	36.7 ^b

Data are presented as means (n = 3). Different letters indicate significant differences (P < 0.05)

ture. In the present study the leaves were dried at 60 °C by convection and the leaves extracts were obtained with methanol in a Soxhlet system also at 60 °C. Despite this the contents of chlorophylls, carotenoids and total pigments were higher in this study (Table I).

This may be due to the drying and extraction treatments not caused an excessive degradation of pigments. Although chlorophylls are not considered dietary antioxidants, they are widely distributed among green fruits and vegetables with chlorophyll A and B derivatives predominate in higher plants and possess antimutagenic activity and antioxidant activity by breaking the radical chain reaction caused by autoxidation via a hydrogen donating mechanism²⁴. Meanwhile, carotenoids often occur along with chlorophylls during the chloroplasts, but are also present in other chromoplasts²⁵. There are three possible mechanisms that could account for the reaction of carotenoids with radical species, especially singlet oxygen (O_2) and peroxy radicals ($ROO\bullet$), including electron transfer, hydrogen abstraction, and addition of a radical species²⁶. Whilst drying and extraction processes affect the content of chlorophylls and carotenoids, the remaining contents of both pigments could partially confer the antioxidant activity of the *Stevia rebaudiana* extracts.

Determination of total phenolic content

The total phenolic content of *Stevia rebaudiana* extracts was determined using Folin-Ciocalteu method and reported as gallic acid equivalents by reference to standard curve (table 1). According to Jahan et al.²⁷ the total phenolic content in ethanol extracts of stevia leaf ranged between 25.3 - 65.2 mg/g gallic acid equivalents. In the present study the phenolic content of the extracts will be considered as included in this range. Interest on natural food additives has been increasing and plant extracts possessing natural food antioxidants were shown to influence human health when consumed daily²⁸. The phenolic compounds present in the herbs and spices have been reported to show natural antioxidant activity and are applied as food preservatives²⁹. The predominant mode of antioxidant activity of phenolic compounds is believed to be a radical scavenging via hydrogen donation. Other radical quenching mechanisms are through electron donation and singlet oxygen quenching. Substituents on the aromatic ring affect the stabilization and therefore affect the radical-quenching ability of these compounds³⁰. As antioxidants, dietary polyphenols may protect cell constituents against oxidative damage and therefore, limit the risk of various degenerative diseases associated to oxidative stress. Numerous studies on animal models have shown that, when added to the diet, they limit the development of cancers, cardiovascular diseases, neurodegenerative diseases, diabetes, and osteoporosis³¹.

Determination of total flavonoids content

The total flavonoids content of *Stevia rebaudiana* extracts was determined using the aluminum chloride method, and the total amount of flavonoid compounds was determined in mg of quercetin equivalents/g (table 1). Mandal and Madan³², evaluated the content of flavonoids in varieties of *Stevia rebaudiana* from different geographical sources of India, and reported the total flavonoids content in methanol extracts of stevia leaf ranged between 39.8 - 62.2 mg/g quercetin equivalents. In the present study the flavonoids content of the extracts would be considered as included in this range. Flavonoids are a broad class of low molecular weight, secondary plant phenolics characterized by the flavan nucleus. In plants, these compounds afford protection against ultraviolet radiation, pathogens, and herbivores³³. The protective effects of flavonoids in biological systems are ascribed to their capacity to transfer electrons free radicals, chelate metal catalysts, activate antioxidant enzymes, reduce alpha-tocopherol radicals and inhibit oxidases. It is now widely accepted that dietary flavonoids may play an important role in protecting the body against chronic diseases, such as cancer, cardiovascular diseases and diabetes mellitus³⁴.

Trolox equivalent antioxidant capacity

The Trolox equivalent antioxidant capacity (TEAC) method uses a spectrophotometer to measure the loss of color when an antioxidant is added to the blue-green chromophore ABTS $\cdot^+$, 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid). The antioxidant reduces ABTS $\cdot^+$ to ABTS, decolorizing it. ABTS $\cdot^+$ is a stable radical. The *Stevia rebaudiana* extracts efficiently scavenged ABTS radicals generated by the reaction between 2,2'-azinobis (3-ethylbenzothiazolin-6-sulphonic acid) (ABTS) and potassium persulfate (figure 1).

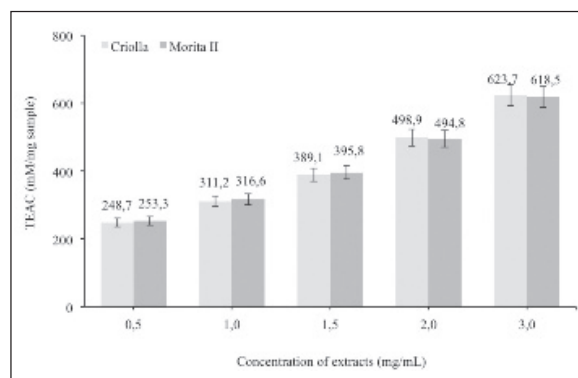


Fig. 1.—Trolox equivalent antioxidant capacity (TEAC) in extracts of *Stevia rebaudiana* Bertonii. Data are presented as means (n = 3).

The TEAC activity shows a direct correlation in a dose-dependent manner with the concentration of the extracts. This behavior was similar to that reported by Leong and Shui³⁵ for the extracts of different parts of *Stevia rebaudiana* (root, stem, leaf, and flower). TEAC and DPPH assays are excellent tools for determining the antioxidant activity of hydrogen-donating antioxidants and of chain-breaking antioxidants.

DPPH free radical-scavenging assay

The DPPH free radical-scavenging assay measures by spectrophotometer, the reduction effect that the antioxidants have on the radical 2,2- diphenylpicryl-hydrazyl (DPPH). This radical has the advantage of being unaffected by certain side reactions, such as metal-ion chelation and enzyme inhibition, brought about by various additives. It is also important to note that the DPPH test only recognizes free-radical scavenging effects and not pro-oxidant activity. Free radical scavenging capacities of the *Stevia rebaudiana* leaves extracts measured by DPPH assay are shown in figure 2.

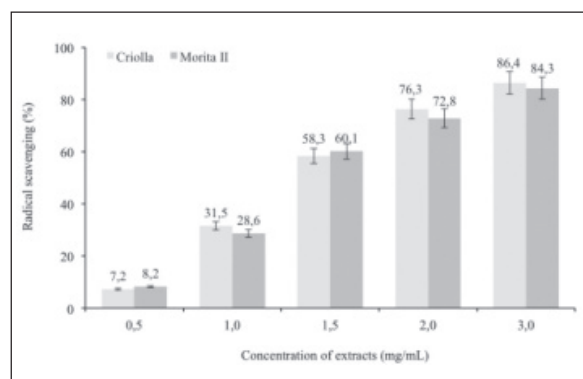


Fig. 2.—DPPH radical scavenging activity in extracts of *Stevia rebaudiana* Bertoni. Data are presented as means (n = 3).

The antioxidant activity showed a direct correlation in a dose-dependent manner with the concentration of the extracts. Singh et al.⁷ evaluated the antioxidant activity of methanolic extracts of different parts of *Stevia rebaudiana* (root, stem, leaf, and flower) and reported radical scavenging activities (%) ranged between 47.1 - 82.4% for leaf and flower, respectively. In the present study both varieties of *Stevia rebaudiana* exhibited higher values of scavenging activity that indicate that the leaf extracts of *Stevia rebaudiana* act like hydrogen-donating and of chain-breaking antioxidants.

β-carotene bleaching assay

The β-carotene bleaching assay evaluates the principle of antioxidant activity based on the availability of

electrons to neutralize free radicals. β-Carotene usually undergoes rapid discoloration in the absence of an antioxidant; this is because the oxidation of β-carotene in the presence of CuSO₄ generates free radicals that attack the highly unsaturated β-carotene molecule. Hence β-carotene is oxidized losing its orange color which is then monitored spectrophotometrically. The results obtained from this assay are shown in figure 3.

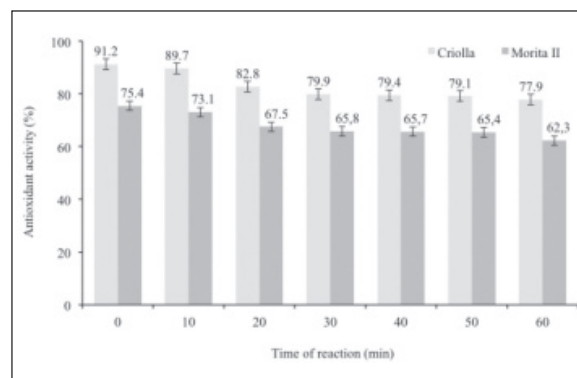


Fig. 3.—Antioxidant activity of extracts of *Stevia rebaudiana* Bertoni. Determined by β-carotene bleaching test. Data are presented as means (n = 3).

Although, both extracts prevented the bleaching of β-carotene during the test (0-60 min), the Criolla extract had a slightly higher activity. When the Criolla extract interacted with β-carotene it lost only 14.5% of the β-carotene compared with the loss of 17.4% in presence of the Morita II extract. These results are also consistent with the results obtained from TEAC and DPPH test.

Ferric reducing power assay

Reducing power was measured by direct electron donation in the reduction of Fe³⁺(CN)₆⁻–Fe²⁺(CN)₆⁻. The product was visualized by forming the intense Prussian blue color complex; a higher absorbance value that indicates a stronger reducing power of the samples. Table 2 presents the reductive capabilities of the methanolic extracts of *Stevia rebaudiana*.

In the concentration range investigated (0.5 - 3.0 mg/mL), the extracts demonstrated reducing power that increased linearly with concentration. The results of this assay indicate that both extracts are able to donate electrons to reactive radicals, reducing them into more stable and unreactive species.

Chelating of metal ions Cu²⁺ and Fe²⁺

Metal ion chelating activity of an antioxidant molecule prevents oxyradical generation and the consequent oxidative damage. Metal ion chelating capaci-

Table II
Ferric reducing power and chelating capacity of extracts of Stevia rebaudiana Bertoni

Parameter (%)	<i>S. rebaudiana</i> <i>Bertoni</i>	Concentration of extract (mg/mL)				
		0.5	1.0	1.5	2.0	3.0
Reducing power	Criolla	54.8 ^a	72.1 ^a	76.9 ^a	82.3 ^a	86.0 ^a
	Morita	58.4 ^a	73.7 ^a	78.8 ^a	84.4 ^a	85.2 ^a
Cu ²⁺ chelating capacity	Criolla	26.6 ^a	29.2 ^a	39.5 ^a	48.3 ^a	57.3 ^a
	Morita	24.7 ^a	34.7 ^a	41.0 ^a	52.8 ^a	59.4 ^a
Fe ²⁺ chelating capacity	Criolla	13.8 ^a	17.2 ^a	22.0 ^a	38.2 ^a	52.2 ^a
	Morita	13.5 ^a	18.9 ^a	30.1 ^a	41.5 ^a	54.4 ^a

Data are presented as means (n = 3)
 Different letters indicate significant differences (P < 0.05)

ty plays a significant role in antioxidant mechanisms since it reduces the concentration of transition metal ions that are potent catalysts, and capable of initiating processes in lipid peroxidation, especially in cellular membranes. Chelating of metal ions capacities of the *Stevia rebaudiana* leaves extracts are shown in Table 2. The chelating activity showed a direct correlation in a dose dependent manner with the concentration of the extracts. Although, both extracts exhibited chelating activity, the Morita II extract had a slightly higher activity. The main strategy to avoid reactive oxygen species generation that is associated with redox active metal catalysis involves chelating of the metal ions. Both *Stevia rebaudiana* methanolic extracts interfered with the formation of ferrous and cupric complex, suggesting that these have chelating activity and capturing metallic ions.

Conclusion

The ethanolic extracts of varieties of *Stevia rebaudiana* Bertoni adapted to cultivation in southern Mexico were found to be effective radical scavengers, possessing a good reducing power and chelating activity. Earlier reports on the antioxidant activity of varieties of *Stevia rebaudiana* Bertoni adapted to cultivation in southern Mexico are very rare in the literature. The high antioxidant activity of *Stevia rebaudiana* Bertoni enhanced the potential interest in this natural source of sweeteners to improve the efficacy of different products as nutraceutical and pharmacological agents. The consumption of the *Stevia rebaudiana* Bertoni may play a role in preventing human diseases in which free radicals are involved such as cancer, cardiovascular disease, and aging. The results of this study indicate that methanolic leaf extracts of *Stevia rebaudiana* Bertoni attenuated oxidative activity via its antioxidant properties in *in vitro* assays. However, further investigations on their *in vivo* antioxidant activity, the different antioxidant mechanism, and identification of the different phytochemicals involved are warranted.

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Original/*Alimentos funcionales*

The Mediterranean Diet and micronutrient levels in depressive patients

Olga Ibarra¹, Margalida Gili¹, Miguel Roca¹, Margalida Vives¹, María Jesús Serrano¹, Antonio Pareja¹, Javier García-Campayo², Rocío Gómez-Juanes¹ and Mauro García-Toro¹

¹Institut Universitari d'Investigació en Ciències de la Salut (IUNICS). Universitat de les Illes Balears. Red de Investigación en Actividades Preventivas y Promoción de la Salud (RedIAPP). ²Departamento de Psiquiatría, Hospital Miguel Servet. Zaragoza. Red de Investigación en Actividades Preventivas y Promoción de la Salud (RedIAPP). España.

Abstract

Introduction: An inverse association between depression and some serum micronutrient levels (selenium, zinc, iron, magnesium, vitamin B and folic acid) has been reported. In addition, other studies reported that this micronutrient supplementation may improve depressed mood. The Mediterranean diet contains a sufficient amount of the micronutrients mentioned, although no study has reported an association between diet prescription and increased levels of them in depressive patients.

Objective: To examine the impact of dietary patterns recommendations on micronutrient levels in depressive patients.

Methods: 77 outpatients were randomly assigned either to the active (hygienic-dietary recommendations on diet, exercise, sleep, and sun exposure) or control group. Outcome measures were assessed before and after the six month intervention period.

Results: Serum selenium and zinc levels were slightly low at basal point and serum selenium was inversely correlated with severity of depression ($r=-0.233$; $p=0.041$). A better outcome of depressive symptoms was found in the active group. Nevertheless, no significant differences in micronutrient levels were observed after the Mediterranean diet pattern prescription, probably due to an insufficient adherence.

Conclusion: Selenium, zinc, iron, magnesium, vitamin B₁₂ and folic acid serum levels didn't increase in depressed patients after six months of the Mediterranean diet pattern prescription.

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Key words: *Depressive disorder. Lifestyle. Diet. Selenium. Zinc.*

DIETA MEDITERRÁNEA Y NIVELES DE MICRONUTRIENTES EN PACIENTES DEPRESIVOS

Resumen

Introducción: Se ha comunicado una correlación inversa entre depresión y el nivel sérico de algunos micronutrientes (selenio, zinc, hierro, magnesio, vitamina B y ácido fólico). Además, otros estudios han señalado que la suplementar de estos micronutrientes puede mejorar la depresión. La dieta mediterránea proporciona una suficiente cantidad de los micronutrientes mencionados, aunque ningún estudio ha probado si la prescripción de dicha dieta puede incrementar los niveles de micronutrientes en pacientes depresivos.

Objetivo: Examinar el impacto de recomendar un patrón dietético mediterráneo en los niveles de micronutrientes de pacientes deprimidos.

Material y Métodos: 77 pacientes ambulatorios se aleatorizaron entre un grupo de intervención (recomendaciones higiénico-dietéticas sobre dieta, ejercicio, sueño y exposición solar) y un grupo control. La evolución fue evaluada antes y después de los seis meses del periodo de intervención.

Resultados: Los niveles de selenio y de zinc fueron ligeramente bajos en la determinación basal y el nivel de selenio correlacionaba inversamente con la severidad de la depresión ($r=-0.233$; $p=0.041$). El grupo activo evolucionó mejor de la clínica depresiva. Sin embargo, no se observaron diferencias significativas en los niveles de micronutrientes después de la prescripción del patrón de dieta mediterránea probablemente a causa de una insuficiente adherencia.

Conclusión: Los niveles séricos de selenio, zinc, hierro, magnesio, vitamina B₁₂ y ácido fólico no aumentaron en pacientes depresivos seis meses después de prescribir un patrón de dieta mediterránea.

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Palabras clave: *Depresión. Estilo de vida. Dieta. Selenio. Zinc.*

Correspondence: Mauro García-Toro.
Departamento de Psicología. Edificio Institutos Universitarios.
Campus UIB. Ctra de Valldemossa km 7.5
07122 Palma de Mallorca. España.
E-Mail: mauro.garcia@uib.es

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Abbreviations

MDD: Major depressive disorder.

GP: General Practitioner.

ET: Trace elements.

Introduction

Major depressive disorder (MDD) is a prevalent disorder with high personal and social cost¹⁻³. Recent evidence suggests that there have been substantial increases in depression rates in developed societies and suicide is the most dramatic manifestation^{4,5}. MDD is a complex and multifactorial condition; different biological and psychosocial factors interact in a particular and a dynamic form in each patient^{2,3,6}.

The increased incidence of depression can be at least partially explained by changes in lifestyle factors^{2,4}. Decreased social support, increased chronic stress, sedentarism, decrease in hours of sleep, reduced exposure to sunlight and dietary changes are some of the factors playing a significant role in current lifestyle of developed countries⁵. There is some evidence to suggest that diet consumed in these countries fails to supply the needed amount of vitamins, minerals and others micronutrients for optimal brain function^{1,4,6,8}. Traditional diets such as Mediterranean and Asiatic diet contain a sufficient amount of micronutrients⁹.

Selenium, zinc, magnesium, vitamin B₁₂ and folic acid have been found inversely associated with increased risk of depression^{7-9,11}. Therefore, the study of these micronutrients in depressive patients is important, especially in countries where traditional diets are being abandoned^{1,4}. The availability of micronutrients depends not only on diet quality, but on soil and water characteristics and genetic factors as well⁶⁻¹². Selenium, zinc, magnesium, vitamin B and folic acid are vital to the proper functioning of the nervous, immune, endocrine and reproductive systems, as well as in the prevention of cancer and cardiovascular diseases¹³⁻¹⁸. Several hypothesis link selenium, zinc, iron, magnesium, vitamin B₁₂ and folic acid with the physiopathology of depression, being the oxidative stress one of the main mechanisms implicated^{13,14}. It has been proposed that the Mediterranean diet reduces the oxidative stress and help to prevent many illnesses, including depression^{15,16}. It has also been shown that the Mediterranean diet ensures the entire micronutrients intake and that micronutrients deficit can increase the risk to develop depression¹⁶⁻¹⁸. Consistent with this, longitudinal studies have shown the preventive role of the Mediterranean diet in depression¹⁴⁻¹⁶. For these reasons, it has been proposed to promote the Mediterranean diet in people at risk of suffering micronutrients deficiencies with a wide range of health problems, depression included¹⁸.

Although it might be less effective, it has been suggested that dietary changes are safer than micronu-

trient supplementation¹⁹. However, as far as we know, it still has not been proved the efficacy of this dietary strategy in depressive patients. The hypotheses of this study is that giving a simple pattern of the Mediterranean diet, low micronutrient levels in depressive patients can improve after six months.

Methods

Participant Characteristics

We screened 77 patients that were recruited for a study already published about the effectiveness of prescribing hygienic-dietary recommendations for depression²⁰. Eligibility criteria included age over 18 years, meeting the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria for major depressive disorder, dysthymic disorder or bipolar disorder, receiving current antidepressant treatment and having a determination of plasma micronutrient levels during the previous month. The exclusion criteria were having any other mental or severe neurological disorder, uncontrolled medical comorbidity or medical issues that would preclude participation in the trial; suffer from delusions or hallucinations; active suicidal risk and being pregnant or lactating.

Fifty-one patients completed the study after the six months period and obtained the final analytical determinations. Reasons for drop out were: patient decision, protocol violations (current active alcohol or drug abuse or dependence) or any medical illness not previously diagnosed. The study protocol was approved by the local ethical committee (CEIC: Comité Ético y de Investigación Clínica de las Islas Baleares) and was registered (Trial registration: Current Controlled Trials ISRCTN59506583) and published²¹.

Dietary Patterns

After signing informed consent outpatients were randomly assigned either to the active treatment or the control group. Patients assigned to the active treatment group received an envelope containing a sheet of paper with the four hygienic-dietary recommendations under consideration, the last one related to the Mediterranean diet guidelines:

1. Go to bed when sleepy and not before 11 p.m. Use your bed and bedroom only for sleep and sex (do not read, watch TV or lie on the bed during the day). If you do not fall asleep after 15 or 20 minutes, get up and start an activity until you feel sleepy enough to go back to bed. Get up early, never later than 9 a.m., no matter how well you have slept the night before. Do not lie down or take a nap during the day.
2. Walk at least 1 hour a day, at a good pace but without becoming short of breath or being una-

ble to talk while walking. If you think you have a medical problem which makes walking difficult or uncomfortable consult your doctor. Use appropriate footwear for walking and have a shower or a bath afterwards.

3. Expose yourself to sunlight at least 2 hours per day, taking precautions to avoid sunburn or sunstroke (sunscreen, hat, etc.).
4. Try to eat a healthy and balanced diet. Eat at regular hours without snacking between meals. Avoid especially sweet or sugary drinks. Eat fish at least three times per week, plus fruit, cereals, nuts and vegetables daily.

The control group received an identical envelope, but in this case the recommendation was to perform the pattern of eating and exercise according to what they thought might make them feel better:

1. Sleep the hours that you feel your body needs.
2. Adapt the pace of daily physical activity that meets your needs.
3. If exposed to sunlight take precautions to avoid sunburn or sunstroke (sunscreen, hat, etc.).
4. Try to eat a healthy and balanced diet.

Outcome

The Mini International Neuropsychiatric Interview (MINI), the Hamilton rating scale for depression (HAM-D) 17-item version, the 21-item Beck Depression Inventory, and the Clinical Global Impression scale (CGI) were administered. After the sixth month intervention tests were again administered by blind raters. During this time the patients were taking antidepressants, and continued to be treated by their General Practitioner (GP) or psychiatrist without any interference from the research team. Analytical determinations were measured again after six months. The samples were taken between 8am and 10am in BD Vacutainer tubes for trace elements (ET). The laboratory that made the study considered optimal selenium levels from 90 ug/L; zinc levels from 80 ug/dl, magnesium levels from 1.80 mg/dl; vitamin B12 from 200 pg/ml and folic acid from 3.37 ug/mL.

Statistical Analysis

Categorical variables were described using percentages. Continuous variables were expressed by mean and the standard deviation or the median and the interquartile range were used depending on a normal distribution (Kolmogorov-Smirnov test). To detect significant differences between groups Fisher's exact test was used for categorical variables and Student t test and Mann-Whitney test for continuous variables according to follow a normal distribution or not. Subsequently, the strength of the linear correlation between variables was calculated using the Pearson

correlation coefficient, setting the significance level at $p < 0.05$.

Results

The main sociodemographic and clinical data of the study sample are shown in table I. At baseline, we observed a slight negative correlation between selenium levels and Hamilton Depression Rating Scale (HAM-D) ($r = -0.233$; $p = 0.041$). Groups were unbalanced according to the sex percentages and the diagnosis of major depressive disorder. After six months, the rating scales for depression pointed to a trend of improvement in the active group compared to the control group. Selenium plasma levels found in patients was lower than the limit considered as normal in laboratory ($86.06 \text{ ug/L} \pm 17.3$). Up to 31 of the 77 patients (40.3%) had selenium levels in plasma lower than 89 ug/L, but anyone had lower levels than 40 ug/L.

Zinc, iron, magnesium, vitamin B12 and folic acid levels are also shown in table I. Forty-one of the 77 patients (51.3%) had zinc levels in plasma lower than 80 ug/L. There were not significant differences related to the micronutrient levels analyzed after the six months period in both groups.

Discussion

Selenium levels in this sample at baseline were moderately low and slightly correlated to depression severity. However, these levels were still low six months after in both control and active group despite the fact that the active group received a prescription of the Mediterranean diet pattern. The rest of micronutrients analyzed (zinc, iron, magnesium, folic acid and vitamin B12) neither changed. Low serum levels of all these micronutrients can be related to depression, so the low serum levels of zinc found in the present study may suggest that there could be an etiopathogenic role of this element in the patients depression symptoms as well^{22,23}.

The correlation with selenium and depression could be also explained according to an inverse interaction. Therefore, depressed patients tend to worsen the quality of their diet toward processed foods, easy to prepare and hypercaloric, with few vegetables, cereals and fish^{24,25}. These diets do not ensure an adequate intake of micronutrients and it has been suggested that they might be also induced by taking some kind of psychotropics drugs²⁶. An important consideration when interpreting our results is the possibility that patients may not adequately met dietary recommendations; therefore their nutritional status has not changed. In medical literature it is already pointed that modifying dietetic habits in population to improve the micronutrients intake is a complex and difficult problem²⁷. Adherence to dietary recommendations could be even lower in patients with depression^{5,27,28}. It is possible

Table I
Demographic and Clinical Characteristics

	Active n=38	Control n=39	P value
Female sex, N°	33	26	0.03
Age y, Mean (SD)	49.1 (12.5)	51.8 (10.8)	NS
Major Depression, N°	23	13	0.01
HAM-D increment	- 8.14 (8.8)	- 4.72 (5.6)	0.08
BDI increment	- 8.75 (8.8)	- 4.51 (6.6)	0.05
GCI increment	- 1.64 (1.3)	- 0.62 (1.0)	0.03
Selenium basal (ug/L)	85.89 (18.9)	86.23 (15.8)	NS
Selenium increment (ug/L)	4.61 (18.7)	2.52 (18.7)	NS
Zinc basal (ug/dl)	79.51 (16.2)	81.31 (17.1)	NS
Zinc increment (ug/dl)	0.88 (20.2)	-1.20 (22.6)	NS
Iron basal (ug/dl)	76.05 (16.2)	89.74 (17.1)	NS
Iron increment (ug/dl)	6.79 (17.3)	0.41 (2.6)	NS
Magnesium basal (mg/dl)	2.16 (0.24)	2.07 (0.16)	NS
Magnesium increment (mg/dl)	4.16 (6.9)	1.83 (3.3)	NS
Folic acid basal (ng/mL)	8.20 (4.2)	7.34 (3.3)	NS
Folic acid increment (ng/mL)	0.03 (3.1)	- 0.48 (3.1)	NS
Vitamin B12basal (pg/mL)	421.97 (151.3)	414.02 (200.0)	NS
Vitamin B12 increment (pg/mL)	16.33 (81.9)	- 20.57 (92.2)	NS

Hamilton 17-item scale (HAM-D), Beck Depression Inventory 21-item (BDI), Global Clinical Impression scale (GCI).

that the differential mood enhancement founded could be related to other lifestyle suggestions that were recommended to patients such as physical exercise²⁹. In fact, we objectively confirmed, with a group of these patients by using actigraphs, that they changed their activity level⁵. It would have been interesting to use objective diet adherence measures from all the patients during the follow-up. Unfortunately, it could not be put into practice due to logistical limitations. However, the aim of the study was to assess the effectiveness of these recommendations, not assess the compliance.

Our study has some other weaknesses that need to be acknowledged for proper interpretation, such as small sample size and the short follow-up period. The reduced size of the sample may explain the imbalance between groups in terms of sex and diagnosis, something we think did not have any influence on the results. Finally, a validated dietary questionnaire was not performed at baseline and the dietary prescription does not completely describe the Mediterranean diet¹⁷.

In summary, to our knowledge this is the first attempt to explore the impact of dietary recommendations in serum micronutrient level of depressed patients. However, it could not be demonstrated that the provision of an informational sheet with simple recommendations concerning the Mediterranean diet exert changes in micronutrient levels six months later.

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Conflict of interest

Authors declare that they have no conflict of interest.

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Original/*Alimentos funcionales*

Chia induces clinically discrete weight loss and improves lipid profile only in altered previous values

Luciana Tavares Toscano^{1,3}, Lydiane Tavares Toscano^{1,3}, Renata Leite Tavares³, Cássia Surama Oliveira da Silva³ and Alexandre Sérgio Silva^{2,3}

¹Departament of Nutrition, Center of Health Sciences, Federal University of Paraíba, João Pessoa, PB, Brazil.

²Departament of Physical Education, Center of Health Sciences, Federal University of Paraíba, João Pessoa, PB, Brazil.

³Research Laboratory of Applied Physical Training to Performance and Health (LETFADS), Federal University of Paraíba, João Pessoa, PB, Brazil.

Abstract

Introduction: chia (*Salvia hispanica* L.) has an elevated concentration of dietary fiber, it has been used to weight loss and enhance blood glucose and lipid profile. However, data in human are still scarce or do not exist, according to the analyzed variable.

Aim: to evaluate the effect of chia supplementation in body composition, lipid profile and blood glucose in overweight or obese individuals.

Methods: men and women were randomly allocated in groups that ingested 35g of chia flour/day (CHIA; n=19; 48.8±1.8 years) or placebo (PLA; n=7; 51.4±3.1 years) for 12 weeks. Body composition and food intake were evaluated in each four weeks. Lipid profile and blood glucose were measured in the beginning and in the end of the study.

Results: Chia induced significant intragroup reduction in body weight (-1.1±0.4kg; p<0.05), with a greater reduction among obese than overweighted individuals (-1.6±0.4kg; p<0.00), but without difference when compared to PLA. Waist circumference reduced 1.9±0.6 cm in CHIA group (p <0.05), but only intragroup. It was observed a reduction in total cholesterol (p=0.04) and VLDL-c (p=0.03), and an increase in HDL-c (p=0.01) but only in the groups that ingested chia flour and presented abnormal initial values. Triglycerides, blood glucose and LDL-C showed no changes for either group.

Conclusion: consumption of chia for 12 weeks promotes significant but discrete reduction in weight and waist circumference, and enhances lipid profile dependent of initial values.

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Correspondence: Alexandre Sérgio Silva.
Rua Silvino Lopes,
410 /apto 804 – Tambaú – João Pessoa, PB.
CEP 58039-190.
E-mail: alexandresergiosilva@yahoo.com.br

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CHÍA PROMUEVE REDUCCIÓN DE LO PESO CORPORAL, PERO CLÍNICAMENTE DISCRETO, Y LA MEJORA DE LO PERFIL LIPÍDICO SÓLO EN LOS VALORES PREVIOS ALTERADOS

Resumen

Introducción: Debido al alto contenido de fibra dietética, la chía (*Salvia hispanica* L.) han sido propuesta para la pérdida de peso y mejora del perfil lipídico y glucémico. Pero los datos en humanos son escasos o inexistentes, en función de la variable analizada.

Objetivo: Evaluar el efecto de la suplementación con harina de chía en la composición corporal, perfil lipídico y glucémico de individuos con sobrepeso y obesidad.

Métodos: hombres y mujeres fueron asignados aleatoriamente en grupos que consumieron 35 g / día de chía (CHIA; n = 19; 48.8 ± 1.8 años) o placebo (PLA; n = 7; 51.4 ± 3.1 años) durante 12 semanas. La composición corporal y el consumo de alimentos fueron evaluados la cada cuatro semanas de intervención. Perfil lipídico y los niveles de glucosa se midieron al principio y al final del estudio.

Resultados: La chía promovió reducción significativa en el peso corporal (-1.1kg; p <0.05) con la mayor reducción entre los obesos (-1.9kg; p <0.00), mientras que el grupo PLA tenía ningún cambio. Circunferencia de la cintura disminuyó en 1,9 cm en el grupo CHIA (p <0.05), pero sólo intragrupo. Fue observada una disminución en el colesterol total (p = 0.04) y VLDL-c (P = 0.03) y el aumento de los niveles de HDL-c (p = 0.01), pero sólo en el grupo que consumió la chía y tenía valores anormales al inicio del estudio. Los niveles de triglicéridos, glucosa y LDL-c no mostraron cambios en ninguno de los grupos.

Conclusión: El consumo de chía durante 12 semanas reduce el peso corporal y la circunferencia de la cintura de manera significativa, pero clínicamente discreto. Chía promueve la mejora del perfil lipídico, pero estos efectos son dependientes de los valores iniciales de los grupos.

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Palabras clave: *Chía*. Pérdida de peso. Composición corporal. Colesterol.

Abbreviations

ANOVA: Analysis of variance
BMI: Body mass index
TC: Total cholesterol
HDL: High density lipoprotein
LDL: Low density lipoprotein
TG: Triglycerides
WHO: World Health Organization
VLDL: Very low density lipoprotein
WC: Waist circumference

Introduction

An important population behavior is a strong tendency to use foods, nutritional supplements or diets that have reporting of weight loss^{1,2}. Often, studies show a discrete weight loss or only in abdominal region, however the information that becomes popular relates only to weight loss without the details of the magnitude. Indeed, a review of literature showed the presence of diverse nutritional supplements with a potential property of weight loss, but none showed reduction bigger than 2 kg³.

It is well known that dietary fiber may promote weight loss, enhance in lipid profile and blood glucose and reduce blood pressure⁴⁻⁶. These fibers can lead to weight loss by delaying gastric emptying and increasing secretion of intestinal hormones which promote satiety⁷. Chia (*Salvia hispanica* L.) is a source of dietary fiber that has been investigated in recent years. Studies show that eating chia seeds can reduce systolic blood pressure, postprandial blood glucose and inflammation, and increases α -linolenic acid and plasma concentrations of eicosapentaenoic acid⁸⁻¹⁰.

These results seem to have popularized the chia. However, perhaps for its rich fiber content, it was spread one concept not shown in previous studies, that chia could have slimming capacity. In fact, the unique study that tested this property was the one performed by Nieman et al.¹¹, who found no effect of chia in slimming overweight or obese men and women. In other studies in which the properties of chia were tested for blood pressure, lipid or glucose profile, inflammation and oxidative stress, the variable body weight or waist circumference was treated as a secondary variable. Still, only one study showed that chia promoted reduction of waist circumference¹².

Therefore, chia has been popularly and commercially proposed to weight loss without scientific basis to support this possibility. Moreover, few studies appear insufficient to determine the impact of chia in weight loss.

In this sense, the present study was conducted to evaluate the effect of chia flour (*Salvia hispanica* L.) supplementation for 12 weeks on body composition in middle-aged men and women with overweight and obesity grade I. Additionally, the effect of chia on lipid profile and blood glucose was evaluated.

Methods

Subjects

Individuals of both sexes were recruited to participate in a randomized, double-blind placebo controlled experimental study. Were considered as inclusion criteria: age between 35 and 65 years, BMI between 25 and 35 kg / m², sedentary, do not have the habit of consuming chia (*Salvia hispanica* L.) or food supplements containing active substances present in that food (dietary fiber and α -linolenic acid) and not use drugs or supplements aiming weight loss. It would be excluded from the study volunteers who, throughout the study, begun to make use of weight loss drugs or nutritional supplements, altered their eating and physical activity habits as well did not use the amount of product supplied.

The project was submitted to the Ethics Committee on Human Research of the Lauro Wanderley University Hospital of the Federal University of Paraíba, being approved under protocol No. 206 338/13. All participants were informed about the research and asked to sign the Instrument of Consent as required by Resolution 196/96 of the National Health Council, which regulates the ethical aspects of researchs involving humans.

The study started with 29 volunteers who were randomized (www.randomizer.org) for groups CHIA and PLA. Three subjects did not complete the study, so that the groups ended up with the following configuration: (CHIA n = 19) and (PLA, n = 7).

Study design

Volunteers were initially submitted to anthropometric measurements (weight, body fat, height, and waist circumference), food intake evaluation and blood samples for analysis of plasma glucose (fasting plasma glucose) and lipid profile (total cholesterol, HDL-c, LDL-c, VLDL-c and triglycerides). Then the groups started the supplementation protocols lasting 12 weeks. In every four weeks, it was conducted a nutritional evaluation through anthropometric measurements and dietary intake. Forty-eight hours after the intervention period, volunteers were tested for the same initial variables.

Anthropometric evaluation

For determination of body weight and fat percentage, it was used a digital balance (Tanita, BF-683W, Rio de Janeiro, Brazil) with an accuracy of 0.1 kg and 150 kg capacity and 0.1% to fat percentage. Height was measured using a portable stadiometer (Sanny, São Paulo, Brazil) with measurement scale in 0.1cm. The values of body weight and height were used to calculate the Body Mass Index (BMI, kg/m²) according to

World Health Organization (WHO)¹³. Waist circumference was measured with inelastic and flexible anthropometric tape (Sanny, SN-4010, São Paulo, Brazil).

For purposes of analysis of possible changes in body composition with consumption of chia, it was adopted the subdivision of CHIA group in overweight or obese, according to BMI values obtained¹³.

Food intake evaluation

The eating habits were assessed using 24-hour dietary recall, applied before of the study to define exclusion criteria and during and after the supplementation period in order to verify changes in the habitual food intake of volunteers. Two of these were representative of weekday and one weekend day. The application of food recalls and the dietary nutrient analysis were performed by a nutritionist using Avanutri software version 4.0 (Avanutri, Rio de Janeiro, Brazil). After fist nutritional evaluation, the volunteers were instructed not to change their diets during the study.

In association with food recalls, issues regarding to potential gastrointestinal symptoms (constipation, diarrhea, heartburn, flatulence and nausea), allergy or intolerance attributed to the consumption of chia or placebo were added.

Supplementation protocols

CHIA group consumed 35 g of chia flour/day for 12 weeks, added to water, yogurt, vitamins, fruit or juices, since the volunteers were already accustomed to these foods. PLA group consumed the same amount of toasted wheat bran Cacalia, Rio Grande do Sul, Brazil, following the procedure adopted by Vuksan et al.⁸ in a previous study. The volunteers were instructed to avoid products provided as meal replacements, but as a complement to the usual food intake and it could be eaten at any time of day, in the main meals or snacks.

The delivery of the products occurred every four weeks of intervention. These were packaged in individual containers of similar appearance, in the quantity of the daily consumption. Volunteers were asked to return the packages monthly, so they could receive new products in order to ensure consumption control. All volunteers were instructed to retain the product in a cool dry place, and not subject them to any heating process. To encourage faithfulness in the consumption of the product supplied, the researchers sent messages by cell phone daily, for all who have accepted this procedure.

Chia flour used in the study contained the following nutritional composition in 35 grams of product: energy (154.3 kcal), carbohydrate (3.8 g), protein (10.8 g), total fat (10.1 g), omega 3 (3.8 g), omega 6 (1.4 g), omega 9 (0.7 g) and dietary fiber (14.7 g) according to the manufacturer. The wheat flour used as a placebo,

presented in 35 grams: energy (112 kcal), carbohydrates (10.5 g), proteins (5.6 g) and dietary fiber (14.0 g). This product is considered a neutral lipid, due to the absence of total, saturated, unsaturated and trans fat and cholesterol in its chemical composition.

Biochemical analysis

Blood samples (10 mL) were collected after 12 hours of fasting, for the analysis of markers of lipid and glucose profile at the beginning and in the end of the study. The total cholesterol (TC), high density lipoprotein (HDL-C), triglycerides (TG) and fasting glucose were measured using commercial kits (Labtest, Minas Gerais, Brazil) in automatic analyzer LabMax 240 premium. The amounts of low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein (VLDL-C) were estimated using the equation Friedewald¹⁴ [$LDL-C = (TC - HDL-C) - (TG / 5)$].

To assess possible changes in biochemical parameters after consumption of chia, we adopted the procedure of subdividing the CHIA group in normality or alteration in baseline biochemical variables, as recommended by the V Brazilian Guidelines on Dyslipidemia and Prevention of Atherosclerosis¹⁵.

Statistical analysis

Data are presented as mean and standard error of the mean. The normality and homogeneity of data were evaluated by the Shapiro-Wilk and Levene. ANOVA for repeated measures was used in the analysis of dietary intake and anthropometry, in each four-week intervention. For comparison between CHIA and PLA groups it was used one-way ANOVA and Tukey post hoc. Biochemical parameters were analyzed by paired and independent t test. The analysis were performed in GraphPad Instat 3.0 software (San Diego, CA, USA), adopting a statistical significance of $p < 0.05$ for all test.

Results

Groups showed similarities for all variables at baseline. They were middle-aged adults (48.8 ± 2 and 51.4 ± 3 years for CHIA and PLA groups, respectively) with no significant difference between them. Volunteers from both groups were overweight or obese, showed high waist circumference, hyperlipidemia and slightly increased blood glucose at baseline, but without a diagnosis of diabetes. The pre intervention values after chia group divided by normal and abnormal values of BMI, blood glucose and lipid profile are presented in table I and II.

Groups showed normal consumption of carbohydrates, proteins and lipids at baseline. The average daily intake of calories, macronutrients, and dietary fiber

Table I
Anthropometric data of CHIA and PLA groups at baseline and every four weeks of study

	CHIA			PLA
	General (n=19)	Overweight (n=8)	Obesity (n=11)	(n=7)
Weight (kg)				
Baseline	83.6±2	77.8±3	88.7±2	79.6±7
Week 4	83.0±2	77.8±3	87.6±2	79.3±7
Week 8	83.3±2	77.8±3	88.2±2	80.0±7
Week 12	82.5±2*	77.4±3	87.1±2***	79.4±7
BMI (kg/m²)				
Baseline	31.5±1	28.2±0	34.1±1	32.0±3
Week 4	31.3±1	28.2±0	33.8±1	32.0±3
Week 8	31.4±1	28.2±0	34.0±1	32.2±3
Week 12	31.2±1	28.1±0	33.7±1	32.0±3
Fat (%)				
Baseline	34.5±2	30.8±3	36.5±3	34.2±3
Week 4	34.9±2	31.9±3	36.6±3	36.6±3
Week 8	34.6±2	32.1±3**	36.1±3	34.6±3
Week 12	35.6±2	32.0±3	37.9±2*	36.7±3
WC (cm)				
Baseline	98.6±2	92.9±3	103.2±1	99.3±6
Week 4	97.0±2*	91.3±3	101.7±1	99.7±6
Week 8	97.4±2	91.1±3	102.4±1	98.2±6
Week 12	96.7±2*	90.9±3	101.4±1	98.1±6

BMI = body mass index; WC = waist circumference. Data are expressed as mean ± standard error. *p <0.05; ** P = 0.03; *** p <0.00; differences from baseline; ANOVA for repeated measures.

during the intervention period showed no significant differences from baseline (table III). However, it was observed that CHIA group exhibited increased protein intake on the fourth week compared to PLA.

Body weight significantly decreased in CHIA group after 12 weeks of intervention compared to baseline (table I) with a reduction of 1.1±0.4 kg. However,

Table II
Biochemical parameters evaluated at baseline and after 12 weeks of study

	CHIA		PLA (n=7)	
	Baseline	Week 12	Baseline	Week 12
Blood glucose (mg/dL)				
General (n=19)	112.1±7	114.7±5	105.8±7	104.0±6
Normal (n=6)	93.0±1	98.5±2		
Abnormal (n=13)	120.9±9	122.3±7		
TC (mg/dL)				
General (n=19)	239.2±18	219.8±11	240.1±15	229.0±14
Normal (n=6)	167.7±4	187.7±17		
Abnormal (n=13)	272.3±20	234.6±12*		
HDLc (mg/dL)				
General (n=19)	40.9±3	41.8±2	40.8±4	39.8±3
Normal (n=6)	51.1±2	44.1±4		
Abnormal (n=13)	31.8±3	39.8±2**		
LDLc (mg/dL)				
General (n=19)	163.2±17	147.8±11	134.1±14	132.1±9
Normal (n=6)	66.3±26	98.3±17		
Abnormal (n=13)	171.8±18	153.0±12		
VLDLc (mg/dL)				
General (n=19)	41.3±8	33.9±5	42.3±8	48.1±8
Normal (n=6)	22.8±2	32.5±8		
Abnormal (n=13)	81.5±14	36.8±4***		
TG (mg/dL)				
General (n=19)	214.1±40	151.8±22	215.0±34	259.0±38
Normal (n=6)	89.8±8	95.7±11		
Abnormal (n=13)	352.3±56	214.3±35		

TC = total cholesterol; HDLc = high density lipoprotein; LDLc = low density lipoprotein; VLDLc = very low density lipoprotein; TG = triglycerides. Data are expressed as mean ± standard error. *p = 0.04; **p = 0.01; ***p = 0.03, difference from baseline; paired t test.

when this group was subdivided into subjects with overweight and obesity, it was noted that the decrease in body weight was observed only in the obese subgroup (1.6±0.4 kg), whereas overweight group showed only 0.4±0.2 kg reduction. We could also observe that the statistical difference occurred only in intragroup analysis, so that the weight at the end of the interven-

Table III
Average daily intake of energy, macronutrients and dietary fiber of the volunteers

	CHIA (n=19)			PLA (n=7)		
	Baseline	Week 4	Week 12	Baseline	Week 4	Week 12
Energy (kcal)	1669.6±126	1739.8±112	1624.1±88	1742.0±155	1624.0±164	1677.1±143
Carbohydrate (g)	219.5±18	225.9±18	209.0±13	261.6±22	214.9±28	215.1±22
Protein (g)	74.5±6	92.9±6 [#]	89.0±8	62.7±8	56.8±6	75.5±10
Fat (g)	47.1±5	56.9±6	43.6±5	42.5±7	46.1±6	51.8±7
Fibers (g)	14.3±2	15.2±2	16.2±1	13.5±3	14.2±1	14.5±2

Data are expressed as mean ± standard error. [#] Difference from the placebo group, p <0.05; one way ANOVA test.

tion did not differ between CHIA and PLA groups. Since it was not possible to subdivide the PLA group in overweight and obesity, this analysis was conducted only among groups CHIA (without subdivision) versus PLA. Despite the reduction in body weight in CHIA group, there was no reduction in the percentage of fat in this group. On the contrary, CHIA group showed an increase in body fat when this group was divided into subgroups of overweight and obesity. BMI did not change in either group.

Waist circumference significantly decreased in the fourth and 12th weeks of study in volunteers who consumed chia (1.9±0.6 cm), without this phenomenon has been noted when the analysis was performed in subgroups of overweight and obesity. Despite the reduction observed, CHIA group did not finish the intervention with lower waist circumference compared to the PLA group.

Biochemical parameters did not change in groups CHIA and PLA. However, when subdividing CHIA group for normal or altered serum concentration, there was a reduction in total cholesterol (13.8%) and VLDL-C (54.8%) and an increase in HDL-c (25%) in the subgroup of volunteers who consumed chia and had abnormal values at baseline. Triglycerides, glucose and LDL-c exhibited no changes in any of the groups (table II).

Discussion

The present study demonstrated that 12 weeks of supplementation with 35 g of chia flour/day caused a significant reduction in body weight and waist circumference, but this reduction was observed only in the intragroup analysis and clinically discrete. Furthermore, the supplementation was able to enhance the serum concentration of TC, VLDL-C and HDL-C, but only when considered volunteers who presented abnormal values at baseline for these variables.

Dietary fiber may improve satiety, decrease caloric intake and promote weight loss^{4,16}. Chia flour and placebo used in the study contain similar amounts of dietary fiber. However, the fibers present in chia have high viscosity leading to gel formation in gastrointestinal tract¹⁷ that may confer to this food an additive effect on satiety, as demonstrated by Vuksan et al⁹, while placebo does not have this property of viscosity. The high content of omega-3 present in chia can help to reduce obesity by suppressing appetite, improving lipid oxidation and energy expenditure and reducing fat deposition, although these effects are only clearly evident in studies with animals¹⁸.

Despite these likely slimming possibility, few clinical studies have shown that intake of dietary fiber has a positive effect on weight control⁵. When specifically chia was studied it was only demonstrated increased satiety⁹ despite this seed contain about 30% fibers¹⁹. Meanwhile, the ability of chia to promote bodyweight reduction had only been investigated in three studies, at least to our knowledge.

Our findings demonstrate reduction in body weight with consumption of chia, which was not observed in previous studies that evaluated body composition after consumption of that food. Nieman et al.¹¹ demonstrated that the ingestion of 50 g of chia seed/day, for 12 weeks, was not able to reduce the body weight in obese or overweight subjects. Vuksan et al.⁸ demonstrated that ingestion of 37g of chia seeds/day for 12 weeks did not alter body weight in type 2 diabetic subjects with overweight. In this study, participants were instructed to consume a diet according to the nutritional recommendations of the Canadian Diabetes Association, which includes the daily intake of 25 to 35 g of dietary fiber. However, even with the adoption of a standard diet, and amounts of chia and period of use similar to our study, no body weight changes were observed in these individuals. Likewise, Nieman et al.²⁰ found that 25 g of chia seeds/day, for 10 weeks had no

effect on body composition in overweight women, but the period of use of chia was lower than ours.

It is noteworthy that the present study followed the possible changes in body weight every four weeks of intervention, which was not adopted in previous studies. However, the difference in body weight did not appear until the end of the 12 weeks of supplementation with flour chia. Despite these findings, Egras et al.²¹ stated that data are still limited to suggest the use of chia seeds in weight loss, although considered safe in short term. Our study had the longest intervention, along with Vuksan et al.⁸ and Nieman et al.¹¹ who also supplemented for 12 weeks. Considering the weight reduction only in our study, and that this phenomenon was only observed at 12 weeks, still with a clinically discrete magnitude, there is still a need to investigate whether protocols with longer periods of supplementation promote more weight loss.

Waist circumference in CHIA group reduced in the fourth week of supplementation, as well as in the end of the intervention. Although previous studies with consumption of chia isolated had not analyzed this parameter, Guevara-Cruz et al.¹² corroborate our findings by showing reduction in waist circumference (95.7 ± 8.6 vs 93.0 ± 8.9 cm, $p < 0.0001$) after consumption standard diet containing chia seeds, soy, nopal and oats by individuals with metabolic syndrome. However, this result was probably due to calorie reduction in the habitual diet (-500kcal), since the placebo group also showed decreased waist circumference (95.2 ± 9.0 vs 92.1 ± 9.0 cm, $p < 0.0001$). The decrease in waist circumference observed in our study was more discrete in relation to these data, but this phenomenon is easily explained by the fact that this previous study linked the consumption of chia with other grains and with a reduction in caloric intake, which alone can already promote waist circumference reduction, as actually occurred in control.

Previous studies using animal models showed robust results of consumption of chia in lipid profile. Reduction in visceral adiposity, prevention of dyslipidemia, hypertriglyceridemia normalization²²; improvement in adipose tissue and lipid metabolism dysfunction²³; lipid redistribution²⁴; decrease in serum triglycerides and increased HDL-C were observed in rats²⁵. However, data in humans are more inconsistent.

Biochemical parameters evaluated in this study showed change only when subdividing the group CHIA as normal or modified basal serum values to total cholesterol and VLDL-c and increasing serum concentrations of HDL-c. Serum triglyceride levels showed no differences, as opposed to the result found by Guevara-Cruz et al.¹² that demonstrated lowering serum triglycerides (-284.0 mg / dL) with the use of standard diet containing chia seeds and other grains, for two months in individuals with metabolic syndrome. However, this effect cannot be attributed solely to chia, since other grains have been consumed in combination. The absence of alterations in subjects with pre-

viously normal values corroborates Vuksan et al.⁸ and Nieman et al.¹¹, who also found no changes in serum lipids in subjects similar to those considered normal in our study initial conditions.

As for blood glucose, our findings do not suggest changes in any of the groups. Unlike, Vuksan et al.⁹ demonstrated a reduction of postprandial blood glucose by consuming different amounts of chia (7, 15 and 24 g), in healthy subjects. Moreover, our data corroborate Vuksan et al.⁸, Nieman et al.¹¹ and Nieman et al.²⁰ who found no differences in concentrations of fasting glucose in diabetics and overweight and obese individuals.

The small sample size of the PLA group made it impossible the formation of subgroups for assessment of body composition and biochemical parameters, as adopted for CHIA group, constituting the main limitation that we can see for this study. Thus, comparisons between groups could only be carried out between the groups PLA and CHIA without division into subgroups. Considering that the effects observed in this study were only noted at 12 weeks, our data point out the need of further studies with longer duration intervention, and sample size that allows the stratification of subjects according to body weight and biochemical profile in both experimental and placebo groups.

Taken together, our data show that consumption of 35 g of chia flour for 12 weeks can reduce body weight and waist circumference significantly, but clinically discrete in overweight or obese individuals. It promotes improvement in lipid profile with more clinically relevant magnitude, but these effects of chia consumption are dependent on the initial values of groups for body composition as for the lipid profile.

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Original/Investigación animal

Effect of computer radiation on weight and oxidant-antioxidant status of mice

Xuexian Pei, Qijun Gu, Dongdong Ye, Yang Wang, Xu Zou, Lianping He, Yuelong Jin and Yingshui Yao

School of public Health, Wannan Medical College, Wuhu, Anhui 241002, China.

Abstract

Objectives: To explore the effects of computer radiation on weight and oxidant-antioxidant status of rats, and further to confirm that whether vitamin C has protective effects on computer radiation.

Methods: Sixty Male adult ICR mice were randomly divided into six groups. each group give different treatment as follows: group A was control, group B given vitamin C intake, group C given 8 h/day computer radiation exposure, group D given vitamin C intake and 8 h/day computer radiation group E given 16 h/day computer radiation exposure, group F given vitamin C intake plus exposure to 16 h/day computer radiation. After seven weeks, mice was executed to collect the blood samples, for detecting total antioxidant capacity (T-AOC) and alkaline phosphates (ALP) content in serum or liver tissue were determined by ELIASA.

Results: No difference was found for the change of weight among six groups at different week. In the group C, D and F, the liver tissue T-AOC level were higher than the group A. In the group B, C and E, the serum ALP level were lower than the group A ($P < 0.05$).

Conclusions: The study indicate that computer radiation may have an adverse effect on T-AOC and ALP level of mice, and vitamin C have protective effect against computer radiation.

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Correspondence: Yingshui Yao.
School of Public Health, Wannan Medical College,
No. 22 Road wenchangxi, Yijiang district,
Wuhu, Anhui 241002 China.
E-mail: yingshuiyao@163.com

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EFFECTO DE LA RADIACIÓN SOBRE EL PESO Y LA COMPUTADORA EL ESTADO ANTIOXIDANTE DEL OXIDANTE DE RATONES

Resumen

Objetivos: Explorar los efectos de la radiación de ordenador sobre el peso y el estado oxidativo-antioxidativo de los ratones, y además para confirmar si la vitamina C tiene efectos protectores contra la radiación de ordenador.

Métodos: Sesenta ratones machos adultos ICR fueron aleatoriamente divididos en seis grupos. Cada grupo recibió un tratamiento diferente del modo siguiente: el grupo A fue el grupo de control, el grupo B recibió vitamina C, el grupo C fue sometido a una exposición a la radiación de ordenador de 8 h/día, el Grupo D recibió vitamina C y fue sometido a una exposición a la radiación de ordenador de 8 h/día, el Grupo E fue sometido a una radiación de ordenador de 16 h/día, el grupo F recibió vitamina C y fue sometido a una exposición a la radiación de ordenador de 16 h/día. Al cabo de siete semanas, los ratones fueron ejecutados para extraer las muestras de sangre, para detectar la capacidad antioxidante total (T-AOC) y el contenido de fosfatasa alcalina (ALP) en suero o en tejido hepático fue determinado mediante ELISA.

Resultados: No se encontraron diferencias en cuanto a cambio de peso entre los seis grupos diferentes. En los grupos C, D y F, el nivel de T-AOC en tejido hepático fue más alto que en el grupo A. En los grupos B, C y E, el nivel de ALP en suero fue más bajo que en el Grupo A ($P < 0,05$).

Conclusiones: El estudio indican que la radiación de ordenador puede tener un efecto adverso en los niveles de T-AOC y ALP de ratones, y que la vitamina C tendría un efecto protector contra la radiación del ordenador.

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Palabras clave: *Radiación electromagnética. Vitamina C. Antioxidantes.*

Introduction

With the development of modern science and technology, more and more electronic products gained popularity in daily life, so that human surrounded by electromagnetic fields (EMF) and extremely low frequency fields (ELF). Much research have shown that the electromagnetic radiation is harmful to human body. In a study it can be concluded that electromagnetic fields are harmful and can have adverse effect on human body depending upon the intensity and frequency of electromagnetic field. An increasing number of people report subjective symptoms and hypersensitivity to a wide variety of electromagnetic sources including power lines, radio and TV broadcasting stations, cellular phones, and computer monitors. Among the environmental risk factors of human, ELF-EMFs may have a possible association with childhood malignancy, especially leukemia, cancer, cardiovascular, neurological, and psychological diseases in adults¹⁻⁴. Therefore, people gradually pay attention to the potential harm of electromagnetic radiation, especially in the computer widely available at the present.

Recently, several studies reported that long-term exposure to radiation leads to reduction in serum testosterone levels. In vivo and in vitro experiments pointed the enhancement of free radical presence after electromagnetic field exposure⁵⁻⁷. Excessive production of free radical specifically reactive oxygen species, have been reported in wide variety of clinical disorders⁸⁻¹⁰. Vitamin C (vit C), as a powerful antioxidant, it may have benefits in diseases. Existing studies have shown that vitamin C provides a protective to body in some organs and tissues^{11, 12}.

Despite the limited research shows vitamin C could enhance the antioxidant defense systems in the liver and kidney of irradiated animals. Based on our knowledge, there is little study in investigating the possible protective effects of vitamin C against radiation generated by computer^{13, 14}. Thus our study has two aims: The first purpose is to confirm that whether computer radiation have a adverse effect on serum and liver tissue. Next, we will investigate the protective effects of vitamin C on serum and the liver tissue after exposure to the radiation of computer.

Methods

Sixty male mice (average 12g and four weeks old, in puberty period) were divided into Six groups (control=A, vitamin C=B, exposure to 8 h/day=C, exposure to 8 h/day plus vitamin C=D, exposure to 16 h/day=E, exposure to 16 h/day plus vitamin C=F). Every group includes ten Male ICR rats. Group A served as a control, group B was given orally vitamin C at a dose of 500 mg/kg and the remaining four groups, C,D,E and F were exposed to radiation generated by main-frame of computer. At the same time, group D and F

was given orally vitamin C at a dose of 500 mg/kg^{15, 16}. Group C and D were exposed to computer radiation for 8 hours daily and group E and F were exposed to computer radiation for 16 hours daily for the period of 7 weeks. During the study, all the animals were house in 6 cages in the similar environment and were fed with standard pellet diet and water ad-libitum.

At the end of the study period, killed the rats to collect the blood samples of serum and the liver tissue of homogenizes. The upper, clear part of serum and homogenizes was used in the measurements. Serum ALP and T-AOC levels were measured from the supernatants. ALP levels were measured by alkaline phosphates assay kit. T-AOC was measured by total antioxidant capacity assay kit with ABTS method. Additionally, the liver tissues were submitted for histological and morphologic examinations.

The study was approved by the Ethics Committee of Wannan Medical College.

All statistical analyses were carried out using R software programming language¹⁷. Data were given as mean $\pm$ standard deviation (mean $\pm$ SD). In the statistical evaluation of the results, One-way analysis of variance test was performed; Bonferroni's Multiple Comparison Test was used for Post test. Statistical significance was defined as a p value lower than 0.05.

Results

Figure 1 showed the change of weight by week, no difference was found among six groups at different week. The table I, figure 2 and figure 3 showed that the serum T-AOC, ALP level and liver tissue T-AOC level in all group. In the group C, D and F, the liver tissue T-AOC level were higher than the group A. In the group B, C and E, the serum ALP level were lower than the group A ($P < 0.05$).

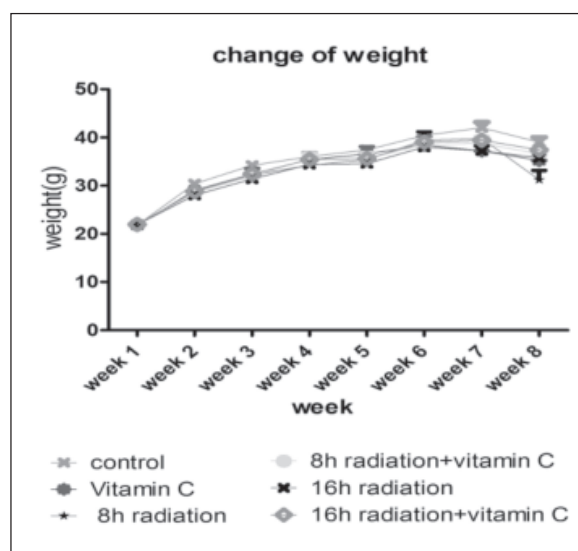


Fig. 1.—Change of weight by week.

Table II
The mainframe of computer radiation effect in the serum and liver tissue (Mean±SD)

Groups	Serum T-AOC level (mM)	Serum ALP level (mM)	Liver tissue T-AOC level (mmol/g)
A	1.058±0.339	1.536±0.338	1.522±1.466
B	1.318±0.278	1.202±0.237*	2.471±0.643
C	1.383±0.269	1.149±0.497*	3.351±0.945*
D	1.043±0.418**	1.278±0.301	3.207±0.691*
E	1.066±0.089	1.141±0.299#	3.228±1.257#
F	1.091±0.289	1.337±0.326	2.145±0.768##

The asterisk indicates a $p < 0.05$ compare with group C. The double asterisk indicates a $p < 0.05$ for group C versus group D. The sharp indicates a $p < 0.05$ for group A versus group E. The double sharp indicates a $p < 0.05$ for group E versus group F. ($F=4.016, P=0.0041$).

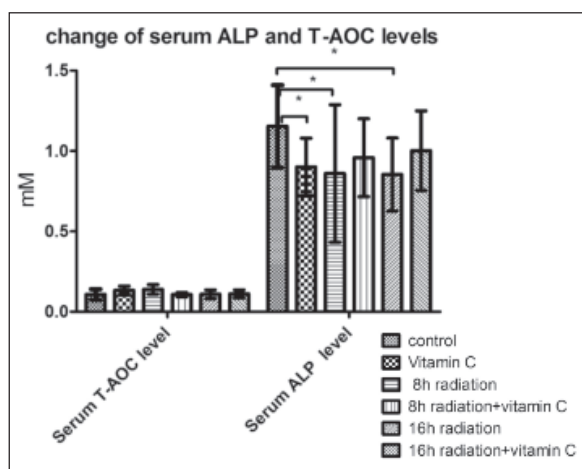


Fig. 2.—Compare of level of serum T-AOC and ALP among six groups.

Discussion

Our present study finds the change of total antioxidant capacity (T-AOC) and alkaline phosphates (ALP) level between the experimental group and the control group. The serum T-AOC, ALP level and the liver tissue T-AOC level are significant difference when the mice were exposed to computer radiation for 8 hours daily, which reveal the effect of exposure to low frequency fields. Increase the exposure time, when the rats were exposed to computer radiation for 16 hours daily, we also find that seems to have differences compared to control group. Vitamin C (vit C) is a powerful antioxidant so that counteract oxidative stress^{11, 12, 18}. Another discover of our study is that the difference was found between group D exposure to 8 h/day computer radiation plus vitamin C and group C exposure to 8 h/day computer radiation in serum T-AOC level.

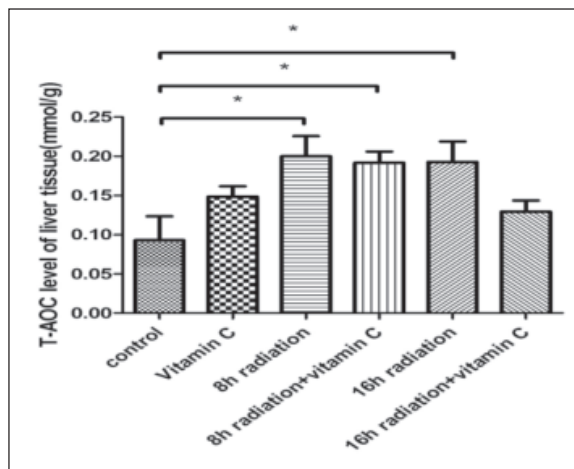


Fig. 3.—Compare of level of liver tissue T-AOC among six groups.

In the exposure to 16 h/day plus vitamin C group, the liver tissue T-AOC level was significantly lower, compared with the exposure to 16h/day group.

The increasing number of people fall into the dilemma which surrounded by electromagnetic fields, when they are using computer. In response to public concern, the government take measures to decline the harm, for instance to develop safety standards. In order to provide reliable evidence, scientists have made a contribution to the research in the related field. ELF-EMFs may affect biological systems by increasing free radical life span and the concentration of free radicals^{19, 20}. Recent studies have suggested that human and animal exposure to cell phone radiation lead to a significant overproduction of ROS (reactive oxygen species)²¹⁻²³. There are some studies have confirm the relation ROS with superoxide dismutase (SOD), glutathione Peroxides (GSH-Px), malonaldehyde (MDA), catalyses (CAT)^{11, 18}.

In conclusion, exposure to mainframe of computer radiation has a negative effect on mice. The antioxidant, vitamin C maybe reduces the damage from the long-term radiation. There is a need for further study in order to get more reliable conclusions. For instance, adjust the dose of vitamin C and Increase in exposure group to explore dose-response relationship.

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Disclosure of conflict of interest

None.

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Original/Ancianos

Estimación y validación de puntos de corte de índice de masa muscular esquelética para la identificación de sarcopenia en adultos mayores chilenos

Lydia Lera¹, Bárbara Ángel¹, Hugo Sánchez¹, Yaisy Picrin², María José Hormazabal¹, Andrea Quiero³ y Cecilia Albala¹

¹Instituto de Nutrición y Tecnología de los Alimentos (INTA) de la Universidad de Chile. ²CISA. ³Servicio de Salud y Educación, Municipalidad Huechuraba, Chile.

Resumen

Objetivos: Estimar y validar puntos de corte de índice de masa muscular esquelética (IMMAE) en adultos mayores chilenos, para el diagnóstico de sarcopenia

Métodos: Estimación de puntos de corte para IMMAE determinados por DEXA y por ecuación antropométrica en un análisis secundario de datos transversales de 440 Adultos Mayores (AM) chilenos, y posterior validación transversal en una muestra de 164 AM. Se realizaron pruebas de rendimiento físico, auto-reporte de salud, antropometría y DEXA. Se definió la fuerza muscular disminuida por dinamometría de mano <15 kg mujeres y <27 kg hombres. Los puntos de corte del IMMAE se definieron los inferiores al p20 según medición DEXA y con curvas ROC para aquellos estimados por ecuación. La validez biológica del algoritmo se efectuó contrastando el diagnóstico con pruebas de rendimiento físico y funcionalidad.

Resultados: Los puntos de corte de IMMAE obtenidos por DEXA fueron 7,19 kg/m² en hombres y 5,77 kg/m² en mujeres y 7,45 kg/m² y 5,88 kg/m² respectivamente para las estimaciones del modelo. La sensibilidad y especificidad de las estimaciones respecto a DEXA fueron 80% y 92% en hombres y 77% y 89% en mujeres.

Conclusiones: Se obtuvieron puntos de corte para el IMMAE en adultos mayores chilenos, calculados por DEXA y estimados a través de una ecuación de predicción, con buena sensibilidad y especificidad respecto de la medición por DEXA. Ello permitirá aplicar el algoritmo diagnóstico del EWGSOP en la atención primaria para diagnosticar precozmente esta condición y desarrollar programas destinados a su prevención, retardo y reversión.

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Palabras clave: Índice de masa muscular esquelética. Sarcopenia. Adulto mayor.

Correspondencia: Dr. Lydia Lera y Dr. Hugo Sánchez
Dirección Postal: El Líbano 5524, Casilla 138, Correo 11
Santiago-Chile.
E-mail: llera@inta.uchile.cl; hsanchez@inta.uchile.cl

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VALIDATION OF CUT POINTS OF SKELETAL MUSCLE MASS INDEX FOR IDENTIFYING SARCOPENIA IN CHILEAN OLDER PEOPLE

Abstract

Objectives: To estimate and validate cut-off points of skeletal muscle mass index (SMI) in Chilean population, for using in an algorithm for a diagnosis of sarcopenia developed by European Working Group on Sarcopenia in Older People (EWGSOP).

Methods: Secondary analysis of Cross-sectional data in 440 Chilean older subjects to estimate cut-off points of SMI determined by DEXA and predicted by an anthropometric equation. Afterward a cross-sectional validation in a sample of 164 older people was performed. Anthropometric measures, self-reported health status, physical performance tests and DEXA were carried out. Decreased muscle strength was defined as handgrip strength <15 kg in women and <27 kg in male. Cut-off points of SMI were defined as values under 20th percentile for DEXA measures and estimated through ROC curves for the anthropometric model. Biological validity of the algorithm was tested by contrasting the diagnosis with physical performance tests and functionality.

Results: Cut-off points of SMI obtained by DEXA were 7.19 kg/m² in men and 5.77 kg/m² in women and 7.45 kg/m² and 5.88 kg/m², respectively for the predicted by the model. Sensibility and specificity of estimations vs DEXA measures were 80% and 92% in men and 77% and 89% in women.

Conclusions: We obtained cut-off points of SMI for DEXA and for a prediction equation for older adults Chilean, with good sensibility and specificity for the measurement by DEXA. It will allow to apply the EWGSOP algorithm to the early diagnosis of sarcopenia and to develop programs for prevention, delay or reversion this syndrome.

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Keys words: Skeletal muscle mass index. Sarcopenia. Older adults.

Abreviaturas

DEXA: dual energy x ray absorptiometry.
MMAE: masa muscular apendicular esquelética.
IMMAE: índice de masa muscular esquelética.
SMI: skeletal muscle mass index.
IC 95%: intervalo de confianza del 95%.
Kg: kilogramos.
cm: centímetros.
m: metros.
seg: segundos.
AM: Adultos mayores.
IMC: Índice de Masa Corporal.
DE: desviación estándar.
EWGSOP: Grupo de trabajo europeo sobre sarcopenia.
CAPS: Centros de atención primaria de salud.
SPPB: Short Physical Performance Battery.
TUG: Time & up go.
ROC: Receiver Operating Characteristic.
RV: razón de verosimilitud.
VPPP: valores predictivos positivos.
VPPN: valores predictivos negativos.

Introducción

La sarcopenia es un síndrome geriátrico resultante de múltiples factores de riesgo, que produce graves repercusiones en la salud de las personas mayores¹⁻³. Aunque no existe una definición clínica de consenso ni criterios internacionales para su definición, hay bastante acuerdo en caracterizarlo como la pérdida de masa, calidad y fuerza muscular esquelética en personas mayores. Es generalmente aceptado y ampliamente reportado en la literatura internacional, que la sarcopenia es un importante factor de riesgo para pérdida de funcionalidad, caídas, disminución de la función inmune³⁻⁸ y disminución de la masa esquelética⁹, asociándose con fragilidad, fracturas, hospitalización, dependencia, institucionalización y muerte^{10,11} en personas mayores.

La disminución de la discapacidad en la población mayor observada en las últimas décadas en el mundo desarrollado¹² no ha seguido una trayectoria similar en América Latina, donde el rápido proceso de envejecimiento cursa con altas tasas de discapacidad en adultos mayores (AM), alcanzando cifras superiores a 20% en limitación de al menos una actividad básica de la vida diaria (ABVD) en la Región¹³. En Chile la esperanza de vida estimada para el período 2010-2015, alcanza a 82,2 años en mujeres y 76,1 años en hombres¹⁴ con cifras de limitación funcional superiores a 45% y significativo mayor riesgo en los grupos económicamente más vulnerables¹⁵.

Considerando que la sarcopenia es un importante factor de riesgo para discapacidad y dependencia y que se ha demostrado que en etapas tempranas es posible prevenirla, retardarla, e incluso revertirla a través de intervenciones destinadas a mejorar la nutrición y la acti-

vidad física^{4,16-18}, su identificación temprana es un hito inevitable si se quiere impactar sobre estas condiciones.

El diagnóstico de sarcopenia requiere la cuantificación de la masa muscular (MM), y específicamente la masa magra apendicular esquelética (MMAE), que es la suma de la masa magra (Kg) de las piernas y los brazos. En los estudios clínicos se considera como Gold Standard su medición a través de absorciometría dual de rayos X (DEXA), resonancia magnética o impedanciometría³. Estos exámenes son costosos, por lo que en la atención primaria, donde se concentran los sectores más vulnerables y en estudios poblacionales, se dificulta su diagnóstico.

Aunque reconocida globalmente como una condición que aumenta la vulnerabilidad de los AM, la sarcopenia no ha sido universalmente reconocida como una entidad clínica por falta de definiciones de consenso. Si bien es cierto, todas las definiciones publicadas incluyen la cuantificación de la MM y específicamente la MMAE, difieren en la utilización de los indicadores y puntos de corte para evaluarla y en los tests de funcionalidad que se utilizan. De ahí que según la definición utilizada, su prevalencia varía ampliamente con cifras que van desde 5 a 50%¹⁹.

La importancia de este síndrome – dados los efectos adversos sobre la salud que produce y el alto costo asociado- y la urgente necesidad de lograr una definición de aplicación universal, han llevado a las sociedades científicas internacionales a buscar un consenso en su definición.

En el año 2010, el Grupo Europeo de Trabajo sobre sarcopenia en AM (EWGSOP) desarrolló una definición clínica práctica consensuada que utiliza como indicadores de función muscular la velocidad de marcha y la dinamometría de mano. El algoritmo diagnóstico evalúa primero la dinamometría y la velocidad de marcha. Si cualquiera de ambas está disminuida, entonces se realiza un examen de composición corporal por DEXA para calcular el índice de masa muscular esquelética (IMMAE).

Considerando que la validez de las definiciones que se utilicen para el diagnóstico de sarcopenia depende del uso de puntos de corte de referencia obtenidos de poblaciones de similar composición etárea, racial y étnica²⁰ y que las características morfológicas de la población Latinoamericana difieren de la europea²¹ nos propusimos estimar puntos de corte propios de IMMAE, para su utilización en el algoritmo del consenso europeo para el diagnóstico de sarcopenia³. Asimismo, dada la baja accesibilidad de nuestra población a las determinaciones por DEXA, validamos los valores correspondientes estimados por un modelo con variables antropométricas, previamente desarrollado por nuestro grupo²².

Material y método

El estudio se diseñó en dos etapas:

Primera etapa: Predicción. Análisis secundario de datos transversales para estimar puntos de corte pro-

pios del IMMAE en AM chilenos, medidos por DEXA y estimados por la ecuación de predicción.

Segunda etapa: Validación. Validación transversal de los puntos de corte estimados por la ecuación de predicción y por DEXA, en una nueva muestra de AM beneficiarios del sector público de salud,

Población objetivo

Adultos de 60 años y más pertenecientes al sector público de salud, viviendo en la comunidad, en Santiago de Chile.

Criterio de inclusión: AM autovalentes según criterio de screening de funcionalidad utilizado en todos los Centros de Atención Primaria de Salud (CAPS) chilenos²³.

Criterios de exclusión: sospecha de demencia²⁴, presencia de cáncer, IMC>40, talla: ≤146 cm en mujeres y ≤150 cm en hombres.

Muestra de predicción

De un universo de 1139 AM participantes de las cohortes SABE²⁵ y ALEXANDROS¹⁷, evaluados entre 2008 y 2011, se obtuvieron 565 sujetos con antropometría completa que cumplían con los criterios de inclusión y exclusión. De ellos, 440 tenían además datos de función física. Esta muestra es capaz de detectar una proporción esperada de sarcopenia de 50% o menor, con una amplitud de intervalo de confianza (IC) de 0.10, un nivel de confianza de 95% y un poder de 90%²⁶.

Muestra de validación

164 AM inscritos en CAPS de la comuna de Huechuraba en Santiago, que cumplían con los criterios de inclusión y exclusión. La muestra se calculó considerando una proporción esperada de sarcopenia de 0,4⁹ para un IC 95% de ±0.075 con un poder de 90%²⁶. La muestra así calculada se obtuvo a partir de los registros -previamente aleatorizados- de los AM inscritos en los CAPS. Los sujetos seleccionados fueron contactados telefónicamente -manteniendo el orden del listado aleatorizado- para invitarlos a participar en el estudio. En este llamado se verificaron los criterios de inclusión y los que cumplían con dichos criterios y aceptaron participar, fueron citados. En esta cita se les informó del estudio, y se verificaron los criterios de exclusión.

A todos los sujetos se les realizó una entrevista, en la que se registraron variables sociodemográficas, auto-reporte de salud y las mismas variables de estado de salud, de funcionalidad, antropometría y rendimiento físico que las incluidas en la etapa 1. Las evaluaciones y mediciones se efectuaron de igual forma y con instrumentos similares que en la muestra de predicción por personal calificado.

Una vez estimados los puntos de corte de IMMAE por DEXA y por la ecuación de predicción, se aplicó el

algoritmo diagnóstico del consenso europeo para calcular la prevalencia de sarcopenia en ambas muestras, utilizando como puntos de corte para dinamometría disminuida, valores previamente calculados en Chile^{27,28}.

Esta investigación fue aprobada por el Comité de Ética del INTA, Universidad de Chile y todos los participantes firmaron un consentimiento informado.

Variables primarias

Masa muscular: La medición de la MMAE se realizó por DEXA (LUNAR IDEXA 13.6), que se calcula como la suma de la masa magra (Kg) de las piernas y los brazos. La evaluación de masa muscular disminuida se hace mediante el IMMAE que relaciona la MMAE con la talla: $IMMAE = MMA / \text{talla}^2$ (kg/m²).

Así mismo la MMAE se estimó por el modelo:

$MMAE \text{ (kg)} = 0,107(\text{peso-kg}) + 0,251(\text{altura rodilla-cm}) + 0,197(\text{circunferencia pantorrilla-cm}) + 0,047(-\text{dinamometría-kg}) - 0,034(\text{circunferencia de cadera-cm}) + 3,417(\text{Sexo-Hombre}) - 0,020(\text{edad-años}) - 7,646$ ²².

Mediciones antropométricas y fuerza muscular: Se midieron peso, talla, altura de rodilla, circunferencias de cintura, cadera, pantorrilla y brazo, y dinamometría de mano, de acuerdo a métodos previamente descritos^{22,29}. La fuerza muscular se midió a través de la de fuerza de agarre de la mano con un dinamómetro (Hand Dynamometer T-18; Country Technology, Inc.) utilizando la mano dominante, registrando la marca mayor.

Pruebas de función de extremidades inferiores: velocidad de marcha de 3 metros, balance y sentadillas³⁰. La velocidad de marcha se evalúa registrando el tiempo en segundos que demora el individuo en caminar 3 metros a paso normal. El test de equilibrio consiste en 5 pruebas: pararse en un pie durante 10 segundos, repetir lo mismo con el otro pie, pararse con los pies juntos en paralelo durante 10 segundos, pararse con los pies en tándem y en semitándem durante 10 segundos; las sentadillas consisten en sentarse y pararse 5 veces de una silla. El conjunto de pruebas de función de extremidades inferiores descrito, corresponde al *Short Physical Performance Battery* (SPPB) con una puntuación de 0 a 12, en que el mejor rendimiento corresponde a 12 puntos³¹.

Prueba Timed up & go (TUG): Corresponde al tiempo en segundos, que demora un individuo en levantarse de una silla, caminar 3 metros y volver a sentarse. Se considera el mejor tiempo de 2 intentos³².

Covariables

Variables Sociodemográficas y de salud: edad, sexo, nivel educacional, arreglos familiares, auto-reporte de salud y enfermedades crónicas.

Variables de Funcionalidad: Auto-reporte de capacidad de bañarse, que es la más compleja de las

actividades básicas de la vida diaria, actividades instrumentales de la vida diaria (preparar comida, administrarse sus medicamentos, administrar su dinero, efectuar quehaceres livianos de la casa, usar el teléfono) y actividades avanzadas de la vida diaria (caminar 1, 8 y 15 cuerdas, subir escalas, agacharse, levantar los brazos, acarrear 5 Kg de peso, tomar una moneda desde una mesa, hacer los quehaceres pesados de la casa).

Puntos de corte y diagnóstico de sarcopenia

Se estimaron puntos de corte de IMMAE en AM chilenos para su utilización en el algoritmo diagnóstico de sarcopenia del consenso europeo³, que propone evaluar además la velocidad de marcha y la dinamometría de mano. Si la primera es $\leq 0,8$ m/seg y/o la dinamometría es baja se calcula la IMMAE que si es baja define al sujeto como sarcopénico. El Gold Standard para el IMMAE fue calculado por DEXA y luego estimado por el modelo de predicción²². Como punto de corte para IMMAE disminuida se utilizó el percentil 20 (p20) de la muestra de 565 AM chilenos de los estudios SABE²⁸ y ALEXANDROS¹⁷ con medición de composición corporal por DEXA. Los puntos de corte de fuerza muscular disminuida habían sido previamente definidos en el estudio SABE cómo aquellos valores menores que el percentil 25 (p25) Dichos valores, posteriormente confirmados por nuestro grupo en 5618 AM chilenos, corresponden a <15 kg para las mujeres y <27 kg para los hombres²⁷⁻²⁸. Para velocidad de marcha disminuida utilizamos el valor de corte propuesto por EWGSOP³, que corresponde a $> 0,8$ m/seg.

Análisis estadístico

Las variables fueron descritas como promedio $\pm$ DE o proporciones expresadas en %. Se realizaron pruebas t de Student, de tendencia de grupos ordenados, Chi² y análisis de la distribución de los datos. Se utilizaron curvas ROC (Receiver Operating Characteristic) para la obtención de puntos de corte de los valores estimados por la ecuación de predicción. Se calculó sensibilidad, especificidad, razón de verosimilitud positiva (RV+) y negativa (RV-), valores predictivos positivos (VPPP) y negativos (VPPN), de la definición de sarcopenia propuesta utilizando los valores obtenidos por la ecuación de predicción usando como Gold Standard las mediciones obtenidas por DEXA ($<p20$ de IMMAE).

Todos los análisis fueron realizados con STATA 12,1³³.

Resultados

En la tabla I se muestran las características de las muestras de predicción y validación, por sexo. Se observa que las edades y la distribución por sexo, son similares, aunque el promedio de años de estudio es mayor en la muestra de predicción en ambos sexos (hombres: 9,5 vs 7; mujeres: 9,3 vs 6,2; $p<0,0001$). No hay diferencias

significativas entre los AM de las muestras de predicción y validación con relación a la autopercepción de salud ni en el número de enfermedades crónicas autoreportadas (HTA, diabetes, depresión y osteoartritis). Sin embargo, en ambas muestras, las mujeres presentan mayor número de enfermedades crónicas y mayor proporción de mala autoevaluación de la salud. Con relación a las actividades instrumentales de la vida diaria no hay diferencias entre ambas muestras aunque los hombres presentan mejor desempeño que las mujeres. Con relación a las actividades avanzadas, la muestra de predicción presenta mayor proporción de sujetos que pueden realizarlas.

En la tabla II se presenta el estado nutricional y la funcionalidad física de los sujetos de ambas muestras. Se observa un mayor índice de masa corporal (IMC) en la muestra de validación que en la de predicción (hombres: 27,8 vs 29,8; $p=0,032$; mujeres: 29 vs 30,8; $p=0,0044$) y consecuentemente una mayor prevalencia de obesidad (hombres: 27,9 vs 48,8; $p=0,027$; mujeres: 37,2 vs 51,7; $p=0,011$). En relación a las condiciones de funcionalidad, los AM de la muestra de predicción presentan mejores condiciones de funcionalidad física -fuerza muscular, velocidad de marcha, TUG y SPPB- que los de la muestra de validación.

La figura 1 muestra las curvas ROC para las estimaciones de puntos de corte de IMMAE de la ecuación de predicción tomando como Gold Standard las mediciones del DEXA (hombres: 7,19 kg/m²; mujeres: 5,77 kg/m²) y la sensibilidad, especificidad, RV+, RV-, VPPP y VPPN de los puntos de corte del índice de masa muscular esquelética obtenidos por las curvas ROC (7,45 kg/m² hombres; 5,88 kg/m² mujeres). La sensibilidad y especificidad fue alta en las dos muestras, siendo mejor en los hombres que en las mujeres (sensibilidad: 82,5 vs 75,7%; especificidad: 80,6% vs 86,4%; respectivamente).

La tabla III muestra la sensibilidad, especificidad, RV+, RV-, VPPP y VPPN para el algoritmo diagnóstico de sarcopenia usando los valores estimados por la ecuación de predicción y utilizando DEXA como Gold standard, en la muestra de validación. Se observa que la sensibilidad y la especificidad son buenas, siendo mejor la especificidad en ambos sexos, y mayor en los hombres que en las mujeres (sensibilidad: 85,70% vs 75%; especificidad: 94,3% vs 89,1%; respectivamente). Los VPPN son altos tanto en hombres como en mujeres (94,4%). En los hombres, la RV+ nos indica que es 14 veces más probable obtener un diagnóstico positivo en pacientes enfermos que sanos y que la probabilidad de obtener un diagnóstico negativo en pacientes sanos es casi el cuádruple (4,8 veces) que en pacientes enfermos. En las mujeres es 7 veces más probable obtener un diagnóstico positivo en pacientes enfermos que sanos y la probabilidad de obtener un diagnóstico negativo en pacientes sanos es casi el doble (1,9 veces) que en pacientes enfermos.

La prevalencia de sarcopenia obtenida por la ecuación de predicción es ligeramente mayor que la obtenida por DEXA (15 vs 13,5; $p=0,1893$).

Tabla I
Características generales de la muestra por etapa y sexo

		Muestra de predicción		Muestra de validación	
		Hombres n=148	Mujeres n=292	Hombres n=46	Mujeres n=118
Edad ¹	promedio ± DE	69,26±6,25	68,74±5,94	69,87±5,84	69,06±5,28
	IC 95%	68,25-70,28	68,06-69,43	68,22-71,51	68,10-70,02
Sexo ²	%	33,63	66,36	28,05	71,95
	IC 95%	29,20-38,07	61,93-70,80	21,10-35,00	65,00-78,90
Años de escolaridad ³	promedio ± DE	9,5±4,4**	9,29±4,56***	7,0±3,41**	6,19±3,0***
	IC 95%	8,77-10,22	8,76-9,82	5,97-7,99	5,64-6,785
<8 años ²	%	48,97*	45,10***	71,74*	80,87***
	IC 95%	40,73-57,20	39,30-50,91	58,22-85,26	73,51-88,17
Autopercepción de salud ²					
Buena	%	65,1	56,0	57,1	52,5
	IC 95%	56,2-73,3	49,9-61,9	42,2-71,2	43,2-61,7
Regular	%	31,0	35,7	40,8	39,2
	IC 95%	23,2-39,7	30,1-41,7	27,0-55,8	30,4-48,5
Mala	%	3,9	8,3	2,0	8,3
	IC 95%	1,3-8,8	5,3-12,2	0,1-11,0	4,1-14,8
Número de enfermedades crónicas ²					
0	%	37,8	17,1	26,1	11,0
	IC 95%	30,0-46,2	13,0-21,9	14,3-41,1	6,0-18,1
1	%	26,4	29,8	34,8	33,1
	IC 95%	19,5-34,2	24,6-35,4	21,4-50,2	24,7-42,3
2	%	27,7	32,2	34,8	28,8
	IC 95%	20,7-35,7	26,9-37,9	21,4-50,2	20,8-37,9
3 ó +	%	8,1	20,9	4,4	27,1
	IC 95%	4,3-13,7	16,4-26,0	0,5-14,8	19,3-36,1
Actividades instrumentales de la vida diaria (AIVD) ²⁺					
0	%	78,4	71,6**	76,1	66,1**
	IC 95%	70,9-84,7	66,0-76,7	61,2-87,4	56,8-74,6
1	%	14,9	22,3	15,2	17,8
	IC 95%	9,6-21,6	17,6-27,5	6,3-28,9	11,4-25,9
2	%	6,7	6,2	8,7	16,1
	IC 95%	3,3-12,1	3,7-9,6	2,4-20,8	10,0-24,0
Actividades avanzadas de la vida diaria (AAVD) ²					
0	%	31,1	24,0**	37,0	18,6**
	IC 95%	23,7-39,2	19,2-29,3	23,2-52,5	12,1-26,9
1	%	31,1	21,2	28,3	35,6
	IC 95%	23,7-39,2	16,7-26,4	16,0-43,5	27,0-44,9
2	%	21,6	22,3	30,4	28,0
	IC 95%	15,3-29,1	17,6-27,5	17,7-45,8	20,0-37,0
3+	%	16,2	32,5	4,4	17,8
	IC 95%	10,7-23,2	27,2-38,2	0,5-14,8	11,4-25,9

¹t-student; ²test exacto de Fisher; ³test de Wilcoxon: *p<0,01; **p<0,001; ***p<0,0001; DE: desviación estándar; IC: intervalo de confianza

Tabla II
Estado nutricional y función de la muestra por etapa y sexo

		Muestra de predicción		Muestra de validación	
		Hombres (n=148)	Mujeres (n=292)	Hombres (n=46)	Mujeres (n=118)
IMC¹					
	Promedio ± DE	27,81 ±4,58*	29,0±5,61**	29,83± 5,26*	30,77 ±5,5**
	IC 95%	27,06-28,55	28,36-31,68	28,21-31,45	29,76-31,78
Estado nutricional²					
Normal	%	29,25*	25,17**	18,60*	14,67**
	IC 95%	22,05-37,31	20,28-30,58	6,49-3630,72	9,12-21,19
Sobrepeso	%	42,86	37,59	32,56	33,62
	IC 95%	34,74-51,27	31,99-43,44	17,97-47,15	24,89-42,35
Obeso	%	27,89	37,24	48,84	51,72
	IC 95%	20,82-35,88	31,66-43,09	33,27-64,40	42,49-60,95
Dinamometría¹					
	Promedio ± DE	36,2±7,88*	21,46±5,91	33,57±7,27*	20,52 ±4,48
	IC 95%	34,93-37,49	20,78-22,14	31,41- 35,73	19,70-21,34
>P25²					
≤ 75 años	%	92,44	92,34	86,11	90,91
	IC 95%	0,86-0,96	0,88-0,95	74,24-97,98	85,15-96,67
>75 años	%	72,41	75	60,00	63,16
	IC 95%	0,53-0,87	0,60-0,87	23,06-96,94	39,27-87,04
Velocidad de marcha¹					
	Promedio ± DE	0,98±0,21***	0,88±0,21***	0,74±0,20***	0,63±0,16***
	IC 95%	0,95-1,01	0,86-0,91	0,68-0,80	0,60-0,66
TUG¹					
	Promedio ± DE	7,72±2,24**	8,44±3,27**	8,79±2,75**	10,42±3,92**
	IC 95%	7,36-8,08	8,06-8,81	7,97-9,60	9,70-11,13
SPPB³					
	Mediana	12***	11***	10***	9***
	P25 – P75	11-12	10-12	8-11	8-11
Puede caminar más de 15 cuerdas²					
	%	69,8***	62,1***	37,0***	16,1***
	IC 95%	61,1-77,5	56,1-67,8	23,2-52,5	10,0-24,0

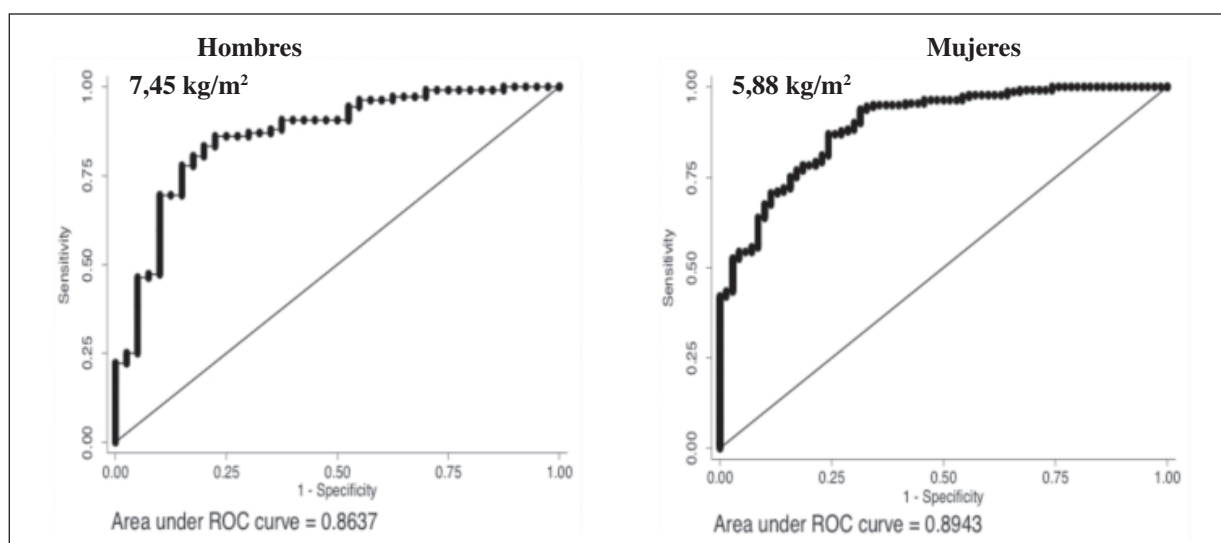
¹t-student; ²test exacto de Fisher; ³test de Wilcoxon: *p<0,05; **p<0,01; ***p<0,001

DE: desviación estándar; IC: intervalo de confianza; P25-P75: percentil 25-percentil 75; IMC: índice de masa corporal; SPPB: Short Physical Performance Battery; TUG: Time & UP GO.

Cuando se efectúan pruebas de funcionalidad física en individuos diagnosticados con y sin sarcopenia (tabla IV) se observa que el desempeño es significativamente mejor en los sujetos sin sarcopenia y que ello ocurre tanto en los diagnosticados con IMMAE medido por DEXA como en aquellos diagnosticados con IMMAE estimado a través de la ecuación antropométrica.

Discusión

En este estudio se obtuvieron puntos de corte para IMMAE en AM chilenos, calculados por DEXA. Asimismo, considerando que la ecuación antropométrica sobrestima ligeramente la MMAE en relación al DEXA, se estimaron puntos de corte para las estimaciones de la ecuación de predicción²², obteniéndose



		Muestra de predicción n=440		Muestra de validación n=164	
		Hombres n= 148	Mujeres n= 292	Hombres n=46	Mujeres n=118
Sensibilidad		82,5	75,7	80	76,9
	IC 95%	67,2-92,7	64,0-85,2	44,4-97,5	56,4-91
Especificidad		80,6	86,4	91,7	89,1
	IC 95%	71,8-87,5	81,2- 90,7	77,5-98,2	80,9- 94,7
RV+		4,24	5,6	9,6	7,1
	IC 95%	2,8-6,4	3,9-8,0	3,11-29,6	3,8-13,2
RV-		0,22	0,28	0,22	0,26
	IC 95%	0,11-0,43	0,19-0,43	0,06-0,757	0,13-0,52
VPPP		61,1	63,9	72,7	66,7
	IC 95%	46,9-74,1	52,6-74,1	39-94	47,2-82,7
VPPN		92,6	91,8	94,3	93,2
	IC 95%	85,3-97	87,2-95,2	80,8-99,3	85,7-97,5

IC: intervalo de confianza; RV+ y RV-: razón de verosimilitud positiva y negativa respectivamente; VPPP y VPPN: valores predictivos positivos y negativos, respectivamente.

Fig. 1.—Puntos de corte del IMMAE obtenidos por curva ROC para los valores correspondientes estimados por un modelo con variables vs los obtenidos por DEXA por sexo (hombres: 7,19 kg/m²; mujeres: 5,77 kg/m²) y validez de los puntos de corte del IMMAE estimados por ecuación vs los obtenidos por DEXA en las muestras de predicción y validación.

buena sensibilidad y especificidad respecto de la medición por DEXA.

Los valores obtenidos en población chilena calculados con el p20 de la distribución, al igual que Newman et al en el estudio Health ABC³⁴, resultaron similares a los obtenidos por ese autor, especialmente en mujeres en que nuestro cálculo fue de 5,77 kg/m² vs 5,67 kg/m² en el estudio ABC. En hombres la diferencia también es mínima siendo ligeramente inferiores los chilenos (7,19 kg/m² vs 7,25 kg/m²). Otros autores⁷, utilizando el mismo método para calcular el punto de corte, obtuvieron valores iguales a los de Newman y similares a los nuestros. Los valores de corte de IMMAE obtenidos en este estudio también son similares a los obtenidos por Baumgartner en el estudio Rosetta

en Nuevo México¹⁹ (hombres 7,26 kg/m²; mujeres 5,5 kg/m²), utilizando como punto de corte 2 desviaciones estándar bajo el promedio de adultos jóvenes¹⁹.

Una vez calculados los puntos de corte de IMMAE, se adaptó y validó el algoritmo diagnóstico de sarcopenia desarrollado por EWGSOP³, en una muestra de 440 AM chilenos autovalentes. Posteriormente se efectuó una validación transversal en una muestra aleatoria proveniente de AM inscritos en CAPS de Santiago de Chile, identificando la condición de sarcopenia de acuerdo a DEXA y al modelo de predicción, el que mostró alta sensibilidad y especificidad respecto de los cálculos efectuados con DEXA.

Dentro de los métodos estadísticos usados por otros autores para el cálculo de puntos de corte está el méto-

Tabla III
Validez del algoritmo diagnóstico de sarcopenia con IMMAE estimado por la ecuación antropométrica usando como Gold Standard el algoritmo con IMMAE calculado por DEXA en la muestra de validación

		Hombres n=46	Mujeres n=118	Total n=164
Sensibilidad		80	79,2	79,4
	IC 95%	44,4-97,5	57,8-92,9	62,1-91,3
Especificidad		94,4	89,4	90,8
	IC 95%	81,3-99,3	81,3- 94,8	84,4- 95,1
Área curva ROC		0,87	0,84	0,85
	IC 95%	0,74-1,0	0,75- 0,93	0,78- 0,92
RV+		14,4	7,44	8,6
	IC 95%	3,62-57,4	4-13,8	4,9-15,1
RV-		0,21	0,23	0,23
	IC 95%	0,06-0,73	0,11-0,51	0,12-0,44
VPPP		80	65,5	69,2
	IC 95%	44,4-97,5	45,7-82,1	52,4-83
VPPN		94,4	94,4	94,4
	IC 95%	81,3-99,3	87,4-98,2	88,8-97,7

IC: intervalo de confianza; ROC: Receiver Operating Characteristic; RV+ y RV-: razón de verosimilitud positiva y negativa respectivamente; VPPP y VPPN: valores predictivos positivos y negativos, respectivamente

do de los residuos, que considera incluir en un modelo de regresión lineal la MMA en función de la masa grasa y la talla, utilizando los residuos para clasificar a los sujetos con o sin sarcopenia; aquellos con residuos negativos se considerarían como posibles sarcopénicos, tomándose como punto de corte el P20 de la distribución de los residuos, para clasificarlos como sarcopénicos. Aunque dicho método ajusta por masa grasa además de la talla, lo que se arguye mejora la validez del diagnóstico en sujetos con sobrepeso y obesos³⁴, nosotros preferimos utilizar la distribución percentilar dada la mayor facilidad para su cálculo a nivel individual en la atención primaria. Aún sin el ajuste por masa grasa, cuando aplicamos el algoritmo diagnóstico en una población con altas tasas de obesidad como es la muestra de validación, las diferencias en la prevalencia de sarcopenia son mínimas y no significativas. Así mismo se demostró la validez biológica del algoritmo, contrastando el diagnóstico de sarcopenia efectuado con puntos de corte DEXA y con estimaciones, con pruebas de rendimiento físico y funcionalidad, las que resultaron especialmente robustas para SPPB y TUG, encontrándose que el grupo diagnosticado con sarcopenia, tanto calculado por DEXA como por los valores estimados por la ecuación, presenta peor desempeño físico que los no sarcopénicos.

La prevalencia de sarcopenia determinada por la ecuación es sensiblemente igual (1,5 puntos porcentuales de diferencia) que la obtenida con mediciones DEXA y tiene alta especificidad, lo que nos garantiza que en aquellos AM que son diagnosticados sin sarcopenia, la probabilidad de ser un falso negativo es muy pequeña (5,6%).

Con relación a la fuerza muscular disminuida, el EWGSP recomienda los puntos de corte estimados por Laurentani et al⁴ con curvas ROC, en una muestra de 1030 adultos entre 20 y 102 años, que corresponde a dinamometría <30 kg (hombres) y <20 kg (mujeres). En nuestro estudio utilizamos como punto de corte el p25 de la distribución de las dinamometrías del estudio SABE Chile previamente validado^{28,27}, que corresponde a <27 kg (hombres) y <15 kg (mujeres), lo que nos muestra que en nuestra población, si bien el IMMAE es similar al descrito en estudios previos efectuados en Europa y USA, la función muscular es inferior.

Se sabe que la sarcopenia no es una consecuencia obligada del envejecimiento, sino que es posible de prevenir, retardar e incluso revertir a través de intervenciones destinadas a mejorar la nutrición y la actividad física^{4,16,35}. Una revisión bibliográfica exhaustiva de 106 trabajos realizada por Padilla et al¹⁸ muestra que los ejercicios de fuerza en AM pueden retardar la aparición de sarcopenia en este grupo etáreo. En Chile una intervención con ejercicios de resistencia progresiva, sumada al programa de alimentación complementaria para AM (PACAM) efectuada en el marco del estudio CENEX mostró una significativa efectividad en aumentar la velocidad de marcha en el grupo intervenido con relación a los no intervenidos³⁵.

Una limitación del algoritmo diagnóstico de sarcopenia para la realidad local, es que incluye la dinamometría, la que no se efectúa en forma rutinaria en la atención primaria. Sin embargo, considerando su asociación negativa con mortalidad, discapacidad e

Tabla IV
Funcionalidad física en individuos con y sin sarcopenia diagnosticada con IMMAE medido por DEXA y estimado por ecuación antropométrica

		Sarcopenia		No sarcopenia	
		DEXA n=82	Ecuación n=87	DEXA n=523	Ecuación n=518
¹ Equilibrio en semi tandem	%	90,3	90,2	94,6	94,7
	IC 95%	81,0-96,0	81,7-95,7	92,2-96,4	92,3-96,5
¹ Equilibrio en tandem	%	67,1**	68,7*	80,3**	80,3*
	IC 95%	55,1-77,7	55,6-78,4	76,5-83,7	76,5-83,7
² Tiempo marcha (seg)	promedio±DE	4,8±1,3****	4,9±1,9****	3,7±1,3****	3,7±1,1****
	IC 95%	4,6-5,1	4,5-5,3	3,6-3,9	3,6-3,8
² Sentarse y pararse 5 veces de una silla (seg)	promedio±DE	13,7±6,9*	14,3±6,7***	12,1±5,3*	12,0±5,2***
	IC 95%	12,0-15,3	12,9-15,8	11,6-12,6	11,5-12,4
³ Puntaje SPPB	promedio±DE	9,5±2,4****	9,3±2,5****	10,5±1,8****	10,6±1,8****
	IC 95%	8,9-10,0	8,8-9,9	10,4-10,7	10,4-10,7
² Equilibrio pie derecho	promedio±DE	6,9±3,9*	7,3±4,0*	8,0 ±4,02*	8,0±4,0*
	IC 95%	5,9-7,8	6,4-8,3	7,6-8,4	7,6-8,3
² Equilibrio pie izquierdo	promedio±DE	7,0±4,0*	7,4±3,7	8,1±4,3*	8,1±4,3
	IC 95%	5,9-8,0	6,4-8,3	7,7-8,5	7,7-8,5
² Prueba TUG (seg)	promedio±DE	10,1±4,0**	10,3±5,5****	8,5±3,3**	8,5±2,8****
	IC 95%	9,3-11,0	9,2-11,5	8,2-8,8	8,2-8,7

¹t-Student; ²Prueba exacta de Fisher; ³Prueba de rangos de Wilcoxon: *p<0,05; **p<0,01; ***p<0,001; ****p<0,00001;
 DE: desviación estándar; IC: intervalo de confianza; SPPB: Short Physical Performance Battery; TUG: Time & UP GO

institucionalización, su inclusión constituye un argumento más para su incorporación al examen clínico del AM⁴. Una limitación del estudio es que se trata de una validación transversal y que se requieren validaciones longitudinales para un diagnóstico de mayor precisión.

La principal fortaleza del estudio es el método de validación empleado en la obtención de puntos de corte chilenos para el diagnóstico de sarcopenia, basados en una ecuación de predicción de MMA cuyos valores estimados presentan una alta concordancia con los valores obtenidos por el DEXA²².

El algoritmo propuesto para el diagnóstico de sarcopenia, es válido y seguro, de bajo costo y fácil de obte-

ner, y puede ser utilizado tanto en la atención primaria como en estudios poblacionales. El poder incorporar un algoritmo de estas características tiene gran relevancia ya que permite identificar de mejor forma una condición de riesgo en un grupo poblacional que va en aumento, lo que permitirá su consideración en las políticas públicas relacionadas con el AM.

Conclusiones

Los puntos de corte de IMMAE determinados para la población AM Chilena, representan un importante

aporte para el diagnóstico de sarcopenia. Si a ello se suma la obtención de puntos de corte de IMMAE estimados por ecuación antropométrica, que no requiere DEXA, nos encontramos frente a una herramienta fundamental para el diagnóstico de sarcopenia, que es válida, segura y accesible para los equipos de salud.

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Original/Ancianos

Nutritional status of institutionalized elderly Brazilians: a study with the Mini Nutritional Assessment

Maria Luiza Amorim Sena Pereira¹, Pricilla de Almeida Moreira², Carolina Cunha de Oliveira³, Anna Karla Carneiro Roriz², Magali Teresópolis Reis Amaral⁴, Adriana Lima Mello² y Lílían Barbosa Ramos²

¹Universidade Federal do Oeste da Bahia, Barreiras, Bahia. ²Universidade Federal da Bahia, Salvador, Bahia. ³Universidade Federal de Sergipe, Lagarto, Sergipe. ⁴Universidade Estadual de Feira de Santana, Feira de Santana, Bahia, Brazil.

Abstract

Objective: To assess the nutritional status of elderly living in nursing homes in the city of Salvador, Brazil and associated factors.

Methods: Cross-sectional study performed with 359 individuals of both sexes, ages equal or over 60 years old, located in Nursing Homes in the urban area of the city of Salvador, Bahia, Brazil.

Results: Regarding nutritional status according to Mini Nutritional Assessment (MNA), 66.3% of the evaluated elderly were malnourished and at risk of malnutrition. When comparing sexes, it has been observed that among men the prevalence of this condition (76.6%) was higher than in women (62.4%). It has been observed, as a result of the multivariate analysis, that only the variable functional capacity for Activities of Daily Living (ADL) was statistically significant. There was moderate correlation between MNA and Mini-Mental State Examination ($r=0.454$; $p<0.0001$), as well as between MNA and the ADL scale ($r=0.569$; $p<0.0001$). There was weak negative correlation between MNA total score and age ($r=0.159$; $p=0.002$).

Conclusion: Malnutrition and malnutrition risk were conditions of remarkable importance, with almost two-thirds of the elderly in this situation. ADL functional capacity must be monitored given their close relationship with the nutritional status of the elderly. An interdisciplinary approach in the context of institutionalization is needed due to the association between nutritional status and variables of different dimensions.

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Key words: Nutritional Status. Elderly. Nursing homes. Mini Nutritional Assessment.

Correspondence: Maria Luiza Amorim Sena Pereira.
Universidade Federal do Oeste da Bahia.
Centro das Ciências Biológicas e da Saúde.
Rodovia BA 827, s/n, Campus Reitor Edgard Santos.
47.800-000, Barreiras, Bahia, Brazil.
E-mail: marialuizasena@hotmail.com

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ESTADO NUTRICIONAL DE ANCIANOS BRASILEÑOS INSTITUCIONALIZADOS: UN ESTUDIO CON EL MINI NUTRITIONAL ASSESSMENT

Resumen

Objective: Evaluar el estado nutricional de los ancianos residentes en Hogares para Ancianos, en la ciudad de Salvador, Brasil y factores asociados.

Métodos: Estudio transversal con 359 individuos mayores de 60 años, de ambos sexos y residentes en hogares de ancianos en la zona urbana de la ciudad de Salvador, Bahia, Brasil.

Resultados: En cuanto al estado nutricional de acuerdo con Mini Nutritional Assessment (MNA), el 66,3% de los ancianos evaluados estaban desnutridos y en riesgo de desnutrición. La prevalencia de esta afección fue mayor entre los hombres (76,6%) en comparación con las mujeres (62,4%). Se ha observado, como resultado del análisis multivariado, que sólo la capacidad funcional variable para Actividades de la Vida Diaria (AVD) fue estadísticamente significativa. Hubo correlación moderada entre MNA y Mini Examen del Estado Mental ($r = 0,454$; $p < 0,0001$), así como entre MNA y la escala AVD ($r = 0,569$; $p < 0,0001$). Hubo correlación débil negativa entre la puntuación total del MNA y la edad ($r = 0,159$; $p = 0,002$).

Conclusión: La desnutrición y el riesgo de desnutrición fueron de importancia excepcional de las condiciones, porque casi dos tercios de los ancianos estaban en esta situación. La capacidad funcional para AVD debe ser supervisada por su estrecha relación con el estado nutricional de las personas mayores. Un enfoque interdisciplinario en el contexto de la institucionalización es necesario debido a la asociación entre el estado nutricional y variables de diferentes dimensiones.

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Palabras clave: Estado Nutricional. Anciano. Hogares para Ancianos. Mini Nutritional Assessment.

Abbreviations

MNA: Mini Nutritional Assessment.
HD: Health District.
GDS: Geriatric Depression Scale.
ADL: Scale of Daily Living Activities.
SPSS: Statistical Package for Social Science.
CI: Confidence intervals.
BMI: Body mass index.
PR: Prevalence ratios.

Introduction

Population is aging at an accelerate rhythm due to significant declines in mortality and fertility rates occurring in a relatively short time¹. In Brazil, it is estimated that, during the next four decades, the elderly population will more than triple, and Brazil will increase from 20 million seniors in 2010 to approximately 65 million in 2050. This process is characterized not only by a proportional increase in the elderly, but also in life expectancy, making this age group able to reach older ages².

This scenario has triggered an increase in demand for Nursing homes³. However, institutionalization imposes changes in daily life of the elderly, which can undermine their health⁴.

Whereas the peculiarities of the aging process and elderly institutionalization have an impact on the nutritional status of these subjects, it is extremely important to perform a nutritional evaluation in these population, including appropriate methods⁵.

In the past decades, instruments have been developed that allow evaluating the nutritional statuses of elderly, as the Mini Nutritional Assessment (MNA). This tool is able of expressing the malnutrition phenomenon, being of easy application and low cost and for these reasons it has been widely used by researchers and practitioners in the world⁶.

Thus, the present study aims to assess the nutritional status of elderly living in nursing homes in the city of Salvador, Brazil and associated factors.

Methods

Cross-sectional study performed with individuals of both sexes, ages equal or over 60 years old, located in Nursing Homes in the urban area of the city of Salvador, Bahia, Brazil.

A survey was made in 29 Nursing Homes in the city, with a total of 1239 elderly, (323 men and 916 women). The sample size calculation was performed to ensure its representativeness, being stratified by Health District (HD) of the city, with sample power of 80%, totaling 412 individuals. However, MNA application was possible in 359 elderly, residents in 15 Nursing Homes, located in eight HD, due to the high number

of frail elderly, with severe physical or mental impairment that prevented the collection, or because they were absent of the Nursing Homes due to hospitalization.

A previously standardized and coded questionnaire was used, and specific scales for assessment of nutritional status, cognitive, psychological and clinical aspects and functional capacity were applied. A properly trained multidisciplinary team performed data collection and the procedures were standardized as a measure of quality control and consistency.

Nutritional Status

For the assessment of nutritional status, MNA has been used. This instrument consists in 18 items covering 4 blocks: anthropometry (body mass index, calf circumference and arm circumference), dietary (number of meals, autonomy to feed, water and food ingestion), global assessment (medicines, residence, mobility, dementia, stress and nutritional status). The interpretation is based on the total score, being considered as malnourished individuals who obtained scores lower than 17; between 17 and 23.5, at risk of malnutrition; and when the score is greater than or equal to 24 they are considered as adequate⁷.

Cognitive ability

Cognitive functions were assessed from the applications of the Mini-Mental State Examination^{8,9}. Diagnostic criteria considering schooling were the ones recommended by Bertolucci *et al.*¹⁰.

Suspected depression

Suspected depression was evaluated according to the Geriatric Depression Scale in its short version (GDS-15) of Yesavage *et al.*¹¹, adapted and classified according to Sheikh and Yesavage¹².

Clinical aspects

To review clinical aspects the previously standardized and coded questionnaire has been used, containing questions regarding the use of medication and presence of comorbidity (hypertension, diabetes mellitus and dyslipidemia).

Functional capacity

For the assessment of functional capacity the Scale of Daily Living Activities (ADL) has been used¹³.

Data processing and statistical analysis

Data were analyzed with the Statistical Package for Social Science (SPSS), version 16.0. Individuals malnourished and at risk were grouped for analysis, involving *t-Student's* test to compare averages, and the verification of association with several variables were made by Pearson's Chi-square test and Fisher's test, when needed. For correlation analysis the Pearson's correlation coefficient was used. For all of the above analyzes a significance level of 5% was considered.

Poisson regression has been performed, presenting the reasons for raw and adjusted prevalence and their respective confidence intervals at 95% (CI 95%). Variables that were associated with significance level under 10% ($p < 0.10$) were included in the model.

Ethical aspects

The Ethics Committee of the Federal University of Bahia School of Nutrition, under decision 11/2012, approved this study.

For this study the authorization of Nursing Homes was previously required, through their respective directors and/or senior administrators and elderly participation in the study was voluntary, by signature or fingerprint on the Statement of Informed Consent. All results were returned to the Nursing Homes.

Results

Elderly residents were evaluated in 15 institutions, located in eight Health Districts in the city of Salvador. Sociodemographic characteristics, body mass index (BMI), morbidity and institutionalization length are presented in table I. From 359 individuals, the majority (72.7%) were female. Individual were between 60 and 102 years old and more than half (54.6%) were over 80 years old. The average age was 74.3 (+8.7) years among men and 81.5 (+8.7) years among women ($p < 0.0001$). Among the evaluated elderly, the proportion of individuals who had finished elementary school was 71.3%.

Regarding morbidity profile and medication use, it is highlighted that more than half of the evaluated individuals (55.6%) had hypertension, and used three or more medications per day (60.6%).

According to BMI, 44.3% were underweight, 34.3% normal weight and 21.4% were overweight. The average BMI was 22.7 kg/m², with no statistically significant difference between men and women (data not shown).

Regarding nutritional status according to MNA, 66.3% of the evaluated elderly were malnourished and at risk of malnutrition. When comparing sexes, it has been observed that among men the prevalence of this condition (76.6%) was higher than in women (62.4%) (Fig. 1).

Table I
Socio-demographic characteristics, BMI, morbidity and institutionalization length of the institutionalized elderly in Salvador, Bahia, 2014

Variables	N	%
Gender		
Male	98	27.3
Female	261	72.7
Age		
60 to 79 years	163	45.4
80 years or more	196	54.6
BMI		
Underweight	159	44.3
Appropriate	123	34.3
Overweight	77	21.4
Education		
Up to complete primary education	204	71.3
From the incomplete secondary education	82	28.7
Morbidities		
Hypertension	188	55.6
Diabetes	60	18.1
Dyslipidemia	55	16.7
Use of medications		
Less than 3 per day	138	39.4
Three or more per day	212	60.6
	Mean	Standard deviation
Age (years)	79.5	9.3
BMI (kg/m ²)	22.7	5.3
Institutionalization length (years)	6.1	8.9

BMI: Body Mass Index.

A relation has been found between nutritional status and sociodemographic characteristics (Table II). It is observed that only gender ($p = 0.012$) and education ($p = 0.042$) were associated with nutritional status.

Regarding the variables related to elderly health, it has been found that dyslipidemia, cognitive capacity, the suspicion of depression and functional capacity for ADLs was associated to nutritional status (Table III).

The raw and adjusted Prevalence ratios (PR) of independent variables and their respective confidence intervals are presented in table IV. It was observed, as a result of the multivariate analysis, that only the variable functional capacity for ADL was statistically significant.

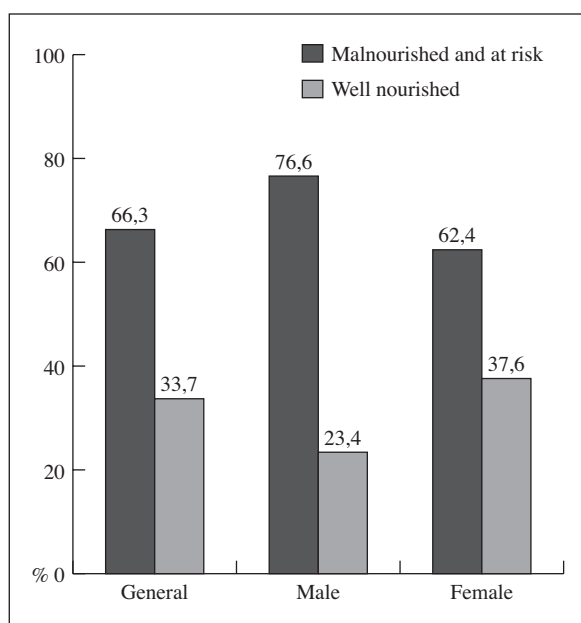


Fig. 1.—Classification of nutritional status (MNA – Mini Nutritional Assessment) according to the gender of the institutionalized elderly in Salvador, Bahia, 2014.

There was moderate correlation between MNA and Mini-Mental ($r=0.454$; $p<0.0001$), as well as between MNA and the ADL scale ($r=0.569$; $p<0.0001$). There was weak negative correlation between MNA total score and age ($r=0.159$; $p=0.002$) (data not shown).

Discussion

Approximately two thirds of the evaluated elderly in Nursing Homes of Salvador where malnourished or at risk of malnutrition, according to MNA. Although few studies evaluate the nutritional status of institutionalized

elderly, many of these have shown similar results, both in Brazil¹⁴ as well as in other countries^{15,16,17}.

Such evidences point to the nutritional vulnerability of institutionalized elderly, emphasizing the importance of nutritional care geared to this population, since malnutrition in this group is associated with increased morbidity and dependence¹⁸.

Malnutrition in the elderly, generally, is related to adverse socioeconomic conditions, as well as depressive states and pathophysiological factors^{19,20,21,22}. In the institutionalization context, it is common to have the presence of aspects that affect the elderly alimentation, among them, are the food preparation and monotony of menus. A negative impact may be observed due to the institutional feeding routine⁴. In the present study, nutritional status was associated with gender, education, dyslipidemia, cognitive ability, suspected depression and functional capacity for ADLs.

Elderly men had a greater potential for malnutrition and malnutrition risk. This result is similar to the one found by Menezes and Marucci²³, who identified a high proportion of elderly with low weight, especially among men, an aspect attributed to the fact of women having longer weight gain (plateau around 75 years old) than men (plateau around 65 years old) declining thereafter^{5,24}.

In the study by Pereira Machado and Santa Cruz Coelho²⁵, also held in Brazil, education was associated to the nutritional status. In the work above, most investigated subjects had few education, as observed in this study. This result may be related to low socioeconomic status and poor access to information. Barreto *et al.*²¹ also suggests that low education is a risk factor for low weight, explained by lower income in old age²⁶.

The study performed by Wu *et al.*²⁷, in Taiwan, with 111 institutionalized individuals, despite its methodological differences, found an association between cognitive capacity and nutritional status, as well as in the

Table II
Socio-demographic characteristics and nutritional status of the institutionalized elderly in Salvador, Bahia, 2014

	Total N	MNA		p-value*
		Malnourished and at risk N(%)	Well nourished N(%)	
Gender				
Male	359	75 (31.5)	23 (19.0)	0.012
Female		163 (68.5)	98 (81.0)	
Age				
60 to 79 years	359	109 (45.8)	54 (44.6)	0.833
80 years or more		129 (54.2)	67 (55.4)	
Education				
Up to complete primary education	286	131 (75.7)	73 (64.6)	0.042
From the incomplete secondary education		42 (24.3)	40 (35.4)	

MNA: Mini Nutritional Assessment; * p-value according to MNA by the Chi-squared test.

Table III
Characteristics of health according to the nutritional status of institutionalized elderly in Salvador, Bahia, 2014

	Total N	MNA		p-value*
		Malnourished and at risk N(%)	Well nourished N(%)	
Use of medications				
Less than 3 per day	350	97 (41.6)	41 (35.0)	0.234
Three or more per day		136 (58.4)	76 (65.0)	
Hypertension				
Yes	338	124 (54.9)	64 (57.1)	0.692
No		102 (45.1)	48 (42.9)	
Diabetes				
Yes	332	39 (17.6)	21 (19.1)	0.734
No		183 (82.4)	89 (80.9)	
Dyslipidemia				
Yes	329	30 (13.6)	25 (23.1)	0.029
No		191 (86.4)	83 (76.9)	
Cognitive ability				
Cognitive decline	253	96 (63.6)	47 (46.1)	0.006
Without cognitive decline		55 (36.4)	55 (53.9)	
Depression				
Suspected depression	256	64 (41.6)	30 (29.4)	0.048
Without suspected depression		90 (58.4)	72 (70.6)	
Functional ability to ADL				
Dependent and partially dependent	328	114 (52.1)	13 (11.9)	<0.0001
Independent		105 (47.9)	96 (88.1)	

MNA: Mini Nutritional Assessment; ADL: Activity of daily living. * p-value according to MNA by the Chi-squared test.

present study. These observations confirm the relevance of this variable in the nutritional status of elderly living in Nursing Homes²⁸, since the decline of cognitive capacity can lead to anorexia, decrease of food intake and weight loss, increasing the risk of morbidity and mortality²⁹.

Regarding the functional ability to perform ADLs, in this study associations between this variable and nutritional status have been observed, as was observed by Wu *et al.*²⁵. This association was also verified in an Italian study performed with 718 elderly, 316 of which lived in institutions¹⁷. In that study the authors concluded that this association was more pronounced among those living in institutions compared to those living in the community.

In this work it has been observed that dependent or partially dependent individuals for performing ADLs are approximately 1.6 times more malnourished or at risk of malnutrition than independent individuals. In an analysis by Azevedo *et al.*²⁰, with hospitalized elderly, those that had mobility loss had 5.27 times more chances of being malnourished or being at nutritional

risk. This may have been observed because the research has been performed with hospitalized elderly, whose health conditions differ from the ones of institutionalized individuals.

The impaired functional capacity may be the cause or the consequence of the nutritional status of institutionalized elderly. It is possible that nutritional status is an important factor in maintaining functional capacity, due to some aspects such as the lowest level of physical activity and muscle atrophy^{30,31}.

Different methods have been used in the specific evaluation of nutritional status, however, there is no agreement about the most appropriate. It has been noted, however, that many are the studies using MNA as a tool for nutritional assessment of the elderly population^{16,18,6,26,19,32}.

MNA, the main tool for assessment of nutritional status of elderly in the present study, is widely recommended and used worldwide³³, by promoting the detection of malnutrition risk, enabling rapid interventions that benefit the nutritional status and reducing the consequences of inadequate intake. Moreover, MNA has been

Table IV
Prevalence ratio of crude and adjusted association and confidence intervals at 95% of the variables composing the model. Institutionalized elderly in Salvador, Bahia, 2014

	PR	IC 95%	PR adjusted	IC 95%
Gender				
Male	1.225	1.061-1.416	1.220	0.826-1.803
Female	1.0	-	1.0	-
Education				
Up to complete primary education	1.254	0.991-1.585	1.068	0.692-1.646
From the incomplete secondary education	1.0	-	1.0	-
Dyslipidemia				
Yes	0.782	0.607-1.008	0.848	0.509-1.412
No	1.0	-	1.0	-
Cognitive ability				
Cognitive decline	1.343	1.078-1.672	1.179	0.804-1.728
Without cognitive decline	1.0	-	1.0	-
Depression				
Suspected depression	1.226	1.008-1.490	1.138	0.780-1.660
Without suspected depression	1.0	-	1.0	-
Functional ability to ADL				
Dependent and partially dependent	1.718	1.487-1.986	1.590	1.072-2.359*
Independent	1.0	-	1.0	-

ADL: Activities of daily living; PR: Prevalence ratio, CI: Confidence interval; *IC95% statistically significant.

recommended for both the evaluation as well as for the monitoring of this population. However, its application is limited in debilitated individuals, and prevents the identification of obese or overweight individuals^{6,16,34}.

Thus, the nutritional status assessment presented itself as a fundamental aspect in Nursing Homes' context and the results of researches conducted around the world, as well as the results found in this study, corroborate with the hypothesis that factors such as depression, functional and cognitive capacity may be associated with nutritional status of the elderly living in institutions.

Conclusion

From these results, it is possible to conclude that malnutrition and malnutrition risk were conditions of remarkable importance, with almost two-thirds of the elderly in this situation. This fact points to the need of a proper nutritional approach for providing assistance to institutionalized individuals.

Variables such as gender, education, dyslipidemia, cognitive ability, suspected depression and, especially, ADLs functional capacity must be monitored, given their close relationship with the nutritional status of the elderly.

Finally, according to the association between nutritional status and variables of different dimensions, an interdisciplinary approach in the context of institutionalization is needed, in order to improve the health and quality of life of the elderly.

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Original/*Ancianos*

Prevalencia de desnutrición en personas mayores institucionalizadas en España: un análisis multicéntrico nacional

Raúl Vaca Bermejo¹, Iciar Ancizu García¹, David Moya Galera¹, Mónica de las Heras Rodríguez² y Josep Pascual Torramadé³

¹Departamento de Investigación, SARquavitae (Barcelona). ²Coordinación Técnica-Asistencial, SARquavitae (Madrid).

³Dirección Técnica-Asistencial, SARquavitae (Barcelona).

Resumen

Introducción: Un estado nutricional deficitario tiene importantes consecuencias en la salud de los colectivos en situación de especial vulnerabilidad, como las personas con enfermedades crónicas o personas mayores en situación de dependencia.

Objetivo: Conocer el estado nutricional al ingreso de usuarios en centros SARquavitae.

Material y Método: Se estudió el estado de salud, cognitivo y funcional de las personas que ingresaron durante el año 2012 en algún centro de la compañía. El estado nutricional fue evaluado mediante la versión corta del Mini Nutritional Assessment. Asimismo, se realizó un análisis para conocer las variables con mayor influencia en el estado nutricional de la muestra objeto de estudio.

Resultados: Se analizaron las historias clínicas de 4.297 ingresos. La edad media fue de 82,08 años. Un 66,1% eran mujeres con una alta pluripatología. Al ingreso, un 30,4% de la muestra se encuentra en situación de desnutrición y un 49,4% en riesgo de desnutrición. Se observa una mayor prevalencia de desnutrición en mujeres, en aquellas personas que son derivadas por un hospital de agudos o por sus consultas externas, con peor estado funcional y cognitivo y en aquellas con procesos patológicos como demencia, enfermedades cerebrovasculares o disfagia.

Conclusiones: Los resultados de este estudio ponen de manifiesto la alta complejidad clínica de las personas que ingresan en los centros residenciales estudiados, evidenciando la necesidad de realizar valoraciones integrales que permitan establecer planes de cuidados específicos para los perfiles atendidos.

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Palabras clave: Desnutrición. Prevalencia. Centros residenciales especializados.

PREVALENCE OF MALNUTRITION IN SPANISH INSTITUTIONALIZED OLDER PEOPLE: A MULTICENTRIC NATIONWIDE ANALYSIS

Abstract

Introduction: Deficient nutritional status has important implications on vulnerable people's health status, such as those with chronic diseases or older people in situation of dependency.

Objective: To examine SARquavitae centers users' nutritional status at admission.

Material and Methods: Health, cognitive and functional status of people admitted to any company centers during 2012 was studied. Nutritional status was assessed using the short version of the Mini Nutritional Assessment. Finally, an analysis was performed to identify the most influential variables on the sample's nutritional status.

Results: Clinical records of 4,297 admissions were analyzed. The average age was 82.08 years and 66.1% were women with high comorbidity. At admission, 30.4% of the sample was in malnutrition and 49.4% at risk of malnutrition. A higher prevalence of malnutrition is found in women, in those coming from an acute care hospital or its outpatient clinics, with worse functional and cognitive status and those with chronic conditions such as dementia, cerebrovascular disease or dysphagia.

Conclusions: As demonstrated by the study results, people admitted to SARquavitae nursing homes present a high clinical complexity. Comprehensive assessments are needed that allow establishing specific care plans for people with complex care needs in nursing homes.

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Key words: Malnutrition. Prevalence. Specialized nursing homes.

Correspondencia: Raúl Vaca Bermejo
Departamento de Investigación SARquavitae
Aribau, 185 Entlo.
08021 - Barcelona.
e-mail: rvaca@sarquavitae.es

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Abreviaturas

MNA®: Mini Nutritional Assessment.

CIE-9: Clasificación Internacional de Enfermedades 9ª Versión.

MMSE: Mini-Mental State Examination.

MNA-SF®: Mini Nutritional Assessment Versión Corta.

ABVD: Actividades Básicas de la Vida Diaria.

SPSS: Statistical Package for the Social Sciences.

DE: Desviación Estándar.

GN: Grupo Normal.

GR: Grupo de Riesgo Nutricional.

GD: Grupo de Desnutrición.

RC: Residuos Corregidos.

Introducción

Se entiende por malnutrición al trastorno, por exceso o defecto, en la ingesta o absorción de nutrientes en relación con los requerimientos individuales, mientras que la desnutrición únicamente se refiere a las consecuencias clínicas de este déficit¹. La desnutrición y el riesgo nutricional, a los cuáles hacemos referencia en esta publicación se asocian a diferentes complicaciones y efectos adversos sobre el estado y evolución clínica y funcional del individuo².

El origen del riesgo nutricional y la desnutrición puede ser complejo y variado identificándose diferentes causas individuales, tales como cambios de hábitos; causas funcionales; causas patológicas, como alteraciones del aparato digestivo, neurológicas o del metabolismo; causas psicológicas o sociales, como aspectos culturales o bajos ingresos económicos; causas institucionales y/o legislativas, como la ausencia de políticas que garanticen la transversalidad en la atención nutricional o la ausencia de protocolos de intervención nutricional homogéneos; y finalmente, a causas relacionadas con los propios profesionales de la salud, como la falta de programas de formación sanitaria específicos en nutrición y la posterior incorporación de éstos a la práctica clínica³⁻⁷.

La desnutrición adquiere especial relevancia por sus consecuencias físicas, funcionales, sociales y económicas entre los colectivos más vulnerables, tales como personas con enfermedades crónicas complejas o personas mayores. Así, la desnutrición se asocia a un mayor riesgo de mortalidad, mayores tasas de infección, un aumento del número de caídas y fracturas, estancias hospitalarias más largas, agravamiento y aumento de la mortalidad de las personas con enfermedades agudas y/o crónicas, así como un deterioro global de la calidad de vida de las personas que la sufren^{3,5,8-13}.

En un estudio realizado en España en 2011 con población institucionalizada, con una edad media de 80 años, se ha encontrado que la incidencia de desnutrición es mayor entre las personas con deterioro cognitivo, con neoplasias o con cardiopatías¹⁴. La edad avanzada uni-

da a la presencia de múltiples y graves enfermedades, acentúa la vulnerabilidad de estas personas¹⁵.

Además, la desnutrición asociada a otras patologías, o presente como consecuencia de ellas, conlleva un aumento del coste económico debido a la mayor complejidad de los tratamientos necesarios o una mayor tasa de reingresos hospitalarios de estas personas¹⁶⁻¹⁹.

La prevalencia encontrada de desnutrición en personas mayores varía de forma importante en función del ámbito en el que se realice el estudio y del método de cribado o diagnóstico utilizado para evaluar el estado nutricional^{18,20,21}.

De esta forma, diferentes estudios internacionales sitúan el porcentaje de desnutrición en personas mayores entre el 1% y 15% de las que acuden a servicios de atención primaria, entre el 25% y 60% en personas institucionalizadas y entre el 35% y el 65% en aquellas personas hospitalizadas^{2,3,22-25}. En relación a las personas mayores institucionalizadas, los porcentajes aumentan hasta situarse entre el 24% y el 74% en el caso de personas frágiles o de especial vulnerabilidad²⁶.

Respecto a las investigaciones realizadas en España, los resultados también varían en función del ámbito clínico y del método de cribado. Así, el rango de personas mayores hospitalizadas en situación de desnutrición se sitúa entre el 4,1% y el 77,3%, entre el 2% y 62% para las personas institucionalizadas y entre el 0% y 19% para aquellas personas que viven en la comunidad^{10,27,28}.

La valoración y detección de la desnutrición es un aspecto clave en los centros residenciales para personas mayores. El objetivo es detectar precozmente estados de déficit nutricional y adoptar el plan de intervención necesario para su tratamiento³.

Los datos sobre prevalencia de desnutrición en personas institucionalizadas han sido obtenidos, en su gran mayoría, en estudios de ámbito local y/o con una muestra limitada a una región específica. Por ello, se ha considerado de interés contar con un estudio amplio de ámbito español que recoja una muestra significativa de personas mayores institucionalizadas procedentes de todas las regiones.

Objetivos

El objetivo principal de este estudio es evaluar el estado nutricional al ingreso de los usuarios de centros residenciales y de atención diurna de SARquavita.

Además se pretende conocer la prevalencia de patologías que se han asociado a una mayor prevalencia de desnutrición, así como la relación de la desnutrición con el estado cognitivo y la situación de dependencia de las personas objeto del estudio.

Métodos

Estudio observacional descriptivo y retrospectivo en el que se analizan datos seleccionados registrados

en las historias clínicas al ingreso de los usuarios de 50 centros residenciales y 3 específicos de atención diurna para mayores de SARquavita, o gestionados por la compañía, en toda España. Se incluyeron datos de las personas que ingresaron entre el 01 de enero y el 31 de Diciembre de 2012, ambos días incluidos.

Todas las variables analizadas se extraen de la valoración clínica multidisciplinar habitual que se realiza, de forma sistematizada, a todos los ingresos y cuyos resultados se registran en una historia asistencial informatizada (GCR®). Estas variables se exportaron a una base de datos separada que no incluye datos identificativos de las personas y a partir de la cual se analizó la información agrupada de la muestra de estudio. Se excluyeron de la muestra de análisis las personas con discapacidad física, intelectual o con enfermedad mental y los casos con el Mini Nutritional Assessment (MNA®) no realizado al ingreso, al tratarse de la variable principal de estudio.

Para el análisis se incluyeron variables sociodemográficas como la edad, género, procedencia del ingreso, tipo de estancia y servicio en el que ocurre la estancia. Asimismo se incluyeron todos los diagnósticos al ingreso (CIE-9), y datos clínicos correspondientes al Índice de Barthel³⁰, Mini-Mental State Examination (MMSE)³¹, presencia de caídas previas al ingreso, número de planes farmacológicos (número de medicamentos y otras formas o productos farmacéuticos por persona, por ejemplo, inhaladores o colirios), presencia de prótesis dentales, tipo y consistencia de dieta indicada y vía de administración de la alimentación. Se consideró como variable principal de estudio el estado nutricional de las personas al ingreso medido por el MNA®-SF (versión corta)³².

El Mini Nutritional Assessment (MNA®)^{29,33} es aceptado como uno de los mejores indicadores para valorar el estado nutricional de las personas mayores, siendo validado y ratificado en diversos estudios²⁹. Además, es el instrumento recomendado por algunos organismos oficiales, como la European Society of Parenteral and Enteral Nutrition¹⁰. En esta investigación, se ha utilizado la versión corta del MNA® (MNA-SF) considerada como una prueba rápida y fiable para la identificación de personas en situación de malnutrición y en riesgo de padecerla con mínimos errores de clasificación³². El rango de puntuaciones que pueden obtenerse con el MNA®-SF varía entre 0 y 14 puntos. Se considera que las puntuaciones en 12 y 14 reflejan un estado nutricional normal, las puntuaciones entre 8 y 11 indican una situación de riesgo de desnutrición y, finalmente, las puntuaciones iguales o inferiores a 7 indican malnutrición.

El Índice de Barthel³⁰ es el instrumento más difundido y utilizado para la valoración del grado de dependencia en la realización de las actividades básicas de la vida diaria (ABVD). Este instrumento consta de 10 ítems heteroadministrados cuya puntuación varía entre 0 y 100 puntos en el que una mayor puntuación es indicativa de una mayor independencia.

El Mini Mental State Examination (MMSE) en su versión validada para población española³¹ es la prueba de cribado más utilizada para la valoración de la existencia de deterioro cognitivo. Esta prueba evalúa de forma rápida y breve varios dominios y habilidades cognitivas tales como la orientación, la fijación de material verbal, la concentración y cálculo, la memoria inmediata para material verbal, lenguaje y praxias. El rango de puntuaciones varía entre 0 y 30 puntos en el que una mayor puntuación indica un mejor estado cognitivo.

Para el análisis descriptivo y bivariado de las variables de interés se utilizó el programa estadístico SPSS v20 (SPSS para Windows, SPSS Inc., Chicago, IL, EEUU). El nivel de significación estadística utilizado es del 5%.

Resultados

Análisis descriptivo

Se analizaron un total de 4.297 ingresos ocurridos en 2012 en los centros SARquavita que corresponden a 3.681 personas. La diferencia corresponde a los reingresos durante el periodo de estudio. El 66,1% de los ingresos eran mujeres y la edad media de la muestra fue de 82,08 años (desviación estándar -DE- 9,61 años). Un 30,84% de las personas procedía de su domicilio, esto implica que proceden de alguno de los siguientes servicios: centro de atención primaria, hospitalización domiciliaria, consultas externas del hospital o ambulatorio de salud mental. El resto de los ingresos, el 69,16%, procedían de algún recurso asistencial, ya sea un centro residencial social, sociosanitario, un hospital de agudos o un centro de día. Por otro lado, en el 56,6% de los casos el tipo de estancia prevista era de larga duración y un 78% ingresó en un servicio residencial (tabla 1).

Se registraron una media de 3,82 diagnósticos por persona (2,43 DE; rango 0-10) con un 67% de los ingresos con tres o más diagnósticos CIE-9 (tabla 2). Hay que señalar, por su especial repercusión en el estado nutricional, que un 18,3% de la muestra ingresó con diagnóstico de *diabetes mellitus* y un 8,7% de *disfagia*.

El 46,3% de las personas tiene, al momento del ingreso, prescritos entre 7 y 12 *planes farmacológicos* y un 15,9% más de 12 planes (tabla 2) situándose la media de planes farmacológicos en 8,15 (4,57 DE)

Tan sólo el 12,3% de los ingresos obtuvo puntuaciones en el MMSE correspondientes a un estado cognitivo normal. Un 14,90% presentaba un deterioro leve de las funciones cognitivas frente al 28,2% y el 37,2% que presentaron un deterioro moderado y grave respectivamente. El 7,4% restante se correspondía con aquellos casos que obtuvieron puntuaciones límites.

Respecto a la capacidad funcional, un 23,3% obtuvo una puntuación en el Índice de Barthel indicativa de una total dependencia, un 17,1% de dependencia grave, un 17,6% moderada, el 36,4% en dependencia leve y

Tabla I
Procedencia, tipo estancia y servicio asignado a las personas al ingreso

	<i>Frecuencia</i>	<i>Porcentaje</i>
Procedencia (n=4.297)		
Residencia Social	1.404	32,70%
Centro de Atención Primaria	1.184	27,60%
Recurso Sociosanitario	641	14,90%
Hospital General de Agudos	631	14,70%
Centro de día propio	296	6,90%
Hospitalización domiciliaria	104	2,40%
Consultas externas hospital	27	0,60%
Ambulatorio de salud mental	10	0,20%
Tipo de Estancia (n=4.297)		
Larga estancia	2.433	56,60%
Unidad de respiro	927	21,60%
Centro de día	531	12,40%
Convalecencia	332	7,70%
Otros	74	1,70%
Tipo de Servicio (n=4.297)		
Residencial	3.351	78,00%
Centro de día	545	12,70%
Sociosanitario	235	5,50%
Respiro familiar	139	3,20%
UTC	21	0,50%
Hospital de día	6	0,10%

únicamente un 5,7% de los ingresos se consideraron totalmente independientes. Cabe destacar que un 57,60% era totalmente independiente para alimentarse, mientras que un 26,40% necesitaba algún grado de ayuda y un 16% era totalmente dependiente para esta ABVD. En relación al estado de marcha, se observó que un 37,8% de los ingresos referían alguna caída previa.

En cuanto a los elementos que pueden afectar a la capacidad de masticación o a la ingesta dietética, se observó que un 46,4% de la muestra utilizaba alguna *prótesis dental*. En el 76,76% de los casos estas prótesis eran dobles (superiores e inferiores); en un 18,95% únicamente superiores y en el 4,30% sólo inferiores. Por lo que respecta a la *dieta*, un 44,1% de los ingresos tenían dieta normal, un 23,7% especial para personas con diabetes, un 23% hiposódica y un 9,3% otro tipo de dietas. La *vía de alimentación* en el 97,4% de los casos se realizaba por vía oral, y tan sólo el 1% de personas eran portadores de sonda nasogástrica, el 1,5% gastrostomía y 2 casos (0,05%) portadores de nutrición parenteral. La *consistencia de la dieta* estipulada

Tabla II
Número de diagnósticos y planes farmacológicos de las personas al ingreso

	<i>Frecuencia</i>	<i>Porcentaje</i>
Número de diagnósticos		
0	281	6,50%
1	437	10,20%
2	701	16,30%
3	763	17,80%
4	610	14,20%
5	532	12,40%
6	353	8,20%
7	246	5,70%
8	159	3,70%
9	85	2,00%
10	130	3,00%
Total	4297	100,00%
Diagnósticos Principales y Secundarios		
Enf. Hipertensiva	1825	42,47%
Enf. de Alzheimer y otras demencias	1473	34,28%
Enf. Sist. Nervioso	1144	26,62%
Factores que influyen en la salud	1112	25,88%
Enf. y deficiencias nutricionales	995	23,16%
Enf. Aparato musculoesquelético	987	22,97%
Enf. Aparato digestivo	745	17,34%
Trastornos mentales	712	16,57%
Otras enfermedades cardíacas	624	14,52%
Enf. Cerebrovascular	585	13,61%
Enf. Aparato genital	505	11,75%
Afecciones mal definidas	489	11,38%
Planes farmacológicos		
0	81	1,90%
1-6	1543	35,90%
7-12	1991	46,30%
>12	682	15,90%
Total	4297	100,00%

era normal para el 62,2% de las personas, blanda para el 18,3%, triturada para el 17,6%, líquida para el 1,4% y en un 0,5% tamizada u otros tipos de consistencia.

El análisis del estado nutricional de las personas al ingreso muestra que un 20,2% de las personas que ingresaron en 2012 en algún centro SARquavitaie presentó un estado nutricional normal. El 30,4% se en-

contraba en situación de desnutrición establecida y un 49,4% en riesgo de desnutrición. Al analizar los ítems específicos del MNA®-SF (tabla 3), destaca que un 22,5% refiere alguna pérdida de peso mientras que el 14,8% desconoce cuánto peso ha perdido.

Análisis Bivariados

Se realizaron análisis de contingencia entre las diferentes variables medidas en función de la categoriza-

Tabla III
Resultados obtenidos en el Mini Nutritional Assessment (MNA) – Versión Abreviada

	<i>Frecuencia</i>	<i>Porcentaje</i>
MNA – Versión Abreviada		
Normal	866	20,20%
Riesgo de malnutrición	2124	49,40%
Malnutrición	1307	30,40%
Pérdida de apetito		
Anorexia grave	201	4,70%
Anorexia moderada	708	16,50%
Sin anorexia	3388	78,80%
Pérdida reciente de peso		
> 3 kg	361	8,40%
No lo sabe	635	14,80%
Entre 1 y 3 kg	607	14,10%
No hay pérdida de peso	2694	62,70%
Movilidad		
De la cama al sillón	1728	40,20%
Autonomía en el interior	1879	43,70%
Sale del domicilio	690	16,10%
Enfermedad aguda o situación de estrés en los últimos 3 meses		
Sí	2313	53,80%
No	1984	46,20%
Problemas neuropsicológicos		
Demencia o depresión grave	856	19,90%
Demencia o depresión moderada	2120	49,30%
Sin problemas psicológicos	1321	30,70%
IMC		
< 19	555	12,90%
19 ≤ IMC < 21	786	18,30%
21 ≤ IMC < 23	1480	34,40%
≥ 23	1476	34,30%

ción del MNA®-SF, es decir, grupo normal (GN) y grupo de riesgo nutricional (GR) (tabla 4) y grupo normal y grupo de desnutrición (GD) (tabla 5). La realización de estas dos comparaciones se basa en las diferencias en la atención y los cuidados nutricionales que se proporcionan desde SARquavita a las personas categorizadas en cada uno de los tres grupos establecidos por el MNA®-SF. De manera adicional se han analizado los residuos corregidos (RC) para conocer dónde están las desviaciones más significativas de las frecuencias obtenidas en las diferentes categorías.

No se obtuvieron diferencias significativas en ninguna de las comparaciones entre el estado nutricional de los usuarios en función de la edad. Es preciso señalar que se ha utilizado, como punto de corte para el establecimiento de las dos categorías de edad, los 80 años por corresponder aproximadamente con la media de edad de la muestra estudiada. En cuanto al sexo de la muestra estudiada, se alcanzó el nivel de significación en la comparación del GN con el GR de forma que, para las mujeres, aumenta la probabilidad de encontrarse en situación de riesgo nutricional.

Las diferencias en el estado nutricional en función de la procedencia de los ingresos se analizaron considerando, por un lado, a los procedentes de su domicilio frente a los procedentes de un recurso de atención y los derivados de un hospital general de agudos. En este sentido, un 20,32% de las personas procedentes de algún recurso presentaban un estado nutricional normal, un 48,92% en riesgo de desnutrición y un 30,75% en situación de desnutrición frente al 19,77%, el 50,57% y el 29,66%, respectivamente, de las personas que procedían de su domicilio no encontrándose diferencias significativas en ninguna de las comparaciones realizadas.

No obstante, al analizar los residuos corregidos de ambas comparaciones se observó que había un número de personas con un estado nutricional normal significativamente mayor de lo esperable entre aquellos ingresos que procedían de un centro residencial social [RC: 5,9 y 9,8 para la comparación entre el GN y el GR y entre el GN y el GD, respectivamente] y de un centro de día propio [RC: 2,7 para la comparación entre el GN y el GD] de SARquavita.

Para finalizar con el grupo de personas procedentes de un centro asistencial, se encontró para aquellos procedentes de un recurso sociosanitario una menor frecuencia de personas con un estado nutricional normal en la comparación entre el GN y el GD [RC: -3,2].

En cuanto a las personas procedentes de su domicilio se obtuvo un número de personas en situación de desnutrición [RC: 11,5] y en riesgo nutricional [RC: 7,4] significativamente mayor de lo esperado. Además, se encontró un número de personas en riesgo nutricional significativamente mayor de lo esperable entre los procedentes de la hospitalización domiciliaria [RC: 2,5]. Finalmente, se observó una frecuencia mayor de lo esperado en las personas en situación de desnutrición entre las procedentes de las consultas externas del hospital [RC: 2,1].

Tabla IV
Análisis bivariados Grupo Estado nutricional normal y grupo de riesgo nutricional

		Estado Nutricional (MNA)				
		Normal		Riesgo de Desnutrición		Chi-Cuadrado de Pearson
		Frecuencia	Porcentaje	Frecuencia	Porcentaje	Sig.
Edad	<80	290	28,97%	711	71,03%	,982
	≥80	574	28,93%	1410	71,07%	
Sexo	Hombres	324	32,66%	668	67,34%	,002*
	Mujeres	542	27,13%	1456	72,87%	
Procedencia	Domicilio	262	28,11%	670	71,89%	,490
	Recurso de Atención	604	29,35%	1454	70,65%	
MMSE	Deterioro Cognitivo ≤24	616	27,70%	1608	72,30%	,001*
	Sin Deterioro Cognitivo ≥25	225	34,14%	434	65,86%	
Índice de Barthel	Dependencia Grave -Total	110	11,74%	827	88,26%	,000*
	Dependencia Moderada - Nula	752	36,90%	1286	63,10%	
Planes Farmacológicos	0-6	353	34,68%	665	65,32%	,000*
	≥7	433	24,44%	1339	75,56%	
Caídas	No	571	30,75%	1286	69,25%	,005*
	Sí	292	25,98%	832	74,02%	
Prótesis dentales	No	393	27,37%	1043	72,63%	,052
	Sí	470	30,60%	1066	69,40%	
Dieta	Normal	384	28,59%	959	71,4%	,687
	Otras	482	29,27%	1165	70,7%	
Vía de alimentación	Oral	848	29,25%	2051	70,75%	,050*
	Otras	18	19,78%	73	80,22%	
Consistencia	Normal	724	34,91%	1350	65,09%	,000*
	Otras	142	15,50%	774	84,50%	
Principales Diagnósticos						
Enf. Hipertensiva	No	511	29,92%	1197	70,08%	,184
	Sí	355	27,69%	927	72,31%	
Enf. Sist. Nervioso	No	636	29,03%	1555	70,97%	,897
	Sí	230	28,79%	569	71,21%	
Factores que Influyen en la Salud	No	660	29,54%	1574	70,46%	,229
	Sí	206	27,25%	550	72,75%	
Enf. Aparato Musculoesquelético	No	643	28,60%	1605	71,40%	,450
	Sí	223	30,05%	519	69,95%	
Enf. Nutricionales	No	653	28,57%	1633	71,43%	,387
	Sí	213	30,26%	491	69,74%	
Enf. de Alzheimer	No	737	29,79%	1737	70,21%	,029*
	Sí	129	25,00%	387	75,00%	
Enf. Aparato Digestivo	No	735	29,36%	1768	70,64%	,272
	Sí	131	26,90%	356	73,10%	

Tabla IV (cont.)
Análisis bivariados Grupo Estado nutricional normal y grupo de riesgo nutricional

		Estado Nutricional (MNA)				
		Normal		Riesgo de Desnutrición		Chi-Cuadrado de Pearson
		Frecuencia	Porcentaje	Frecuencia	Porcentaje	Sig.
Trastornos Mentales	No	722	28,82%	1783	71,18%	,700
	Sí	144	29,69%	341	70,31%	
Otras Enfermedades Cardíacas	No	751	29,38%	1805	70,62%	,221
	Sí	115	26,50%	319	73,50%	
Demencias	No	774	29,76%	1827	70,24%	,013*
	Sí	92	23,65%	297	76,35%	
Enf. Cerebrovascular	No	784	30,17%	1815	69,83%	,000*
	Sí	82	20,97%	309	79,03%	
Enf. Aparato Genital	No	776	29,28%	1874	70,72%	,282
	Sí	90	26,47%	250	73,53%	
Afecciones Mal Definidas	No	769	28,74%	1907	71,26%	,426
	Sí	97	30,89%	217	69,11%	
Otras Demencias	No	854	29,28%	2063	70,72%	,017*
	Sí	12	16,44%	61	83,56%	
Deficiencias Nutricionales	No	859	28,93%	2110	71,07%	,658
	Sí	7	33,33%	14	66,67%	
Diabetes	No	671	27,41%	1777	72,59%	,000*
	Sí	195	35,98%	347	64,02%	
Disfagia	No	848	29,81%	1997	70,19%	,000*
	Sí	18	12,41%	127	87,59%	

*: El estadístico de chi-cuadrado es significativo en el nivel 0.05.

En cuanto al análisis del estado nutricional en función del estado cognitivo, se han encontrado diferencias significativas en ambas comparaciones, señalando un peor estado nutricional de las personas con deterioro cognitivo.

A la hora de utilizar el estado funcional como predictor de la situación nutricional se ha comparado por un lado, aquellas personas con dependencia grave y total; y por otro, la dependencia moderada, leve y total independencia. La razón para utilizar este corte es la importante diferencia en cuanto a las necesidades asistenciales que tienen, grosso modo, estos dos grupos de personas. Así, se encontró una relación significativa entre el estado funcional y el nutricional, a mayor nivel de dependencia mayor probabilidad de sufrir malnutrición o situarse en riesgo de sufrirla.

Resultados similares a los anteriores se obtuvieron al utilizar las caídas, el número de fármacos (considerando más de 6 como punto de corte para la polime-

dicación), la vía de alimentación (oral frente a otras vías) y consistencia de la dieta (normal frente a otras consistencia). En el caso de la vía de alimentación, la mayor probabilidad de estar en situación de desnutrición o en riesgo nutricional la tienen las personas con una vía distinta a la oral. En cuanto a la consistencia de la dieta, las diferencias se obtuvieron para las personas con una consistencia diferente a la normal.

Al analizar, por separado, la utilización de prótesis dentales y el tipo de dieta (normal frente a otros tipos) únicamente se han encontrado diferencias significativas en la comparación entre el GN y el GD. En este sentido, los datos parecen indicar que si se utiliza algún tipo de prótesis dental o se necesita algún tipo de dieta diferente a la normal sería más probable estar en situación de desnutrición.

Se han encontrado resultados significativos que parecen indicar que habría una mayor probabilidad de tener un estado de desnutrición o riesgo de desnutrición si

Tabla V
Análisis bivariados Grupo Estado nutricional normal y grupo de desnutrición

		Estado Nutricional (MNA)				
		Normal		Desnutrición		Chi-Cuadrado de Pearson
		Frecuencia	Porcentaje	Frecuencia	Porcentaje	Sig.
Edad	<80	290	42,65%	390	57,35%	,076
	≥80	574	38,63%	912	61,37%	
Sexo	Hombres	324	41,17%	463	58,83%	,345
	Mujeres	542	39,11%	844	60,89%	
Procedencia	Domicilio	262	40,00%	393	60,00%	,927
	Recurso de Atención	604	39,79%	914	60,21%	
MMSE	Deterioro Cognitivo ≤24	616	35,92%	1099	64,08%	,000*
	Sin Deterioro Cognitivo ≥25	225	58,59%	159	41,41%	
Índice de Barthel	Dependencia Grave –Total	110	12,25%	788	87,75%	,000*
	Dependencia Moderada - Nula	752	59,45%	513	40,55%	
Planes Farmacológicos	0-6	353	45,78%	418	54,22%	,000*
	≥7	433	34,98%	805	65,02%	
Caídas	No	571	41,41%	808	58,59%	,000*
	Sí	292	37,06%	496	62,94%	
Prótesis dentales	No	393	33,62%	776	66,38%	,000*
	Sí	470	47,47%	520	52,53%	
Dieta	Normal	384	42,62%	517	57,38%	,027*
	Otras	482	37,89%	790	62,11%	
Vía de alimentación	Oral	848	41,11%	1215	58,89%	,000*
	Otras	18	16,36%	92	83,64%	
Consistencia	Normal	724	56,78%	551	43,22%	,000*
	Otras	142	15,81%	756	84,19%	
Principales Diagnósticos						
Enf. Hipertensiva	No	511	40,08%	764	59,92%	,798
	Sí	355	39,53%	543	60,47%	
Enf. Sist. Nervioso	No	636	39,80%	962	60,20%	,933
	Sí	230	40,00%	345	60,00%	
Factores que Influyen en la Salud	No	660	40,97%	951	59,03%	,072
	Sí	206	36,65%	356	63,35%	
Enf. Aparato Musculoesquelético	No	643	37,71%	1062	62,29%	,000*
	Sí	223	47,65%	245	52,35%	
Enf. Nutricionales	No	653	37,94%	1068	62,06%	,000*
	Sí	213	47,12%	239	52,88%	
Enf. de Alzheimer	No	737	41,15%	1054	58,85%	,007*
	Sí	129	33,77%	253	66,23%	
Enf. Aparato Digestivo	No	735	41,20%	1049	58,80%	,006*
	Sí	131	33,68%	258	66,32%	

Tabla V (cont.)
Análisis bivariados Grupo Estado nutricional normal y grupo de malnutrición

		Estado Nutricional (MNA)				
		Normal		Riesgo de Desnutrición		Chi-Cuadrado de Pearson
		Frecuencia	Porcentaje	Frecuencia	Porcentaje	Sig.
Trastornos Mentales	No	722	40,07%	1080	59,93%	,654
	Sí	144	38,81%	227	61,19%	
Otras Enfermedades Cardíacas	No	751	40,20%	1117	59,80%	,409
	Sí	115	37,70%	190	62,30%	
Demencias	No	774	41,52%	1090	58,48%	,000*
	Sí	92	29,77%	217	70,23%	
Enf. Cerebrovascular	No	784	41,33%	1113	58,67%	,000*
	Sí	82	29,71%	194	70,29%	
Enf. Aparato Genital	No	776	40,46%	1142	59,54%	,114
	Sí	90	35,29%	165	64,71%	
Afecciones Mal Definidas	No	769	40,45%	1132	59,55%	,131
	Sí	97	35,66%	175	64,34%	
Otras Demencias	No	854	39,98%	1282	60,02%	,352
	Sí	12	32,43%	25	67,57%	
Deficiencias Nutricionales	No	859	40,23%	1276	59,77%	,006*
	Sí	7	18,42%	31	81,58%	
Diabetes	No	671	38,70%	1063	61,30%	,029*
	Sí	195	44,42%	244	55,58%	
Disfagia	No	848	44,01%	1079	55,99%	,000*
	Sí	18	7,32%	228	92,68%	

*: El estadístico de chi-cuadrado es significativo en el nivel 0.05.

se tienen los siguientes diagnósticos CIE-9: enfermedad de Alzheimer u otras demencias, enfermedades cerebrovasculares o disfagia. Por otro lado, las personas con enfermedades del aparato digestivo y deficiencias nutricionales tendrían más probabilidad de encontrarse en situación de desnutrición. Por el contrario, las personas con diagnóstico de diabetes tendrían menor probabilidad de encontrarse en situación de desnutrición o en riesgo nutricional y las personas con enfermedades musculoesqueléticas o nutricionales menor probabilidad de encontrarse en situación de desnutrición.

No se alcanzó el nivel de significación establecido en el resto de las comparaciones.

Discusión

En el presente estudio se ha analizado el estado nutricional de los 4.297 ingresos que, durante 2012, in-

gresaron en algún centro de SARquavita. Únicamente un 20,2% presentaron un estado nutricional normal con un 30,4% en situación de desnutrición y un 49,4% en riesgo de sufrirla. Estos resultados contrastan con los encontrados en un estudio realizado en Bélgica con 1.188 personas mayores que vivían en centros gerontológicos en el que se encontró que un 19,4% estaban desnutridas, el 38,7% se situaban en riesgo nutricional y un 41,9% tenían un estado nutricional normal³⁴. Bien es cierto que el estudio belga se realizó con personas institucionalizadas y en el que se presenta aquí se analiza el estado nutricional de las personas en el momento de su ingreso en un centro residencial. En relación a los estudios realizados en España, los datos presentados en la presente investigación se sitúan dentro de la amplia horquilla de prevalencia de desnutrición encontrada por otros trabajos que la sitúan entre el 2% y 62% de las personas que viven en un entorno residencial^{10,27,28}.

En el momento del ingreso en SARquavita, la mayor parte de la muestra vivía en algún recurso asistencial con mayor o menor grado de apoyos y cuidados provistos. Por otro lado y según los datos obtenidos, parece que algo más de la mitad las personas que ingresan lo hacen buscando un recurso asistencial de larga estancia. No obstante, el resto solicitan un servicio que les permita compaginar la asistencia profesional con los cuidados en el ámbito familiar.

En cuanto al perfil clínico de los ingresos, los datos encontrados nos permiten afirmar que las personas que ingresaron en un centro de SARquavita durante el 2012 sufrían una alta pluripatología y una alta polifarmacia asociada. Entre los diagnósticos más comunes destacaron las enfermedades hipertensivas, los trastornos neurocognitivos debidos a una demencia, enfermedades del sistema nervioso, nutricionales, del aparato musculoesquelético y otros factores que influyen en la salud de las personas. Además, una gran mayoría de la muestra presentaba un deterioro cognitivo moderado o grave y una dependencia de moderada a total.

Al analizar la influencia de las distintas variables en el estado nutricional de las personas, los resultados obtenidos parecen indicar que las mujeres tienen una mayor probabilidad de encontrarse en situación de riesgo nutricional.

No se encontraron diferencias en el estado nutricional de las personas en función de su procedencia. No obstante, los análisis más específicos permiten afirmar que acude un mayor número de personas con peor estado nutricional entre las procedentes de un entorno domiciliario. Además, se ha hallado una frecuencia mayor de personas con un estado nutricional normal entre aquellas provenientes de otros centros residenciales o de centros de día propios de SARquavita. Los datos obtenidos en referencia al estado nutricional deficitario de las personas que ingresaron en SARquavita durante el 2012 derivados de un hospital de agudos o de sus consultas externas pueden explicarse por la influencia de la suma de los procesos patológicos que cursan en estas personas. Por otra parte, los buenos resultados observados en el estado nutricional de las personas procedentes de algún centro residencial o centro de día de la compañía pueden deberse a los efectos beneficiosos de la implantación de intervenciones nutricionales adecuadas.

Diversos estudios realizados en nuestro entorno^{2,3,22-25} concuerdan con los datos referentes a las personas que proceden de algún recurso asistencial, en cambio la prevalencia de malnutrición de las personas que ingresan procedentes de su domicilio es algo mayor a la encontrada en dichos estudios. La diferencia entre los resultados de estos estudios y el que aquí se presenta puede deberse a que, en los primeros, la muestra la componían personas que acuden a un centro de atención primaria sin ser necesaria su posterior derivación a un centro residencial.

Además, un peor estado cognitivo, un peor estado funcional, el hecho de sufrir caídas, mayor número de

planes farmacológicos, vía de alimentación diferente a la oral y la consistencia de la dieta diferente a la normal se asocian a una mayor probabilidad de estar en situación de riesgo nutricional o en desnutrición establecida.

En lo referente a las prótesis dentales o al tipo de dieta, los resultados indican que la utilización de las prótesis o necesitar una dieta diferente a la normal se asocia con un estado de desnutrición.

Finalmente, los diagnósticos de enfermedad de Alzheimer u otras demencias, enfermedades cerebrovasculares o disfagia indicarían una mayor probabilidad de encontrarse en riesgo de malnutrición o en situación de malnutrición establecida. En cambio, las personas con enfermedades del aparato digestivo y deficiencias nutricionales tienen más probabilidad de encontrarse en situación de desnutrición. Las personas con diabetes tienen menor probabilidad de encontrarse en situación de desnutrición o en riesgo nutricional y aquellas con enfermedades musculoesquelético o nutricionales tienen menor probabilidad de encontrarse en situación de desnutrición.

Estos datos concuerdan con los hallados por Verbrugge et al.³⁴ que obtuvieron en población institucionalizada una relación significativa entre un estado de desnutrición y un peor estado cognitivo, haber sido hospitalizado recientemente, sufrir problemas oncológicos, problemas de deglución, la presencia de úlceras por presión o ser receptor de una intervención nutricional. Además, observaron una relación significativa y negativa entre desnutrición y personas con diabetes o aquellos que recibían comida adicional de los miembros de su entorno afectivo.

Hasta donde alcanza nuestro conocimiento, éste es el primer estudio que analiza el estado nutricional de las personas que ingresan en algún centro residencial o de atención diurna para personas mayores en España.

Mediante la identificación de los factores asociados a un estado nutricional deficitario o en riesgo de serlo se pueden poner en marcha intervenciones nutricionales que busquen paliar, mantener o evitar el empeoramiento en el estado nutricional de las personas mayores. De sobra es conocida la relación bidireccional entre el estado nutricional y estado de salud de las personas². Por este motivo, la intervención nutricional debe ser un aspecto central en el diseño y provisión de cuidados a los colectivos en situación de especial vulnerabilidad como lo es el de las personas mayores que ingresa en centros residenciales SARquavita.

Por otro lado, los resultados de esta investigación ponen de manifiesto la elevada complejidad en las necesidades terapéuticas de las personas que ingresaron en centros SARquavita. Es necesario destacar la labor que realizan estos centros reduciendo la carga asistencial de otros niveles de atención. Por tanto, se debe reconocer la actuación de los centros residenciales especializados que contribuyen a garantizar una atención especializada continua, coordinada y centrada en la persona.

El presente estudio tiene como limitación más importante que los datos analizados se obtuvieron de una misma organización aunque es cierto que se refieren al momento del ingreso lo que garantizaría que están libres de la uniformidad dotada por un sistema asistencial compartido. Además, se trata de un estudio retrospectivo con una muestra de conveniencia lo que podría limitar la generalización de las conclusiones extraídas. No obstante, consideramos que el tamaño de la muestra y su distribución por todo el territorio español, asegura una alta validez de los resultados y conclusiones extraídas para la población estudiada.

Finalmente, sería interesante que investigaciones futuras analizaran el efecto que tiene la asistencia, tratamientos e intervenciones planteados en SARquavita para mejorar el estado nutricional de las personas atendidas en los centros del grupo.

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Original/*Ancianos*

Repercusión del ejercicio físico en la composición corporal y la capacidad aeróbica de adultos mayores con obesidad mediante tres modelos de intervención

José Antonio Prieto¹, Miguel Del Valle¹, Paloma Nistal¹, David Méndez¹, Cristian Abelairas-Gómez² y Roberto Barcala-Furelos²

¹Área de Salud, Escuela Medicina del Deporte. Universidad de Oviedo. ²Facultad de Ciencias de la Actividad Física y Deporte. Universidad de Vigo. España.

Resumen

Objetivo: El objetivo de este estudio fue analizar la influencia del ejercicio aeróbico en la composición corporal y la capacidad aeróbica de una muestra de adultos mayores, sedentarios y con índices de obesidad, mediante tres modelos diferentes de intervención (recomendación, prescripción en el hogar y monitorización).

Material y método: Participaron 76 adultos mayores con una edad media 67.1 +/- 1.2 años, sedentarios, con un IMC > 30 kg/m² que se distribuyeron aleatoriamente en cuatro grupos: Control (CON) recomendación (REC), prescripción en el hogar (PRES) y monitorización en un centro deportivo (MON). Se desarrolló un mismo programa de ejercicio físico aeróbico para los grupos de hogar y centro deportivo durante 24 semanas, 3 días a la semana. Se determinó antes y después de la intervención el IMC, el Índice-Cadera-Cintura (ICC), el % grasa (Σ Pliegues) y la capacidad aeróbica (T 6M) en toda la muestra.

Resultados: Los grupos MON y PRES mostraron mejoras significativas en las variables ICC, Σ Pliegues y T 6M, no siendo así en el IMC. Sin embargo el grupo MON presentó diferencias significativas respecto al grupo PRES en el análisis entre-grupos ($p < 0.001$). La recomendación no obtuvo efectos positivos.

Conclusión: La monitorización es la metodología más eficaz para los programas de ejercicio físico en población adulta con obesidad. Sin embargo la prescripción del ejercicio en el hogar desde la atención temprana supone un importante enfoque para personas que por motivos físicos y/o psicológicos como es el caso de la obesidad no pueden acceder a los centros deportivos a participar en actividades dirigidas por un monitor. Se despejan incógnitas del ejercicio aeróbico en el hogar que son de gran

IMPACT OF EXERCISE ON THE BODY COMPOSITION AND AEROBIC CAPACITY OF ELDERLY WITH OBESITY THROUGH THREE MODELS OF INTERVENTION

Abstract

Objective: The objective of this study was to analyze the influence of aerobic exercise on body composition and aerobic capacity of a sample of older, sedentary adults with obesity rates by three different models of intervention (recommendation, prescription at home and monitoring).

Material and Methods: A total of 76 older adults with a mean age 67.1 +/- 1.2 years, sedentary, with a BMI > 30 kg/m² were randomized in to four groups: Control (CON) recommendation (REC), prescription home (PRES) and monitoring in a sports center (MON). The same program of aerobic exercise for groups of home and sports center for 24 weeks, 3 days a week was developed. It was determined before and after the intervention BMI, Waist-Hip-index (ICC), the % fat (Σ folds) and aerobic capacity (T6M) throughout the sample.

Results: MON and PRES groups showed significant improvements in the ICC, Σ folds and T 6M variables, not the case in BMI. However the MON group presented significant differences from group PRES between-group analysis ($p < 0.001$). The recommendation did not get positive effects.

Conclusion: Monitoring is the most effective exercise programs in adults with obesity methodology. However the exercise prescription at home since early intervention is an important approach for people with physical and/ or psychological reasons such as obesity cannot access the sports centers to participate in activities led by a monitor. Unknowns of aerobic exercise are cleared in the

Correspondencia: Jose Antonio Prieto Saborit.
Escuela Medicina del Deporte, Universidad de Oviedo
C/Catedrático Gimeno s/n. 33008, Oviedo, Spain. Ext: 1.
E-mail: prietojose@uniovi.es

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repercusión para las políticas sociales con relación a la salud de la población adulta mayor.

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Palabras clave: *Adultos mayores. Obesidad. Ejercicio físico. Prescripción.*

Introducción

La obesidad es reconocida como una importante amenaza para la salud a lo largo de la vida, y la prevalencia en personas adultas mayores es muy significativa en los países industrializados. Alrededor de un tercio de los estadounidenses mayores de 60 años es considerado obeso¹ y es de esperar un notable incremento teniendo en cuenta el aumento de obesidad en las nuevas generaciones^{2,3}.

En España, los datos publicados relativos a la prevalencia de sobrepeso y obesidad entre las personas mayores, indican un progresivo aumento desde el año 2004 con un 81 % hasta el año 2010 con un 84 %^{4,5}. Además, el 56 % de la población mayor de 65 años sufre obesidad central, lo que es considerado como uno de los principales indicadores de mortalidad en esta población⁵.

En este sentido, la obesidad en adultos de edad avanzada se asocia con un elevado riesgo de síndrome cardiometabólico, discapacidad física, deterioro de la calidad de vida e incluso demencia⁶, suponiendo una disminución de la salud y calidad de vida⁷. Faeh y cols. mostraron un incremento en el riesgo de mortalidad absoluta hasta la edad de 75 años. Para su delimitación se han utilizado mediciones como el IMC, la circunferencia de la cintura, el índice cadera-cintura⁹. Sin embargo, Chang y cols. en una revisión sistemática sobre las mediciones utilizadas para la tercera edad, sugiere que el IMC no es suficientemente representativo para esta población, por lo que deben combinarse con otras mediciones como el porcentaje de grasa a través de la medición de pliegues cutáneos¹⁰ o ICC como criterio de obesidad abdominal¹¹.

Por otro lado, se ha demostrado una asociación inversa entre la actividad física y la obesidad en la tercera edad^{12,13} además de una disminución del declive funcional¹⁴. Se ha sugerido, que la actividad física es capaz de revertir los cambios de composición corporal en adultos mayores¹⁵, lo que parece indicar que el hábito del ejercicio físico en el estilo de vida de adulto mayor es un buen indicador de salud respecto a la obesidad.

La literatura científica recomienda la combinación del ejercicio físico con una dieta equilibrada para el control del sobrepeso y la obesidad. Sin embargo, un reciente meta-análisis confirmó que un programa de ejercicio aeróbico, sin dieta hipocalórica puede mostrar efectos beneficiosos para reducir el tejido adiposo¹⁶.

home that are of great impact for social policies regarding the health of the elderly population.

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Keys words: *Elderly. Obesity. Exercise. Prescription.*

En esta línea, los organismos públicos han tomado medidas y en los últimos años se ha incrementado significativamente la oferta de actividades físicas aeróbicas dirigidas para personas mayores en centros deportivos. No obstante, son muchos los adultos mayores que siguen sin asistir a estos programas monotorizados por distintos motivos, como la lejanía, timidez, accesibilidad¹⁷. El problema, es aún mayor en el caso de las personas con obesidad, fundamentalmente por la estigmatización social que supone¹⁸ y por los problemas físicos y psicológicos que origina¹⁹.

A tenor de estas dificultades, la prescripción del ejercicio tanto en el hogar como en la comunidad ha sido estudiada^{20,21}. Recientes investigaciones han enfocado sus esfuerzos en estimular una actividad física dentro de un estilo de vida activo, asociando la actividad física en el hogar a las tareas cotidianas del individuo y relacionándolas con el fitness funcional²² o con la prevención de caídas²³. Sin embargo, estos estudios se centraron en poblaciones mayores específicas con distintas patologías o discapacidades, pero no con índices de obesidad.

Desde esta perspectiva, se desconoce las diferentes influencias que puede tener un mismo programa de ejercicio físico en el hogar a través de la prescripción y en un centro deportivo a través de la monitorización para personas mayores con obesidad. Además es necesario conocer si la simple recomendación médica sobre el ejercicio físico es suficiente para que el adulto mayor lo realice de forma regular.

Por tanto, el objetivo de este estudio ha sido analizar la repercusión del ejercicio aeróbico en la composición corporal y capacidad aeróbica de una muestra de adultos mayores, sedentarios y con índices de obesidad mediante tres modelos diferentes de intervención (recomendación, prescripción y monitorización).

Material y métodos

Participantes

La muestra del estudio estuvo formada por un total de 76 adultos mayores con una edad media de 67.1 +/- 1.2 años. El reclutamiento de la muestra se realizó en colaboración con el servicio de Salud de la Comunidad Autónoma, a través de los centros de atención primaria, y se utilizaron los siguientes criterios de inclusión: edad entre los 65 y 70 años, sedentarios y con un IMC dentro del rango de la obesidad ($IMC > 30 \text{ kg/m}^2$). Para

comprobar el sedentarismo se utilizó la escala The Rapid Assessment of Physical Activity (RAPA) en su versión española²⁴.

Fueron descartados todos aquellos que padecían alguna patología (problemas cardiovasculares, metabólicos, pulmonares o articulares) que limitase la práctica de ejercicio físico.

Los sujetos fueron informados verbalmente y por escrito de los objetivos y metodología del trabajo, con especial consideración en los riesgos y posibles molestias que pudiera ocasionar el estudio y se solicitó a todos los participantes el consentimiento informado. El presente trabajo de investigación se desarrolló respetando la Carta de Helsinki para investigaciones en seres humanos.

Procedimiento

La muestra fue dividida de forma aleatoria y controlada con bloqueo (con relación al sexo, realizando la aleatorización de las mujeres por un lado y de los varones por otro) en cuatro grupos iniciales de 19 sujetos cada uno (tres grupos experimentales y uno de control). Sólo 2 integrantes de la muestra inicial renunciaron posteriormente por motivos personales o de salud, lo que representó una tasa de atrición del 2,6%.

Los grupos experimentales fueron los siguientes:

Grupo con recomendación (REC): desde su centro de salud, el médico de atención primaria de cada sujeto de la muestra le recomendó verbalmente y por escrito la práctica de actividad física. Todos los sujetos recibieron la misma información a través de un guion preestablecido.

Grupo de prescripción de ejercicio (PRES): al que se le facilitó un programa de ejercicio físico para poder realizarlo de forma independiente en su casa. Durante un periodo de dos días se les enseñó a realizar las actividades programadas, así como los calentamientos y estiramientos. Cada tres semanas acudían al centro de salud donde visitaban a su médico de cabecera y la persona responsable de la investigación.

Grupo monitorizado (MON) (actividad física dirigida por un monitor en un centro deportivo): Este programa consistió en un entrenamiento de una hora de duración 3 días a la semana, bajo la dirección de un monitor especializado en actividad física.

Se decidió utilizar un mismo programa de ejercicio aeróbico para los tres grupos experimentales. El programa consistió en un trabajo de resistencia aeróbica durante tres días a la semana en un periodo total de 24 semanas. Los ejercicios fueron incrementándose en intensidad cada tres semanas. Se estableció un protocolo para que el programa del grupo prescripción respetase la misma carga, intensidad y orientación que el del grupo monitorización.

Todas las sesiones contenían un calentamiento previo de 5-10 min, una parte principal (aeróbica) de 35-40 min y una vuelta a la calma en base a estiramientos de 10 min. Cada día de la semana se utilizaba una actividad física distinta que se repetía todas las semanas. Las actividades semanales fueron: un circuito aeróbico multifunción, aeróbic, caminar/correr.

El circuito consistía en diez estaciones distribuidas por tiempo de trabajo y descanso (se incrementaba el trabajo y disminuía la recuperación cada 4 semanas), la clase de aeróbic aumentaba la intensidad en base a los ritmos preestablecidos y la actividad caminar/correr, combinaba el tiempo de caminar con tiempos de trote (o caminar muy rápido).

Los tres grupos siguieron el mismo programa, con la diferencia de que al grupo recomendación solamente se le aconsejó la práctica de estas tres actividades semanales sin ningún tipo de programación. Al grupo prescripción se le entregó y supervisó el programa, junto con grabaciones del aeróbic. No obstante se utilizó un tiempo inicial de dos días para enseñarles todos los ejercicios del programa. El grupo monitorizado contó con la intervención de un monitor durante todo el tiempo en cada una de las actividades programadas.

Antes y después de la finalización del programa se efectuaron mediciones de IMC, índice cintura-cadera y el porcentaje graso. Asimismo se realizó el test de 6 minutos (6MT) para conocer su resistencia aeróbica.

Finalmente se les informó a los participantes que debían mantener los hábitos alimenticios durante el desarrollo de la investigación.

Tabla I
Descripción de la muestra

GRUPOS	Edad (años)	Talla (cm)	Peso (kg)	IMC
CON	66,8 (+/- 1,1)	158,4 (+/- 8,1)	84,1 (+/- 14,6)	33,7 (+/-2,9)
REC	67,8 (+/- 0,8)	160,1 (+/- 8,8)	87,2 (+/- 12,8)	34,1(+/- 2,0)
PRE	67,2 (+/- 1,7)	158,9 (+/- 9,6)	82,1 (+/- 9,8)	32,9(+/- 1,9)
MON	66,6 (+/- 0,9)	159,2 (+/-9,9)	84,6 (+/-11,7)	33,5(+/-2,8)
Media	67,1 (+/- 1,2)	159,6(+/- 9)	84,5 (+/- 12,2)	33,5(+/- 2,4)

CON: Control; REC: Recomendación; PRES: Prescripción; MON: Monitorización.

a) Variables antropométricas y de composición corporal

Se determinaron como variables descriptivas la talla, el peso, el porcentaje de grasa ($\Sigma 6$ Pliegues) y el índice cintura-cadera (ICC). El porcentaje graso ha sido calculado a partir de la medición de seis pliegues cutáneos (subescapular, suprailíaco y abdominal, tríceps, muslo anterior y medial de pierna) calculando el porcentaje de grasa por la fórmula de Carter²⁵.

Para la obtención del peso, altura e IMC, los participantes se subieron totalmente descalzos y con la menor ropa posible, manteniendo una posición erguida y la cabeza mirando al frente. A partir de estos datos se calculó el IMC de todos los sujetos.

Se midió el perímetro de la cintura (en posición bipodal, a la altura de la última costilla flotante) y cadera (a la altura de los glúteos). Finalmente, ambos valores fueron utilizados para la obtención del índice cintura-cadera (ICC) con el coeficiente entre el diámetro de la cintura (cm) y cadera (cm).

Para la obtención de las medidas se siguió las recomendaciones en cuanto a protocolo y material de la Federación Española de Medicina del Deporte²⁶.

b) Capacidad Aeróbica

El 6MT es una prueba submáxima para adultos que evalúa la capacidad aeróbica y consiste en recorrer el mayor número de metros posibles en un lapso de tiempo de seis minutos²⁷.

Análisis estadístico

Para la comparación de medias pre y post intra grupo, es decir antes y después de la intervención en cada uno de los grupos, se utilizó la t de student, usando el test Kolmogorov y Smirnov para determinar la suposición de normalidad.

Para el análisis entre grupos, se ha realizado un análisis ANOVA de un factor (intervención) con un grupo control y tres grupos experimentales (recomendación,

prescripción y monitorización) todos con el mismo número de sujetos por grupo. Como variables dependientes se tomaron las diferencias entre dos momentos de observación, uno pre- intervención y otro post-intervención. Al existir grupo control, utilizar instrumentos de medida precisos, momentos temporales de medida próximos en el tiempo y dada la naturaleza de las variables (medibles al menos a nivel de intervalo) se decidió un tipo de diseño y análisis ANOVA robusto a la no asunción de supuestos y apropiado para determinar las diferencias entre dos o más grupos, procediendo posteriormente a un análisis Scheffé para determinar entre qué dos grupos se establecen las diferencias cuando éstas son estadísticamente significativas en el análisis entre todos los grupos.. El nivel de confianza fue siempre el 95%. Todos los análisis estadísticos se realizaron con el programa SPSS, versión 21.

Resultados

Medidas antropométricas (Composición corporal)

Los resultados correspondientes al efecto del programa de ejercicio físico en las diferentes formas de intervención sobre la composición corporal se detallan en la tabla II mediante el análisis intra-grupos. Se observó un descenso del ICC en los grupos de PRES ($p < 0,05$) y MON ($p < 0,001$), no observándose modificaciones significativas en los grupos REC y CON. No se apreció un efecto significativo del ejercicio físico en el IMC de ninguno de los grupos.

En el análisis entre-grupos (Tabla III) se observaron diferencias significativas del grupo MON respecto al resto de grupos en todas las medidas analizadas, destacando en los valores del ICC y el Σ de pliegues ($P < 0,001$). También se detectaron mejoras significativas del grupo PRES respecto al grupo CON y REC ($p < 0,01$).

Capacidad aeróbica

En cuanto a la capacidad aeróbica medida a través del test de los 6 minutos, solo se observaron cambios significativos en el grupos MON ($p < 0,001$) y en el gru-

Tabla II
Análisis intra-grupos. Efecto del programa en los distintos grupos de intervención

GRUPOS	CON PRE/POST	REC PRE/POST	PRES PRE/POST	MON PRE/POST
IMC	33,7/33,9	34,1/34,4	32,9/32,5	33,5/32,1
ICC	0,95/0,88	0,94/0,91	0,97/0,89*	0,94/0,86***
$\Sigma 6$ PLIEGUES	135,8/ 137,4	148,6 /149,2	140,1/133*	143,2/132,3***

Medidas antropométricas antes y después de la intervención (pre/post) de los 4 grupos. (* $p < 0,05$ ** $p < 0,01$ *** $p < 0,001$).

po PRES ($p<0,05$). El grupo MON obtuvo diferencias significativas respecto al resto de grupos del estudio ($p<0,001$) y el grupo PRES solo las obtuvo respecto al grupo control ($p<0,01$) (Tabla IV).

Discusión

El objetivo del estudio fue comprobar la eficacia de un programa de ejercicio físico aeróbico en los cambios de composición corporal de una muestra de adultos mayores sanos, sedentarios y con índices de obesidad, mediante tres modelos diferentes de intervención (recomendación, prescripción y monitorización).

Los principales hallazgos indicaron que un programa aeróbico es útil para la mejora de la composición corporal tanto en de forma prescrita en el hogar como de forma monitorizada. Sin embargo, se observaron importantes diferencias significativas entre los grupos PRES y MON. La simple recomendación parece no ser suficiente para obtener los mínimos resultados.

IMC-ICC-% Graso

Dentro de los parámetros antropométricos analizados antes y después del programa de ejercicio físico, observamos, que si bien tanto en el grupo MON como en el grupo PRES disminuyó el IMC, este descenso no fue significativo. Por el contrario, tanto en el ICC como en el % Graso (Σ de pliegues), encontramos que la disminución existente fue altamente significativa. Es de suponer por tanto, que si la disminución del porcentaje graso es de mayor importancia que la del peso corporal, los grupos PRES y MON han conseguido, al menos mantener la cantidad de su masa muscular²⁸.

El grupo MON fue el que mejores valores mostró en todos los análisis, destacando la significatividad en las variables de ICC y sumatorio de pliegues ($p<0,001$). Los hallazgos del grupo MON concuerdan con los resultados obtenidos en informes previos. Viana y cols. mostraron mejoras en el porcentaje graso, manteniéndose los niveles en el IMC, en un programa de ejercicio físico monitorizado de un año de duración²⁷. Más recientemente, Araya y cols. presentaron resultados similares en una muestra de mujeres mayores de 60 años, en los que después de una intervención de ejercicio físico monitorizado durante 12 semanas encontraron mejoras en el ICC, no siendo así en el peso y el IMC²⁹.

Por su parte, el grupo PRES, a pesar de mostrar mejoras significativas en las mismas variables, obtuvo diferencias importantes respecto al grupo MON ($p<0,001$) en el análisis entregupos. En el diseño del programa de ejercicio aeróbico para los grupos PRES y MON se tuvo en cuenta la recomendación general de 150 min/ sem de actividad física moderada para personas con obesidad con el fin de disminuir enfermedades cardiovasculares³⁰, lo que suponía una distribución de tres días semanales. No obstante, una reciente revisión sistemática concluye que los beneficios de programas aeróbicos de tres días deben ser de vigorosa intensidad, siendo de cinco días a la semana los de moderada intensidad³¹. En nuestro estudio, es posible que el grupo MON experimentase un trabajo más intensivo que el grupo PRES, favorecido por la motivación del monitor que dirigía la sesión. De este modo la intensidad y la motivación en el ejercicio aeróbico podrían ser factores determinantes en las diferencias encontradas en los indicadores de los grupos experimentales de este estudio. A pesar de ello, el ejercicio físico en el hogar es de vital importancia para personas margi-

Tabla III

Análisis entre-grupos. Diferencias entre los grupos para los resultados obtenidos de la prueba (pre-post)

MEDIDAS ANTROPOMÉTRICAS	Grupos: 1-CON, 2-REC, 3-PRES, 4-MON.
IMC	1,4 ($p<0,05$), 2-4 ($p<0,05$)
ICC	1-4 ($p<0,001$), 1-3 ($p<0,01$), 2-3 ($p<0,01$), 2-4 ($p<0,001$), 3-4 ($p<0,001$)
Σ 6 PLIEGUES	1-4 ($p<0,001$), 1-3 ($p<0,01$), 2-3 ($p<0,01$), 2-4 ($p<0,001$), 3-4 ($p<0,001$)

Tabla IV

Efecto del programa de ejercicio físico sobre la capacidad aeróbica entre e intragrupos

GRUPOS	CON (1) (pre/post)	REC (2) (pre / post)	PRES (3) (pre / post)	MON (4) (pre / post)
Capacidad aeróbica (intragrupos)	659,3 / 645,7	654,7 / 660,3	32,9/32,5	33,5/32,1
Capacidad aeróbica (entregupos)	1-4, 2-4, 3-4 ($p<0,001$); 1-3 ($p<0,01$)			

nadas como el caso de la obesidad. En este sentido, destaca la situación de personas institucionalizadas donde la prevalencia de la obesidad está aumentando significativamente, llegando a considerarse un criterio de no admisión en el hogar de ancianos³².

Es importante señalar algunas características de las variables analizadas en la composición corporal para explicar las diferencias obtenidas en los resultados de la presente investigación. El IMC es el indicador más utilizado en la población en general. A pesar de ello, hay autores que consideran que el IMC utilizado de manera unitaria no es un indicador fiable en la vejez¹⁰. Existe la certeza de una disminución de la estatura asociada con el envejecimiento, determinada por compresión de discos intervertebrales, cifosis, estos valores inciden en el IMC, por lo que es posible que los valores antropométricos de esta población de vean alterados en las escalas recomendadas por los Institutos Nacionales de Salud. De este modo la prevalencia de sobrepeso y obesidad pueda ser sobreestimada, aunque esta sobreestimación en el IMC podría ser compensada por la reducción de la masa magra que se produce con la edad, lo que hace que una persona mayor tendría un mayor porcentaje de grasa corporal que un joven con el mismo IMC³³.

El debate existente sobre el IMC y la inconsistencia en definir el mejor predictor de obesidad en esta edad, ha sugerido la utilización de varios indicadores que acompañen a esta medida. En este sentido, el ICC y el porcentaje graso han demostrado ser predictores más adecuados de mortalidad elevada en adultos mayores^{10,34}. Estos factores de confusión en el IMC podrían ser la explicación a las diferencias encontradas en nuestro estudio entre esta variable respecto del ICC y el porcentaje graso.

Por lo tanto, teniendo en cuenta los resultados obtenidos en el ICC y el % graso, es oportuno considerar que un programa de trabajo aeróbico obtiene mejoras en la composición corporal de las personas con obesidad, tanto en programas llevados a cabo en centros deportivos como en el hogar.

En este sentido, el trabajo aeróbico ha reportado beneficios en composición corporal de la población adulta en el hogar. Un reciente estudio, concluyó que un programa de entrenamiento de resistencia aeróbica con cinta o tapiz rodante en el hogar redujo la masa grasa epicárdica y abdominal en mujeres posmenopáusicas³⁵. Los importantes resultados obtenidos en este estudio con un programa aeróbico en el hogar podrían deberse a la influencia del material utilizado para el desarrollo del programa aeróbico más que al propio programa. La utilización de tapices rodantes en todos los hogares analizados, permitió un mayor control de los parámetros de volumen e intensidad y una mayor homogeneidad del programa en todos los hogares. Sin embargo, es obvio que la utilización de la cinta rodante en el hogar se aleja de la realidad social, ya que es un instrumento muy caro y que ocupa gran espacio, lo que representa un hándicap para la mayoría de los hogares.

En el presente estudio, la variedad de las actividades del programa aeróbico en el que se requerían tres actividades distintas por semana, sugiere un aumento de motivación para los que se ejercitan en el hogar. Sin embargo, una de las actividades programadas fue la de caminar/correr. Es este aspecto, es posible que su cumplimiento se viese influenciado por la climatología típica del lugar. No obstante, los sujetos podían repetir las actividades programadas en interior para sustituir la actividad de caminar/correr en caso de climatología adversa.

Capacidad aeróbica

Por otro lado, la muestra de estudio mostró escasa capacidad aeróbica inicial, determinada por su sedentarismo, lo que obligó a iniciar el programa a baja intensidad del ejercicio en las primeras semanas. No obstante, los programas de ejercicio aeróbico pueden recuperar y aumentar la capacidad aeróbica en solo 12 semanas de trabajo aeróbico³⁶.

En esta investigación, los resultados de resistencia aeróbica presentaron importantes diferencias entre grupos. El grupo que mayor cambio experimentó entre el test de 6 minutos inicial y el final fue el grupo MON mejorando una media de 154, 8 m (24,5%) respecto a los 38,6 m (6 %) del grupo PRES y a los 5,6 m (0,8%) del grupo REC ($p < 0,001$). Estudios previos indican una mejora del 13 % en la capacidad aeróbica mediante la prueba de 6 minutos en una muestra de adultos mayores después de un programa de 16 semanas de ejercicio monitorizado³⁷.

En la misma línea, pero con metodología de prescripción, Petrella y cols. mostraron incrementos de la capacidad aeróbica en los dos grupos de prescripción en los que se dividió a una muestra de 360 pacientes con edad entre 55-85 años³⁸. Recientemente, Knigh y cols. en lo que consideran el primer informe de prescripción en el hogar sobre comportamiento sedentario en adultos mayores, hallaron que la prescripción de varias intensidades a través de la atención primaria mejoró el estado de salud cardiometabólico y sugirieron la práctica continua de evaluación de la capacidad aeróbica y actividad física prescrita para el manejo y prevención de enfermedades crónicas³⁹.

Las principales limitaciones de este estudio han sido, por un lado, la ausencia de una estrategia de motivación sobre el grupo PRES. En este sentido recientes investigaciones demuestran la utilidad de combinar las nuevas tecnologías con la prescripción y sugieren la utilización de este enfoque desde la atención primaria⁴⁰. Tampoco se han tenido en cuenta otras variables de confusión como puede ser la alimentación. Todos los sujetos fueron informados de la necesidad de mantener los hábitos de alimentación y de la obligación de notificarlo en caso de realizarlo. Sin embargo, las actitudes personales de cada sujeto se escapaban al control de esta investigación.

Por otro lado, en este estudio no se ha tenido en cuenta la adherencia del ejercicio después de concluir el programa desde las diferentes formas de intervención. Es posible que después de los programas de monitorización, el efecto motivador que ejerce el monitor desaparezca y afecte al mantenimiento de la actividad física⁴¹, sin embargo al no existir este condicionante en el hogar la adherencia hacia la actividad física pudiera ser mayor. Se sugiere por tanto, estudios en los que se comparen la adherencia de ejercicio físico en hogar y en centros deportivos con actividades dirigidas hacia poblaciones sedentarias, adultas y con índices de sobrepeso y/o obesidad.

En contraste, la fortaleza del estudio radica en el uso de tres estrategias de intervención diferentes en la misma investigación. Hasta la fecha, no hemos encontrado ningún estudio que compare las tres metodologías (recomendación, prescripción en el hogar y el seguimiento en un centro deportivo), en adultos sedentarios.

Conclusión

Los datos aportados en este estudio señalan que un programa de ejercicio físico aeróbico de 6 meses de duración produce cambios en la composición corporal y la capacidad aeróbica de los adultos mayores con índices de obesidad, mostrándose de manera significativa en el ICC, el porcentaje de grasa medido a través del sumatorio de pliegues y el test de los 6 minutos.

En cuanto a las metodologías de intervención, la actividad dirigida en un centro deportivo por un monitor (Monitorización) resultó ser la más eficaz en todas las variables analizadas. No obstante, la prescripción en el hogar, a pesar de mostrar diferencias respecto a la monitorización, obtuvo resultados significativamente positivos en las mismas variables lo que sugiere que la prescripción de ejercicio físico en el hogar a través de la atención primaria debería tenerse en cuenta como una alternativa al sedentarismo y concretamente hacia una población que por causas concretas como la obesidad, se encuentra con barreras físicas, psicológicas y/o económicas para asistir regularmente a los centros deportivos.

Finalmente, la simple recomendación, aun siendo la herramienta más utilizada en la atención primaria, no es una metodología eficaz para obtener beneficios en la composición corporal y capacidad aeróbica, por lo que las políticas sociales deberían estudiar fórmulas que permitan al médico de atención primaria pasar de la simple recomendación a una prescripción programada de ejercicio físico.

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Original/Deporte y ejercicio

Influencia de la práctica físico-deportiva sobre indicadores antropométricos y la satisfacción con el peso en hombres universitarios: estudio piloto

Nerea Telleria-Aramburu¹, Celia Sánchez¹, Laura Ansotegui¹, Ana M^a Rocandio^{1,2} y Marta Arroyo-Izaga^{1,2}

¹Departamento de Farmacia y Ciencias de los Alimentos Facultad de Farmacia, Universidad del País Vasco UPV/EHU. ²Grupo de Investigación BIOMICS, Centro de Investigación y Estudios Avanzados Lucio Lascaray CIEA, Universidad del País Vasco UPV/EHU.

Resumen

Introducción: Los jóvenes universitarios presentan en general niveles bajos de actividad física, lo que podría repercutir en su peso y composición corporal y en el conocimiento y aceptación de su propio cuerpo.

Objetivo: Evaluar el estado de peso y la composición corporal, así como la autopercepción y satisfacción con el peso corporal en universitarios, y analizar la influencia de la actividad físico-deportiva sobre estas variables.

Métodos: La muestra estuvo formada por 62 estudiantes varones con una edad media de 20,7 $\pm$ 1,7 años. La práctica de deporte y/o ejercicio físico en el tiempo libre se analizó mediante cuestionario. El estado de peso y la composición corporal se evaluaron mediante antropometría. También se registraron datos de peso autodeclarado y deseado, y de talla autodeclarada. Las medidas de peso real, autodeclarado y deseado se utilizaron para estimar la autopercepción y satisfacción con el peso. El análisis estadístico se realizó con el programa SPSS versión 22.0.

Resultados: El 17,7% de los participantes presentaba sobrepeso y el 6,5% bajo peso. El 45,2% tenía un gasto por el deporte y/o ejercicio físico $\leq$ 3.000 kcal/semana y el 32,3% $>$ 3.000 kcal/semana. La autopercepción y satisfacción con el peso fue mejor en el grupo que practicaba deporte y/o ejercicio físico a razón de $\leq$ 3.000 kcal/semana, que en aquellos que no practicaban ningún ejercicio físico o deporte ($P < 0,05$).

Conclusión: La práctica regular de actividad físico-deportiva moderada está relacionada con una mejor percepción y satisfacción con el peso corporal, en comparación con el sedentarismo. Debería aprovecharse el periodo de estudios universitarios para fomentar la práctica de ejercicio físico-deportivo, empleando los recursos o activos con los que cuenta la Universidad.

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Palabras clave: Ejercicio físico. Deporte. Antropometría. Percepción. Satisfacción.

Correspondence: Marta Arroyo-Izaga.

Departamento de Farmacia y Ciencias de los Alimentos.
Facultad de Farmacia. Universidad del País Vasco UPV/EHU.
Paseo de la Universidad, 7. 01006 Vitoria, España.
E-mail: marta.arroyo@ehu.es

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INFLUENCE OF SPORT PRACTICE AND PHYSICAL EXERCISE ON ANTHROPOMETRIC INDICATORS AND WEIGHT SATISFACTION IN MEN UNIVERSITY STUDENTS: A PILOT STUDY

Abstract

Introduction: University students generally have low levels of physical activity, which could affect the body weight and composition and the knowledge and acceptance of their own body.

Objective: To assess weight status and body composition, as well as self-perception and satisfaction with body weight in university students, and to analyze the influence of sport practice and physical exercise on these variables.

Methods: A sample of 62 male students with a mean age of 20.7 $\pm$ 1.7 years was evaluated. Sport practice and physical exercise in leisure time were analyzed by questionnaire. Weight status and body composition were assessed by anthropometry. Data about self-reported and desired weight and self-reported height were also registered. Measurements of actual, self-reported and desired weight were used to estimate self-perception and satisfaction with weight. Statistical analysis was performed using SPSS version 22.0.

Results: Overall 17.7% of participants had overweight and 6.5% underweight. The energy consumption due to sport practice and/or physical exercise was $\leq$ 3,000 kcal/week in the 45.2% of the students and $>$ 3,000 kcal/week in the 32.3%. Self-perception and satisfaction with weight was better in the group who practiced sport and/or physical exercise at the rate of $\leq$ 3.000 kcal/week than in those who did not practice any sport or exercise ($P < 0.05$). **Conclusion:** Regular practice of sport or physical exercise is associated with a better self-perception and satisfaction with body weight compared with a sedentary lifestyle. The university studies period should be used to promote sport practice and physical exercise, using the resources or assets of the University.

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Key words: Exercise. Sport. Anthropometry. Perception. Satisfaction.

Abreviaturas

AB: Área del brazo.
AC: Agua corporal.
AGB: Área grasa del brazo.
AMB: Área muscular del brazo.
DS: Desviación estándar.
ESCAV: Encuesta de salud de la Comunidad Autónoma del País Vasco.
GC: Grasa corporal.
IMC: Índice de masa corporal.
IMLG: Índice de masa libre de grasa.
ISAK: International Society for the Advancement of Kinanthropometry.
kcal: kilocalorías.
METs: Metabolic Equivalents.
MM: Masa magra.
NS: Diferencias no significativas.
PMB: Perímetro muscular del brazo.
UPV/EHU: Universidad del País Vasco/Euskal Herriko Unibertsitatea.

Introducción

La práctica regular de actividad física está asociada a múltiples beneficios para la salud y la calidad de vida¹, ya que tiene efectos positivos tanto a nivel físico como mental. Las personas activas físicamente tienen menor incidencia de enfermedades cardiovasculares, diabetes mellitus no insulino-dependiente, y obesidad, entre otras patologías²⁻⁴.

A pesar de que desde hace años se recomienda la práctica de ejercicio físico regular^{5,6}, la población en general, y la joven en particular está lejos de cumplir esta recomendación. Estudios recientes llevados a cabo en universitarios revelan que aproximadamente la mitad de ellos no son físicamente activos⁷. Al parecer, en los jóvenes se produce una disminución en la práctica de actividad física al comienzo de los estudios universitarios⁸⁻¹¹. En general, la transición a la edad adulta marca un periodo de la vida crítico en lo que respecta a hábitos relacionados con la salud, en esta etapa suele disminuir la práctica de actividad física y aumentar el consumo de alcohol y tabaco⁹. Los jóvenes universitarios perciben los beneficios de la actividad física, pero en ocasiones estos no son suficientes para derribar barreras que impiden su práctica como: la exigencia académica, la falta de tiempo, el cansancio o la vergüenza¹⁰.

Por otro lado, la práctica regular de actividad física se ha relacionado también con un peso y composición corporal más saludables^{12,13}, y con un mayor control y conocimiento del propio cuerpo y del peso corporal^{14,15}. Algunos autores han sugerido que las personas que hacen ejercicio físico o deporte regularmente están más satisfechos con su peso que quienes no lo hacen^{8,15}. Sin embargo, las personas sedentarias que quieren modificar su peso corporal habitualmente no

utilizan el ejercicio físico como estrategia para perder peso¹⁶.

Hasta la fecha son escasos los estudios sobre la influencia de la práctica físico-deportiva sobre el peso y composición corporal, y sobre el conocimiento y satisfacción con el propio peso. Pero estos datos podrían ser de gran utilidad en el diseño de estrategias para la promoción de la actividad física, puesto que, de existir tal influencia, serviría de motivación para practicar deporte y/o ejercicio físico. Por estos motivos, nos planteamos el presente trabajo con el objetivo de evaluar el estado de peso y la composición corporal, así como la autopercepción y satisfacción con el peso corporal en jóvenes universitarios, y analizar la influencia de la actividad físico-deportiva sobre estas variables.

Métodos

Participantes

La muestra objeto de estudio estuvo formada por 62 hombres, estudiantes de la Universidad del País Vasco (UPV/EHU), con edades comprendidas entre 18,1 y 23,9 años, con una media de 20,7±1,7 años. Todos los participantes declararon estar sanos, no tomar medicación y no practicar deporte a nivel de competición. Quienes realizaban algún tipo de actividad físico-deportiva lo hacían a nivel recreativo. Los estudiantes recibieron información sobre el objetivo y medidas a realizar en el estudio y dieron su consentimiento por escrito. Los datos recogidos se codificaron para respetar la confidencialidad. Este estudio fue aprobado por el Comité de Ética para las investigaciones relacionadas con Seres Humanos de la UPV/EHU.

Práctica de deporte y ejercicio físico en el tiempo libre

La recogida de datos sobre la práctica de deporte y/o ejercicio físico en el tiempo libre se realizó mediante cuestionario. Se registró información sobre el tipo, la duración y la frecuencia del deporte/s y/o ejercicio/s físico/s, y se estimó el gasto energético. Para el cálculo de dicho gasto se utilizaron los *Metabolic Equivalents* (METs) promedio del *Compendium of Physical Activities*¹⁷.

A partir de los METs se estimaron las kilocalorías (kcal) correspondientes a cada actividad deportiva o a cada ejercicio físico, utilizando para ello el peso del individuo y las horas semanales dedicadas a ese deporte o ejercicio físico¹⁸. Las kcal calculadas de este modo pertenecían únicamente a la práctica de deporte o ejercicio físico, a los participantes que no realizaban ningún tipo de actividad físico-deportiva se les asignó el valor de 0 para esta variable. Para facilitar el análisis de los resultados se establecieron tres subgrupos en base al número de kcal consumidas por la actividad fí-

sico-deportiva: grupo 1, sujetos que consumían 0 kcal semanales, es decir, que no practicaban deporte en su tiempo libre; grupo 2, sujetos que consumían ≤ 3.000 kcal por semana; y grupo 3, sujetos que consumían más de 3.000 kcal semanales.

Estado de peso y composición corporal mediante antropometría

Se realizaron las siguientes medidas antropométricas: peso, talla, perímetro medio del brazo y pliegues adiposo-cutáneos (subescapular, abdominal, suprailíaco, axilar medio, pectoral, del muslo, de la pantorrilla, bicipital y tricipital). Todas estas medidas se realizaron siguiendo la metodología propuesta por la International Society for the Advancement of Kinanthropometry (ISAK)¹⁹. Se empleó una báscula-tallímetro (con una precisión para el peso de 100 g y para la talla de 1 mm), un lipocalibre (Holtain Ltd. Crymch U.K. con una precisión de 0,2 mm) y una cinta antropométrica Harpenden, previamente calibrados.

A partir de las medidas de peso y talla, se calculó el índice de masa corporal (IMC), mediante la ecuación $\text{peso (kg)} / \text{talla}^2 (\text{m}^2)$. Estos datos se clasificaron de acuerdo a las categorías de la OMS²⁰ y se compararon con los datos del mismo grupo etario de la Encuesta de Salud de la Comunidad Autónoma del País Vasco (ESCAV)²¹. Además a partir de los datos antropométricos recogidos se calcularon los siguientes índices derivados: perímetro muscular del brazo (PMB), área del brazo (AB), área muscular del brazo (AMB), masa magra (MM), índice de masa libre de grasa (IMLG), porcentaje de grasa corporal (GC), porcentaje de agua corporal (AC), área grasa del brazo (AGB) y grasa en distintas regiones del cuerpo (brazo, tronco y pierna).

Para la estimación de la densidad corporal se utilizaron las ecuaciones de Jackson y Pollock²² que incluyen siete pliegues cutáneos (pectoral, abdominal, del muslo, tricipital, subescapular, suprailíaco y axilar). El %GC se estimó con la ecuación de Siri²³ y se interpretó con la clasificación de Bray y col.²⁴, según la cual datos inferiores al 12% se consideran por debajo de lo normal, entre 12 y 20% normales, entre 21 y 25% sobrepeso y mayor de 25% obesidad. La distribución de la grasa corporal en distintas regiones del cuerpo se estimó utilizando los pliegues adiposo-cutáneos. Para la grasa a nivel de brazo se consideraron los pliegues bicipital y tricipital, para la grasa del tronco los pliegues subescapular, abdominal y suprailíaco y para la grasa a nivel de la pierna los pliegues del muslo y de la pantorrilla.

El IMLG se calculó teniendo en cuenta la talla, el peso y el %GC, utilizando la ecuación de Kouri y col.²⁵. Valores de IMLG entre 16 y 18 se clasificaron como bajos, entre 19 y 21 como medios, entre 22 y 24 como considerable musculatura y entre 25 y 26 como el límite superior de muscularidad que puede conseguirse sin el uso de esteroides²⁶.

Autopercepción y satisfacción con el peso corporal

Antes de realizar las medidas antropométricas se registraron datos de peso autodeclarado y deseado y de talla autodeclarada. Las preguntas a las que respondieron fueron las siguientes: “¿Cuánto pesas sin ropa ni zapatos?”, “¿Cuánto mides sin zapatos?” e “Idealmente, ¿Cuánto te gustaría pesar?”. A partir de las medidas auto-declaradas de peso y talla se calculó el IMC autodeclarado. Posteriormente se analizó la autopercepción del peso corporal a partir de la diferencia entre las medidas reales y las autodeclaradas.

Para la evaluación de la satisfacción con el peso corporal se utilizaron los valores de peso autodeclarado y deseado, y se aplicaron cuatro métodos, uno de ellos cuantitativo y tres cualitativos (dos de ellos basados en valores absolutos y otro en porcentajes de peso corporal). Se asumió que valores idénticos y diferentes de peso autodeclarado y deseado representan, respectivamente, satisfacción e insatisfacción con el peso²⁷.

El análisis cuantitativo determina la diferencia entre el peso autodeclarado y el deseado expresados en kilos. El análisis cualitativo de la satisfacción con el peso corporal se basó en los siguientes criterios¹⁶: a) verificar si los sujetos quieren ganar, mantener o perder peso; b) determinar si los sujetos están satisfechos, insatisfechos o muy insatisfechos con el peso autodeclarado, considerando que valores menores de 1 kg como satisfecho, entre 1 y 5 kg como insatisfecho, y más de 5 kg en relación al peso deseado como muy insatisfecho; y c) identificar si el peso deseado es mayor o menor en un 5% del peso autodeclarado.

Análisis estadístico

El análisis estadístico se llevó a cabo en el programa informático SPSS vs. 22.0. Los resultados se presentan en forma de medias, desviaciones estándar (DS) y frecuencias. La normalidad de las variables continuas se comprobó con el test Kolmogorov-Smirnov-Lilliefors. Las diferencias entre muestras independientes (grupos según nivel de actividad físico-deportiva) se evaluaron mediante la prueba de ANOVA o la de Kruskal-Wallis y las diferencias entre muestras dependientes con la t de Student o el test de Wilcoxon. La Chi-cuadrado se utilizó para comparar la distribución de la satisfacción con el peso corporal en tablas de contingencia. También se calcularon coeficientes de correlación lineal con pruebas de significación estadística asociadas. El nivel de significación utilizado fue de $P < 0,05$.

Resultados

Según los resultados de la evaluación del nivel de actividad físico-deportiva, el 22,6% de los participantes no realizaba ningún tipo de deporte o ejercicio físico, el 45,2% tenía un gasto ≤ 3.000 kcal/semana y

el 32,3% de más de 3.000 kcal/semana. Aquellos que practicaban deporte o ejercicio físico lo hacían con una frecuencia de 4,4±3,5 horas/semana. El gasto calórico medio correspondiente a la práctica físico-deportiva fue de 2.385,1±1.975,6 kcal/semana.

Según la clasificación del IMC, el 75,8% de los participantes presentaba normopeso, el 6,5% bajo peso y el 17,7% sobrepeso. No se registró ningún caso de obesidad. El %GC osciló entre 4,6 y 20,9. Según este índice, el 50% fueron clasificados como normalidad, el 43,5% presentó valores por debajo de lo normal y el 6,5% se clasificó como sobrepeso. No hubo ningún caso de obesidad teniendo en cuenta el %GC.

En la tabla I se presentan los resultados de los índices antropométricos derivados según el nivel de actividad físico-deportiva. Solamente se encontraron diferencias significativas en el PMB entre los participantes del grupo 2 y 3 ($P < 0,05$). Las correlaciones entre los índices antropométricos derivados (PMB, AB, AMB, MM, IMLG, GC, AC y AGB) y el gasto calórico debido a la práctica físico-deportiva no fueron significativas ($P > 0,05$).

No se encontraron diferencias en las medidas antropométricas autodeclaradas (peso y talla), ni en el peso deseado entre los grupos según actividad físico-deportiva. Sin embargo, las diferencias entre el peso real y autodeclarado, sí que fueron significativas entre grupos ($P < 0,05$) (tabla II). La autopercepción del peso corporal fue mejor en el grupo 2 que en el grupo 1.

En las tablas III, IV y V se presentan los datos de

satisfacción con el peso corporal según el nivel de actividad físico-deportiva. Se observaron diferencias significativas entre los grupos 1 y 2 en el deseo de mantener el peso, siendo mayor el porcentaje de estudiantes que deseaba mantener su peso corporal en el grupo 2 que en el grupo 1 ($P < 0,01$) (tabla III). El porcentaje de casos satisfechos con su peso corporal también fue mayor en el grupo 2 que en el grupo 1 ($P < 0,01$) (tabla IV). Sin embargo no se encontraron diferencias significativas en el número de casos con un peso deseado mayor o menor en un 5% del peso autodeclarado según el nivel de actividad físico-deportiva (tabla V).

Discusión

El propósito de este estudio fue evaluar el peso corporal (estado actual, autopercepción y satisfacción) y la composición corporal en un grupo de hombres universitarios, así como analizar la influencia de la actividad físico-deportiva sobre estas variables. El IMC medio en el grupo estudiado fue similar al encontrado por otros autores^{28,29} e inferior al obtenido en universitarios italianos y norteamericanos^{8,30}. La prevalencia de sobrepeso en base al IMC (17,7%) fue semejante a la de otros universitarios europeos^{29,31,32}, así como a la prevalencia de exceso de peso corporal registrada en la última ESCAV²¹, según la cual, el 14,1% de los hombres jóvenes presenta sobrepeso y el 3,9% obesidad. En relación a la composición corporal, el %GC

Tabla I
Índices antropométricos derivados según nivel de actividad físico-deportiva en la muestra estudiada: hombres estudiantes universitarios

	Media±DS				P
	Total n=62	Grupo 1 n=14	Grupo 2 n=28	Grupo 3 n=20	
IMC (kg/m ²)	22,3 ±2,2	22,4±2,7	22,2±2,2	22,4±2,1	NS ^a
PMB (cm)	24,7±3,6	24,5±2,4	23,6±1,6	26,5±5,5	* ^a
AB (cm ²)	65,4±20,9	65,6±14,9	60,3±8,1	72,4±32,7	NS ^a
AMB (cm ²)	49,5±19,2	47,9±9,3	44,4±5,8	57,9±31,1	NS ^a
MM (kg)	41,6±3,0	41,5±2,7	41,1±2,8	42,3±3,5	NS ^a
IMLG (kg/m ²)	19,3±1,5	19,2±1,6	19,1±1,6	19,6±1,5	NS ^a
GC (%)	13,1±4,2	13,4±4,6	13,2±4,2	12,7±4,2	NS ^a
AC (%)	59,6±1,9	59,6±2,3	59,8±1,7	59,2±1,9	NS ^a
AGB (cm ²)	15,8±6,3	17,7±8,3	15,9±6,0	14,5±5,1	NS ^a
GC (mm)					
Brazo	16,3±6,2	18,0±7,4	16,9±6,0	14,5±5,2	NS ^b
Tronco	36,3±12,6	40,3±14,8	35,9±12,0	34,1±11,8	NS ^b
Pierna	33,0±16,4	29,2±13,3	34,3±15,0	34,0±20,2	NS ^b

AB, área del brazo; AC, agua corporal; AGB, área grasa del brazo; AMB, área muscular del brazo; DS, desviación estándar; GC, grasa corporal; Grupo 1, 0 kcal/semana de actividad físico-deportiva; Grupo 2, ≤ 3.000 kcal/semana de actividad físico-deportiva; Grupo 3, > 3.000 kcal/semana de actividad físico-deportiva; IMC, índice de masa corporal; IMLG, índice de masa libre de grasa; MM, masa magra; NS, diferencias no significativas; PMB, perímetro muscular del brazo; ^aANOVA; ^bKruskal-Wallis; *Diferencias significativas entre grupos 2 y 3 ($P < 0,05$).

Tabla II
Diferencias entre medidas antropométricas reales, autodeclaradas y deseadas según nivel de actividad físico-deportiva en la muestra estudiada: hombres estudiantes universitarios

	Media±DS				P
	Total n=62	Grupo 1 n=14	Grupo 2 n=28	Grupo 3 n=20	
$P_{\text{real}} - P_{\text{autodeclarado}}$	-1,2±2,4*** ^c	-2,4±2,9* ^c	-0,5±2,0	-1,4±2,3* ^c	* ^a
$P_{\text{real}} - P_{\text{deseado}}$	-1,2±4,0* ^d	-2,3±5,2	-0,4±3,3	-1,6±3,9	NS ^b
$P_{\text{autodeclarado}} - P_{\text{deseado}}$	0,0±3,5	0,1±4,3	0,1±3,2	-0,2±3,6	NS ^a
$IMC_{\text{real}} - IMC_{\text{autodeclarado}}$	-0,4±1,0* ^c	-0,7±0,9* ^c	-0,2±0,8	-0,3±1,2	NS ^a

DS, desviación estandar; Grupo 1, 0 kcal/semana de actividad físico-deportiva; Grupo 2, ≤ 3.000 kcal/semana de actividad físico-deportiva; Grupo 3, > 3.000 kcal/semana de actividad físico-deportiva; IMC, índice de masa corporal; NS, diferencias no significativas; P, peso; ^aANOVA; ^bKruskal-Wallis; ^ct de Student; ^dtest de Wilcoxon; *P < 0,05; **P < 0,01; ***P < 0,001; *^aDiferencias significativas entre grupos 1 y 2.

Tabla III
Deseo de ganar, mantener o perder peso según nivel de actividad físico-deportiva en la muestra estudiada: hombres estudiantes universitarios

Deseo	n (%)				P ^a
	Total n=62	Grupo 1 n=14	Grupo 2 n=28	Grupo 3 n=20	
Ganar peso	11 (17,7)	5 (35,7)	2 (7,1)	4 (20,0)	NS
Mantener peso	37 (59,7)	4 (28,6)	20 (71,4)	13 (65,0)	**
Perder peso	14 (22,6)	5 (35,7)	6 (21,4)	3 (15,0)	NS

Grupo 1, 0 kcal/semana de actividad físico-deportiva; Grupo 2, ≤ 3.000 kcal/semana de actividad físico-deportiva; Grupo 3, > 3.000 kcal/semana de actividad físico-deportiva; NS, diferencias no significativas; ^aChi-cuadrado; *P < 0,05; **P < 0,01; ***P < 0,001.

Tabla IV
Satisfacción con el peso corporal según nivel de actividad físico-deportiva en la muestra estudiada: hombres estudiantes universitarios

Clasificación según satisfacción con el peso	n (%)				P ^a
	Total n=62	Grupo 1 n=14	Grupo 2 n=28	Grupo 3 n=20	
Satisfecho	37 (59,7)	4 (28,6)	20 (71,4)	13 (65,0)	**
Insatisfecho	18 (29,0)	7 (50,0)	6 (21,4)	5 (25,0)	NS
Muy insatisfecho	7 (11,3)	3 (21,4)	2 (7,1)	2 (10,0)	NS

Grupo 1, 0 kcal/semana de actividad físico-deportiva; Grupo 2, ≤ 3.000 kcal/semana de actividad físico-deportiva; Grupo 3, > 3.000 kcal/semana de actividad físico-deportiva; NS, diferencias no significativas; ^aChi-cuadrado; *P < 0,05; **P < 0,01; ***P < 0,001.

Tabla V
Relación entre el peso autodeclarado y deseado según nivel de actividad físico-deportiva en la muestra estudiada: hombres estudiantes universitarios

	n (%)				P ^a
	Total n=62	Grupo 1 n=14	Grupo 2 n=28	Grupo 3 n=20	
$P_{\text{deseado}} > P_{\text{autodeclarado}}$ en un 5%	7 (11,3)	3 (21,4)	2 (7,1)	2 (10,0)	NS
$P_{\text{deseado}} < P_{\text{autodeclarado}}$ en un 5%	8 (12,9)	3 (21,4)	4 (14,3)	1 (5,0)	NS

Grupo 1, 0 kcal/semana de actividad físico-deportiva; Grupo 2, ≤ 3.000 kcal/semana de actividad físico-deportiva; Grupo 3, > 3.000 kcal/semana de actividad físico-deportiva; NS, diferencias no significativas; P, peso; ^aChi-cuadrado.

fue próximo al encontrado en otros estudios llevados a cabo en universitarios norteamericanos³⁰, pero inferior al de otros trabajos^{33,34}. Y el IMLG fue parecido al de jóvenes de otros países²⁶.

En cuanto a la actividad físico-deportiva, el 77,4% de los participantes realizaba algún tipo de actividad física y/o deportiva habitualmente, dato que concuerda con el del mismo grupo etario de la población general del País Vasco (18,1%)²¹. En otros estudios llevados a cabo en universitarios^{7,12,29}, sin embargo, se encontraron porcentajes inferiores.

En el análisis del estado de peso y de la composición corporal según el nivel de actividad físico-deportiva no se encontraron diferencias, salvo en el PMB que fue mayor en el grupo 3 (sujetos que consumían más de 3.000 kcal/semana en la práctica de actividad físico-deportiva) que en el grupo 2 (sujetos que consumían $\leq$ 3.000 kcal/semana en la práctica físico-deportiva) ($P < 0,05$). Otros autores tampoco han encontrado diferencias en datos antropométricos como el peso, la talla, el IMC y el %GC en función de la práctica de ejercicio físico y/o deporte^{16,35}. No obstante, otros estudios han registrado diferencias en este sentido entre quienes practican deporte y quienes no lo hacen habitualmente^{12,13}.

Respecto a la autopercepción del peso corporal, los estudiantes que participaron en el presente trabajo sobrevaloraron su peso, declararon que pesaban como media 1,2 kg más de lo que pesaban realmente. Este resultado concuerda con el de otros autores³⁶ y podría estar relacionado con el deseo de tener un cuerpo más musculado³⁷. La autopercepción del peso fue mejor en el grupo que practicaba deporte y/o ejercicio físico a razón de $\leq$ 3.000 kcal/semana, que en aquellos que no practicaban ningún ejercicio físico o deporte ($P < 0,05$). En concordancia con estos datos, otros autores han comprobado que las personas que practican regularmente ejercicio y/o deporte tienen una mejor percepción de su imagen corporal¹⁵ y un mayor control y conocimiento de su cuerpo^{14,15}.

Acerca de la satisfacción con el peso corporal, cabe destacar que el 17,7% deseaba pesar más y el 22,6% menos. La mayoría de los estudios que han evaluado la satisfacción con el peso corporal en hombres han concluido que aproximadamente la mitad desea perder peso y la otra mitad ganarlo³⁸. Otros autores, sin embargo, han obtenido porcentajes inferiores en hombres que deseaban perder peso, en concreto un 35%³⁹ y un 38,4%⁸; y también en hombres que deseaban ganar peso, en particular un 15%³⁹ y un 28,3%⁸. El análisis cualitativo de la satisfacción con el peso reveló una mayor satisfacción en el grupo que practicaba deporte y/o ejercicio físico a razón de menos de 3.000 kcal/semana, que en aquellos que no practicaban ningún ejercicio físico o deporte ($P < 0,01$). Este resultado concuerda con el de otros autores^{8,15} y contrasta con el de Mendes Soares de Araújo y col.¹⁶ que no encontraron asociación entre la actividad física y el nivel de satisfacción con el peso corporal. Estas discrepancias

pueden deberse a diferencias metodológicas, socioculturales y geográficas.

En cuanto a las limitaciones del estudio, cabe destacar que el tamaño muestral no permite extrapolar los resultados a la población de estudiantes de la UPV/EHU, pero sí que ofrece información de interés para seguir investigando en esta línea. En un futuro se prevé ampliar el tamaño muestral y se intentará identificar a los sujetos más vulnerables a desarrollar trastornos relacionados con la percepción y/o insatisfacción con el peso corporal.

A la vista de los resultados obtenidos, concluimos que la práctica regular de actividad físico-deportiva moderada está relacionada con una mejor percepción y satisfacción con el peso corporal, en comparación con el sedentarismo. Por ello, sería conveniente aprovechar el periodo de estudios universitarios para fomentar la práctica de ejercicio físico-deportivo, empleando los recursos o activos con los que cuenta la Universidad.

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Original/*Deporte y ejercicio*

Hábitos de práctica física en escolares: factores influyentes y relaciones con la condición física

Daniel Arriscado¹, José Joaquín Muros², Mikel Zabala³ y Josep María Dalmau¹

¹Dpto. de Ciencias de la Educación, Universidad de La Rioja. Logroño. ²Dpto. de Nutrición y Bromatología, Universidad de Granada. Granada. ³Dpto. de Educación Física y Deportiva, Universidad de Granada. Granada. España.

Resumen

Introducción: Los estilos de vida actuales han provocado un aumento de las actividades sedentarias y una disminución de la actividad física, lo que puede conllevar un empeoramiento de la salud presente y futura de la población infantil.

Objetivos: El objetivo del estudio fue describir los hábitos de vida y actividad física de una población de escolares de una ciudad del norte de España, así como analizar las relaciones entre dichos hábitos y la composición corporal, la condición física y algunos factores sociodemográficos.

Métodos: El estudio se llevó a cabo sobre una muestra representativa de 329 escolares de sexto de primaria (11-12 años) de las 31 escuelas de Logroño (La Rioja). Se registraron datos sociodemográficos, antropométricos, tensión arterial, desarrollo madurativo, condición física y hábitos de vida y de actividad física.

Resultados: Los alumnos de género masculino, quienes practicaban actividades deportivas extraescolares y los que se encontraban en un estadio de desarrollo menor reportaron mayores niveles de actividad física. Se encontraron correlaciones directas entre la práctica y la condición física, especialmente con la capacidad aeróbica ($r=0,38$), e inversas con las horas frente a la pantalla ($r=-0,18$), pero no con la composición corporal.

Conclusiones: Dadas las relaciones entre los niveles de actividad y la condición física, estrategias de promoción de la práctica física deberían fomentarse con el fin de mejorar la salud de los jóvenes. Las intervenciones deberían centrarse en favorecer el acceso a las actividades deportivas extraescolares, reducir los hábitos sedentarios y aumentar el nivel de práctica física del género femenino.

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Palabras clave: Niño. Actividad física. Hábitos. Condición física. Composición corporal.

PHYSICAL ACTIVITY HABITS IN SCHOOLCHILDREN: INFLUENTIAL FACTORS AND RELATIONSHIPS WITH PHYSICAL FITNESS

Abstract

Introduction: Current lifestyles have led to an increase in sedentary activities and a decrease in physical activity, which can lead to a worsening of the present and future health of children.

Aims: This study sought to describe the lifestyle and physical activity habits of schoolchildren in a city in northern Spain and to analyse the relationships between these habits and body composition, physical fitness and certain socio-demographic factors.

Methods: The study was conducted on a representative sample of 329 sixth grade elementary school students (aged 11-12) from 31 schools in Logroño (La Rioja). Socio-demographic data, anthropometric data, blood pressure, development level, physical fitness and lifestyle habits and physical activity were recorded.

Results: The male students who performed extracurricular sports activities and those at earlier stages of development reported higher levels of physical activity. Direct correlations between physical exercise and fitness were detected, especially with respect to aerobic capacity ($r = 0.38$), and inverse correlations with hours in front of a screen ($r = -0.18$), but not with body composition.

Conclusions: Given the relationships between levels of physical activity and fitness, strategies to promote physical exercise should be encouraged in order to improve the health of young people. Interventions should focus on promoting access to extracurricular sports activities, reducing sedentary habits and increasing the level of physical exercise in girls.

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Keywords: Child. Physical activity. Habits. Physical fitness. Body composition.

Correspondencia: Daniel Arriscado Alsina.
C/Río Linares, nº 6, 1º C. 26140, Lardero (La Rioja).
E-mail: danielarriscado@hotmail.com
Teléfono: +34607843206.
Universidad de La Rioja.

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Abreviaturas

VO2max: Volumen máximo de oxígeno.

PAQ-C: Physical Activity Questionnaire for older Children.

Introducción

El descenso en los niveles de actividad física ha hecho que el sedentarismo se haya convertido en uno de los grandes problemas del siglo XXI¹. Entre otros, dicho descenso está relacionado con el aumento del sobrepeso y la obesidad infantil, así como con el empeoramiento general de la salud infantil².

Con el fin de revertir esta situación, es necesario un modelo de balance energético entre las calorías que se ingieren y las que el cuerpo necesita³. No obstante, en las primeras etapas de la vida, debido a los requerimientos energéticos del crecimiento, es más recomendable que el citado ajuste provenga del aumento de la actividad física que de la restricción calórica⁴, de ahí que la Organización Mundial de la Salud recomiende la práctica de 60 minutos diarios en jóvenes de 5 a 17 años⁵.

Diferentes investigaciones han relacionado los comportamientos sedentarios, especialmente el tiempo frente al televisor y ordenador, con un mayor riesgo de padecer sobrepeso u obesidad⁶. Por el contrario, mayores niveles de práctica física, especialmente si es vigorosa, se han asociado a una mejor condición física⁷, mayor satisfacción corporal⁸, menor riesgo cardiovascular⁹ y a una más saludable composición corporal¹⁰. De este modo, aumentar los niveles de actividad física entre la población infantil resulta fundamental, especialmente, teniendo en cuenta que la presencia de sobrepeso u obesidad en la infancia es un fuerte predictor de padecerlos en la edad adulta¹¹.

El objetivo de este estudio fue describir los hábitos de vida y práctica física de una población representativa de escolares de sexto curso de Educación Primaria (11-12 años) de Logroño. Además, se analizaron las relaciones entre los citados hábitos y la composición corporal, la condición física, la tensión arterial y algunos factores sociodemográficos.

Métodos

Sujetos

Se diseñó un estudio transversal con una muestra representativa de los alumnos escolarizados en sexto curso de Educación Primaria (11,7±0,4 años) de la ciudad de Logroño. Los datos para ese intervalo de edad durante el curso 2011-2012 comprendían 1.595 alumnos. Asumiendo un error del 5% y sobreestimando la participación en un 20%, la selección de los escolares se realizó a través de un muestreo aleatorio simple entre todos los centros educativos públicos y concertados de

la ciudad, siendo la participación del 88,4%, lo que supuso un total de 329 alumnos. Se eliminó del análisis a siete sujetos que no pudieron realizar práctica física con normalidad y a cuatro por no completar los cuestionarios correctamente, quedando 318 escolares. La investigación se llevó a cabo durante la primavera de 2012.

Todos los alumnos participaron de manera voluntaria y respetando el acuerdo sobre ética de investigación de Helsinki. Se solicitó el consentimiento informado de los padres o tutores de los alumnos. El Comité Ético de Investigación Clínica de La Rioja aprobó este estudio.

Datos sociodemográficos

Los propios participantes del estudio informaron de su sexo, fecha de nacimiento y país de origen. La clasificación de escuelas públicas o concertadas fue facilitada por la Consejería de Educación del Gobierno de La Rioja. El nivel socioeconómico y sociocultural de los alumnos se determinó en función de la información recogida en el Proyecto Educativo del Centro al que asistían, dividiéndolo en las siguientes categorías: medio-bajo, medio y medio-alto.

Medidas antropométricas

Todas las medidas antropométricas fueron tomadas siguiendo el protocolo establecido por la *International Society for the Advancement of Kinanthropometry*¹² y por un único evaluador experimentado, acreditado como nivel II por la citada entidad.

El peso se determinó con una balanza SECA (713, Hamburg, Alemania), con una precisión de 0,1 kg. Para la talla se empleó un tallímetro Holtain (Holtain Ltd., Dyfed, Reino Unido), con una precisión de 1 mm. A partir de estos datos, se calculó el índice de masa corporal como el peso dividido por la altura al cuadrado (kg/m²). El sobrepeso y la obesidad fueron definidos de acuerdo a los criterios internacionales¹³. Los perímetros de cintura y cadera fueron medidos con una cinta de acero flexible Lufkin (Lufkin W606 PM, Michigan, EEUU) de 0,1 cm de precisión. Posteriormente, se calculó el cociente entre cintura y cadera. Se midieron los pliegues cutáneos de tríceps y subescapular con un plicómetro Holtain (Holtain Ltd., Crosswell, Reino Unido), con una precisión de 0,2 mm y una presión constante de 10 g/mm². El porcentaje de masa grasa se estimó mediante las ecuaciones de Slaughter¹⁴.

Maduración sexual

El nivel de maduración sexual fue determinado por investigadores entrenados, del mismo sexo del alumno, a través de dos procedimientos diferentes: autoevaluando su estado madurativo¹⁵ y mediante ecuaciones que determinan la aceleración del crecimiento (*peak*

height velocity), basándose en la edad cronológica, el sexo y medidas antropométricas¹⁶.

Presión arterial

Los niveles de presión arterial sistólica y diastólica se determinaron mediante un esfigmomanómetro aneroides Riester (minimus III, Jungingen, Alemania) calibrado y un estetoscopio. Las medidas se realizaron por la mañana, con los alumnos en sedestación, tras más de cinco minutos de reposo previo y con un brazalete adaptado al tamaño del brazo. Personal titulado y experimentado fue el responsable de tomar la tensión arterial en los dos brazos de cada participante. Se registraron las medidas en milímetros de mercurio (mmHg).

Condición física

La condición física se determinó mediante los test de campo de la Batería ALPHA-Fitness¹⁷, a la que se añadió el test *sit and reach*. De manera resumida, éstos son:

- *20 meter Shuttle Run Test*¹⁸: Mediante este test de campo incremental, se determinó el volumen de oxígeno máximo (VO₂max) en relación a la masa corporal. En función de dicho VO₂max y según los últimos estándares de referencia Fitnessgram para cada edad y sexo¹⁹, se clasificó a los alumnos en “zona saludable” y “algún o alto riesgo” para la salud.
- *Test de dinamometría manual*: Esta prueba evalúa la fuerza máxima isométrica de prensión manual a través de un dinamómetro digital (TKK5101, Tokio, Japón; rango 5 a 100 kg, precisión 0,1 kg), cuyo agarre se ajusta a la mano del alumno. Se registró la media en kilogramos (kg) de la mejor medida de cada mano.
- *Test de salto horizontal sin impulso*: Este test evalúa la fuerza explosiva del tren inferior mediante la máxima distancia alcanzada. Se registraron los centímetros (cm) desde el talón más atrasado hasta la línea de despegue.
- *4x10m*: Con el objetivo de valorar la velocidad-agilidad. Se registraron los segundos (s) y décimas de segundo en completar el recorrido.
- *Sit and reach*: Este test evalúa la flexibilidad de la musculatura isquiotibial y lumbar del alumno. Partiendo de la posición de sentado en el suelo con las piernas completamente estiradas y descalzo, consiste en flexionar el tronco todo lo posible hacia delante, sin doblar las piernas y mediante un movimiento continuo y sostenido. Se registraron los centímetros (cm) que sobrepasaron las puntas de los pies con las dos manos paralelas.

Todos los test se realizaron dos veces, registrando la mejor marca, excepto la prueba de capacidad aeróbica que se desarrolló una sola vez.

Nivel y hábitos de actividad física

Con el objetivo de determinar el nivel de actividad física de los alumnos, éstos completaron el cuestionario *Physical Activity Questionnaire for older Children* (PAQ-C), validado y adaptado al idioma español²⁰. El cuestionario pretende valorar la práctica moderada a vigorosa en los últimos siete días mediante nueve cuestiones que tratan sobre el tipo y frecuencia de actividad. De las respuestas se obtiene una puntuación del 1 al 5, siendo mayor cuanto más activo es el niño. En función de la misma, se clasificó a los participantes en terciles correspondientes al nivel de actividad física: bajo, medio y alto. El cuestionario se complementó con preguntas sobre la práctica de actividad deportiva extraescolar, la hora en que se acostaban y levantaban, las horas de ejercicio físico y de tiempo frente a la pantalla, y el modo en que acudían al colegio, diferenciando entre transporte activo (caminando, en bici...) o pasivo. El mismo se administró de forma guiada por un investigador entrenado y bajo la supervisión de tres colaboradores que aseguraban la comprensión del mismo por parte de todos los participantes.

Análisis estadístico

Las variables cuantitativas se presentan con la media y su desviación típica. La normalidad de los datos se comprobó mediante el test de Kolmogorov-Smirnov. Las comparaciones de estas variables se realizaron mediante la prueba T de Student o el ANOVA de un factor para muestras independientes según si el número de grupos a comparar fue de dos o de más. Estas pruebas fueron aplicadas para variables con distribución normal, el resto fueron analizadas mediante las pruebas U de Mann-Whitney y Kruskal Wallis, respectivamente. Las variables cualitativas se presentan según su distribución de frecuencias. A través del test Chi-cuadrado de Pearson se analizó la relación de las mismas.

Se estudió la asociación entre las variables mediante la correlación de Pearson o Spearman, en función de su distribución. Para comprobar el grado de determinación que algunas variables tenían sobre el nivel de actividad física, se llevó a cabo un modelo de regresión lineal simple. Los datos fueron analizados con el programa estadístico SPSS versión 21,0 para Windows. El nivel de significación se estableció en 0,05.

Resultados

La edad, desarrollo madurativo, hábitos de vida, tensión arterial, características antropométricas y nivel de condición física de la muestra de estudio se recogen en la tabla I. La misma se dividió en función del sexo y el nivel de práctica física.

En función del sexo, las chicas mostraron un estado madurativo superior, así como unos valores mayores en

Tabla I
Características de la muestra

	Total		Sexo		Nivel de actividad física (terciles)			
	(N=318)	Chicas (N=158)	Chicos (N=160)	p valor	Bajo (N=105)	Medio (N=117)	Alto (N=96)	p valor
EDAD (años)	11,7±0,4	11,8±0,4	11,7±0,4	0,162	11,8±0,4	11,8±0,4	11,7±0,4	0,050
TANNER (estadio)	2,3±0,6	2,5±0,8	2,2±0,5	0,000***	2,4±0,7	2,3±0,7	2,2±0,5	0,061
AC (años)	-2,5±0,4	-2,4±0,4	-2,6±0,4	0,001**	-2,5±0,4	-2,5±0,4	-2,6±0,5	0,092
PAQ-C	3,0±0,6	2,8±0,5	3,2±0,6	0,000***	2,4±0,3	3,0±0,1	3,6±0,3	0,000***
AF (horas)	1,4±0,7	1,2±0,7	1,6±0,7	0,000***	1,0±0,6	1,4±0,7	1,9±0,7	0,000***
TV (horas)	1,6±0,9	1,6±0,8	1,6±0,9	0,994	1,8±0,9	1,5±0,8	1,4±0,8	0,000***
DESC (horas)	9,6±0,7	9,5±0,6	9,7±0,8	0,066	9,5±0,7	9,6±0,6	9,6±0,9	0,567
PAS (mmHG)	100,7±10,9	100,3±11,0	101,1±10,7	0,333	101,1±11,3	100,3±11,4	100,7±9,7	0,892
PAD (mmHG)	54,3±6,3	53,8±6,1	54,8±6,5	0,156	54,6±6,1	53,6±6,6	55,0±6,2	0,252
IMC (kg/m²)	19,6±3,1	19,5±2,7	19,7±3,5	0,883	19,5±3,1	19,7±3,2	19,5±3,2	0,703
PC (cm)	65,6±7,1	64,2±6,1	67,0±7,7	0,001**	65,7±7,3	65,5±7,2	65,6±6,8	0,994
CIN/CAD	0,78±0,05	0,76±0,04	0,81±0,03	0,000***	0,78±0,05	0,78±0,05	0,79±0,04	0,276
% GRASO	24,6±9,9	25,0±7,6	24,1±11,7	0,028*	25,7±9,6	24,6±10,3	23,3±9,6	0,177
VO2max (ml/kg/min)	44,8±4,8	43,0±3,6	46,6±5,2	0,000***	42,1±3,5	45,0±4,3	47,5±5,0	0,000***
DINA (kg)	20,1±3,7	20,2±3,8	19,9±3,6	0,581	19,8±3,7	20,2±3,5	20,2±4,0	0,746
4X10 (s)	12,7±0,9	12,9±0,8	12,5±0,9	0,000***	13,1±1,0	12,7±0,8	12,3±0,8	0,000***
SALTO (cm)	146±19	143±19	149±18	0,001**	141±20	146±18	153±15	0,000***
FLEX (cm)	1,3±7,7	4,2±8,1	-1,5±6,1	0,000***	1,1±7,9	2,5±7,7	0,0±7,3	0,057

AC, aceleración del crecimiento; AF, horas de actividad física diarias; TV, horas diarias frente a la pantalla; DESC, horas de sueño nocturno diarias; PAS, tensión arterial sistólica; PAD, tensión arterial diastólica; IMC, índice de masa corporal; PC, perímetro de cintura; CIN/CAD, cociente cintura/cadera; VO2max, volumen máximo de oxígeno; DINA, fuerza de prensión manual; FLEX, flexibilidad.
p<0,05*; p<0,01**; p<0,001***.

el perímetro de cadera y porcentaje graso, mientras que los chicos tenían un mayor perímetro de cintura y una mejor condición física en general. En cuanto a los niveles de actividad física, los chicos obtuvieron resultados superiores tanto en el tiempo de práctica diaria (1,6±0,7 horas vs 1,2±0,7 horas), como en la puntuación del cuestionario PAQ-C (3,2±0,6 vs 2,8±0,5). Según la nacionalidad de origen (español o extranjero), los inmigrantes reportaron un mayor tiempo frente a la pantalla (2,0±1,0 horas vs 1,5±0,8 horas) y un menor tiempo de sueño nocturno (9,3±0,9 horas vs 9,7±0,7 horas).

La división en terciles de actividad física reveló diferencias significativas en cuanto a las horas frente a la pantalla. De este modo, los más activos registraron menores valores de tiempo frente a la pantalla (1,4±0,8 horas vs 1,8±0,9 horas). Además, cuanto más bajo era el nivel de actividad, peores rendimientos se obtuvieron en las pruebas de VO2max (47,5±5,0 ml/kg/min en el tercil superior vs 42,1±3,5 ml/kg/min en el inferior), salto (153±15,0 cm vs 141±20,0 cm) y velocidad (12,3±0,8 s vs 13,1±1,0 s). No se apreciaron diferencias significativas en lo que a la composición corporal

se refiere, al igual que tampoco se encontraron en el nivel de práctica al clasificar a los alumnos en función de su índice de masa corporal o de su nivel socioeconómico y sociocultural.

La tabla II muestra los hábitos de la población de estudio. La mayoría de los alumnos dormían entre nueve y diez horas por noche, acudían al colegio de forma activa y practicaban actividades extraescolares. Sin embargo, casi la mitad de los mismos (45%) afirmó pasar dos o más horas frente a la pantalla (televisión, ordenador...) los días de escuela.

En la tabla III se recogen aquellas variables que influyeron sobre los niveles de actividad física. Mayores valores de práctica fueron encontrados entre los chicos y entre quienes poseen un menor estadio de desarrollo madurativo, practican actividades extraescolares o tienen una capacidad aeróbica saludable. La capacidad aeróbica, el sexo y la práctica de actividades extraescolares explicaron el 26% de la varianza del nivel de actividad física. Sin embargo, observamos que no hubo diferencias entre los normopesos y los sobre pesos u obesos (p=0,493).

Tabla II
Hábitos de actividad física, tiempo frente a la pantalla y sueño nocturno

	Total (N=318)	Chicos (N=160)	Chicas (N=158)
Horas de actividad física diarias	0	7,6%	5,4%
	1	50,9%	40,1%
	2	34,8%	46,1%
	3 o más	6,7%	8,4%
P valor = 0,000			
Horas frente a la pantalla diarias	0	4,6%	3,6%
	1	50,3%	52,7%
	2	32,0%	29,9%
	3 o más	13,1%	13,8%
P valor = 0,064			
Horas de sueño nocturno	Menos de 9	13,4%	13,2%
	De 9 a 10	68,0%	63,5%
	Más de 10	18,6%	23,4%
P valor = 0,075			
Transporte activo	Sí	66,8%	68,9%
	No	33,2%	31,1%
P valor = 0,412			
Act. Extra. Deportiva	Sí	68,6%	72,5%
	No	31,4%	27,5%
P valor = 0,125			

Tabla III
Distribución del nivel de actividad física en función de diferentes variables

Nivel af Paq-C (terciles)	Sexo		Desarrollo biológico (Tanner)		Actividad extraescolar		Capacidad aeróbica		Índice de masa corporal	
	Chicas	Chicos	1-2	3-4	No	Sí	Algún/alto riesgo	Zona saludable	Normopesos	Sobr./Obes.
Bajo (N=105)	N 66	39	62	43	56	49	28	77	75	30
	% 41,8%	24,4%	29,7%	39,4%	56,6%	22,4%	57,1%	28,8%	32,5%	34,5%
Medio (N=117)	N 66	51	74	43	27	90	16	100	82	35
	% 41,8%	31,9%	35,4%	39,4%	27,3%	41,1%	32,7%	37,5%	35,5%	40,2%
Alto (N=96)	N 26	70	73	23	16	80	5	90	74	22
	% 16,5%	43,8%	34,9%	21,2%	16,2%	36,5%	10,2%	33,7%	32,0%	25,3%
N=318	P valor = 0,000		P valor = 0,031		P valor = 0,000		P valor = 0,000		P valor = 0,493	

Las correlaciones entre variables se recogen en la tabla IV. En la misma se observa como el nivel de práctica física se asoció inversamente con las horas de pantalla ($r=-0,18$), especialmente en chicas ($r=-0,22$), y directamente con el rendimiento en las pruebas de VO2max, velocidad y salto, sobre todo en los chicos. Las horas frente a la pantalla se asociaron con

un menor sueño nocturno ($r=-0,21$) y, en menor medida, con un peor rendimiento en las pruebas de aptitud citadas. Además, en las chicas, más horas frente a la pantalla se asoció con unos mayores valores de tensión arterial, tanto sistólica como diastólica, así como con un peor rendimiento en el test de flexibilidad ($r=-0,23$).

Tabla IV
Coeficientes de correlación entre hábitos de vida y tensión arterial, medidas antropométricas y condición física

	PAQ-C	H. AF	H. TV	Sueño	PAS	PAD	IMC	Perim. Cintu	% Graso	VO2max	DINA	Salto	4x10	FLEX
Chicas (N=158)	PAQ-C	1,000	,465**	-,216**	,020	-,012	-,021	,114	,079	,263**	,150	,170*	-,121	,071
	TV	-,216**	-,003	1,000	-,125	,212**	,176*	-,014	,035	-,033	-,029	-,160*	,142	-,233**
	DESC	,020	-,126	-,125	1,000	-,047	,036	-,100	-,080	-,041	-,053	-,046	,063	-,049
Chicos (N=160)	PAQ-C	1,000	,451**	-,203*	-,010	-,019	-,014	-,128	-,159*	,451**	-,002	,242**	-,340**	-,009
	TV	-,203*	-,071	1,000	-,275**	-,037	-,075	-,073	-,103	-,157*	-,110	-,107	,135	,157*
	DESC	-,010	,009	-,275**	1,000	-,029	-,016	-,066	-,069	,027	,024	,143	-,057	-,050
Total ^a (N=318)	PAQ-C	1,000	,505**	-,181**	-,040	-,020	,009	-,015	-,051	,383**	,081	,234**	-,267**	,027
	TV	-,181**	-,053	1,000	-,209**	,089	,029	-,076	-,069	-,122*	-,073	-,124*	,111*	-,071
	DESC	-,040	-,063	-,209**	1,000	-,042	,042	-,048	-,046	,015	-,021	,013	-,005	-,051

P<0,05*; P<0,01**.

^a Análisis controlando el efecto del sexo.

H. AF, horas de actividad física diarias; H. TV, horas frente a la pantalla diarias; DESC, horas de sueño nocturno diarias; PAS, tensión arterial sistólica; PAD, tensión arterial diastólica; IMC, Índice de Masa Corporal; VO2max, volumen máximo de oxígeno; DINA, fuerza de prensión manual; FLEX, flexibilidad.

Discusión

Los resultados del estudio indicaron que, a pesar de que la participación en actividades extraescolares fue similar en ambos sexos, los chicos registraron mayores niveles de práctica física, lo que coincide con estudios anteriores²¹. También se encontraron diferencias significativas en función del nivel de maduración de los alumnos. La bibliografía existente confirmó que la práctica física moderada o vigorosa disminuye en torno a 40 minutos anuales entre los 9 y los 15 años de edad²². En nuestra población de estudio, con una edad cronológica similar, se observó que dicha práctica decrece a medida que aumenta el desarrollo madurativo, lo que, en parte, pudiera explicar las diferencias entre sexos, al madurar antes las chicas.

El 45% de los alumnos permanecía dos o más horas diarias frente a la pantalla y el 69% practicaba actividades deportivas extraescolares. Este resultado incidió sobre los niveles totales de actividad física, al igual que ocurrió en niños y adolescentes griego-chipriotas, que contaban con más opciones de ser activos si realizaban práctica física en clubes deportivos (OR=3,4)²³. Con respecto al transporte activo hasta la escuela, se registró que el 67% de los escolares acudían al colegio andando o en bicicleta, mismo porcentaje que el observado en niños ingleses²⁴. Sin embargo, en éstos, el caminar hasta la escuela se asoció con el tercil de mayor actividad (OR=1,8), hecho que no se encontró en el presente estudio. Esto podría explicarse porque la escolarización responde a criterios de proximidad geográfica, con lo que las distancias suelen ser pequeñas. Por último, en lo que a las horas de sueño nocturno se refiere, no se encontraron relaciones con ninguna de las variables estudiadas, lo que concuerda con otras investigaciones que hallaron asociaciones inversas entre el sueño nocturno y las probabilidades de padecer sobrepeso en los primeros años de vida, pero no entre los cinco y los trece²⁵.

Los resultados mostraron una moderada relación entre los niveles de práctica física y la capacidad aeróbica. Este hecho ya había sido constatado en otros estudios, tanto con metodologías objetivas, donde el VO2max correlacionó con la actividad física vigorosa (r=0,23)²⁶, como mediante cuestionarios, obteniendo los físicamente activos mayores valores de VO2max que los inactivos (de 0,42 a 1,22 ml/kg/min)²⁷. Aunque en menor medida, también se han estudiado asociaciones con otros componentes de la condición física. Así, en escolares italianos, aquéllos con mayores niveles de práctica consiguieron mejores rendimientos en las pruebas de salto y velocidad, aunque los resultados sólo fueron significativos en los chicos⁷.

Sin embargo, no se encontraron relaciones entre la actividad física y la composición corporal de los alumnos. En este sentido, la bibliografía existente no es unánime. Algunas investigaciones, en las que la actividad física se valoró de forma objetiva, determinaron asociaciones con el porcentaje de grasa, es-

pecialmente, en el caso de los chicos y de la práctica física vigorosa ($r=-0,38$)²⁸. Sin embargo, no ocurrió lo mismo al valorarla de forma subjetiva²⁹, siendo los niveles de actividad física independientes del índice de masa corporal. El hecho de que únicamente la práctica física vigorosa se relacione con la composición corporal podría explicar que no se encuentren asociaciones con la práctica autorreportada, ya que las herramientas subjetivas tienden a sobreestimar los niveles de actividad, posiblemente, por la dificultad para cuantificar la intensidad³⁰. En la misma línea, otros autores encontraron niveles de participación similares en actividades deportivas entre normopesos y sobrepesos³¹, al igual que ocurrió en la población estudiada.

No obstante, los precedentes en adolescentes españoles indicaron que la aptitud física posee una mayor influencia sobre la salud que la propia actividad física³², de modo que ésta incrementará los niveles de salud siempre que aumente el rendimiento de la condición física, especialmente, de la capacidad aeróbica. Además, existen evidencias de que la práctica física puede favorecer un perfil lipídico más saludable incluso sin producir cambios sobre las medidas corporales³³.

Al contrario de lo reportado por escolares portugueses³⁴, no se encontraron asociaciones entre la práctica física y la tensión arterial, aunque, en las chicas, sí que se dio una relación directa entre la misma y las horas frente a la pantalla. Además, este tiempo de pantalla correlacionó de forma negativa con el nivel de actividad física, lo que significa que las actividades sedentarias podrían desplazar la práctica de la misma. Anteriormente, ya se habían constatado relaciones similares entre ambos constructos ($r=-0,39$)³⁵, aunque también existen estudios en los que aparecen como independientes²³.

Nuestra investigación contó con una serie de limitaciones. La falta de medidas objetivas de los niveles de actividad podría conllevar que éstos sean sobreestimados o subestimados. Sin embargo, la incorporación de acelerómetros hubiera disminuido las opciones de conseguir una muestra representativa. Por otro lado, el carácter transversal del estudio hace que no se puedan obtener relaciones de causalidad en las asociaciones observadas, por lo que más estudios longitudinales y de intervención son requeridos en este sentido. En cuanto a las fortalezas, destacar que se siguió el mismo protocolo de actuación en todos los centros educativos de la ciudad y que todas las mediciones fueron valoradas por los mismos profesionales, descartando así el error interindividual.

Como conclusión, el estudio reveló relaciones significativas entre los niveles de práctica física y la condición física, especialmente, en lo referente a la capacidad aeróbica o cardiorrespiratoria. Mayores niveles de actividad fueron registrados por los chicos y por quienes participaban en actividades extraescolares deportivas. Al contrario, los menores niveles fueron reportados por quienes más tiempo pasaban frente a la

pantalla. Estos resultados implican que, desde el ámbito sanitario, deberían impulsarse políticas e intervenciones destinadas a fomentar la práctica física entre los escolares, con el objetivo de mejorar su salud a través de un incremento de su aptitud física. Dichas políticas tendrían que dirigirse, principalmente, al género femenino, a la participación en actividades extraescolares que aseguren unos mínimos de práctica y a la disminución de los hábitos sedentarios.

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Original/*Deporte y ejercicio*

Efectos de la dieta y práctica de deportes aeróbicos o anaeróbicos sobre los trastornos del comportamiento alimentario

Alejandro Martínez-Rodríguez

Departamento de Ciencias de la Actividad Física y del Deporte. Facultad de Deporte. UCAM Universidad Católica San Antonio de Murcia. España.

Resumen

Introducción: Actividades físicas de larga duración, con predominio aeróbico, requieren una práctica deportiva extensiva y continuada para obtener mejoras en el rendimiento. Mientras que las actividades anaeróbicas, requieren de un volumen de entrenamiento menor, aunque a intensidades más elevadas para alcanzar un buen estado de forma deportiva. La disminución del porcentaje graso dentro de la composición corporal, tanto de deportes aeróbicos como anaeróbicos, es una cuestión presente, sobre todo en estos últimos tiempos. Conseguir un adecuado estado nutricional, con estrategias inadecuadas, puede originar la aparición de trastornos de la conducta alimentaria.

Objetivo: determinar las diferencias existentes entre dos grupos de deportistas en función de la práctica de deportes aeróbicos o anaeróbicos, en cuanto a la presencia de desórdenes alimentarios, adherencia a dieta baja en grasa y actividad física.

Método: En este estudio participaron 206 sujetos varones entrenados que cumplimentaron los cuestionarios de actividad física en el tiempo libre de Minnesota abreviado, EAT-26 y Predimed de "Adherencia a dieta baja en grasa".

Resultados: Los deportistas que practican deportes aeróbicos muestran mayores puntuaciones en la mayoría de las subescalas y en el resultado total del cuestionario EAT-26. A mayor número de sesiones de práctica en deportes aeróbicos, aparecen puntuaciones superiores en el Control Oral. Dentro de esta población, el consumo de suplementos incrementa significativamente las puntuaciones del EAT-26 y la predisposición a un TCA, al igual que los planes de entrenamientos muy estrictos.

Discusión: Los deportistas que practican deportes de corte más aeróbico parecen mostrar una mayor predisposición a la presencia de un TCA.

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Palabras clave: *Actividad física. Trastornos alimentarios. Hábitos alimentarios. Dieta baja en grasa.*

Correspondencia: Alejandro Martínez-Rodríguez.
Departamento de Ciencias de la Actividad Física y del Deporte.
Facultad de Deporte. UCAM Universidad Católica
San Antonio de Murcia. España.
Campus de los Jerónimos, s/n. 30107. Guadalupe (Murcia)
E-mail: amartinez2@ucam.edu

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EFFECTS OF DIET AND AEROBIC OR ANAEROBIC EXERCISES ON EATING DISORDERS

Abstract

Introduction: Endurance exercises have a direct influence on aerobic capacity. To improve this quality is necessary develop an extensive and continuous training sessions. However anaerobic exercise requires low volume of training and high intensity to sport performance. In aerobic or anaerobic exercise is obvious to state that weight reduction must be performed from the body fat component, furthermore is an important point of view from the last years. Therefore, it is of vital importance to control the strategies used by the athletes in order to obtain the correct weight and avoid eating disorders.

Objective: identify differences comparing for groups that develop aerobic or anaerobic exercises, and concerns related to eating disorders, dietetic habits and physical activity.

Method: 206 trained men were examined and participated in the study, that can be screened using the validated EAT-26 questionnaire, Predimed fat-free diet questionnaire and Spanish short version of the Minnesota Leisure Time Physical Activity questionnaire.

Results: Athletes who practice aerobic physical activity showed higher values at majority of EAT-26 scales and total score. When this population increased their training sessions presented higher scores of Oral Control. The effects of consuming supplementation increases EAT-26 scores and eating disorder predisposition. In addition, high-structured training session increases EAT-26 scores and eating disorder predisposition too.

Discussion: Practice aerobic physical activities seem to show a greater predisposition to the presence of TCA in athletes.

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Key words: *Physical activity. Eating disorders. Eating habits. Fat-free diet.*

Abreviaturas

ABDG: Adherencia a Dieta Baja en Grasa.
AE: deportes aeróbicos.
AN: Anorexia Nerviosa.
ANAE: deportes anaeróbicos.
BN: Bulimia Nerviosa.
CIE-10: Clasificación Internacional de Enfermedades, Décima versión.
EAT-26: Eating Attitudes Test en su versión de 26 ítems.
IMC: Índice de Masa Corporal.
TAA: Trastornos Alimentarios Atípicos.
TCA: Trastornos del Comportamiento Alimentario.
WADA: Agencia Mundial Antidopaje.

Introducción

Para mantener un peso corporal adecuado, se recomienda la práctica de ejercicio físico con la intención de mantener una relación equilibrada entre el consumo calórico y el gasto energético. Sobre todo se suele incidir en la práctica de deportes aeróbicos como medida para llevar a cabo una reducción del peso incidiendo sobre el porcentaje de masa grasa.

Por un lado, la proporción de masa grasa en la composición corporal de los deportistas está relacionada con el rendimiento en deportes aeróbicos (AE), como sucede, entre otros, en la carrera continua, que se practica de forma popular¹. Asimismo, el número de años de práctica deportiva, el peso libre de masa grasa y la frecuencia de entrenamiento influyen en el rendimiento deportivo. A nivel fisiológico, el desempeño de actividades aeróbicas de larga duración, comprometen seriamente el metabolismo intra y extracelular, provocando reacciones perjudiciales para el organismo². Por lo que respecta a la composición corporal, en modalidades aeróbicas, el componente ectomórfico incide como factor predisponente de rendimiento deportivo. Aquellos sujetos con un peso superior al porcentaje graso idóneo, que suele ser el más bajo posible sin comprometer la grasa esencial, acusan una disminución del rendimiento.

Por otro lado, la vía anaeróbica está presente en aquellos deportes con movimientos explosivos repetidos con breves períodos de recuperación. El rendimiento en los deportes con predominio anaeróbico está influenciado, entre otros factores, por el peso y la composición corporal³.

En deportes o actividades físicas de corte más anaeróbico (ANAE), dentro de los que se pueden encontrar por ejemplo las disciplinas de control de peso (judo, karate, lucha, etc.), normalmente el porcentaje de masa grasa de los competidores es bajo, con un porcentaje alto de masa muscular, que ayuda a los deportistas a mejorar el rendimiento deportivo de cada modalidad.

Las tasas de prevalencia y morbilidad en relación con los trastornos del comportamiento alimentario

(TCA) se han visto incrementadas dentro de la población de deportistas en los últimos tiempos⁴. Los TCA afectan a deportistas centrados en obtener una mejora en el rendimiento deportivo, así como a aquellos que identifican a la evaluación estética como una medida de aprobación social, por lo que ambos podrían verse influenciados por los parámetros de composición corporal⁵. Es por ello, que cada vez parece haber una preocupación mayor sobre los TCA dentro de la población de deportistas.

Cabe destacar la importancia del control de las estrategias de pérdida de peso en este tipo de población como son los deportistas, ya que aparece un riesgo destacable en cuanto a la posibilidad de que se presente un TCA. Dentro de la población de deportistas, en la mayoría de los casos, aparece una prevalencia aumentada de problemas de TCA asociados a mujeres⁶. Sin embargo, empiezan a destacarse la presencia de TCA en la población de deportistas varones, aunque hay menos información sobre su relación con los TCA⁷. Algunos autores indican que el nivel deportivo de cada atleta también puede ser uno de los factores influyentes a considerar en cuanto a la posible aparición de los TCA⁸.

Las particularidades de los TCA⁹ pueden englobarse en tres criterios diagnósticos como son la anorexia nerviosa (AN), la bulimia nerviosa (BN) y los trastornos alimentarios atípicos (TAA) según la Clasificación Internacional de Enfermedades en su décima versión (CIE-10).

En jóvenes estudiantes se ha determinado una mayor incidencia en el desarrollo de TCA debido a una alteración en los hábitos alimentarios relacionados con la edad y la independencia. En cuanto a otros factores, como la raza o el nivel social o económico, no se han encontrado diferencias significativas. Las diferencias entre los distintos tipos de deporte, indican que las mujeres que participan en deportes estéticos, tienen un riesgo significativamente mayor de presentar TCA y puntuaciones más altas en el cuestionarios para determinar la posible presencia de un TCA, que aquellos deportes de otras modalidades, como deportes aeróbicos o anaeróbicos. Sin embargo, entre los deportistas masculinos, algunos estudios todavía no evidencian diferencias significativas según el tipo de deporte o modalidad practicada.

A grandes rasgos, se podría realizar una clasificación del tipo de deporte en función de las vías metabólicas de obtención de energía predominantes, en la que se diferenciarían deportes AE y ANAE. En la actualidad, prácticamente todas las modalidades deportivas, a excepción de algunas puntuales, se trata de optimizar el rendimiento deportivo teniendo en cuenta unas adecuadas estrategias dietético-nutricionales, que contribuyan a mantener un estado nutricional óptimo. Las malas praxis en las reducciones de peso hacen que se ponga en riesgo el estado de los deportistas, pudiendo originar problemas asociados a los TCA.

Objetivos

El propósito de este estudio es conocer las diferencias en relación a la posible presencia de un TCA y los hábitos alimentarios relacionados con el seguimiento de dietas bajas en grasa entre deportistas que realizan modalidades AE y ANAE.

Métodos

Población de estudio

Deportistas entrenados de la Comunidad Valenciana que realizan modalidades deportivas aeróbicas y anaeróbicas, participaron de forma voluntaria en el presente estudio. Fueron un total de 206 varones, 100 sujetos realizaban deportes AE: ciclismo, carrera y natación ($21,8 \pm 4,9$ años; $73,4 \pm 8,7$ kg peso; $177 \pm 6,3$ cm altura) y 106 ANAE: musculación, deportes de equipo y deportes de combate ($20,8 \pm 3,4$ años; $72,2 \pm 8,6$ kg peso; $178 \pm 6,4$ cm altura). Este estudio se llevó a cabo bajo el cumplimiento de las normas éticas del Comité de Investigación o de Ensayos Clínicos correspondiente y de la Declaración de Helsinki vigente.

La muestra se obtuvo en las inmediaciones próximas a las instalaciones deportivas de las universidades Miguel Hernández de Elche y Universidad de Alicante, en Mayo de 2013; y el tipo de muestreo fue aleatorio por conglomerados.

Se utilizó el cuestionario Eating Attitudes Test (EAT) en su versión de 26 ítems (EAT-26) en español¹⁰ y se administró a los sujetos de estudio para realizar una valoración de las actitudes alimentarias de los individuos que realizaban prácticas deportivas AE o ANAE. Este test auto-aplicado permite conocer la presencia de un posible TCA a través del cómputo global de sus 26 ítems, clasificados dentro de tres escalas diferenciadas: a) Dieta o restricción alimentaria; b) Bulimia y preocupación por los alimentos; c) Control por vía oral. La puntuación para determinar el test como positivo y alertar de un posible TCA, ya sea AN o BN, se sitúa en 20 puntos de los 78 posibles, pese a que hay estudios que usan el EAT con puntos de corte diferentes¹¹. Las respuestas se presentan en formato likert del 1 (nunca) al 6 (siempre), cuyo orden representará una puntuación de “0, 0, 0, 1, 2 y 3 puntos” en todas las preguntas a excepción de los ítems 1 y 25, “me gusta comer con otras personas” y “disfruto probando comidas nuevas y sabrosas”, en la que la puntuación está establecida en el orden inverso. Se realizó el análisis de fiabilidad del instrumento a través del coeficiente de fiabilidad (alfa de Cronbach): 0,79 para Dieta, 0,88 para Bulimia y 0,75 para Control por vía oral.

La valoración individual del grado de adherencia a la dieta baja en grasa se llevó a cabo mediante el cuestionario PREDIMED de adherencia a la dieta baja en grasa (ADBG)¹². En este cuestionario se compone de nueve cuestiones que tratarán de estudiar los patrones de ali-

mentación en relación con el tipo, cantidad y frecuencia de alimentos consumidos y la proporción de grasas en su composición nutricional. Las cuestiones puntúan (1 punto) o no, en función de si el consumo específico de un alimento o grupo de alimentos, se considera que pre-dispone al consumo de una dieta baja en grasa. La puntuación máxima del cuestionario son 9 puntos; cuanto más elevada sea la puntuación, significa que el sujeto presenta en mayor medida, una dieta baja en grasa. El coeficiente de fiabilidad (alfa de Cronbach) fue superior a 0,70 para cada una de las cuestiones del cuestionario.

Datos del consumo de suplementos

Es importante identificar si aparece el consumo de suplementos deportivos, ya que pueden producir cambios en el comportamiento de los individuos, relacionados con la práctica de actividad física y las estrategias dietético-nutricionales, siendo su finalidad la de incrementar la masa muscular, así como reducir la masa grasa¹³.

Datos de práctica deportiva

Se utilizó el cuestionario abreviado de actividad física en el tiempo libre de Minnesota validada para la población española¹⁴. Además se realizaron preguntas acerca del número de sesiones de entrenamiento por día y por semana, de las horas diarias de entrenamiento, el tiempo de años de desempeño de la práctica deportiva, el plan de entrenamiento y la ingesta de suplementos deportivos. Respecto a las propiedades psicométricas del cuestionario, la fiabilidad de este cuestionario fue de 92,5% ($\kappa = 0,88$). Asimismo, es válido y fiable (CCI = 0,95 y CCI = 0,96, respectivamente).

Análisis estadístico

El análisis estadístico se llevó a cabo a través del software SPSS® (versión 20.0 IBM para Windows). Se realizaron análisis de estadísticos descriptivos (media, error estándar de la media y porcentajes), prueba de distribución de la normalidad Kolmogorov-Smirnov para una muestra y comparación de medias de los distintos grupos de estudio a través de los estadísticos U-Mann Whitney, la prueba T para muestras independientes y prueba de Levene. Se emplearon pruebas paramétricas cuando los datos analizados adoptan una distribución normal y no paramétricas cuando los datos no seguían una distribución normal. Se fijó un nivel de significación de $p < 0,05$.

Resultados

Los resultados analizados muestran diferencias significativas entre los deportistas de las modalidades AE

y ANAE en las sub-escalas Dieta ($p=0,035$), Bulimia ($p=0,032$) y en el resultado total del cuestionario EAT-26 ($p=0,049$) (ver tabla I). En todas ellas el grupo AE presenta valores promedios superiores al grupo ANAE.

Dentro del grupo AE también se encuentran diferencias significativas dependiendo del número de sesiones de entrenamiento al día, del número de años de práctica deportiva, así como en seguir o no una planificación deportiva y tomar suplementación.

Aquellos deportistas del grupo AE que realizan dos o más sesiones de entrenamiento al día, muestran valores significativamente superiores en control oral ($p=0,047$) a los sujetos que solamente realizan una sesión al día (ver tabla I). Los deportistas del grupo AE que llevan realizando prácticas deportivas de esta modalidad durante menos de diez años, tienen valores de Bulimia ($p=0,028$) significativamente mayores que aquellos que practican este tipo de deportes más de diez años (ver tabla I). Dentro del grupo AE quienes siguen un plan de entrenamiento específico presentan resultados superiores en las sub-escalas Dieta ($p=0,006$), Bulimia

($p=0,002$) y en el resultado total del EAT-26 ($p=0,001$), significativamente superiores a los de deportistas AE que no siguen un plan de entrenamiento (ver tabla I). Del mismo modo, aquellos deportistas que consumen suplementos deportivos, alcanzan valores mayores que los que no consumen suplementos, de forma significativa tanto en el resultado global del EAT ($p=0,006$) como en las sub-escalas Dieta ($p=0,033$) y Bulimia ($p=0,001$) (ver tabla I). Dentro de los deportistas AE que consumen suplementos, un 7% de los sujetos optan por sustancias consideradas dopantes por la Agencia Mundial Antidopaje (WADA); mientras que ninguno de los deportistas ANAE consumen sustancias dopantes.

Cuando se comparan los resultados dentro del grupo de deportistas ANAE, no se obtienen diferencias significativas en cuanto a las distintas agrupaciones por sesiones de entrenamiento, años de práctica deportiva, seguimiento de plan de entrenamiento o suplementación deportiva. Tampoco hay diferencias en cuanto a las sesiones de entrenamiento por semana o las horas de entrenamiento, ni en deportistas AE como ANAE.

Tabla I
Resultados promedios y error estándar de la media (ESM) del test EAT-26, subescalas del test EAT-26: Dieta, Bulimia y Control Oral y el cómputo global del cuestionario (EAT total)

Grupo	Datos del Ejercicio	n	Dieta		Bulimia		Control Oral		EAT Total	
			Media	ESM	Media	ESM	Media	ESM	Media	ESM
AE	AE	100	2,94	± 0,34*	1,29	± 0,02*	1,55	± 0,02	5,78	± 0,06*
	ANAE	106	2,13	± 0,27*	0,91	± 0,13*	1,43	± 0,17	4,47	± 0,44*
	≤1 sesión/día	90	2,59	± 0,28	1,22	± 0,15	1,40	± 0,18*	5,21	± 0,48*
	≥2 sesiones/día	10	6,10	± 2,18	1,90	± 0,89	2,90	± 0,75*	10,90	± 3,28*
	≤10 años práctica	51	2,65	± 0,37	1,53	± 0,22*	1,86	± 0,29	6,04	± 0,74
	≥10 años práctica	49	3,24	± 0,58	1,04	± 0,24*	1,22	± 0,20	5,51	± 0,86
	Con plan de entrenamiento	76	3,38	± 0,42\$	1,54	± 0,20\$	1,74	± 0,22	6,66	± 0,69\$
	Sin plan de entrenamiento	24	1,54	± 0,43\$	0,50	± 0,15\$	0,96	± 0,27	3,00	± 0,58\$
	Con suplementación	27	4,19	± 0,92*	2,33	± 0,44\$	1,89	± 0,36	8,41	± 1,45\$
	Sin suplementación	73	2,48	± 0,31*	0,90	± 0,13\$	1,42	± 0,21	4,81	± 0,52\$
ANAE	≤1 sesión/día	99	2,20	± 0,29	0,92	± 0,14	1,47	± 0,17	4,60	± 0,47
	≥2 sesiones/día	7	1,14	± 0,70	0,71	± 0,42	0,86	± 0,46	2,71	± 0,84
	≤10 años práctica	57	2,25	± 0,44	1,04	± 0,20	1,28	± 0,22	4,56	± 0,70
	≥10 años práctica	49	2,00	± 0,30	0,76	± 0,15	1,61	± 0,25	4,37	± 0,50
	Con plan de entrenamiento	78	2,18	± 0,31	1,05	± 0,16	1,42	± 0,19	4,65	± 0,53
	Sin plan de entrenamiento	28	2,00	± 0,58	0,50	± 0,16	1,46	± 0,35	3,96	± 0,78
	Con suplementación	23	2,35	± 0,55	0,91	± 0,23	1,43	± 0,34	4,70	± 0,83
	Sin suplementación	83	2,07	± 0,32	0,90	± 0,15	1,43	± 0,19	4,41	± 0,52

Abreviaturas, *: p valor<0,05; \$: p valor<0,01; ESM: Error Estándar de la Media; AE: Deportes Aeróbicos; ANAE: Deportes Anaeróbicos; Sesión/día: frecuencia de práctica deportiva referenciada en nº de sesiones al día; Años práctica: Número de años de práctica deportiva del deporte en cuestión; Con suplementación: el deportista consume suplementos dietéticos; Sin suplementación: el deportista noconsume suplementos dietéticos; Dieta: subescala del cuestionario EAT-26 que representa estrategias de dieta o restricción alimentaria por parte de los sujetos; Bulimia: subescala del cuestionario EAT-26 que representa estrategias bulímicas; Control oral: subescala del cuestionario EAT-26 el control por vía oral por parte de los deportistas; EAT total: cómputo global del cuestionario EAT-26.

Con la intención de comparar los distintos hábitos relacionados con la ADBG entre los deportistas de cada una de las modalidades deportivas de estudio, a continuación se comentan los porcentajes obtenidos dentro de cada uno de los ítems del cuestionario.

El 2% de AE no ingiere ninguna cucharada (10ml) de aceite al día, mientras que el 100% de los ANAE ingieren alguna cucharada, predominando (61%) aquellos que consumen entre 1 y 3 cucharadas, al igual que en AE (60%). El 66% de AE retira la grasa visible o la piel de las carnes frente al 60% de ANAE. Un 33% de los deportistas AE consumen hasta 2 raciones de carne a la semana y un 20% más de 5, mientras que los deportistas ANAE consumen hasta 2 raciones a la semana y más de 5, un 26% y 33% respectivamente. El consumo de ninguna o una ración de mantequilla y productos similares superan el 50% tanto en deportistas AE (67%) como ANAE (54%). El número de deportistas que solamente consumen lácteos desnatados es mayor en AE (35%) que en ANAE (25%). En cuanto al consumo de pescado, hasta dos veces por semana, es superior en ANAE (70%; AE: 63%) pero inferior a AE (15%; ANAE: 8%) cuando se trata de más de cinco veces a la semana. Por último, la bollería y los snacks no se consumen o tan solo una vez a la semana un 34% y 36% en deportistas AE, y 22% y 26% en deportistas ANAE respectivamente.

Discusión

Al parecer, la realización de deportes de resistencia, proporciona beneficios para la salud, reduciendo factores de riesgos cardiovasculares y cáncer¹⁵. No obstante, también dependerá del volumen y las intensidades en el que se lleven a cabo. En principio, la mayoría de estudios con mujeres encuentran diferencias significativas dentro de los deportes de estética y de control de peso en comparación con los deportes de resistencia y de equipo, no sucediendo así cuando se estudian varones.

Los resultados de este estudio, ponen de manifiesto que llevar a cabo prácticas deportivas de resistencia podría llegar a incidir en la presencia de algún TCA. Se consideró utilizar el test EAT-26 debido a que varios autores indican que es la herramienta estándar usualmente más empleada en la medición de las características y sintomatología de los TCA^{16,17}.

Diversos estudios señalan la importancia del volumen de entrenamiento como uno de los factores que predispone hacia un mayor rendimiento en AE^{18,19}. Sin embargo, ante la práctica de actividad física de forma excesiva, podría entenderse como un factor previo a los TCA, como sucede en el grupo AE. Estas prácticas están estrechamente relacionadas con actitudes anoréxicas donde las actividades físicas en exceso aparecen en tareas cotidianas no relacionadas con el deporte²⁰, y en ambos casos acompañadas de un control exhaustivo de la comida.

Según la bibliografía consultada, la realización de actividad física podría aparecer tanto antes como en algunos casos después, de presentar los TCA. Y llama especialmente la atención cómo muchas personas con desórdenes alimentarios, desempeñan actividad física para mejorar su estado.

Respecto al consumo de sustancias prohibidas en forma de suplementos deportivos conducen a la idea de la presencia, dentro de los deportistas AE, de conductas con tendencias obsesivo-compulsivas, perfeccionistas y narcisistas. Todo ello, puede estar influenciado por altos niveles de motivación por la delgadez o la insatisfacción corporal, influyendo de forma excesiva en la motivación, afectando negativamente a las conductas alimentarias.

Por otra parte, los deportistas con menos de diez años de práctica de AE, son más propensos a poder presentar problemas en relación con TCA, lo cual podría indicar que la experiencia dentro de las disciplinas AE influye positivamente dentro de este grupo de sujetos.

En cuanto a los hábitos alimentarios de ambos grupos, se presenta una elevada concienciación en una dieta baja en grasa. Parece tratarse de estrategias dietético-nutricionales enfocadas a la mejora del rendimiento, aunque llevadas a su extremo podría llegar a desencadenar problemas asociados con los TCA.

Una de las principales limitaciones que plantea este estudio fue que no se empleó el procedimiento en doble fase para identificar casos prevalentes de TCA, ya que solamente se realizó el cribado mediante el cuestionario validado EAT-26, sin embargo, posteriormente no se efectúa una evaluación con entrevistas semi-estructuradas (SCAN)²¹ de aquellos deportistas considerados en riesgo tras obtener los resultados del EAT-26 y una muestra de los negativos; con la finalidad de valorar el sentido de la relación entre deporte y la presencia de un TCA. Otra de las limitaciones fue la imposibilidad de poder analizar cómo afecta a los sujetos los resultados obtenidos en las sub-escalas del EAT-26 en la distribución de los compartimentos corporales, principalmente de masa muscular y masa grasa, así como en el rendimiento deportivo. La posibilidad de un análisis de los factores de TCA sobre el rendimiento deportivo serían de utilidad para poder comparar en qué medida aquellos individuos que presentan valores elevados en las sub-escalas del EAT-26 ven afectado su rendimiento deportivo.

Conclusión

Los deportes aeróbicos muestran ser más propensos a presentar TCA que los deportes anaeróbicos. La práctica deportiva reciente, el número de sesiones, un plan de entrenamiento estricto y el consumo de suplementos, parecen ser factores que incrementan la incidencia de posibles TCA en deportistas de disciplinas aeróbicas.

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Original/*Deporte y ejercicio*

Versión española del cuestionario del complejo de Adonis; un cuestionario para el análisis del dimorfismo muscular o vigorexia

Pedro Ángel Latorre-Román, Antonio Garrido-Ruiz y Felipe García-Pinillos

Departamento de Didáctica de la Expresión Musical, Plástica y Corporal. Universidad de Jaén (España).

Resumen

Objetivo: Validar la versión española del cuestionario del complejo de Adonis en deportistas de musculación.

Método: La muestra está compuesta por 99 deportistas de musculación que entrenan regularmente (Edad: 25.45 ± 5.19 años; IMC = 24.53 ± 1.89 kg/m²). Los instrumentos utilizados para valorar la validez discriminante y convergente son la escala revisada de dependencia del ejercicio (*Exercise Dependence Scale-Revised*, EDS-R) y la escala de autoinformes de actitudes y síntomas de los trastornos alimenticios (*Eating Attitudes Test*, EAT-26). Las propiedades psicométricas de la escala se obtuvieron mediante un proceso de validez convergente, análisis factorial de los componentes principales, consistencia interna y fiabilidad test-retest.

Resultados: La consistencia interna del instrumento muestra un alfa de Cronbach de 0.880 en la escala total. El coeficiente de correlación intraclase (CCI) para valorar la consistencia temporal del instrumento fue de CCI = 0.707, (95% intervalo de confianza = 0.336-0.871). El instrumento muestra validez convergente con la escala EDS-R ($r = 0.613$, $p < 0.001$) y EAT-26 ($r = 0.422$, $p < 0.001$). La validez de constructo muestra una estructura factorial de tres factores Factor 1=efecto psicosocial de la apariencia física, factor 2=control apariencia física y factor 3=preocupación por la apariencia física que explican el 65.29% de la varianza.

Conclusiones: El instrumento muestra adecuadas características psicométricas y es útil para la valoración del dimorfismo muscular o vigorexia en deportistas de musculación.

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Palabras clave: Vigorexia. Musculación. Cuestionario. Validez. Fiabilidad.

SPANISH VERSION OF ADONIS COMPLEX QUESTIONNAIRE. A QUESTIONNAIRE TO TEST THE MUSCLE DIMORPHISM AND VIGOREXY

Abstract

Aim: To validate the Spanish version of Adonis Complex Questionnaire in bodybuilders.

Method: Participants included 99 bodybuilders who train regularly (age: 25.45 ± 5.19 y; BMI = 24.53 ± 1.89). In order to test the discriminant and concurrent validity the *Exercise Dependence Scale-Revised* (EDS-R) and the *Eating Attitudes Test* (EAT-26) were used. The scale's psychometric properties were obtained through a concurrent validity process, factorial analysis of principal components, internal consistency, and test-retest reliability.

Results: The internal consistency of this questionnaire was high (Cronbach's Alpha = 0.880) in total scale. The intraclass correlation coefficient (ICC) to test the temporal consistency of the questionnaire was 0.707 (95% IC = 0.336- 0.871). The questionnaire obtained concurrent validity with the EDS-R ($r = 0.613$, $p < 0.001$), and EAT-26 ($r = 0.422$, $p < 0.001$). The results have shown a three-factor structure Factor 1: psychosocial effect of physical appearance, Factor 2: control of physical appearance, Factor 3: concern about physical appearance which explain 65.29% of variance.

Conclusion: The Adonis Complex Questionnaire shows a proper psychometric properties and it is a valid and reliable measure of vigorexy and muscle dimorphism in bodybuilders.

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Key words: Vigorexy. Bodybuilding. Questionnaire. Validity. Reliability.

Correspondencia: Felipe García-Pinillos
E-mail: fgpinill@ujaen.ess

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Introducción

La imagen corporal (IC) corresponde a la imagen mental de uno mismo hacia su cuerpo y se ha definido como un constructo multidimensional que representa cómo los individuos piensan, sienten y se comportan respecto a sus propios atributos físicos¹. En este sentido, la insatisfacción corporal se puede considerar como la alteración de la IC consistente en el conjunto de emociones, pensamientos y actitudes negativos hacia el tamaño y forma del cuerpo². Una IC positiva promueve la salud física y emocional, refuerza la autoestima y disminuye la vulnerabilidad al daño³. Sin embargo, la insatisfacción corporal no es poco común y puede afectar negativamente al funcionamiento psicosocial de los individuos y a la calidad de vida.

Los sentimientos negativos con respecto a la satisfacción corporal se pueden relacionar con baja autoestima, depresión, menor actividad sexual, dificultades en las interacciones sociales, constituye un factor de riesgo importante para los trastornos del comportamiento alimentario (TCA), de los trastornos dismórficos corporales (TDC) e incluso de intentos de suicidio^{4,5,6,7,8,9,10,11,12,13}. La insatisfacción corporal y la ocurrencia de los TCA son influenciados por presiones socioculturales, por ejemplo de los medios de comunicación¹⁴⁻¹⁵ y las relaciones interpersonales¹⁶.

Con la creciente penetración de los medios de comunicación, los individuos de todas las edades y de ambos sexos son hipersensibilizados con imágenes que enaltecen la juventud y que vinculan la autoestima a la delgadez. La influencia que está ejerciendo esta cultura de la delgadez sobre la mujer es superior que la que ejerce sobre el hombre¹⁷. Muchos estudios han analizado las alteraciones de la IC y satisfacción corporal en mujeres^{18, 19, 20}, sin embargo, escasos estudios se han centrado en los hombres²¹. Los hombres que practican más ejercicio físico refieren preocupación respecto de su IC y expresan deseos de aumentar el tamaño de su cuerpo²². Todo ello, puede generar en los hombres un TDC denominado dimorfismo muscular (DM), vigorexia o anorexia inversa puesto que comparte características similares a la anorexia nerviosa (como la distorsión de la IC y la búsqueda incesante del cuerpo deseado aun incurriendo en conductas de riesgo para su propia salud) pero con síntomas inversos a ésta²³. Se caracteriza por una obsesión exagerada por ganar masa muscular y perder grasa y preocupación por ser débil o poco musculoso²⁴. Se ha sugerido que el TDC, y por lo tanto el DM, podría ser conceptualizado más apropiadamente como un trastorno obsesivo-compulsivo (TOC)²⁵. Esta patológica preocupación por la IC se ha denominado popularmente “Complejo de Adonis”. El DM puede afectar a cualquier persona, pero es más frecuente en hombres que en mujeres²⁶. Como señala Rodríguez (2007)²⁷, la existencia de un culto excesivo a la belleza corporal y una obsesión por la salud entendida como perfección son particularidades de la vigorexia. Se trata de un se-

rio revés para la salud del individuo ya que, además de los problemas de carácter psicológico, esta excesiva preocupación por la IC suele ir ligada al consumo de esteroides anabolizantes y otras “drogas por y para la imagen corporal”²⁸. Grieve (2007)²⁹ indica que factores cognitivos, conductuales, socioambientales, emocionales y psicológicos influyen en la expresión de la vigorexia, identificándose nueve variables predictivas (masa corporal, las influencias de los medios, internalización corporal ideal, baja autoestima, insatisfacción corporal, locus de control de salud, el afecto negativo, el perfeccionismo y la distorsión corporal).

El estudio de este trastorno es esencial, sobre todo teniendo en cuenta que en los últimos años se ha incrementado de manera importante la práctica del deporte de musculación³⁰. Además, la frecuencia de sesiones semanales de entrenamiento y la duración de las mismas son factores asociados con la adicción al entrenamiento y, a su vez, con desórdenes alimenticios³¹, que además se relacionan con la vigorexia³².

Uno de los instrumentos empleados internacionalmente en el estudio de la vigorexia es el cuestionario de complejo de Adonis³³. Sin embargo, a pesar de haber sido empleado en numerosas investigaciones^{30,34,35,36} no se ha informado de manera precisa de sus propiedades psicométricas.

Por tanto, el objetivo de este estudio ha sido el análisis de la validez y fiabilidad del cuestionario Adonis en deportistas de musculación españoles.

Método

Participantes

En este estudio han participado de manera voluntaria 99 varones (Edad: 25.45±5.19 años; índice de masa corporal [IMC]=24.53±1.89 Kg/m², deportistas de musculación de dos centros deportivos de la provincia de Jaén. Después de recibir información detallada del estudio, cada sujeto firmó un consentimiento informado. Como criterios de inclusión se tuvo en cuenta: i) tener una experiencia mínima de tres años en el deporte de musculación; ii) no tener ninguna enfermedad cognitiva ni discapacidad intelectual, ni padecer ninguna lesión; iii) y estar entrenando actualmente de forma habitual con 3 o más entrenamientos por semana (los atletas que se habían alejado de la práctica deportiva desde hacía más de una semana por alguna razón fueron excluidos de la muestra). El estudio se realizó en cumplimiento de las normas de la Declaración de Helsinki (versión 2008) y siguiendo las directrices de la Comunidad Europea para la Buena Práctica Clínica (111/3976/88 de julio de 1990), así como el marco legal español para la investigación clínica en los seres humanos (Real Decreto 561/1993 sobre ensayos clínicos). El consentimiento informado y el estudio fueron aprobados por el Comité de Bioética de la Universidad de Jaén, España

La talla (cm) se midió con un estadiómetro (Seca 222, Hamburgo, Alemania) y la masa corporal (Kg) se registró con una báscula Seca 634 (Hamburgo, Alemania). El IMC se halló mediante el cociente resultante tras dividir el peso en kilogramos por el cuadrado de la altura en metros. Para evaluar el grado de preocupación con la imagen corporal empleamos el Cuestionario de Complejo de “Adonis”³³, versión traducida al castellano por Baile, Monroy y Garay (2005)³⁷. Dicho cuestionario consta de 13 ítems con 3 opciones de respuesta (opción no patológica puntúa 0 puntos, la opción intermedia 1 punto y la opción patológica 3 puntos) y valora el grado de preocupación que un sujeto siente por su apariencia física y hasta qué punto puede influir negativamente en su vida, pasando a ser dichas conductas patológicas. Baile et al., (2005)³⁷ establecen que si la puntuación está entre 0-9 se puede interpretar que el sujeto presenta una preocupación leve no patológica; si la puntuación obtenida se encuentra entre 10 y 19 puntos supone un grado moderado de Complejo de Adonis. Cuando la puntuación total se encuentra entre 20 y 29 puntos el sujeto posee un Complejo de Adonis grave; y por último, la puntuación entre 30 y 39 puntos nos señala una preocupación posiblemente patológica con la IC.

La valoración de la dependencia al ejercicio físico se realizó por medio de la “Escala revisada de dependencia del ejercicio” (Exercise Dependence Scale-Revised, EDS-R; Symons, Hausenblas y Nigg, 2004)³⁸, en su versión española³⁹. Es un instrumento empleado para determinar siete síntomas de dependencia y un indicador global. Consta de 21 ítems dividido en 3 ítems por cada factor, los 7 factores son: 1) tolerancia 2) abstinencia 3) efectos deseados 4) pérdida de control 5) tiempo 6) reducción de otras actividades y 7) continuación. Además de una puntuación total. Los participantes que obtengan una puntuación en el rango de riesgo (es decir, 5-6 en la Escala de Likert,) en al menos tres de los siete criterios serán clasificados como en riesgo de dependencia al ejercicio³⁸. En este estudio se obtuvo un valor Alfa de Cronbach=0.930.

Los trastornos del comportamiento alimenticio se analizaron mediante la Escala de Autoinformes de Actitudes y Síntomas de los Trastornos Alimenticios (EAT-26) que consiste en una escala de 26 ítems de 6 puntos cada ítem (siempre, muy a menudo, a menudo, alguna vez, raramente o nunca)⁴⁰. El EAT-26 se compone de 3 subescalas: dieta, bulimia y preocupación por la comida y control oral. Está adaptado por Gandarillas et al., (2002)⁴¹ a población española. Una puntuación de corte según los autores del instrumento por encima de 20 se considera positiva y revela la presencia de trastornos de la alimentación patológicos. En este estudio se obtuvo un valor Alfa de Cronbach=0.805.

De manera autoadministrada e individual se llevó a cabo la cumplimentación de los cuestionarios. Se atendieron las dudas surgidas y se garantizó la confidencialidad y el anonimato de las respuestas. La duración de aplicación de los cuestionarios fue de aproximadamente 40 minutos. A una muestra de 25 sujetos escogidos al azar se les realizó un retest pasados 10 días.

Análisis estadístico

Los datos de este estudio se han hallado mediante el programa estadístico SPSS., v.19.0 para Windows, (SPSS Inc, Chicago, USA). Se ha utilizado la estadística descriptiva (medias, DT), además se han calculado los análisis de consistencia interna (Alfa de Cronbach) de los cuestionarios. La validez de constructo se realizó mediante el análisis factorial (Varimax con Kaiser). El análisis de fiabilidad temporal (test-retest) se realizó mediante coeficiente de correlación intraclass (CCI). Por último, como validación convergente, se realizaron correlaciones (Pearson) entre el resultado del cuestionario Adonis con el EDS-R y EAT-26. El nivel de significación fue de $p < 0.05$.

Resultados

En la tabla I se exponen los estadísticos descriptivos del cuestionario. El índice de adecuación muestral KMO alcanzó un valor de 0.875 y la prueba de esfericidad de Bartlett fue de 566.477 ($p < 0.001$). Estos datos hacen que se rechace la hipótesis nula de que la matriz

Tabla I
Estadísticos descriptivos del cuestionario de Adonis

	Media	Desviación típica
Ítem 1	1.76	0.76
Ítem 2	1.55	0.65
Ítem 3	1.41	0.67
Ítem 4	1.94	0.66
Ítem 5	1.98	0.72
Ítem 6	2.22	0.59
Ítem 7	1.72	0.63
Ítem 8	1.42	0.60
Ítem 9	1.29	0.52
Ítem 10	1.33	0.57
Ítem 11	1.26	0.50
Ítem 12	1.89	0.67
Ítem 13	1.40	0.58

Tabla II
Correlación de los ítems con el total de la escala

	<i>Media de la escala si se elimina el elemento</i>	<i>Varianza de la escala si se elimina el elemento</i>	<i>Correlación elemento-total corregida</i>	<i>Alfa de Cronbach si se elimina el elemento</i>
Ítem 1	19.4747	23.497	0.494	0.876
Ítem 2	19.6869	23.442	0.609	0.868
Ítem 3	19.8283	23.695	0.554	0.871
Ítem 4	19.2929	23.801	0.546	0.872
Ítem 5	19.2525	24.272	0.417	0.880
Ítem 6	19.0202	24.347	0.517	0.873
Ítem 7	19.5152	23.232	0.672	0.865
Ítem 8	19.8182	23.660	0.631	0.867
Ítem 9	19.9495	24.253	0.631	0.868
Ítem 10	19.9091	23.981	0.616	0.868
Ítem 11	19.9798	25.000	0.493	0.874
Ítem 12	19.3434	23.534	0.573	0.870
Ítem 13	19.8384	23.831	0.624	0.868

de correlación inter-ítems es identidad y se considera que las respuestas están sustancialmente relacionadas, lo que justifica la realización del análisis factorial.

A continuación, determinamos las comunidades o proporción de varianza que es explicada por los factores comunes. En general, al no existir valores próximos a cero, se puede afirmar que los 13 ítems son explicados por los componentes. En la tabla II se exponen los resultados de la correlación de los ítems con

el total de la escala y Alfa de Cronbach si se elimina el elemento, que en este caso no superó en ningún ítem el valor Alfa de Cronbach de la escala total. El análisis de los componentes principales y rotación varimax puso de manifiesto, tras 9 iteraciones, la convergencia en tres factores que explican el 65.29% de la varianza (como se puede observar en el gráfico de sedimentación, figura 1). Factor 1 (efecto psicosocial de la apariencia física), factor 2 (control de la apariencia física)

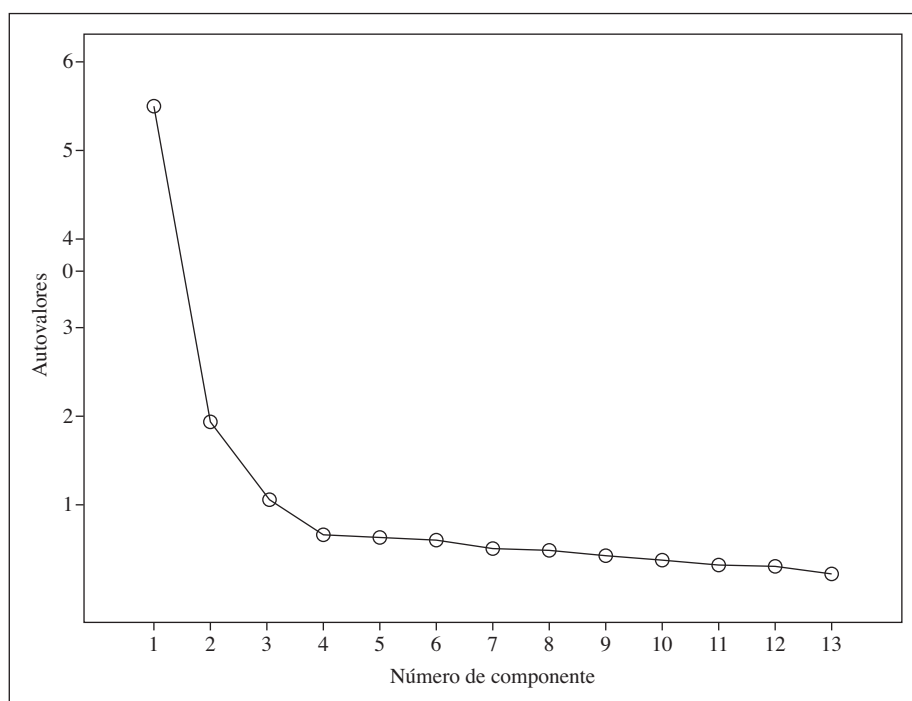


Fig. 1.—Gráfico de sedimentación.

Tabla III
Matriz de componentes rotados y coeficiente alfa de Cronbach por factor

Ítems	Factor 1	Factor 2	Factor 3
Ítem 3	0.842		
Ítem 11	0.825		
Ítem 2	0.747		
Ítem 8	0.746		
Ítem 10	0.693		
Ítem 9	0.513		
Ítem 13		0.750	
Ítem 6		0.700	
Ítem 7		0.669	
Ítem 12		0.653	
Ítem 1			0.799
Ítem 4			0.758
Ítem 5			0.433
Coeficientes alfa de Cronbach	0.875	0.748	0.702

Método de extracción: Análisis de componentes principales. Método de rotación: Normalización Varimax con Kaiser. La rotación ha convergido en 9 iteraciones.

y factor 3 (preocupación por la apariencia física). El primer componente es el que más cantidad de varianza explica, un 42.31%, el segundo factor un 14.87% y el tercer factor un 8.10%. Los ítems quedaron configurados de la forma como se puede apreciar en la tabla III, ordenados de acuerdo al grado de saturación que en todos los casos fue superior a 0.4.

Una vez definida la validez de la escala, calculamos la fiabilidad de la misma mediante el coeficiente alfa de Cronbach, que alcanza un valor de 0.880. La fiabilidad temporal mediante test-retest arroja un CCI= 0.707, (95% intervalo de confianza=0.336- 0.871). Para comprobar la validez convergente del cuestionario Adonis procedimos a realizar un análisis de correlación Pearson con el cuestionario EDS-R y EAT-26 (tabla IV) obteniéndose correlaciones significativas con ambos cuestionarios.

Por último, en este estudio, los resultados del complejo de Adonis muestran un valor en la escala total

de: 21.24 ± 5.26 , presentando el 45.5% de los sujetos un complejo de Adonis moderado, el 46.5% grave y el 8% de carácter patológico. En el EDS-R se obtiene una puntuación de 62.48 ± 17.35 con una frecuencia de deportistas adictos del 8.9% y en el EAT-26 se alcanza una puntuación de 23.70 ± 6.96 , presentando el 79.7% una puntuación por encima de 20.

Discusión

El objetivo de este estudio ha sido comprobar las propiedades psicométricas del cuestionario de complejo de Adonis en deportistas de musculación españoles. En cuanto a la fiabilidad, la escala ha mostrado buena consistencia interna y fiabilidad temporal. Además todos los ítems presentan un elevado poder de discriminación (>200 , correlación elemento-total corregida) de acuerdo con las recomendaciones de Elbel (1965)⁴². En relación con la validez convergente se obtienen correlaciones significativas con el cuestionario EDS-R y EAT-26 lo que señala la asociación entre la vigorexia, la dependencia al ejercicio físico y los TCA. En este sentido Soler et al., (2013)⁴³ indican relación entre vigorexia y dependencia al ejercicio físico en culturistas y usuarios de gimnasio. Además, Baile, González, Ramírez y Suárez (2011)³⁰ encontraron asociaciones significativas entre el complejo de Adonis y los TCA en usuarios de gimnasio. El análisis de validez de constructo del cuestionario muestra una estructura factorial de tres factores: Factor 1=efecto psicosocial de la apariencia física, factor 2=control de la apariencia física y factor 3=preocupación por la apariencia física, que explican el 65.29% de la varianza, siendo las saturaciones de cada uno de los ítems con sus respectivos factores altas.

Los resultados obtenidos en el complejo de Adonis en la muestra de este estudio difieren de la investigación de Baile et al., (2005)³⁷ en la cual el porcentaje de sujetos con puntuación grave o patológica es muy baja, de un 0.0% y un 1.20 % respectivamente. Los resultados en la escala total Adonis de este estudio son superiores a los aportados por Baile et al., (2011)³⁰ en usuarios de gimnasio (7.37 ± 9.45).

El DM es un fenómeno emergente en la sociedad, la presión que ejerce sobre los hombres para parecer más musculosos y delgados ha provocado trastornos psico-

Tabla IV
Correlación Pearson entre el cuestionario Adonis con EDS-R y EAT 26

Abstinencia	Continuación	Tolerancia	Falta de control	Reducción de las actividades	Tiempo de ejercicio	Efectos deseados	EDS-R Total	Dieta	Bulimia y control por la comida	Control oral	EAT-26 total
0.061	0.560**	0.494**	0.258*	0.494**	0.600**	0.249*	0.613**	0.338**	0.389**	0.069	0.422**

* $p < 0.05$, ** $p < 0.01$.

CUESTIONARIO DEL COMPLEJO DE ADONIS

1. ¿Cuánto tiempo dedicas cada día preocupándote por algún aspecto de tu apariencia (no simplemente pensándolo sino preocupándote)?
 - a) Menos de 30 minutos.
 - b) De 30 a 60 minutos.
 - c) Más de 30 minutos.
2. ¿Con que frecuencia estás mal por alguna cuestión relacionada con tu apariencia (preocupado, ansioso, deprimido...)?
 - a) Nunca o raramente.
 - b) Algunas veces.
 - c) Frecuentemente.
3. ¿Con qué frecuencia evitas que partes de tu cuerpo o tu cuerpo entero sea visto por otros? Por ejemplo, ¿con qué frecuencia evitas ir a vestuarios, piscinas o situaciones donde debas quitarte la ropa? O también, ¿con qué frecuencia llevas ropas que alteran u ocultan tu apariencia corporal, como por ejemplo intentar ocultar tu cabello o llevar ropas holgadas para esconder tu cuerpo?
 - a) Nunca o raramente
 - b) Algunas veces
 - c) Frecuentemente
4. ¿Cuánto tiempo dedicas cada día a actividades de aseo para mejorar tu apariencia?
 - a) Menos de 30 minutos.
 - b) De 30 a 60 minutos.
 - c) Más de 60 minutos.
5. ¿Cuánto tiempo dedicas cada día a actividades físicas para mejorar tu apariencia física, tales como levantamiento de pesas, jogging, máquina de caminar? (Nos referimos sólo a esas actividades deportivas cuyo objetivo principal sea mejorar la apariencia física).
 - a) Menos de 60 minutos.
 - b) De 60 a 120 minutos.
 - c) Más de 120 minutos.
6. ¿Con qué frecuencia sigues dietas comiendo alimentos especiales (por ejemplo, de alto grado proteínico o comidas bajas en grasas) o ingieres suplementos nutricionales para mejorar tu apariencia?
 - a) Nunca o raramente.
 - b) Algunas veces.
 - c) Frecuentemente.
7. ¿Qué parte de tus ingresos económicos los empleas en cuestiones dedicadas a mejorar tu apariencia (por ejemplo, comidas especiales de dieta, suplementos nutricionales, productos para el pelo, cosméticos, técnicas cosméticas, equipamiento deportivo, cuotas de gimnasio...)?
 - a) Una cantidad insignificante.
 - b) Una cantidad sustancial, pero nunca hasta el punto de que me cree problemas económicos,
 - c) Una cantidad suficiente hasta el punto de crearme problemas económicos.
8. ¿Con qué frecuencia tus actividades relacionadas con tu apariencia física afectan a tus relaciones sociales (por ejemplo, el tener que dedicar tiempo a entrenamientos, prácticas alimentarias especiales o cualquier otra actividad relacionada con tu apariencia que terminan afectando a tus relaciones con otras personas)?
 - a) Nunca o raramente.
 - b) Algunas veces.
 - c) Frecuentemente.
9. ¿Con que frecuencia tu vida sexual se ha visto afectada por tus preocupaciones relacionadas con tu apariencia?
 - a) Nunca o raramente.
 - b) Algunas veces.
 - c) Frecuentemente.
10. ¿Con qué frecuencia tus preocupaciones con la apariencia o actividades relacionadas con ella han comprometido tu trabajo o carrera (o tus actividades académicas si eres estudiante) (por ejemplo, llegando tarde, perdiendo horas de trabajo o clase, trabajando por debajo de tu capacidad o perdiendo oportunidades de mejora o ascenso por preocupaciones y/o actividades con la imagen corporal)?
 - a) Nunca o raramente.
 - b) Algunas veces.
 - c) Frecuentemente.
11. ¿Con qué frecuencia has evitado ser visto por otra gente debido a tus preocupaciones con tu apariencia (por ejemplo, no yendo a la escuela, al trabajo, a eventos sociales o a estar en público...)?
 - a) Nunca o raramente
 - b) Algunas veces.
 - c) Frecuentemente.
12. ¿Has consumido algún tipo de droga, legal o ilegal, para ganar músculo, perder peso o para cualquier intento de mejorar tu apariencia?
 - a) Nunca.
 - b) Sólo drogas legales, compradas en sitios oficiales o bajo prescripción.
 - c) He usado esteroides legales, píldoras de adelgazamiento u otras sustancias.
13. ¿Con qué frecuencia has tomado medidas extremas (que no sean el uso de drogas) para cambiar tu apariencia, tales como hacer ejercicio excesivo, entrenar incluso estando dolorido, hacer dietas extremas, vomitar, usar laxantes u otros métodos de purga, usar técnicas no convencionales de desarrollo muscular, crecimiento del pelo, alargamiento del pene, etc.?
 - a) Nunca o raramente.
 - b) Algunas veces.
 - c) Frecuentemente.

conductuales a menudo comparados con la anorexia y la bulimia nerviosa; los atletas son particularmente susceptibles a desarrollar trastornos de la IC debido a las presiones que rodean el rendimiento deportivo y las tendencias sociales que promueven la musculatura y la delgadez (Leone et al, 2005)²⁶. Por lo tanto, el estudio de la vigorexia se está convirtiendo en un elemento esencial en el análisis de la salud psicosocial de los deportistas.

Como limitación de este estudio señalamos que los participantes fueron exclusivamente hombres, por lo que será preciso en futuras investigaciones, el análisis de las propiedades psicométricas del cuestionario de Adonis en mujeres. En conclusión, en este estudio se han investigado las propiedades psicométricas del cuestionario del complejo de Adonis en usuarios de gimnasio, mostrando adecuados valores de consistencia interna y fiabilidad, validez convergente con el EDS-R y EAT-26 y una validez de constructo que arroja una estructura de tres factores. Por tanto, este cuestionario puede ser empleado para analizar el DM o vigorexia en usuarios de gimnasio.

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Original/Deporte y ejercicio

Una mejor auto-percepción de la condición física se relaciona con menor frecuencia y componentes de síndrome metabólico en estudiantes universitarios

Deivy Fredery Fonseca-Camacho¹, John Manuel Hernández-Fonseca¹, Katherine González-Ruíz², Alejandra Tordecilla-Sanders³ y Robinson Ramírez-Vélez³

¹Facultad de Salud, Grupo de Ejercicio Físico y Deportes, Programa de Maestría en Ciencias y Tecnologías del Deporte y la Actividad Física, Universidad Manuela Beltrán, Bogotá, D.C. ²Facultad de Salud, Grupo de Ejercicio Físico y Deportes, Programa de Fisioterapia, Universidad Manuela Beltrán, Bogotá, D.C. ³Grupo GICAEDS, Facultad de Cultura Física, Deporte y Recreación, Universidad Santo Tomás, Bogotá, D.C. Colombia.

Resumen

Resumen

Objetivo: Evaluar si la auto-percepción de la condición física (CF) se relaciona con la frecuencia y componentes del síndrome metabólico (SM) en una muestra de estudiantes universitarios de Bogotá, Colombia.

Método: Un total de 493 varones (edad $28,5 \pm 11,5$ años) universitarios sin enfermedad cardiovascular previa, completaron el cuestionario de auto-reporte de la CF "The International Fitness Scale" (IFIS). La identificación de los componentes relacionados al SM se establecieron según los criterios del "International Diabetes Federation" (IDF) y el "National Cholesterol Education Program's Adult Treatment Panel III" (NCEP: ATP-III). La masa grasa (MG), el porcentaje de grasa (%G), la masa libre de grasa (MLG) y el índice de masa grasa (IMG), se estimaron con equipo de impedancia bioeléctrica segmentada.

Resultados: El 23% de los participantes presentaron SM. La obesidad abdominal (33%) fue el factor más prevalente, seguido del c-HDL bajo (31%). Los demás componentes asociados a la presencia de SM fueron hipercolesterolemia (60%), c-LDL elevado (32%) e hipertrigliceridemia (19%). Los sujetos que acusaron como "bueno/muy bueno" en el auto-reporte de *fitness* cardiorespiratorio/muscular, presentaron promedios más saludables en la tensión arterial, MLG, IMG y triglicéridos ($p < 0,05$). Tras ajustar por edad e IMC, los sujetos que respondieron "bueno/muy bueno" presentaron menor prevalencia en los componentes obesidad central, tensión arterial, triglicéridos y c-HDL que los agrupados en "acceptable" y/o "muy malo/malo" ($p < 0,05$).

A BETTER SELF-PERCEPTION OF PHYSICAL FITNESS IS ASSOCIATED WITH LOWER PREVALENCE OF METABOLIC SYNDROME AND ITS COMPONENTS AMONG UNIVERSITY STUDENTS

Abstract

Objective: To evaluate whether more positive self-perception of physical fitness is associated with lower prevalence of metabolic syndrome (MetS) and its components in university students in Bogotá, Colombia

Method: A total of 493 men (mean age 28.5 ± 11.5 years old) without cardiovascular disease university students completed the self-report fitness tool, namely "The International Fitness Scale" (IFIS). The overall prevalence of MetS and its components according to "International Diabetes Federation" (IDF) criteria and the "National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults" (NCEP: ATP-III) were measured. Body Fat Mass (BFM), Body Fat Percentage (BF %), Fat-Free Mass (FFM) and Fat-Free Mass Index (FFMI), were estimated using segmental bioelectrical impedance equipment.

Results: Twenty three percent of participants had met the criteria of MetS. Central obesity (33%) was the most prevalent factor, followed by low HDL cholesterol level (31%). The other factors associated with the presence of MetS were hypercholesterolemia (60%), high LDL cholesterol level (32%) and hypertriglyceridemia (19%). Participants reporting to have a "good/very good" in the self-reported (cardiorespiratory and muscle fitness specific components), shown a healthy range in blood pressure, FFM, FFMI and triglycerides level ($p < 0.05$). After adjustment for age and BMI, participants reporting to have a "good/very good" had lower prevalence in the components central obesity, blood pressure, triglycerides and HDL cholesterol level than those grouped in "acceptable" and/or "very poor/poor" ($p < 0.05$).

Correspondencia: Robinson Ramírez-Vélez.
Universidad Santo Tomás
Carrera 9 N° 51-23.
Bogotá, D.C., Colombia.
robin640@hotmail.com // robinsonramirez@usantotomas.edu.co

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Conclusión: Los sujetos con menor percepción de CF presentan un incremento en la frecuencia y componentes del SM. Se sugiere la herramienta de auto-reporte IFIS como un método útil para ser utilizado en estudios epidemiológicos a gran escala, en los que, por falta de tiempo, equipamiento, o limitaciones de personal cualificado, la CF no pueda ser estimada directamente.

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Palabras clave: Síndrome metabólico. Prevalencia. Condición física. Estudiantes. Colombia.

Conclusion: Participants with a lower self-perception of physical fitness have an increased prevalence of MetS and its components. This study suggests that the self-report tool used in this study, the IFIS tool, is a useful method to be used in large scale surveys and epidemiological studies in which, because of time, equipment, or qualified personnel limitations, fitness cannot be directly measured.

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DOI:10.3305/nh.2015.31.3.8398

Keywords: Metabolic syndrome. Prevalence. Physical fitness. Student. Colombia.

Introducción

La condición física (CF), forma física o aptitud física (en inglés *Physical Fitness*) es un conjunto de atributos físicos que se relacionan con la capacidad para realizar cualquier tipo de actividad física¹. Según el Colegio Americano de Medicina Deportiva (en inglés *American College of Sports Medicine-ACSM*), la condición física es considerada como un indicador “determinante a lo largo de la vida para desarrollar y mantener la capacidad funcional que se requiere para satisfacer las demandas durante la vida y promover una salud óptima”². Una menor CF constituye un factor atribuible del síndrome metabólico (SM)^{1,2}, término empleado en los últimos años para designar un grupo de factores de riesgo que incluyen obesidad abdominal, hipertensión arterial, hiperglicemia y dislipidemia aterogénica, los cuales de forma independiente o en conjunto predisponen al individuo a desarrollar enfermedad arterial coronaria y diabetes *mellitus* tipo 2^{3,4,5}.

Aunque en varios estudios, se ha comprobado la íntima asociación que menores valores de CF incrementan la aparición de SM, actualmente no existe consenso con respecto al tipo, tiempo de duración e intensidad de entrenamiento físico, particularmente en poblaciones de alto riesgo cardiometabólico⁶. No obstante, debido al nivel de complejidad para estimar la CF y sea por el equipamiento, los accesorios para las medidas metabólicas, ventilatorias y cardiovasculares y/o a la asistencia técnica especializada, varios autores han descrito herramientas como cuestionarios de tipo “proxy”, fáciles de administrar, que no requieren material sofisticado y que tengan un buen nivel de confianza y validez por auto-reporte^{6,7}.

Para acercarse a la medición de la CF en estudios epidemiológicos, se han propuesto instrumentos por auto-reporte, cuya ventaja entre otras son: la evaluación de varios sujetos simultáneamente, el poco tiempo de aplicación, la seguridad, su fácil aplicación y bajo coste⁸. Aunado a lo anterior, en varios trabajos se sugiere la inclusión de la CF en investigaciones epidemiológicas, relacionadas con los estilos de vida, por su capacidad para predecir factores de riesgo asociados con el SM^{9,10}. Sobre este último, Borodulin et al.¹¹ han demostrado la relación inversa entre el auto-reporte

de la CF con frecuencia de componentes del SM en 3,803 sujetos entre los 25 y 74 años. En otro estudio, Philips et al.¹² Identificaron en 858 hombres y mujeres de escocia, que el auto-reporte de la CF fue el factor predictor más importante en la mortalidad por todas las causas, sugiriendo que la medición indirecta de la aptitud física puede ser más útil que la medición con equipamiento sofisticado. En EE.UU, el estudio *Women's Ischemia Syndrome Evaluation* (WISE)¹³, financiado por el *National Heart, Lung, and Blood Institute* (NHLB), se encontró que mujeres con mayores niveles de CF por auto-reporte, presentaron menor alteración en la morfología y función de las arterias coronarias y menores componentes asociados a eventos cardiovasculares, tras ajustar por edad, adiposidad e índice de masa corporal.

En jóvenes, el estudio HELENA¹⁴ “*Healthy Lifestyle in Europe by Nutrition in Adolescence*” desarrolló el cuestionario de auto-reporte de la CF “*The International Fitness Scale*” (IFIS), con el objetivo de valorar de manera sencilla, rápida y económica, algunos de los principales componentes de la CF relacionados con la salud cardiometabólica. El estudio, que incluyó a 277 sujetos, 77 hombres y 199 mujeres, entre los 12,5 y 17,5 años, se midió por auto-reporte el acondicionamiento físico general, la aptitud cardiorrespiratoria, la fuerza muscular, la velocidad-agilidad y la flexibilidad. Los resultados mostraron valores de fiabilidad test-retest (*Kappa index*) de 0,54 para la aptitud muscular; 0,58 para la capacidad aeróbica y 0,59 para el componente de flexibilidad. Estos mismos autores, en una sub-muestra del estudio HELENA¹⁵, mostraron que los adolescentes que auto-reportaban mejores niveles en los cinco componentes de la CF medida con el IFIS, presentaron un perfil cardiovascular y metabólico más saludable en ocho de los nueve factores de riesgo estudiados. En Colombia, Español-Moya y Ramírez-Vélez¹⁶ reportaron que la versión de 5 ítems del IFIS, es un cuestionario con alta fiabilidad (*alfa de cronbach* > 0,80) y reproducibilidad (coeficiente de correlación intra-clase entre 0,90 y 0,96) en 2.340 jóvenes colombianos.

A la luz de la evidencia epidemiológica, el auto-reporte de la CF es un componente de la salud capaz de identificar y clasificar sujetos con marcadores tempranos de riesgo cardiovascular de manera independiente

a los niveles de actividad física. No obstante, en América Latina y especialmente en Colombia la situación de este indicador de salud relacionado con la frecuencia en los componentes de SM no ha sido reportada.

Objetivo

Examinar si la auto-percepción de la CF se relaciona con la frecuencia y componentes del SM en una muestra de estudiantes universitarios de Bogotá, Colombia.

Materiales y métodos

Participantes. Durante el primer semestre del 2014, se planteó un estudio observacional descriptivo y transversal, en 493 varones aparentemente sanos entre los 18 y 30 años de edad, procedentes de tres instituciones de educación superior de la ciudad de Bogotá, Colombia. La selección de la muestra se realizó mediante convocatoria voluntaria y muestreo por intención y se excluyó a sujetos con diagnóstico médico o clínico de enfermedad sistémica mayor (incluidos procesos malignos como cáncer), diabetes *mellitus* tipo 1 o 2, hipertensión arterial, hipo/hipertiroidismo, antecedentes de historia de abuso de drogas o alcohol, índice de masa corporal (IMC) $> 35 \text{ kg}\cdot\text{m}^{-1}$ y/o padecimiento de procesos inflamatorios (traumas, contusiones) o infecciosos. Los participantes que aceptaron y firmaron el consentimiento informado se citaron, para los siguientes procedimientos:

Auto-reporte de la CF. Los autores del estudio administraron el cuestionario de auto-reporte de la CF “*The International Fitness Scale-IFIS*”, desarrollado en España por el grupo HELENA^{14,15} y validado en Colombia en población universitaria¹⁶. Este cuestionario se estructura en diferentes sub-dimensiones o categorías a través de una serie de ítems que se agrupan y recogen información correspondiente de cada uno de los componentes de la CF. El ítem 1 recoge datos sobre la CF o acondicionamiento físico general. El ítem 2 indaga acerca de percepción de la condición cardiorrespiratoria. El auto-reporte de la fuerza muscular se recoge en el ítem 3. El ítem 4 informa sobre la velocidad/agilidad y el ítem 5 por la flexibilidad. Las opciones de respuesta del IFIS forman escalas tipo Likert que evalúan el nivel de condición física. Las respuestas son contestadas con opción múltiple con 5 posibles: “Muy mala”, “Mala”, “Aceptable”, “Buena” o “Muy buena”.

Medición antropométrica, composición corporal y clínica. La valoración antropométrica comprendió: estatura, peso y circunferencia de cintura (CC) mediante técnicas estandarizadas por López CA et al.¹⁷ en población Colombiana. La altura se registró en estiramiento con Estadímetro Portátil (Vogel & Halke GMBH & Co., Alemania) (rango 0-220 cm) de 1 mm de precisión. El peso se midió con balanza de piso SECA® Modelo mBCA-514™ (Body Composition Analyzer mBCA

Vogel & Halke GMBH & Co., Alemania) con 10 g de precisión. Con estas variables se calculó el IMC en $\text{kg}\cdot\text{m}^{-1}$. Con cinta métrica plástica con una precisión de 1 mm (Holtain Ltd., Crymych Dyfed, RU) se midió la CC en el punto medio entre las crestas ilíacas y el borde costal inferior.

La masa grasa (MG), el porcentaje de grasa (%G), la masa libre de grasa (MLG) y el índice de masa grasa (IMG), se estimaron con el equipo de impedancia bioeléctrica segmentada de 8 puntos táctiles de electrodos SECA® Modelo mBCA-514™ (Body Composition Analyzer mBCA Vogel & Halke GMBH & Co., Alemania) de acuerdo con las indicaciones y ecuaciones señaladas en el manual del usuario. La frecuencia de inducción se valoró a una intensidad de 50 kHz, con una sensibilidad de estimación de la MG de 0,1 kg (0,1%). La medición se realizó luego de 12 h de ayuno, con la vejiga vacía y sobre una superficie no conductora.

La presión arterial se determinó con esfigmomanómetro digital Welch Allyn® modelo OSZ 5 (Illinois, EE.UU®) en el brazo derecho en dos ocasiones, con un intervalo de cinco minutos entre sí, con los participantes en posición sedente y después de 10 min de reposo. La tensión arterial media (TAM), se calculó mediante la fórmula: $(2 \cdot \text{Tensión arterial sistólica [TAS]} + \text{Tensión arterial diastólica [TAD]})/3$.

Las mediciones bioquímicas se realizaron tomando una muestra capilar sanguínea (50 µl) según las recomendaciones técnicas del fabricante para colesterol total, triglicéridos y colesterol unido a lipoproteínas de alta densidad (c-HDL) mediante equipo portátil CardioChek®. El colesterol unido a lipoproteínas de baja densidad (c-LDL) se calculó por la fórmula de Friedewald ajustada por las concentraciones séricas de triglicéridos. La glicemia capilar se determinó con glucómetro Accu-Chek® Performa siguiendo las especificaciones técnicas recomendadas por el fabricante. Las extracciones de sangre se realizaron en el dedo índice, entre las 08.00 y las 09.00h, tras 12 h de ayuno. Con los valores de CC, TAM, triglicéridos, CT, c-LDL, c-HDL y glucosa se estableció una puntuación de riesgo o score de SM, de modo que los valores superiores a este parámetro suponen un perfil lipídico-metabólico más cardiosaludable. Por la definición, su media es cero como se sugiere en el trabajo de Alberti et al.¹⁸

Componentes de SM. Se tomaron los criterios de SM los sugeridos por la Federación Internacional de Diabetes (International Diabetes Federation, IDF)¹⁹ como la presencia de obesidad central (CC $> 88 \text{ cm}$), asociada a 2 o más de los siguientes criterios: TAS $> 130 \text{ mm Hg}$, TAD $> 85 \text{ mm Hg}$, triglicéridos $> 150 \text{ mg/dL}$, c-HDL $< 40 \text{ mg/dL}$. Adicionalmente, se estimó la prevalencia de otros componentes asociados a la presencia de SM publicados y modificados por el National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III)²⁰, como exceso en la distribución de adiposidad, %G > 25 , glucosa $> 100 \text{ mg/dL}$, c-LDL $> 100 \text{ mg/dL}$, colesterol total $> 200 \text{ mg/dL}$, e IMC $> 26,1 \text{ kg}\cdot\text{m}^{-1}$.

Ética. Este estudio fue aprobado por el Comité de Ética para la investigación en Seres humanos del Centro Coordinador del Estudio, bajo las normas deontológicas reconocidas por la Declaración de Helsinki y la normativa legal vigente colombiana que regula la investigación en humanos (Resolución 008430 de 1993, del Ministerio de Salud).

Plan de análisis. Los valores continuos se expresaron como media y desviación estándar y se calcularon las prevalencias en cada componente asociado al SM. Se efectuaron pruebas de normalidad mediante el test de *Kolmogorov-Smirnov*. La respuesta de cada categoría del IFIS, se recodificaron para homogenizar los grupos en tres categorías a seguir: i) “Muy bajo” y “Bajo”; ii) “Aceptable” CF, iii) “Bueno” y “Muy bueno”. Se aplicaron pruebas de homogeneidad de varianzas (ANOVA) para observar las diferencias entre las variables continuas por sexo y categoría del IFIS y la prueba ji cuadrado (χ^2) para examinar las diferencias en las prevalencias de los componentes asociados al SM. Se calcularon *odds ratio* (OR) e intervalos de confianza al 95% (IC 95%) ajustados por edad e IMC, mediante métodos de selección por pasos de inclusión secuencial (*forward selection*) y de paso a paso (*step by step*). El procedimiento de incorporación de variables fue dado por finalizado cuando la significación de “p” aportada por una variable a su entrada en la regresión excedió 0,05 entre las categorías internas del IFIS y los componentes del SM. Se aceptó un error alfa del 5% y los análisis se realizaron mediante el paquete estadístico *Statistical Package for the Social Sciences* (SPSS for Windows, v. 19.0; Chicago, Illinois, Estados Unidos).

Resultados

Análisis descriptivo

En la tabla I se resumen las características generales de los participantes. El 23% de los participantes presentaron SM según criterios del IDF. La obesidad abdominal (33%) fue el factor más prevalente, seguido del c-HDL bajo (31%). Los demás componentes asociados a la presencia de SM fueron hipercolesterolemia (60%), c-LDL elevado (32%) e hipertrigliceridemia (19%).

Auto-reporte de la CF por cuestionario IFIS

La mayor proporción de respuesta se encontró agrupada en la calificación “bueno/muy bueno” en las categorías del IFIS velocidad/agilidad (64%), acondicionamiento físico general (63%), condición cardiorrespiratoria (54%) y condición muscular (53%), ($p < 0,05$). Un menor grupo de participantes, acusaron auto-reporte de CF “muy malo/malo” en los dominios flexibilidad (25%), condición cardiorrespiratoria (12%) y condición muscular (9%). Las demás agrupaciones se presentan en la figura 1.

Tabla I
Características antropométricas, clínicas, bioquímicas, prevalencia y componentes de SM de universitarios de Bogotá, Colombia, (n=493)

Característica	Media $\pm$ DE
<i>Antropométricas y clínicas</i>	
Edad, (años)	28,5 $\pm$ 11,5
Peso, (kg)	68,2 $\pm$ 13,3
Talla, (m)	1,69 $\pm$ 0,08
Índice de masa corporal, ($\text{kg}\cdot\text{m}^{-1}$)	23,8 $\pm$ 3,7
Circunferencia de cintura, (cm)	80,7 $\pm$ 11,7
Tensión arterial sistólica, (mmHg)	116,1 $\pm$ 13,4
Tensión arterial diastólica, (mmHg)	71,0 $\pm$ 10,2
Tensión arterial media, (mmHg)	85,9 $\pm$ 9,9
<i>Composición corporal</i>	
Masa grasa, (kg)	14,0 $\pm$ 7,1
Masa grasa, (%)	21,3 $\pm$ 8,6
Masa libre de grasa, (Kg)	25,0 $\pm$ 5,9
Índice de masa magra, (Kg/m^2)	17,7 $\pm$ 2,1
<i>Bioquímicas</i>	
Colesterol total, (mg/dL)	165,3 $\pm$ 44,4
Triglicéridos, (mg/dL)	114,9 $\pm$ 80,8
c-HDL, (mg/dL)	47,7 $\pm$ 16,9
c-LDL, (mg/dL)	92,3 $\pm$ 34,2
Glucosa, (mg/dL)	80,3 $\pm$ 13,6
<i>Componentes del SM</i>	
Síndrome metabólico, % (n)	23 (113)
Obesidad abdominal, % (n)	33 (162)
Hipertensión arterial, % (n)	13 (66)
c-HDL bajo, % (n)	31 (152)
Hipertrigliceridemia, % (n)	19 (95)
c-LDL elevado, % (n)	32 (160)
Hiperglicemia, % (n)	7 (35)
Hipercolesterolemia, % (n)	60 (294)
IMC elevado, % (n)	32 (158)
Score de riesgo SM	-1,086 $\pm$ 0,325

Relación entre el auto-reporte de CF con variables clínicas, de composición corporal y bioquímicas

Los sujetos que acusaron como “bueno/muy bueno” en el auto-reporte de condición física general IFIS, presentaron promedios más saludables en el IMC, la glucosa y la puntuación score de SM, frente a los sujetos que respondieron “aceptable” y/o “muy malo/

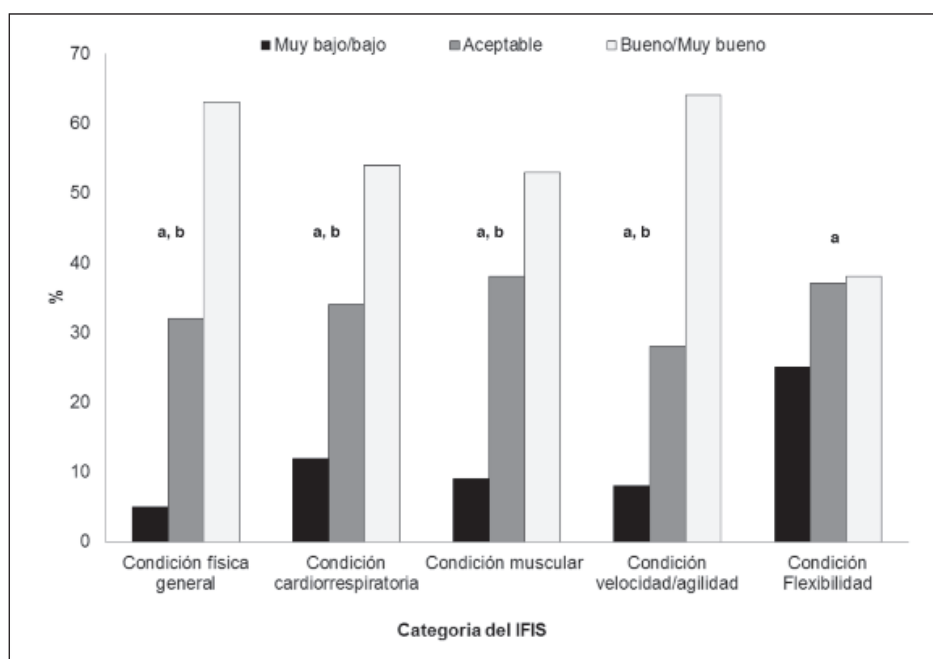


Fig. 1.—Distribución de las respuestas de las cinco preguntas del cuestionario de auto-reporte de la CF “The International Fitness Scale” (IFIS) en universitarios varones de Bogotá, Colombia (n = 493). ^a Diferencias entre “muy bajo/bajo” vs. “Aceptable” ^b Diferencia entre “muy bajo/bajo” vs. “bueno/muy bueno”.

malo” ($p < 0,05$). Esta misma tendencia fue observada en el Ítem 2 (condición cardiorrespiratoria) en las variables MLG y triglicéridos, en el Ítem 3 (condición muscular) en el IMC, CC, TAS, MLG e IMG y en el ítem 4 (condición velocidad/agilidad) en los componentes IMC, MLG, IMG y c-HDL, tabla II.

Relación entre el auto-reporte de CF y componentes de SM

Tras ajustar por edad e IMC, los sujetos que respondieron “bueno/muy bueno” presentaron menor frecuencia en los componentes de SM obesidad central, tensión arterial (TA), triglicéridos y c-HDL, que los agrupados como “aceptable” y/o “muy malo/malo” ($p < 0,05$), figura 2.

Capacidad predictiva del auto-reporte de CF en los componentes asociados al SM

Los participantes que acusaron en la encuesta IFIS “muy malo/malo” en la categoría condición física general, mostraron 2,64 veces (IC 95% 1,16-8,34) la oportunidad de presentar obesidad central, 1,77 veces (IC 95% 1,05-2,53) colesterol total elevado y 2,79 veces (IC 95% 1,17-6,16) un c-HDL < de 40 mg/dL. Esta observación también fue hallada en el componente muscular, incrementando el riesgo en 1,81 veces (IC 95% 1,02-2,35) en colesterol total, 1,67 veces (IC 95% 1,02-3,47) un c-HDL no saludable y 2,61 veces (IC 95% 1,01-4,63) el c-LDL > 100 mm/dL, figura 3.

Discusión

El presente estudio detecta una prevalencia de SM del 23% según criterios del IDF, resultado superior al encontrado en el estudio de Ruiz et al.²¹ (9%) y cercano al reportado por Villegas et al.²² (23,6%) en población Colombiana. Respecto a los componentes del SM, la obesidad abdominal (33%) y c-HDL bajo (31%) fueron los factores más prevalentes, hallazgo similar al descrito por Villegas et al.²² (27,6% en CC) y (38,8% en c-HDL). En estudios poblacionales estadounidenses, con sujetos de edades similares a las presentadas en este trabajo, la prevalencia de SM fue del 24%²³ y en población española del 13,4%²⁴. Respecto a la obesidad abdominal, -componente de mayor prevalencia en este trabajo- el estudio INTERHEART²⁵, y el estudio INTERSTROKE²⁶, mostraron que el incremento de la CC, explicaba el 48,5% y 26,5% del riesgo atribuible poblacional, en la ocurrencia de un primer infarto agudo de miocardio y un primer accidente cerebro-vascular respectivamente. Esta observación también fue descrita también por Pou et al.²⁷, quienes observaron que el aumento en la prevalencia del tejido adiposo visceral y de adiposidad se relacionaban con un incremento de las categorías del IMC y la CC. Sobre este último, organismos científicos como la American Heart Association (AHA)²⁸ y el American College Sport of Medicine (ACSM)² recomiendan que, en la estimación de la obesidad con indicadores antropométricos, se incluyan medidas de adiposidad central como la CC y grasa visceral para estratificar el riesgo cardiovascular en la población general, por lo que su medición en adultos jóvenes está claramente justificada.

Tabla II
Relación del auto-reporte de CF por cuestionario IFIS con variables antropométricas, clínicas, composición corporal y bioquímicas de universitarios de Bogotá, Colombia, (n=493)

	Condición física general			Condición cardiorrespiratoria			Condición muscular			Condición velocidad/agilidad		
	Muy bajo	Aceptable	Bueno	Muy bajo	Aceptable	Bueno	Muy bajo	Aceptable	Bueno	Muy bajo	Aceptable	Bueno
<i>Antropométricas y clínicas</i>												
Índice de masa corporal, (kg•m ⁻¹)	24,0 ± 3,4	23,0 ± 2,8	22,3 ± 2,7 ^{b,c}	23,0 ± 3,1	22,9 ± 3,0	22,3 ± 2,5	22,8 ± 3,1	23,1 ± 2,8	22,3 ± 2,7 ^{b,c}	21,6 ± 2,7	22,1 ± 2,4	23,1 ± 3,0 ^b
Circunferencia de cintura, (cm)	79,3 ± 8,3	77,1 ± 7,0	75,7 ± 7,4	76,8 ± 8,4	76,8 ± 7,1	75,9 ± 7,1	77,3 ± 6,7	75,8 ± 8,6	76,0 ± 7,4 ^{b,c}	77,5 ± 7,8	75,4 ± 6,4	73,3 ± 7,2
Tensión arterial sistólica, (mmHg)	121,3 ± 13,5	118,9 ± 12,8	118,4 ± 13,3	118,5 ± 13,9	119,0 ± 13,4	118,5 ± 12,8	121,4 ± 12,4	118,7 ± 13,2	118,3 ± 13,1 ^c	120,2 ± 13,0	117,7 ± 12,9	114,5 ± 13,5
Tensión arterial diastólica, (mmHg)	75,3 ± 8,2	71,8 ± 9,1	71,4 ± 11,3	73,4 ± 8,3	71,4 ± 9,3	71,6 ± 11,7	73,2 ± 8,2	72,5 ± 9,7	71,3 ± 11,1	72,3 ± 11,7	71,2 ± 9,1	70,8 ± 9,3
Tensión arterial media, (mmHg)	89,0 ± 6,8	87,5 ± 9,4	87,0 ± 10,6	87,1 ± 10,2	86,2 ± 9,9	87,7 ± 10,1	87,6 ± 6,7	88,0 ± 10,1	86,9 ± 10,4	87,7 ± 10,6	86,6 ± 9,6	87,4 ± 8,9
<i>Composición corporal</i>												
Masa grasa, (kg)	16,4 ± 10,3	15,0 ± 8,1	13,3 ± 6,0	14,4 ± 7,4	14,5 ± 8,4	13,6 ± 6,1	15,2 ± 7,4	14,1 ± 8,4	13,6 ± 6,1	14,4 ± 7,7	13,8 ± 8,3	14,0 ± 6,1
Masa grasa, (%)	24,5 ± 11,7	22,3 ± 7,7	20,6 ± 8,6	23,6 ± 8,7	20,8 ± 7,7	21,1 ± 8,9	25,2 ± 8,2	20,6 ± 8,2	21,1 ± 8,6	24,1 ± 9,8	20,2 ± 8,6	21,4 ± 8,1
Masa libre de grasa, (Kg)	23,2 ± 5,8	24,1 ± 6,1	25,3 ± 5,7	21,8 ± 5,1	25,6 ± 5,6	25,1 ± 6,0 ^{b,c}	21,5 ± 5,4	25,7 ± 6,1	25,0 ± 5,7 ^c	21,0 ± 5,6	25,6 ± 5,9	25,1 ± 5,7 ^{b,c}
Índice de masa magra, (Kg/m ²)	17,5 ± 1,6	17,5 ± 2,1	17,6 ± 2,1	16,8 ± 1,8	17,7 ± 1,8	17,7 ± 2,1	16,6 ± 1,6	17,8 ± 2,0	17,7 ± 2,0 ^{b,c}	16,5 ± 1,8	17,5 ± 1,9	17,7 ± 2,1 ^{b,c}
<i>Bioquímicas</i>												
Colesterol total, (mg/dL)	147,2 ± 34,4	149,2 ± 34,2	143,9 ± 31,9	148,2 ± 34,4	147,5 ± 34,4	146,1 ± 32,8	155,4 ± 34,7	148,6 ± 34,5	143,7 ± 32,9	149,8 ± 34,0	147,3 ± 34,4	147,6 ± 34,1
Triglicéridos, (mg/dL)	91,5 ± 48,8	87,3 ± 36,0	85,2 ± 49,8	92,9 ± 50,1	89,8 ± 43,0	83,5 ± 49,0 ^b	87,8 ± 54,5	87,4 ± 38,3	84,3 ± 32,6	80,3 ± 31,1	87,2 ± 43,5	88,8 ± 54,7
c-HDL, (mg/dL)	43,4 ± 13,3	46,9 ± 15,2	48,2 ± 20,1	46,5 ± 14,9	45,8 ± 13,5	48,7 ± 21,3	47,4 ± 16,7	45,6 ± 14,9	48,3 ± 19,8	46,1 ± 14,1	47,1 ± 13,1	48,0 ± 21,9 ^b
c-LDL, (mg/dL)	89,4 ± 24,5	87,2 ± 27,6	83,9 ± 26,2	87,6 ± 26,8	85,2 ± 26,9	85,0 ± 26,5	97,8 ± 25,0	84,5 ± 26,0	84,4 ± 26,8	91,5 ± 25,6	86,0 ± 27,4	83,8 ± 26,1
Glucosa, (mg/dL)	76,0 ± 11,9	77,5 ± 14,0	74,0 ± 11,1 ^b	77,3 ± 14,4	75,8 ± 11,3	73,9 ± 10,9	75,0 ± 11,7	75,8 ± 13,2	75,1 ± 12,0	76,7 ± 12,0	73,2 ± 10,6	74,7 ± 12,7
Score de riesgo SM	-1,13 ± 0,31	-1,02 ± 0,33	-1,01 ± 0,33 ^b	-1,11 ± 0,32	-1,07 ± 0,32	-1,01 ± 0,33	-1,10 ± 0,33	-1,08 ± 0,31	-0,98 ± 0,31	-1,07 ± 0,33	-1,09 ± 0,31	-1,08 ± 0,32

Diferencias evaluadas por análisis de varianzas (ANOVA), p<0,05.

^aDiferencia entre muy bajo/bajo vs. Aceptable.

^bDiferencia entre Aceptable vs. bueno/muy bueno.

^cDiferencia entre muy bajo/bajo vs. bueno/muy bueno.

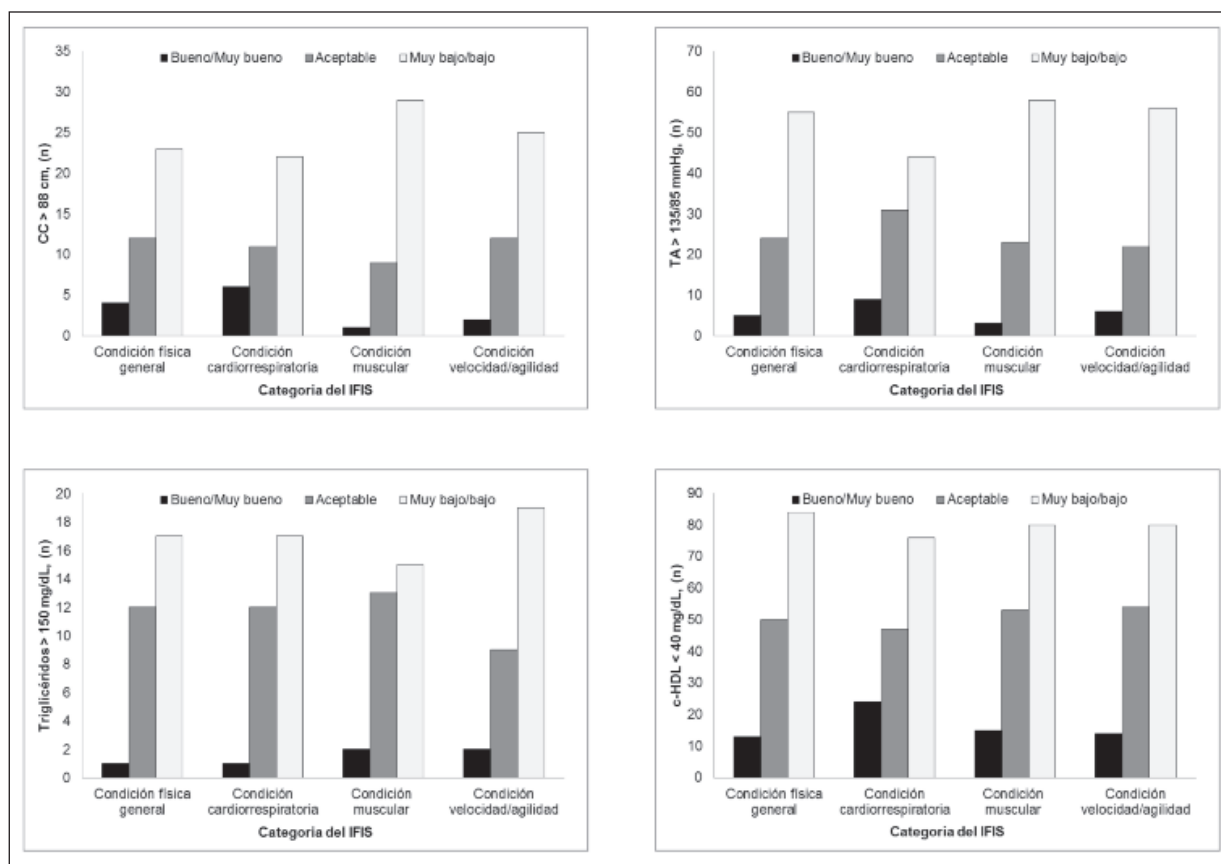


Fig. 2.—Relación entre el auto-reporte del cuestionario de auto-reporte de la CF “The International Fitness Scale” (IFIS) y componentes de SM en universitarios varones de Bogotá, Colombia (n = 493).

Otro resultado del presente trabajo, fue que los sujetos que respondieron como “bueno/muy bueno” en los dominios del IFIS, -ítem de *condición cardiorrespiratoria* y *Fitness muscular*-, presentaron menor prevalencia en la frecuencia de los componentes de SM: obesidad central, tensión arterial, niveles de triglicéridos y c-HDL, que los sujetos agrupados en la categoría de respuesta “aceptable” y/o “muy malo/malo” ($p < 0,05$), tabla II y figura 2. Esta misma observación se encontró con otras variables de riesgo cardiometabólico: IMC, CC, TAS, MLG e IMG, ($p < 0,05$). De la misma forma, se comprobó que menores puntajes en el IFIS -*componente de acondicionamiento físico general*-, predicen la oportunidad de presentar obesidad central OR 2,64 (IC 95% 1,16-8,34) y dislipidemia OR 1,77 (IC 95% 1,05-2,53), mientras que la capacidad predictiva del -*componente muscular*- fue OR 1,81 (IC 95% 1,02-2,35) para el colesterol total y OR 2,61 (IC 95% 1,01-4,63) para c-LDL alterado. Sobre este hallazgo, el trabajo de García-Artero et al.²⁹, demostró una correlación inversa entre la CF muscular con alteraciones del metabolismo lipídico, independiente de los niveles de actividad física, en el estudio Alimentación y Valoración del Estado Nutricional en Adolescentes (Estudio AVENA), realizado en cinco centros españoles (Granada, Madrid, Murcia, Santander, Za-

ragoza), justificando que la medición del *Fitness* muscular, podría representar una medida adicional en la predicción del riesgo cardiometabólico.

Esta observación coincide por la descrita recientemente por Ramírez-Vélez et al.³⁰, en universitarios (edad $19,7 \pm 2,4$ años; peso $65,5 \pm 10,7$ kg; IMC $22,6 \pm 2,8$ $\text{kg} \cdot \text{m}^{-2}$). Después de ajustar por edad, IMC y CC, estos autores observaron relaciones inversas entre el porcentaje de grasa, la CC, los niveles de colesterol total, HDL-c, LDL-c e índice lipídico-metabólico, con mayores valores de fuerza muscular prensil/peso corporal ($p < 0,05$). Esto nos llevaría a suponer que la CF -*en especial el componente muscular*- podría ser considerado como un indicador de salud cardiovascular con alta potencia discriminatória, como también fue descrito en adolescentes europeos en los estudios *Danish Youth and Sports Study*³¹, *Healthy Lifestyle in Europe by Nutrition in Adolescence Study*³² y *European Youth Heart Study*³³. Aunado a lo anterior, hemos usado ecuaciones para estimar la condición física por VO(2)max en sujetos con características similares a las de este estudio, como herramientas metodológicas económicas y eficientes para evaluar este importante indicador de salud y relacionarlo con indicadores de calidad de vida relacionada con la salud y factores de riesgo cardiometabólicos^{34,35}.

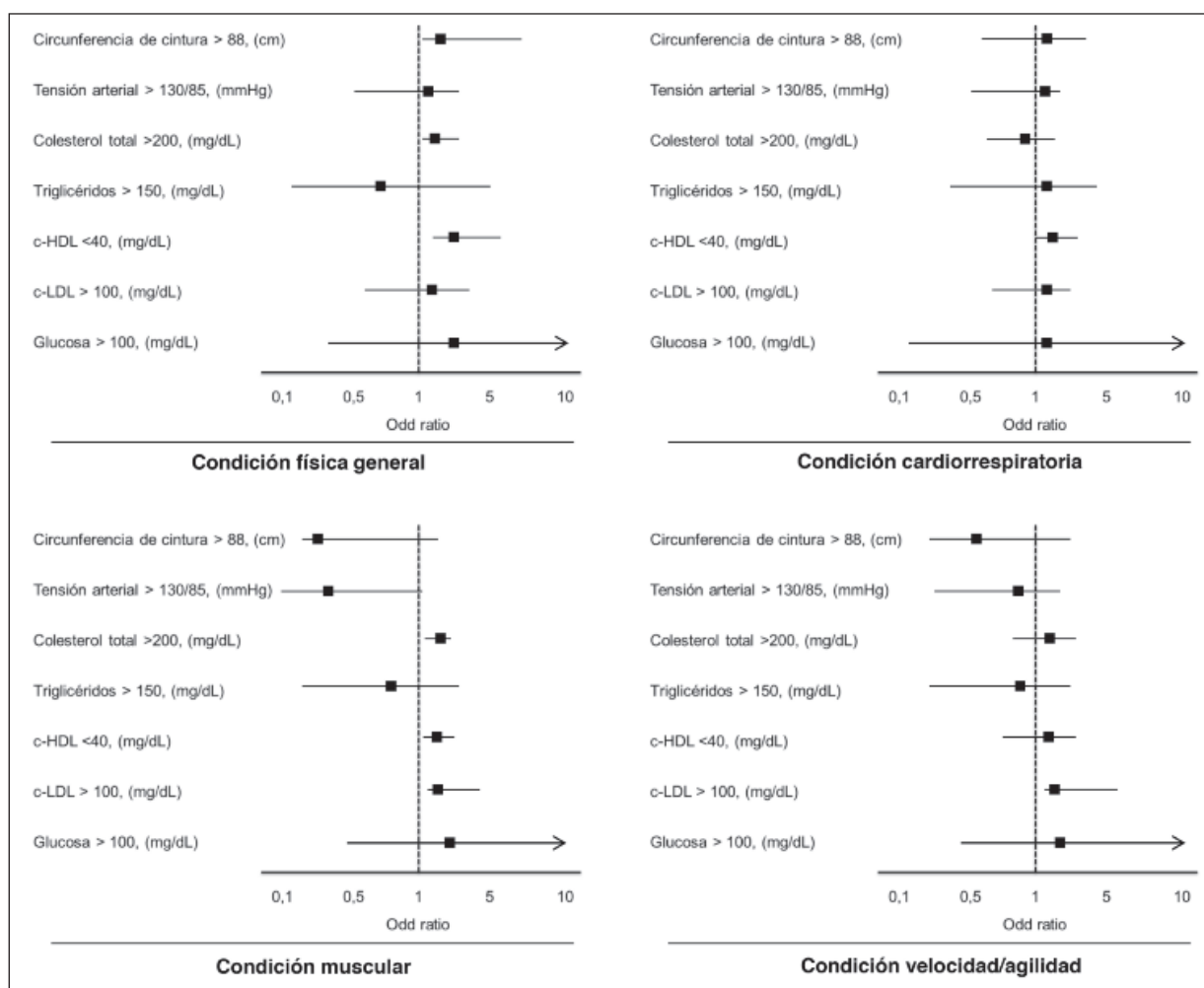


Fig. 3.—Capacidad predictiva del auto-reporte del cuestionario de auto-reporte de la CF “The International Fitness Scale” (IFIS) en los componentes asociados al SM en universitarios varones de Bogotá, Colombia (n = 493).

Algunos aspectos deben ser tenidos en cuenta como limitantes del presente estudio. Por ejemplo, el tamaño de la muestra, las características propias de la población, el diseño del trabajo y el tipo de muestreo, pueden ser consideradas fuentes potenciales de sesgos. Tampoco fueron incluidas otras variables que pueden estar asociados al perfil de riesgo cardiometabólico, tales como la etnia, aspectos socioeconómicos, nutricionales, sociales y niveles de actividad física. Sin embargo, no existen argumentos para creer que las relaciones descritas ocurran exclusivamente en la población de la que procede nuestra muestra, pues se observó convergencia de los resultados con datos descritos en otros estudios nacionales e internacionales^{1,4-6,8,14,15,29-33}.

Como fortaleza, destacamos la utilidad del cuestionario IFIS para ser implementado en estudios epidemiológicos como variable dependiente o para determinar algunos de los componentes de la CF sin medir la frecuencia del comportamiento, como recientemente lo reportó Phillips et al.¹² quienes encontraron que la CF por auto-reporte es un predictor de la mortalidad en adultos

de mediana edad, sugiriendo que una simple medida del *Fitness* subjetivo podría resultar una alternativa útil cuando la evaluación objetiva de la capacidad aeróbica no es posible. Destacamos también que, hasta la fecha, éste es uno de los primeros estudios realizados en población latina que describe explícitamente el marco conceptual a partir del cual se pueda aplicar el IFIS, junto a la medición de los componentes asociados al SM.

A pesar de que el instrumento IFIS no es ajeno a los problemas que son inherentes a todos los instrumentos de auto-reporte, tales como su sensibilidad a los prejuicios sociales, conveniencia y la coherencia, se ha demostrado que el cuestionario IFIS es una medida útil y práctica, para estimar el nivel de *Fitness* de las personas adultas jóvenes¹⁶. Por tanto, este cuestionario permite conocer si existen o no hábitos de actividad física en el entrevistado, a pesar de las evidentes limitaciones, como el diseño transversal del estudio o el grupo poblacional¹⁶. Sería preciso ampliar la población objeto de estudio a diferentes franjas etarias. La razón de haber elegido una muestra entre 18 y 30

años se debe a la variabilidad que podemos encontrar en los hábitos de actividad física en estas edades. Además, sería necesario evaluar componentes principales y validez convergente y discriminante del cuestionario IFIS con otros instrumentos que estimen otros componentes del *Fitness* con medidas estandares como el uso de acelerómetros, pruebas cardiopulmonares y plataformas de fuerza o dinamómetros, especialmente en latinos. No obstante, estas limitaciones no comprometen los resultados obtenidos en este reporte.

En conclusión y en opinión de los autores, se sugiere incluir la evaluación del auto-reporte de la CF, junto a la determinación convencional de los factores de riesgo tradicionales en la prevención y tratamiento de los factores de riesgo asociados al SM, en estudios epidemiológicos a gran escala, en los que, por falta de tiempo, equipamiento, o limitaciones de personal cualificado, la CF no pueda ser estimada directamente. Adicionalmente, se requieren estudios observacionales con un mayor tamaño de muestra, y especialmente estudios longitudinales y prospectivos, para constatar los resultados obtenidos en este trabajo.

Conflicto de intereses

Los autores del estudio declaran no tener conflicto de interés.

Agradecimientos

Estos resultados hacen parte del proyecto “Asociación de la fuerza prensil con manifestaciones tempranas de riesgo cardiovascular en adultos jóvenes colombianos”, aprobado en la convocatoria nacional para jóvenes investigadores e innovadores COLCIENCIAS N° 617-2013 y la Vicerrectoría de Investigaciones convocatoria FODEIN-USTA 2014 N° 2013004. A la empresa MEXGLOBAL Group SA, por el apoyo técnico en la mediciones bioquímicas por CardioCheck® analytical performance.

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Original/*Deporte y ejercicio*

Efecto de la precipitación y el periodo estacional sobre los patrones de desplazamiento al centro educativo en niños y adolescentes de Granada

José Manuel Segura-Díaz¹, Manuel Herrador-Colmenero^{1,2}, Borja Martínez-Téllez^{1,2} y Palma Chillón^{1,2}

¹Facultad Ciencias del Deporte, Departamento de Educación Física y Deportiva, Universidad de Granada, Granada. ²Grupo de investigación PROFITH "PROmoting FITness and Health through physical activity", Granada. España.

Resumen

Introducción: El desplazamiento activo (ir andando o en bicicleta) al centro educativo contribuye a aumentar los niveles de actividad física en jóvenes. Las condiciones climatológicas podrían influir dicho comportamiento.

Objetivo: El objetivo es estudiar la influencia de la precipitación en forma de lluvia y del periodo estacional, en el modo de desplazamiento al colegio e instituto en niños y adolescentes de la ciudad de Granada.

Método: Participaron un total de 384 estudiantes (166 niños y 218 adolescentes) entre 8 y 18 años de 2 centros (colegio e instituto) de la capital Granadina. Los participantes completaron un cuestionario sobre el modo de desplazamiento semanal en las tres estaciones del año académico. Los datos de precipitación en estas tres semanas fueron obtenidos desde la Agencia Estatal de Meteorología. Las asociaciones entre la precipitación en forma de lluvia y la estación con el modo de desplazamiento activo al colegio se estudió mediante el test McNemar.

Resultados: A nivel general, no se encontraron asociaciones significativas entre la precipitación y el periodo estacional con el modo de desplazamiento de los niños y adolescentes ($p > 0,05$) a excepción de dos asociaciones: a) el efecto positivo de la lluvia en el porcentaje de niños que andan al colegio entre un día lluvioso y un día no lluvioso en primavera ($p = 0,031$) y b) el ligero efecto de la estación en el porcentaje de niños y adolescentes que andan entre otoño e invierno (45,8% y 37,5% andan) y entre otoño y primavera (59,7% y 56%) respectivamente ($p = 0,07$).

Conclusión: Las condiciones climatológicas parecen tener poca influencia en el modo de desplazamiento en niños y adolescentes de Granada, pareciendo existir un hábito constante en dicho comportamiento a lo largo del curso académico.

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Palabras clave: Niños. Adolescentes. Desplazamiento activo. Lluvia. Estación.

Correspondencia: Palma Chillón Garzón.
Facultad de Ciencias del Deporte de la Universidad de Granada.
Ctra Alfacar, s/n, 18011 Granada.
E-mail: pchillon@ugr.es

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EFFECT OF PRECIPITATION AND SEASONAL PERIOD ON THE PATTERNS OF COMMUTING TO SCHOOL IN CHILDREN AND ADOLESCENTS FROM GRANADA

Abstract

Background: Active commuting (walking or cycling) to school contributes to increase physical activity levels in young people. Meteorological conditions might have a remarkable influence on this behaviour.

Objective: The aim is to study the impact of the rainfall and seasonality on the mode of commuting to primary school or secondary school in children and adolescents from Granada.

Methods: A total of 384 students (166 children and 218 adolescents) between 8-18 years from 2 different schools (primary and secondary schools) of Granada took part in the research. Participants filled a questionnaire about their weekly pattern on the mode of commuting to school in the three seasons of the academic year. Data about the rainfall in those three weeks was obtained from the National Agency of Meteorology. The association between rainfall and seasonality with mode of commuting to school was studied by McNemar test.

Results: No significant associations were spotted between the rainfall and the seasonality with mode of commuting in children and adolescents ($p > 0,05$) except for: a) a positive effect of rainfall in the percentage of children who usually walked to school between a rainy day and a non-rainy day in spring ($p = 0,031$) and b) a weak effect of the seasonality on the percentage of children and adolescents who usually walk between autumn and winter (45.8% and 37.5% walk to school) and between autumn and spring (59.7% and 56%) respectively ($p = 0,07$).

Conclusions: The meteorological conditions do not seem to influence the mode of commuting to school in children and adolescents from Granada, which might indicate that this behavior keeps a constant pattern throughout the whole academic year.

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Key words: Children. Adolescents. Active Commuting. Rain. Season.

Abreviaturas

AVENA: Alimentación y Valoración del Estado Nutricional en Adolescentes. Introducción. *Párrafo 1. Frase 3.*

HELENA: Healthy Lifestyle in Europe by Nutrition in Adolescence. Introducción. *Párrafo 1. Frase 4.*

P.E: Por ejemplo. Introducción. *Párrafo 3. Frase 1.*

EEUU: Estados Unidos. Introducción. *Párrafo 4. Frase 9.*

N: Tamaño de Población. Método. *Párrafo 7. Frase 2.*

AEMET: Agencia Estatal de Meteorología. *Párrafo 12. Frase 2.*

SPSS: Statistical Package for the Social Sciences, *Párrafo 17. Frase 5.*

Introducción

En la actualidad existe una gran preocupación generalizada por el bajo nivel de actividad física, la creciente incidencia de la obesidad y las enfermedades crónicas en España y el resto de Europa. Así surgieron proyectos como el estudio AVENA o HELENA, con los que se estudió tanto el estado de salud, la situación metabólico-nutricional y los hábitos de comportamiento de una muestra representativa de jóvenes españoles^{1,2}.

La participación en la actividad física se asocia con muchos factores individuales, sociales y ambientales³⁻⁵ y la identificación de estos factores es de gran importancia para el diseño de programas de intervención de salud pública eficaces⁶. Los factores sociales han sido ampliamente estudiados, tales como el nivel económico, la etnia o la edad así como los factores individuales dónde se incluye, el entorno construido, largas distancias, el acceso a las instalaciones, a los parques, al transporte público o a la conectividad de la calle⁷. Los factores ambientales como la variación estacional o las condiciones climáticas como la lluvia, han sido menos estudiadas⁸.

La promoción del desplazamiento activo (p.e andando o en bicicleta) es una forma prometedora para aumentar la actividad física en jóvenes por su integración en la vida cotidiana^{9,10}. Chillón y colaboradores han observado una asociación importante entre el desplazamiento activo y mayores niveles de actividad física en adolescentes¹¹.

Diariamente tomamos las decisiones de cómo desplazarnos, viéndose afectadas por las características del destino, las del desplazamiento, y las condiciones meteorológicas¹². Los efectos concretos de las condiciones meteorológicas (lluvia, temperatura, viento) y el clima estacional (otoño, invierno, primavera y verano) sobre el desplazamiento activo han sido poco estudiados y la evidencia es limitada y no concluyente, posiblemente por ser un parámetro no modificable. Sirad y colaboradores no encontró ninguna asociación entre el estado del tiempo (nublado, soleado, lluvioso, ni-

vosos), la temperatura y el número de estudiantes que viajaban de forma activa (caminando y montando en bicicleta) a la escuela en Carolina del Sur (EEUU)¹³. En cambio, Duncan y colaboradores sí encontraron efectos sustanciales en la disminución del número de pasos que realizaban niños de 5 a 12 años a la escuela en condiciones de lluvia y temperaturas extremas en Auckland (Nueva Zelanda)¹⁴.

Sí existe mayor evidencia sobre la relación entre los niveles de actividad física generales con las condiciones climatológicas, siendo estos más altos en primavera y verano y más bajos en otoño e invierno^{5,8}. La variación estacional de la actividad física se asocia con cambios en la climatología y las horas de luz que acompañan a las diferentes estaciones¹⁵. Estos efectos ambientales están recibiendo cada vez más atención sobre el desplazamiento activo¹⁶. A corto plazo, los cambios en las condiciones climáticas, tales como la cantidad de luz del día, la temperatura y la precipitación, pueden impedir o promover tanto el deseo como la viabilidad del desplazamiento activo¹⁷. En algunos contextos existe una larga tradición de realizar actividades al aire libre independientemente de la estación del año. Incluso durante el invierno en el norte de Europa, los problemas de desplazamiento activo podrían estar más relacionados con el mal estado de las infraestructuras que por el efecto de la estación¹⁸.

Por tanto, el presente estudio tiene como objetivos sobre una población de niños y adolescentes de la capital granadina de: (1) estudiar la influencia de la precipitación en el modo de desplazamiento al centro educativo dentro de una misma semana, entre trayectos (ida o vuelta) y días lluviosos (≥ 10 L/m²) y trayectos y días no lluviosos (< 10 L/m²); (2) estudiar la influencia de las estaciones en el modo de desplazamiento de un mismo trayecto al centro educativo.

Método

Participantes

En el estudio participaron un total de 384 estudiantes entre 8 y 18 años de 2 centros educativos (colegio e instituto) de la capital granadina que completaron todos los ítems del cuestionario. De estos, eran niños (N=166 en otoño, N=103 en invierno y N=105 en primavera) y adolescentes eran (N=218 en otoño, N=216 en invierno y N=185 en primavera).

Para analizar el segundo objetivo (efecto de la estación en el modo de desplazamiento) se incluyeron aquellos sujetos que tenían datos de modo de desplazamiento en las 3 estaciones (N=72 niños y N=159 adolescentes).

El estudio se ha realizado bajo el marco legislativo vigente español. Para la realización del mismo, se informó de forma oral y escrita a la comunidad educativa involucrada en la ejecución del estudio (profesores/as y/o directores/as de centro) sobre el objetivo y carácter

del estudio. El presente estudio está aprobado por el Comité de Ética de Investigación de la Universidad de Granada (caso n° 817).

Diseño e Instrumentos

Es un estudio longitudinal llevado a cabo a lo largo del curso académico 2012-2013, realizando tres medidas sobre patrones de desplazamiento al centro educativo y sobre la precipitación durante 5 días lectivos consecutivos correspondientes a una semana de lunes a viernes. Los tres momentos en que se aplicaron estas medidas fueron en las tres estaciones que se suceden en el curso escolar: otoño (primer trimestre, en la semana 19-23 de noviembre), invierno (segundo trimestre, en la semana 19-23 de febrero y 4-8 de marzo) y primavera (tercer trimestre, en la semana 13-17 de mayo).

Los patrones de desplazamiento se obtuvieron a través de un cuestionario desarrollado por el Departamento de Educación Física y Deportiva de la Universidad de Granada, del que no está actualmente constata la fiabilidad y validez. No obstante, las preguntas que se incluyen son muy similares a las de otros estudios realizados en la misma temática que si han demostrado fiabilidad y validez al traducirlos del inglés¹⁹. El cuestionario se compone de dos preguntas sobre el modo de desplazamiento habitual al y desde el centro educativo de esta forma: “¿cómo te desplazas habitualmente al colegio o instituto?” y “¿cómo vuelves del colegio esta semana?” Para ambas preguntas, las opciones de respuesta fueron: “andando, en bicicleta, en coche, en moto, en autobús o en otros”. Asimismo, se planteó para cada día de la semana, de lunes a viernes una pregunta sobre el modo de desplazamiento del trayecto de ida al colegio o al instituto: “¿cómo vas al colegio/instituto esta semana?”; y otra pregunta sobre el modo de desplazamiento del trayecto de vuelta del colegio o instituto: “¿cómo vuelves del colegio/instituto esta semana?”, ambas con las mismas opciones de respuesta anteriores para cada trayecto de cada día.

Los datos de precipitación se solicitaron a la Agencia Estatal de Meteorología (AEMET). De la estación meteorológica más cercana a la localidad de ubicación del centro educativo, se recogieron los datos y formas de precipitación en las 24 horas de cada uno de los días en los que se evaluó el modo de desplazamiento de los participantes. La forma de precipitación fue siempre en forma de lluvia. Partiendo de los datos brutos de precipitación, se calcularon los promedios las precipitaciones en tres espacios horarios diferentes: a) en el intervalo de horas de entrada del colegio o instituto desde las 7-9 h; b) en el intervalo de horas de salida del colegio o instituto desde las 13-15; y c) en el intervalo de horario escolar de 7-15h.

Los datos meteorológicos de AEMET se transfirieron a una base de datos por dos investigadores distintos de forma independiente (revisión por pares)

donde se cruzaron ambas bases de datos para calcular el porcentaje de concordancia (88%) y discrepancias (12%) entre los dos investigadores. Seguidamente, se analizaron las discrepancias a través de un consenso entre investigadores para conseguir un 100% de concordancia.

Se consideró trayecto o día lluvioso aquel en el que existía una precipitación $\geq 10\text{L/m}^2$ y trayecto o día no lluvioso aquel en el que existía una precipitación $< 10\text{L/m}^2$.

Análisis Estadístico

Se realizaron análisis descriptivos atendiendo al modo de desplazamiento de la ida y la vuelta al colegio e instituto durante los cinco días lectivos registrados en cada estación, y a las precipitaciones recogidas en los intervalos de 7-9h, 13-15h y 7-15h. El análisis del modo de desplazamiento en función de la precipitación y del periodo estacional se estudió mediante el test McNemar.

Para estudiar el efecto de la precipitación en el modo de desplazamiento, se analizó si el porcentaje de los sujetos que se desplazan andando al centro educativo varía entre días lluviosos y días no lluviosos dentro de una misma semana y en el mismo trayecto. Sólo existían trayectos lluviosos ($\geq 10\text{L/m}^2$) en la ida en las semanas de invierno y primavera. También se estudió los efectos que tiene en el desplazamiento dos o más días seguidos lluviosos frente a dos o más días no lluviosos de la misma semana, atendiendo al intervalo de precipitación de 7-15h. Estas condiciones se cumplieron únicamente en los niños por lo que se comparó el promedio del porcentaje de los sujetos que andan en los días lluviosos de martes, miércoles y jueves frente a los que andan en lunes y viernes de la semana de invierno.

Para estudiar el efecto de la estación en el modo de desplazamiento se analizó si el porcentaje de los sujetos que se desplazan andando varía entre estaciones. Este análisis se realizó de forma independiente para cada trayecto (ida y vuelta) y día de la semana, para estudiar si se mantenía el hábito en el modo desplazamiento semanal de cada sujeto a lo largo del curso académico. Todos los análisis se llevaron a cabo mediante el paquete estadístico SPSS 20,0 Las diferencias se consideraron significativas con un valor de $p < 0,05$.

Resultados

En la tabla I y tabla II se presentan los porcentajes del modo de desplazamiento en el trayecto de ida y vuelta durante las tres semanas de cada estación (otoño, invierno y primavera) para niños y adolescentes. También se presenta la precipitación acumulada en los intervalos de 7-9h, 13-15h y de 7-15h.

Tabla I
Modo de desplazamiento al colegio y precipitación en otoño, invierno y primavera en niños de un colegio de Granada

Granada/Colegio	N	Modo de desplazamiento (%)					Precipitación (L/m²)	
		Andan	Bicicleta	Coche	Moto	Bus	I, 7-9h / V, 13-15h	7-15h
Otoño (19-23 Noviembre)								
Ida Lunes	166	44,3	0	40,9	0,6	13,8	0	0
Ida Martes	166	46,1	0	41,9	0,6	11,4	0	0
Ida Miércoles	166	44,9	0	40,7	1,8	12,6	0	0
Ida Jueves	166	46,1	0	40,1	0,6	13,2	0	0
Ida Viernes	166	45,1	0	39,7	3,0	12,6	0	0
Vuelta Lunes	166	47,3	0	37,1	1,2	13,8	0	0
Vuelta Martes	166	43,1	0	43,7	3,0	10,2	0	0
Vuelta Miércoles	166	47,9	0	37,1	1,2	13,8	0	0
Vuelta Jueves	166	44,9	0	39,5	3,0	12,6	0	0
Vuelta Viernes	166	48,5	0,6	36,5	1,8	12,0	0	0
Invierno (4-8 marzo)								
Ida Lunes	103	45,6	0	41,7	1,9	10,7	0	0
Ida Martes	103	45,6	0	41,7	1,0	11,7	8	70
Ida Miércoles	103	48,5	0	38,8	0	12,6	8	58
Ida Jueves	103	44,7	0	40,8	1,9	12,6	38	114
Ida Viernes	103	44,7	0	40,8	1,9	12,6	0	2
Vuelta Lunes	103	48,5	0	37,9	1,0	12,6	0	0
Vuelta Martes	103	46,6	0	43,7	1,9	7,8	0	70
Vuelta Miércoles	103	48,5	1,0	39,8	0	11,7	8	58
Vuelta Jueves	103	43,7	0	42,7	1,9	11,7	0	114
Vuelta Viernes	103	40,8	0	46,6	0	12,6	0	2
Primavera (13-17 mayo)								
Ida Lunes	105	47,6	0	42,9	0	9,5	0	0
Ida Martes	105	45,7	0	42,9	0	11,4	0	0
Ida Miércoles	105	35,2	0	41,0	0	10,5	0	0
Ida Jueves	105	44,8	0	43,8	0	10,5	0	0
Ida Viernes	105	44,8	0	42,9	0	12,4	14	16
Vuelta Lunes	105	49,5	0	39,0	0	11,4	0	0
Vuelta Martes	105	49,5	0	42,9	1,9	5,7	0	0
Vuelta Miércoles	105	50,5	0	38,1	0	10,5	0	0
Vuelta Jueves	105	49,5	0	36,8	1,0	12,4	0	0
Vuelta Viernes	105	46,2	0	39,4	1,0	13,5	0	16

I, ida; V, vuelta

Efecto de la precipitación

Los datos del efecto de la precipitación en el modo de desplazamiento comparando el porcentaje de niños y adolescentes que andan en días lluviosos y no lluvio-

sos en una misma semana se muestran en la figura 1 y figura 2 respectivamente.

En niños, en la semana de invierno, no se observaron cambios significativos al comparar los trayectos de ida de lunes e ida del viernes en los que no llovió

Tabla II
Modo de desplazamiento al instituto y precipitación en otoño, invierno y primavera en adolescentes de enseñanza secundaria obligatoria de un instituto de Granada

Granada/Instituto	N	Modo de desplazamiento (%)					Precipitación (L/m²)	
		Andan	Bicicleta	Coche	Moto	Bus	I, 7-9h / V, 13-15h	7-15h
Otoño (19-23 noviembre)								
Ida Lunes	218	60,6	0	30,8	0,9	9,4	0	0
Ida Martes	218	62,0	0	29,6	1,4	9,4	0	0
Ida Miércoles	218	61,5	0	29,6	1,4	9,9	0	0
Ida Jueves	218	62,0	0	30,5	0,9	8,9	0	0
Ida Viernes	218	61,5	0	29,1	1,9	9,9	0	0
Vuelta Lunes	218	63,4	0	22,5	0	16,0	0	0
Vuelta Martes	218	63,4	0	21,1	0	17,4	0	0
Vuelta Miércoles	218	63,4	0	21,6	0,9	16,0	0	0
Vuelta Jueves	218	63,8	0	20,7	0,5	17,4	0	0
Vuelta Viernes	218	62,0	0	23,0	1,4	15,5	0	0
Invierno (11-15 febrero)								
Ida Lunes	216	59,3	0	30,1	0,5	10,2	0	2
Ida Martes	216	59,3	0	30,1	0,5	10,2	0	0
Ida Miércoles	216	59,3	0	29,2	0	11,6	0	0
Ida Jueves	216	59,7	0	28,7	0,9	10,6	0	0
Ida Viernes	216	58,8	0	28,7	0,5	12,0	14	16
Vuelta Lunes	216	62,0	0	23,6	0	14,8	0	2
Vuelta Martes	216	62,0	0	24,1	0	14,4	0	0
Vuelta Miércoles	216	62,5	0	22,2	0	15,7	0	0
Vuelta Jueves	216	62,0	0	23,1	0	15,3	0	0
Vuelta Viernes	216	61,6	0	22,2	0	16,7	0	16
Primavera (13-17 mayo)								
Ida Lunes	185	55,7	0	33,0	0	11,4	0	0
Ida Martes	185	55,7	0	33,0	0	11,4	0	0
Ida Miércoles	185	56,2	0	31,9	0,5	11,4	0	0
Ida Jueves	185	55,9	0	30,6	2,7	10,2	0	0
Ida Viernes	185	55,7	0	32,3	0	11,9	14	16
Vuelta Lunes	185	62,2	0	22,2	0,5	15,7	0	0
Vuelta Martes	185	62,2	0	20,5	0,5	16,8	0	0
Vuelta Miércoles	185	61,6	0	21,6	0,5	16,2	0	0
Vuelta Jueves	185	62,2	0	22,0	0,5	15,1	0	0
Vuelta Viernes	185	61,6	0	21,0	0	17,3	0	16

I, ida; V, vuelta

(45,6% y 44,7% respectivamente andan), con el trayecto de ida del jueves que llovió (44,7% andan). En la semana de primavera, se comparan los trayectos de ida de miércoles y jueves donde no llovió (35,2% y 44,8%

respectivamente andan) con el trayecto de ida del viernes que llovió (44,8% andan), observándose un cambio significativo al comparar el trayecto del miércoles con el del viernes en primavera ($p=0,031$) (Fig. 1).

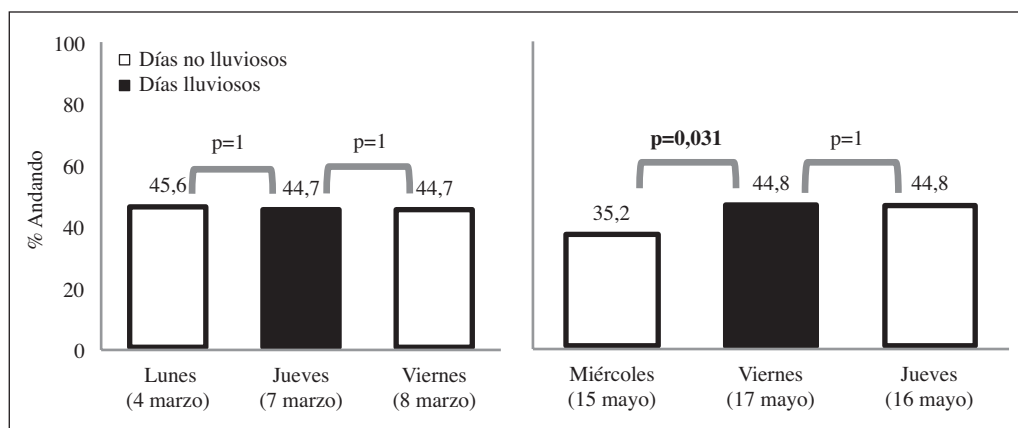


Fig. 1.—Comparación del porcentaje de los que andan al colegio entre un día lluvioso y dos días no lluviosos en invierno y primavera en Granada.

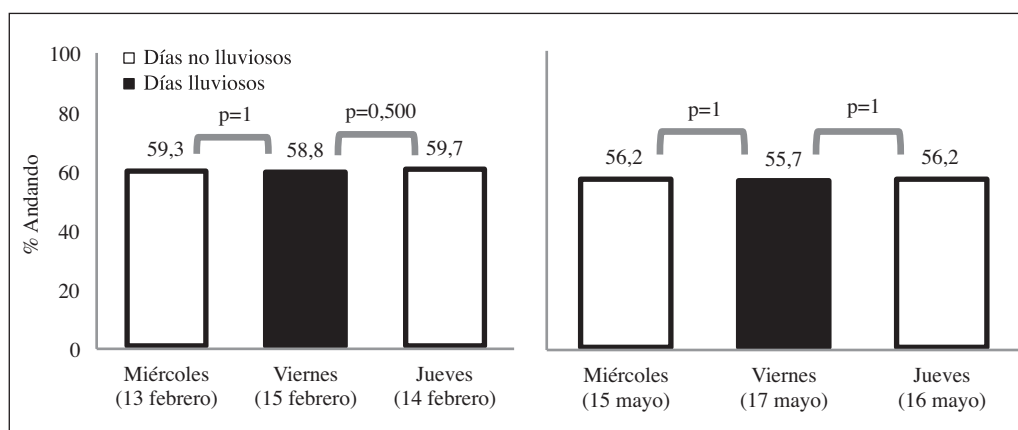


Fig. 2.—Comparación del porcentaje de los que andan al instituto entre un día lluvioso y dos días no lluviosos en invierno y primavera en Granada.

En adolescentes, en la semana de invierno, se compararon los trayectos de ida de miércoles y jueves en los que no llovió (59,3% y 59,7% respectivamente andan), con el trayecto de ida del viernes que llovió (58,8% andan), no observándose cambios significativos en el modo de desplazamiento ($p=1$ y $p=0,500$ respectivamente). En la semana de primavera, se compararon los trayectos de ida de miércoles y jueves en los que no llovió (56,2% y 56,2% respectivamente andan) con el trayecto de ida del viernes que llovió (55,7% andan), no observándose cambios significativos en el desplazamiento ($p=1$) (Fig. 2).

El efecto acumulado de varios días lluviosos (con una precipitación en la franja horaria de 7-15h superior a 10 L/m² cada día) se analizó en niños en la semana de invierno, comparando los días lluviosos de martes, miércoles y jueves (un promedio de 40,8% andan) con los días no lluviosos de lunes y viernes (un promedio de 41,7% andan), no observándose un cambio significativo ($p=1$) (Fig. 3).

Efecto de la estación

Los datos del efecto de la estación en el modo de desplazamiento, se muestra en la tabla III y tabla IV.

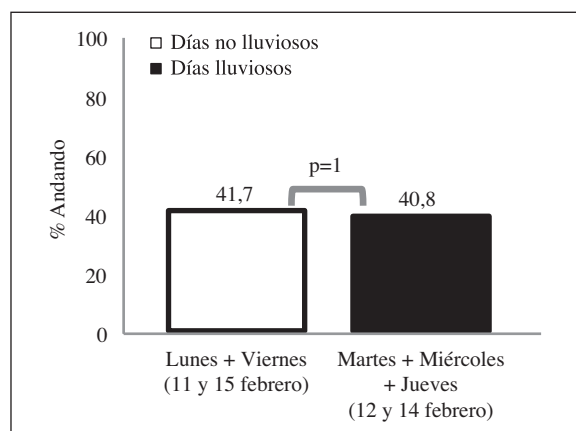


Fig. 3.—Comparación del porcentaje de los que andan al y desde el colegio entre días no lluviosos (Lunes + Viernes) y días lluviosos (Martes + Miércoles + Jueves) en invierno en Granada.

No existieron diferencias significativas al comparar el porcentaje de los que andan para cada trayecto (ida y vuelta) y día de la semana (lunes, martes, miércoles, jueves, viernes) de las 3 estaciones (otoño, primavera, verano). Se observaron dos diferencias cercanas a la significación ($p=0,07$) entre el trayecto de vuelta del vier-

nes de otoño (45,8% andan) con el de invierno (37,5% andan) en los niños (Tabla III), y entre el trayecto de ida del martes de otoño (59,7% andan) con el de primavera (56% andan) en los adolescentes (Tabla IV).

Discusión

Los resultados obtenidos en este estudio indican que la precipitación en forma de lluvia y el periodo estacional no parecen ser factores que influyan en la elección del modo de desplazamiento al centro educativo en estudiantes de Granada.

Pocos son los estudios que han evaluado la asociación entre la precipitación y el desplazamiento activo al colegio, y entre los existentes se evidencia controversia^{13,14,20}. Sirad y colaboradores coinciden con los resultados obtenidos en el presente estudio observando la falta de asociación del modo de desplazamiento y las condiciones meteorológicas en niños¹³ y Robertson-Wilson y colaboradores que también coinciden en la falta de asociación del modo de desplazamiento y de indicadores climatológicos como la lluvia o la temperatura en adolescentes²⁰. En cambio, en otra investigación realizada en Nueva Zelanda por Duncan y colaboradores¹⁴, se observó un ligero efecto en el número de

Tabla III
Comparación del desplazamiento activo al colegio entre estaciones

Granada/Colegio	N	Andan (% sujetos)			P (entre estaciones)		
		Otoño	Invierno	Primavera	Ot*Inv	Inv*Pr	Ot*Pr
Ida Lunes	72	41,7	43,1	41,7	1	1	1
Ida Martes	72	44,4	44,4	38,9	1	0,219	0,219
Ida Miércoles	72	41,7	47,2	41,7	0,289	0,125	1
Ida Jueves	72	41,7	44,4	38,9	0,727	0,289	0,500
Ida Viernes	72	44,4	43,1	40,3	1	0,625	0,375
Vuelta Lunes	72	44,4	47,2	45,8	0,687	1	1
Vuelta Martes	72	40,3	45,8	45,8	0,219	1	0,344
Vuelta Miércoles	72	47,2	47,2	47,2	1	1	1
Vuelta Jueves	72	43,1	43,1	45,8	1	0,754	0,727
Vuelta Viernes	72	45,8	37,5	41,7	0,07	0,508	0,508

Ot, otoño; Inv, invierno; Pr, primavera.

Tabla IV
Comparación del desplazamiento activo al instituto entre estaciones

Granada/Instituto	N	Andan (% sujetos)			P (entre estaciones)		
		Otoño	Invierno	Primavera	Ot*Inv	Inv*Pr	Ot*Pr
Ida Lunes	159	58,5	58,5	56,0	1	0,344	0,289
Ida Martes	159	59,7	58,5	56,0	0,774	0,344	0,07
Ida Miércoles	159	59,7	58,5	56,6	0,774	0,508	0,227
Ida Jueves	159	58,8	58,1	56,2	1	0,549	0,388
Ida Viernes	159	59,7	57,9	56,0	0,581	0,549	0,109
Vuelta Lunes	159	61,0	59,7	61,6	0,625	0,375	1
Vuelta Martes	159	61,0	59,7	61,6	0,625	0,453	1
Vuelta Miércoles	159	61,0	59,7	61,0	0,625	0,727	1
Vuelta Jueves	159	61,2	59,7	61,6	0,375	0,453	1
Vuelta Viernes	159	59,7	59,1	61,0	1	0,508	0,687

Ot, otoño; Inv, invierno; Pr, primavera.

pasos, disminuyendo en los días laborables en un 11% y un 8% por día para los niños y niñas respectivamente, cuando había una precipitación moderada.

En relación al efecto de la estacionalidad sobre el modo de desplazamiento, al igual que ocurre en nuestros resultados, no se encontraron cambios significativos entre los estudios revisados. Tucker y colaboradores en un estudio y Kolle y colaboradores en otro estudio, observaron que el clima estacional no produjo ningún efecto reseñable sobre el modo de desplazamiento a la escuela^{8,21}, mientras que Fyhri y colaboradores sí encontró modificaciones pequeñas en el modo de desplazamiento en función de la estación²². Los resultados encontrados en el presente estudio se encuentran en la línea de mostrar que la actividad física general y el desplazamiento realizado en jóvenes europeos se mantienen independientemente de la estación⁵.

La falta de asociación que aparentemente ocurre entre la elección del modo desplazamiento y las condiciones meteorológicas (precipitaciones y estacionalidad), posiblemente sea por la necesidad de desplazarse de la manera más fácil y más conveniente a la escuela. Puede ser que la elección de los modos de desplazamiento para ir o volver del centro educativo sea un comportamiento rutinario en la población de estudio respondiendo a un patrón familiar en el que se involucran todos los miembros y, por tanto, esté menos influenciada por factores externos como el clima estacional y condiciones meteorológicas como la lluvia. Esas condiciones meteorológicas podrían tener influencia en el modo de desplazamiento si se vuelven extremas y peligrosas y hacen extremadamente difícil el desplazamiento¹⁸. Sin embargo, en Granada y en general, en el sur de España, las condiciones climatológicas se caracterizan por tener temperaturas medias más cálidas y por la escasez de días lluviosos.

Entre las fortalezas que se observan en este estudio, destacar que se trata de un tema poco investigado, ya que se han encontrado pocos estudios que tuvieran en cuenta la influencia de la lluvia y el clima estacional en la manera de desplazarse. En segundo lugar es un estudio cuya población ocupa tanto a niños como adolescentes y en tercer lugar, se tienen en cuenta las tres estaciones que abarcan todo el curso escolar, permitiendo analizar en mejor medida las variaciones que se pueda dar a lo largo del mismo.

Se necesitan más investigaciones para confirmar la ausencia de asociaciones entre condiciones meteorológicas como la lluvia y la estacionalidad, dadas algunas limitaciones en este estudio. En primer lugar, la escasa variabilidad en la precipitación de lluvia dificulta establecer diferencias claras entre días lluviosos y no lluviosos. Se necesitaría replicar estos análisis en otras ubicaciones geográficas con mayores variaciones de lluvia y de características estacionales. En tercer lugar, sería necesario que el número de participantes fuera más elevado, ya que el bajo número de participantes de este estudio impidió utilizar análisis de mayor potencia estadística.

Conclusiones

La precipitación en forma de lluvia y el periodo estacional no parecen influir en el modo de desplazamiento al centro educativo en niños y adolescentes de Granada capital. El patrón del desplazamiento al centro educativo muestra ser constante a lo largo del curso académico y son otros factores no estudiados en el presente estudio los que parecen determinar la elección de un modo de desplazamiento u otro.

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Original/Deporte y ejercicio

Hydration status after exercise affect resting metabolic rate and heart rate variability

Mauricio Castro-Sepúlveda¹, Hugo Cerda-Kohler², Cristian Pérez-Luco³, Matías Monsalves⁴, David Cristobal Andrade⁵, Hermann Zbinden-Foncea¹, Eduardo Báez-San Martín⁶ and Rodrigo Ramírez-Campillo⁷

¹Exercise Science Laboratory, Faculty of Medicine, Universidad Finis Terrae, Santiago, Chile. ²School of Medicine, Universidad Mayor, Santiago, Chile. ³Universidad Santo Tomas, San Joaquin, Chile. ⁴Institute of Nutrition and Food Technology, University of Chile, Santiago, Chile. ⁵Laboratory of Exercise Sciences, MEDS Sport Medicine Center, Santiago, Chile. ⁶Department of Sport and Recreation, University of Playa Ancha, Valparaíso, Chile. ⁷Department of Physical Activity Sciences, Universidad de Los Lagos, Osorno, Chile. Department of Physical Education, Sport and Recreation, Universidad de La Frontera, Temuco, Chile.

Abstract

Introduction: Heart rate variability and resting metabolic rate are commonly to assess athlete's physiological status and energy requirements. Exercise-induced dehydration can reach up to 5% of body mass per hour. Consequently, dehydration may have a profound physiological effect on human's homeostasis.

Objectives: To compare the effects of dehydration and rehydration after exercise on heart rate variability and resting metabolic rate in college athletes.

Methods: 14 college athletes were divided into a dehydration group (n=7) and a rehydration group (n=7), both submitted to basal (T1) heart rate variability and resting metabolic rate measurements. After basal measurements both groups were actively dehydrated ($-3.4 \pm 0.4\%$ of body mass for both groups). Afterwards, dehydration group rested, while rehydration group receive a fluid intake (during a 3 h period) equivalent to 150% of body mass loss achieved during active dehydration. Four hours after active dehydration heart rate variability and resting metabolic rate were re-assessed (T2).

Results: At T2 both rehydration group (+13%) and dehydration group (+30%) achieve a significant ($p<0.05$) increase in resting metabolic rate, however, only dehydration group showed a significant reduction in heart rate variability. More so, the change in resting metabolic rate was significantly higher in dehydration group compared to rehydration group.

Discussion: Hydric homeostasis after exercise affects resting metabolic rate and heart rate variability, highlighting the necessity to control hydration state before resting metabolic rate and heart rate variability assessment.

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Key words: Dehydration. Rehydration. Heart rate variability. Resting metabolic rate. Physiological test. Exercise.

Correspondence: Mauricio Castro-Sepúlveda.
Laboratorio de ciencias del ejercicio. Facultad de medicina.
Universidad Finis Terrae, Santiago, Chile.
Avenida Pedro De Valdivia #1509, Santiago, Chile.
E-mail: m.castro.med@gmail.com

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EL ESTADO DE HIDRATACIÓN DESPUÉS DEL EJERCICIO AFECTA LA TASA METABÓLICA BASAL Y LA VARIABILIDAD DE LA FRECUENCIA CARDÍACA

Resumen

Introducción: La variabilidad del ritmo cardíaco y la tasa metabólica basal se utilizan en evaluaciones de deportistas. La deshidratación por ejercicio puede conducir a pérdidas de hasta 5% de la masa corporal. En consecuencia, la deshidratación produce un profundo efecto sobre la homeostasis humana.

Objetivos: Comparar los efectos de la deshidratación y la rehidratación después del ejercicio en la variabilidad del ritmo cardíaco y la tasa metabólica basal.

Métodos: 14 atletas universitarios fueron divididos en un grupo de deshidratación (n=7) y un grupo de rehidratación (n=7), ambos fueron sometidos mediciones basales (Tiempo 1) de variabilidad del ritmo cardíaco y tasa metabólica basal. Después de las mediciones basales, ambos grupos se deshidrataron activamente ($-3,4 \pm 0,4\%$ masa corporal). Posteriormente, el grupo de deshidratación descansado, mientras que el grupo de rehidratación recibió agua equivalente al 150% de la masa perdida. Cuatro horas después de la deshidratación se re-evaluó la variabilidad del ritmo cardíaco y tasa metabólica (Tiempo 2).

Resultados: El grupo de rehidratación (+13%) y el de deshidratación (+30%) lograron un aumento significativo en la tasa metabólica basal ($p<0.05$), sin embargo, solo el grupo de deshidratación muestran cambios significativos en la variabilidad del ritmo cardíaco (es decir, disminuye). El cambio en la tasa metabólica basal fue significativamente mayor en el grupo de deshidratación comparado con el grupo de rehidratación.

Discusión: la homeostasis hídrica después del ejercicio afecta la tasa metabólica basal y la variabilidad del ritmo cardíaco, destacando la necesidad de controlar el estado de hidratación antes de las evaluaciones de la tasa metabólica basal y variabilidad del ritmo cardíaco.

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Palabras clave: Deshidratación. Rehidratación. Variabilidad de la frecuencia cardíaca. Tasa metabólica basal. Pruebas fisiológicas. Ejercicios.

Abbreviations

HRV: Heart rate variability.

RMR: Resting Metabolic Rate.

USG: Urine specific gravity.

DG: dehydration group.

RG: rehydration group.

RR: Average absolute time between each R-wave during 10-min supine test period.

pNN50: Percentage of successive RR that varied by 50 ms or more during 10-min supine test period.

pNN20: Percentage of successive RR that varied by 20 ms or more during 10-min supine test period.

LF/HF: Ratio low frequency (LF) [ms²]/high frequency [ms²].

rMSSD: Square root of the mean squared successive differences between adjacent RR intervals (ms) over the entire recording.

T1: baseline measurements.

T2: after rehydration measurements.

Introduction

Heart rate variability (HRV) is commonly used as a non-invasive easy to apply assessment tool during athlete's physiological status determination^{1,2}. HRV indicate variations in beat-to-beat intervals and autonomic nervous system activity and can be analyzed by both linear methods within the domains of time and frequency analyses, as well as nonlinear methods³. HRV has been studied extensively regarding athletes's workloads determination, sympatho-vagal balance and vagal tone in relation with sports performance and overtraining syndrome prediction^{4,5}. Another non-invasive easy to apply assessment tool for athlete's physiological status determination is resting metabolic rate (RMR)^{6,7}. RMR is required to calculate athletes' energy requirements so as to maintain their appropriate body mass and composition to achieve peak performance⁸. The ability to accurately determine the energy requirements of athletes is integral to developing nutritional plans and providing recommendations to enhance sports performance. Under- or overestimation of athletes' energy requirements can result in loss of body mass, increased fat mass, diminished sports performance, increased risk of sports injuries and potentially growth failures in young athletes⁹.

Control of contaminants variables is a key feature during athlete's physiological assessment. In this regard, HRV and RMR must be assessed under controlled conditions. However, hydration status among athletes can vary profoundly with exercise. Exercise-induced dehydration can lead to loss of up to 5% of body mass per hour¹⁰. Moreover, athletes may have inadequate hydration and re-hydration strategies^{11, 12}. Consequently, dehydration may have a profound physiological effect on human's homeostasis¹³, negatively affecting proteinuria, leukocyturia and erythrocyturia¹⁴, baroreflex control, blood pressure¹⁵ and Angiotensin II levels¹⁶. Therefore,

it is possible that hydration status affect HRV and RMR. However the effect of active dehydration on HRV and RMR are poorly investigated. Thus, the purpose of this study is to investigate the effects of exercise-induced dehydration on HRV and RMR.

Methods

Participants

Initially 30 male college athletes were recruited to participate in this study, but because exclusion criteria (see below) only 14 were deemed suitable. Athletes fulfilled the following inclusion criteria: absence of renal or arterial diseases; no ingestion of coffee, alcohol, diuretics or any beta- or alpha blocker and no participation in vigorous physical activity of any type at least 3 days before measurements; and to have a basal urine specific gravity (U_{SG}) between 1000 a 1009 gm/ml⁻¹¹⁷. All participants were carefully informed about the experimental procedures and about the possible risks and benefits associated with participation in the study and signed an informed consent document before any of the tests were performed. The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee of the responsible department.

Experimental protocol

All participants were asked to consume 1.5 liters of water per day during 48 h prior to measurements. Participants were cited to the laboratory at 10:00 am and randomly divided in two groups, a dehydration group (DG, n = 7) and a rehydration group (RG, n = 7) (descriptive characteristics in table I). The sample size was computed according to the changes observed in several HRV measures in a group of physically active males submitted to a dehydration-rehydration protocol similar as that used in the present study¹⁸. A statistical power analysis revealed that a total of 5 participants per group would yield a power of 80% and $\alpha = 0.05$. Both groups were submitted to the following baseline measurements (T1):

Table I
Subjects' basal characteristics

	<i>Rehydration group (n = 7)</i>	<i>Dehydration group (n = 7)</i>
Age, y	21.6 ± 1.2	20.7 ± 2.0
Height, cm	172 ± 1.5	175 ± 1.6
Body mass index, kg/m ²	24.7 ± 0.6	24.6 ± 1.2

Values are mean ± standard deviation.

Body mass and height

A high precision (i.e. 0.1 kg) mechanical scale with an incorporated stadiometer (SECA model M20812, Germany) was used for anthropometric measurements.

Urine specific gravity (U_{SG}).

A portable refractometer (Robinar model Spx, USA) previously validated¹⁹ was used to assess U_{SG} and was classified according to previously described values¹⁷.

Heart rate variability (HRV)

A Polar S810 monitoring system (Polar Electro, Finland) previously validated²⁰ was used for HRV assessment, including: a) average absolute time between each R-wave during 10-min supine test period (RR), b) percentage of successive RR that varied by 50 ms or more during 10-min supine test period (pNN50), c) percentage of successive RR that varied by 20 ms or more during 10-min supine test period (pNN20), d) ratio low frequency (LF) [ms²]/high frequency [ms²] (LF/HF) and e) square root of the mean squared successive differences between adjacent RR intervals (ms) over the entire recording (rMSSD). HRV was measured at all times in a quiet room during a 10 min period. Data was analyzed in Kubios Software HRV 2.0 (Biosignal Analysis and Medical Imaging Group, Kuopio, Finland).

Resting metabolic rate (RMR)

RMR was assessed after lying in a resting position during 16 min in a thermo-neutral environment²¹ using indirect calorimetry with a validated²² and calibrated standard metabolic cart (Cosmed FitMate Pro, Rome, Italy).

After T1 both groups were submitted to an active dehydration protocol (carried out at 32°C room temperature), consisting in 1 min of exercise and 1 min of rest, interspersing 5 different exercises (i.e. squats, push-ups, box jumps, 20-m sprints and slalom 20-m runs) for a total period of 45 min. According to a pilot study, the active dehydration protocol was aimed at inducing a dehydration equivalent to 3.5% of body mass, which was checked by body mass measurements every 15 min. After active dehydration protocol, DG rested quietly during 4 h, while during the same time period participants from the RG receive a fluid intake (in a period of 3 h) equivalent to 150% of their body mass loss, as suggested previously²³. Afterwards both groups were re-assessed (T2) for body mass, U_{SG} , HRV and RMR, as described above. Both T1 and T2 measurements were overseen by the same investigator, who was blinded to the hydration condition of participants.

Statistical analysis

All values are reported as mean $\pm$ standard deviation (SD). Normality and homoscedasticity assumptions for all data before and after intervention were checked, respectively with the Shapiro–Wilk and Levene's tests. As data was non-parametrical, the effect of dehydration was analyzed using Mann Whitney U Test and Wilcoxon paired t-test. Alpha level was set at $p < 0.05$. All statistical calculations were performed using the GraphPad Prism statistical package version 6.00 (GraphPad Software, La Jolla California, USA).

Results

At T1 no basal differences were observed between groups for any of the dependent variables (table II).

Table II
Effect of dehydration and rehydration on body weight, resting metabolic rate and heart rate variability

	Rehydration group (n = 7)		Dehydration group (n = 7)	
	Baseline	T2	Baseline	T2
Body mass, kg	72.7 $\pm$ 2.5	72.7 $\pm$ 2.8	75.1 $\pm$ 3.3	72.0 $\pm$ 1.1*
Urine specific gravity, gm/ml ⁻¹	1.005 $\pm$ 0.0008	1.007 $\pm$ 0.0018	1.005 $\pm$ 0.0009	1.023 $\pm$ 0.0017**†
Resting metabolic rate, kcal/d ⁻¹	2211 $\pm$ 64.0	2493 $\pm$ 75.0*	2086 $\pm$ 125	2607 $\pm$ 146**†
RR, ms	910 $\pm$ 126	865 $\pm$ 144	1009 $\pm$ 115	800 $\pm$ 136*†
pNN50, %	26.0 $\pm$ 15.5	16.5 $\pm$ 11.6	42.5 $\pm$ 11.1	23.8 $\pm$ 16.2*†
pNN20, %	61.8 $\pm$ 11.1	48.8 $\pm$ 19.7	73.9 $\pm$ 7.2	54.2 $\pm$ 21.6*†
rMSSD, ms	47.6 $\pm$ 14.9	38.6 $\pm$ 14.0	65.0 $\pm$ 9.7	42.4 $\pm$ 15.7*†
LF/HF ratio, ms ²	3.0 $\pm$ 1.7	2.3 $\pm$ 2.1	1.4 $\pm$ 1.5	2.4 $\pm$ 2.4*†

Values are mean $\pm$ standard deviation. *, ** denotes significant difference with the corresponding baseline value ($p < 0.05$ and $p < 0.01$, respectively). † denote that baseline to T2 change is significantly higher compared with that of the rehydration group ($p < 0.05$). RR: average absolute time between each R-wave during 10-min supine test period; pNN50 y pNN20: percentage of successive RR that varied by 50 ms or more and by 20 ms or more, during 10-min supine test period; LF/HF ratio: low frequency (LF) / high frequency (HF) ratio; rMSSD: square root of the mean squared successive differences between adjacent RR intervals (ms) over an entire recording; T2: after active dehydration.

At T2 the only significant ($p < 0.05$) change observed in RG was an increase in RMR (+13%). On the other side, DG showed a significant ($p < 0.05$) change in body mass (-4.1%), U_{SG} (+1.8%), RMR (+30%), RR (-21%), pNN50 (-44%), pNN20 (-27%), rMSSD (-35%) and LF/HF ratio (+41%). More so, the baseline to T2 change in body mass, U_{SG} , RR, pNN50, pNN20, rMSSD, LF/HF ratio (table II) and RMR (Fig. 1) in DG is significantly higher compared with that of the RG.

Discussion

One of the main outcomes of this study is that hydration status affects HRV, specifically our data shows that dehydration (i.e. DG) reduce HRV (i.e. reduced parasympathetic activity, increased sympathetic activity or both). Our results are similar to those previously reported in participants submitted to exercise under heat stress¹⁸, where dehydration, although induced a lower LF/HF ratio, caused an overall reduced vagal tone. Also in line with our results, it had been shown that HRV assessed through RR and pNN50 were positively correlated with hydration status assessed by total body water analysis and negatively correlated with U_{SG} ²⁴, independent from fitness level or sex. In the same line, in other species (e.g. rats) dehydration also induced a reduction in parasympathetic activity²⁵, suggesting that the effect of hydration status on HRV may be species-independent. It is possible that the effect of dehydration on HRV had been potentiated by hyperthermia, as the combination of these two physiological conditions may induce both an increased sympathetic and a decreased parasympathetic activity²⁵. In fact, dehydration increases heat storage rate and reduces the ability to dissipate body heat, which can be related to both

hyperosmolality and hypovolemia, resulting in an increased cardiovascular strain²⁶. Although all participants in our study were apparently healthy and free of renal or arterial diseases, in other populations it has been stated that a reduced parasympathetic activity may be linked to an increased risk of arrhythmias and development of coronary heart disease^{27, 28}, reinforcing the importance of adequate hydration strategies.

Our results indicate that both RG and DG increase RMR after active dehydration. Previously it has been observed an increased RMR after exercise during 24 h or more^{29, 30}, which can be related to several factors, like intensity, duration and mode of exercise³¹, training state³² and maybe the gender of the participant³³. From a physiological point of view the increased RMR after exercise can be related to replenishment of oxygen depot (i.e. hemoglobin, myoglobin) and high-energy phosphates (i.e. ATP, PC) resynthesis, lactate removal-oxidation, increased Cori cycle activity, increased ventilation, higher heart rate, increased blood circulation, thermogenic effect of increased core temperature and catecholamines, increased triacylglycerol/free fatty acid re-esterification, changes from carbohydrate to lipids preference for energy metabolism³¹ and exercise-induced muscle damage^{34, 35}. Although it is not surprising to observe an increased RMR after 4 h of exercise in RG and DG, we found a significantly higher RMR change in DG compared to RG (Figure 1). Therefore, another main and novel outcome of this study was that hydration status affects RMR, specifically our data shows that dehydration (i.e. DG) increase RMR. Previously, dehydration during submaximal^{36, 37}, high-intensity³⁸ even maximal⁴¹ exercises did not affect oxygen consumption. More so, previous reports show that passively-induced dehydration did not affect post intervention oxygen consumption⁴⁰. The difference between our results and previous studies may be related with the degree of dehydration achieved (i.e. 3.5% in our study vs. 2% in Coles et al., 2006).

In conclusion, hidric homeostasis affects RMR and HRV, highlighting the necessity to control hydration state before RMR and HRV assessment.

The authors have no conflict of interest

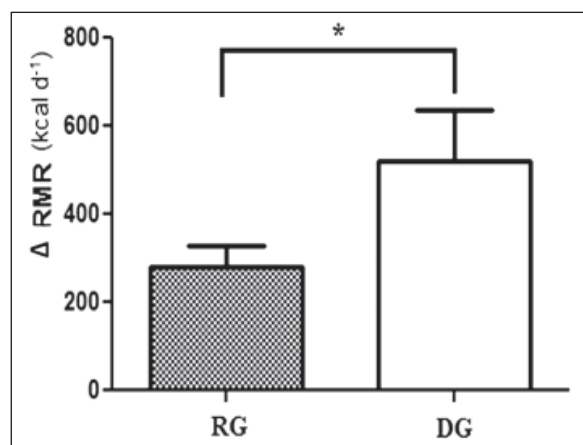


Fig. 1.—Change in resting metabolic rate (RMR) four hours after a 45 min active dehydration protocol in a group submitted to rehydration (RG) or abstained from fluid consumption (DG). * denote significant difference between RG and DG ($p < 0.05$).

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Original/Intensivos

Ángulo de fase como indicador del estado nutricional y pronóstico en pacientes críticos

Renata Reis de Lima e Silva¹, Cláudia Porto Sabino Pinho¹, Isa Galvão Rodrigues¹ y José Gildo de Moura Monteiro Júnior¹

¹Pronto Socorro Cardiológico Universitário de Pernambuco. Brasil.

Resumen

Introducción: El ángulo de fase (AF) viene siendo considerado una herramienta sensible para evaluar el estado nutricional y la efectividad de las intervenciones dietéticas.

Objetivo: Evaluar el AF como indicador del estado nutricional y pronóstico en pacientes críticos.

Métodos: Estudio prospectivo observacional con pacientes admitidos en Unidades de Cuidado Intensivo Coronarias, entre Mayo y Octubre de 2013. El AF se determinó por medio del análisis por Bioimpedancia Eléctrica, considerándose bajo AF valores inferiores a 5° para los hombres y 4,6° para las mujeres. Los valores obtenidos se relacionaron con otros parámetros de evaluación del estado nutricional: antropométricos (circunferencia del brazo – CB, pliegue cutáneo tricipital – PCT, área muscular del brazo corregida – AMBc circunferencia de pantorrilla – CP) y bioquímico (recuento total de linfocitos, hemoglobina, hematocrito), además de los pronósticos clínicos APACHE II (Acute Physiology and Chronic Health Disease Classification System II) y albúmina sérica. La tabulación y análisis de los datos se realizaron a través del paquete estadístico SPSS versión 13.0.

Resultados: La muestra se compuso por 110 pacientes, en la cual se verificó asociación entre bajo AF e insuficiencia renal en diálisis ($p < 0,001$), % de adecuación de CB ($p = 0,028$), % de adecuación de PCT ($p = 0,043$), hipoproteinemia ($p = 0,042$), anemia ($p = 0,040$) y puntuación APACHE II ($p = 0,012$). El AF se correlacionó positivamente con la CP e inversamente con el tiempo de internación ($p = 0,006$).

Conclusiones: El AF en UCI parece ser útil para identificar a pacientes desnutridos precozmente y como indicador pronóstico.

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Palabras clave: Estado nutricional. Unidad de Cuidados Intensivos. Cuidados críticos. Impedancia eléctrica.

Correspondencia: Renata Reis de Lima e Silva.
Rua da Hora, 307, Edf. Francisco Melo, Ap.403, Espinheiro.
Recife-Pernambuco. Brasil.
E-mail: renatareis.nutri@hotmail.com

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PHASE ANGLE AS AN INDICATOR OF NUTRITIONAL STATUS AND PROGNOSIS IN CRITICALLY ILL PATIENTS

Abstract

Introduction: The phase angle (PA) has been considered a sensitive tool to assess nutritional status and effectiveness of interventions dietetics.

Objective: To evaluate the PA as an indicator of nutritional status and prognosis in critically ill patients.

Methods: Prospective observational study of patients admitted to the Coronary Intensive Care Unit between May and October 2013. The PA was determined by bioelectrical impedance analysis, PA was considered low below 5° values for men and 4.6° for women. The values obtained were related to other evaluation parameters of nutritional status: anthropometric (arm circumference - AC, triceps skinfold thickness - TST, corrected arm muscle area - AMAc and calf circumference - CC) and biochemical (total lymphocyte count, hemoglobin, hematocrit), in addition to clinical prognostic APACHE II (Acute Physiology and Chronic Health Disease Classification System II) and serum albumin. The tabulation and analysis were performed using SPSS version 13.0.

Results: The sample consisted of 110 patients, in which an association was found between low AF and renal failure on dialysis ($p < 0.001$), % adequacy AC ($p = 0.028$), % adequacy of TST ($p = 0.043$), albumin level ($p = 0.042$), anemia ($p = 0.040$) and APACHE II ($p = 0.012$) scores. The AF was positively correlated with CC ($p = 0.043$) and inversely with the length of hospitalization ($p = 0.006$).

Conclusions: PA in the ICU may be useful to identify early and malnourished patients as a prognostic indicator.

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Keywords: Nutritional assessment. Intensive Care Units. Critical care. Electrical impedance.

Abreviaturas

AF: Ángulo de fase.
AMBC: Área muscular del brazo corregida.
APACHE II: Fisiología aguda y crónica Evaluación de la Salud.
BIA: La bioimpedancia eléctrica.
CB: Circunferencia del brazo.
CP: Circunferencia de la pantorrilla.
RTL: Recuento total de linfocitos.
DM: Diabetes Mellitus.
HAS: Hipertensión Arterial Sistémica.
NHANES III: *The Third National Health and Nutrition Examination Survey*.
PCT: Pliegue cutáneo del tríceps.
POI: Postoperatoria inmediata.
R: Resistencia.
UCI: Unidad de Cuidados Intensivos.
VM: Ventilación Mecánica.
Xc: Reactancia.

Introducción

En los últimos años, un gran número de métodos para evaluar el estado nutricional viene siendo desarrollado, sin embargo, consensualmente no hay un método patrón oro¹. La determinación del mejor método para clasificar el estado nutricional de pacientes internados, sobre todo entre los pacientes de Unidades de Cuidado Intensivo (UCI), sigue siendo un importante desafío en la práctica clínica nutricional².

Se tiene demostrado que la desnutrición se puede detectar más precozmente por alteraciones funcionales, cambios en la integridad de la membrana celular y del balance hídrico, que preceden las alteraciones antropométricas y bioquímicas y que se pueden mediar a través de análisis de la bioimpedancia eléctrica (BIA)³.

La evaluación de la BIA es una técnica sencilla, rápida, no invasiva y reproducible, pudiendo ser llevada al borde del lecho, para medir la composición corporal total⁴⁻⁶ a través de sus parámetros básicos, resistencia (R) y reactancia (Xc), que vienen siendo útiles en la evaluación de pacientes críticos⁷.

El ángulo de fase (AF) es una medida obtenida desde la relación entre las medidas directas de R y Xc: $\text{Ángulo de fase} = \arctan(\text{reactancia} / \text{resistencia}) \times 180^\circ / \pi$ ¹, siendo independiente de las ecuaciones de regresión o del peso, pudiendo ser medido incluso en situaciones en que las hipótesis de BIA no son válidas (obesidad y trastornos de hidratación, como ascitis y edema), eliminando una gran fuente de error causal^{1,2}. Estudios tienen sugerido que este parámetro puede ser una herramienta sensible para evaluar el estado nutricional y la efectividad de las intervenciones dietoterápicas^{1,2} por el hecho de poder prever la masa corporal de células¹.

Bajos valores del AF vienen siendo significativamente asociados a riesgo nutricional⁸, pudiendo indi-

car peor pronóstico en diversas situaciones clínicas, en que la integridad de la membrana celular es comprometida y alteraciones en el equilibrio de fluidos son notadas^{1,9,10}, a ejemplo de los pacientes críticos⁹.

En la práctica clínica, diagnosticar a los pacientes con desnutrición adecuada y precozmente puede facilitar la intervención nutricional e influenciar positivamente su evolución clínica¹. Objetivando la obtención de un diagnóstico nutricional precoz y ante escasa literatura sobre la aplicación del AF en el enfermo crítico, este estudio objetivó evaluar su efectividad como instrumento de evaluación nutricional, como también indicador pronóstico en esos pacientes.

Métodos

Estudio prospectivo observacional, realizado en las UCI coronarias de un hospital universitario cardiológico localizado en el Nordeste brasileño, durante el período de mayo a octubre de 2013, con individuos adultos y ancianos, de ambos sexos. Se excluyeron los individuos con edad <18 años, los que se encontraban en posoperatorio inmediato (POI), aquellos entre los cuales no fue posible realización de la medición por BIA: amputados, portadores de marcapaso y prótesis valvular, imposibilidad de manipulación (contención mecánica y/o estado general gravísimo), en la presencia de edemas y con período de internación en la UCI inferior a 24h.

La muestra se estimó teniendo en cuenta una prevalencia de bajo AF del 47,1% obtenida en estudio piloto comprendiendo 34 pacientes, un error patrón del 5% y un nivel de confianza del 95%, totalizando 112 individuos que serían estudiados.

El AF, variable dependiente de este estudio, se determinó a través del análisis por BIA, realizada para obtención de las medidas de R y Xc, en el plazo de hasta 48 horas tras admisión en la UCI, por medio de la siguiente fórmula: $\text{Arco tangente } Xc (\Omega) / R (\Omega)$. Para transformar el valor en grados, el resultado obtenido se multiplicó en radianes por $180/\pi$ ¹. Se consideraron bajos valores de AF cuando <5.0° para hombres y <4.6° para mujeres¹¹.

Para el análisis por BIA se utilizó el equipo portátil de marca *Biodynamics* modelo 310, que aplica una corriente de 800 μA , con frecuencia simple de 50 kHz. Las medidas directas de R y Xc se registraron en el instrumento de análisis por BIA, en Omhs¹².

Los pacientes se posicionaron en decúbito dorsal sobre superficie metálica, con el lecho y su cabecera paralelos al suelo, los brazos alejados del tronco en un ángulo de aproximadamente 30° y las piernas alejadas entre sí en un ángulo de aproximadamente 45°, procediéndose con la colocación de dos electrodos distales sobre la superficie dorsal de la mano y del pie, y dos electrodos sobre la prominencia del pulso y entre el maléolo medial y lateral del tobillo^{12,13}.

En cuanto a la evaluación antropométrica, se consideraron los siguientes parámetros: circunferencia

braquial (CB), circunferencia de la pantorrilla (CP) (para ancianos), pliegue cutáneo tricipital (PCT) y área muscular del bazo corregida (AMB_c). Para obtención de las circunferencias y pliegue, se utilizó cinta métrica flexible inelástica y picómetro científico de marca *Cesrcof*, respectivamente.

El *Acute Physiology and Chronic Health Evaluation II* (APACHE II) fue el índice pronóstico utilizado para estimar riesgos de mortalidad. En este estudio, se consideraron pacientes graves a aquellos con puntuación superior a 20¹⁴.

Datos sociodemográficos (edad y género), clínicos (diagnóstico definitivo o provisorio, comorbideces, puntuación APACHE II, evolución clínica – mortalidad, uso y tiempo de ventilación mecánica y tiempo de internación en la UCI) y bioquímicos (albúmina sérica, leucocitos, linfocitos y hemoglobina) se obtuvieron del prontuario. Con relación a los datos bioquímicos, se consideraron los valores del primer examen tras admisión en la UCI.

Se evaluó el Recuento Total de Linfocitos (RTL), teniéndose en cuenta como parámetro nutricional los puntos de corte descritos por Blackburn y Thornton (1979)¹⁵: 1200-2000 mm³ (depleción leve), 800 – 1200 mm³ (desnutrición moderada), < 800 mm³ (desnutrición grave).

La hipoalbuminemia se consideró cuando albúmina sérica <3,5g/dL⁸ y anemia cuando hemoglobina sérica < 13g/dL para los hombres y para las mujeres.

El análisis de dos datos se realizó por el paquete estadístico SPSS versión 13.0 (SPSS Inc., Chicago, IL, USA). Inicialmente, las variables continuas se testaron según la normalidad de distribución por el test de Kolmogorov-Smirnov. Cuando presentaron distribución normal, se describieron bajo la forma de promedio y desviación estándar y los respectivos tests paramétricos se aplicaron. Cuando presentaron distribución no normal, se describieron bajo la forma de promedio e intervalo intercuatílico y los tests no paramétricos aplicados. La correlación lineal de Pearson y Spearman se empleó para testar la correlación entre las variables continuas con distribución normal y no normal, respectivamente. La asociación entre las variables categóricas se evaluó por el test Chi-cuadrado de Pearson. Se adoptó un nivel de significancia de 0,05 para todos los análisis estadísticos.

El estudio fue aprobado por el Comité de Ética en Investigación involucrando a seres humanos del Complejo Hospitalario de la Universidad de Pernambuco, bajo el número 274.057/2013. Todos los pacientes/responsables que se pusieron de acuerdo con participar de la investigación firmaron el Formulario de Consentimiento Informado.

Resultados

Se admitieron 160 pacientes durante el período del estudio. De estos, se excluyeron 48 pacientes potado-

res de marcapaso (el 41,7%), imposibilitados de ser manoseados (contenidos mecánicamente y/o en estado general gravísimo) (el 20,3%), con tiempo de internación en UCI inferior a 24h (el 12,5%), amputados (el 10,4%), en el POI (el 8,3%), edad < 18 años (el 4,2%) y los portadores de prótesis valvular mecánica (el 2,0%). En el momento de la admisión, se observó presencia de edema. Fueron elegibles 112 individuos, sin embargo, 2 no se incluyeron, pues no tuvieron autorización de los familiares para participar del estudio, siendo 110 pacientes efectivamente evaluados.

El promedio de edad de los individuos estudiados fue 63 años (53-70), siendo el 50,9% del sexo masculino y el 64,5% ancianos. El principal diagnóstico clínico en el momento de la admisión en la UCI fue el Infarto Agudo de Miocardio (el 35,5%). De entre las comorbideces, la prevalencia de Hipertensión Arterial Sistémica (HAS) y Diabetes Mellitus (DM) fue el 60,0% y el 28,0%, respectivamente.

Se observó que el 70,0% de los pacientes hicieron uso de VM y que el 37,3% de los individuos evolucionaron para el óbito (Tabla I). El promedio de tiempo de internación en UCI fue de 6 días (4-15,7) días y de

Tabla I
Demografía y caracterización clínica de los pacientes ingresados en unidades de cuidados intensivos coronarios de un hospital universitario de cardiología, Recife-PE, Brasil, 2013 (n=110)

<i>Variables</i>	<i>n (%)</i>
<i>Sexo</i>	
Hombres	56 (50,9)
Mujeres	54 (49,1)
<i>Diagnóstico Clínico</i>	
Infarto agudo de miocardio	39 (35,5)
Insuficiencia Cardíaca	26 (23,6)
Insuficiencia Respiratoria	16 (14,5)
Edema agudo de pulmón	13 (11,8)
Choque cardiogénico	11 (10,0)
Sepsis	2 (1,8)
<i>Hipertensión Arterial Sistémica</i>	66 (60,0)
<i>Diabetes Mellitus</i>	31 (28,2)
<i>Insuficiencia Renal</i>	33 (30,0)
Tratamiento Conservador	8 (24,4)
Díalisis	25 (75,6)
<i>Ventilación Mecánica</i>	77 (70,0)
<i>APACHE II (score)</i>	
<20	68 (61,8)
≥20	41 (37,3)
<i>Bajo AF</i>	47 (42,7)
<i>Resultado Clínico</i>	
Alta de la UCI	69 (62,7)
Muerte	41 (37,3)

APACHE II - *Acute Physiology and Chronic Health Evaluation II*; AFº - Ángulo de Fase; Bajo AF - <5º ♂ <4,6º ♀; UCI - Unidad de Cuidados Intensivos.

tiempo de uso VM, entre aquellos en que se adoptó esta estrategia fue de 11 días (6-25).

El bajo AF estuvo presente en el 42,7% de la muestra, siendo encontrado un promedio de $5,4 \pm 1,9$ ($6,0 \pm 2,2$ en hombres y $4,8 \pm 1,4$ en mujeres).

En cuanto al análisis de los parámetros de evaluación nutricional, se verificó que la desnutrición varió del 30,3% al 81,5%, siendo la CP el parámetro que indicó el menor porcentual de desnutridos, entre los ancianos, y la CTL el parámetro que reveló mayor porcentual de la muestra. (Tabla II).

Se observó mayor prevalencia de bajo AF entre pacientes con insuficiencia renal en tratamiento dialítico ($p < 0,001$), entre los desnutridos, según los parámetros de CB ($p = 0,028$) y AMB_c ($p = 0,033$), entre los anémicos ($p = 0,012$) y entre los pacientes con hipoalbuminemia ($p = 0,042$). En contrapartida, se encontró una menor prevalencia entre pacientes con exceso de peso, según la PCT ($p = 0,043$). Con relación a los parámetros de valor pronóstico, hubo asociación entre AF y la puntuación APACHE II, con mayor prevalencia de bajo AF entre los pacientes con puntuación ≥ 20 ($p = 0,012$) (Tabla III).

Al analizar los coeficientes de correlación entre AF y las variables independientes estudiadas, se observó correlación lineal positiva con la CP ($r = 0,194$; p

$= 0,043$), % de adecuación de CB ($r = 0,199$; $p = 0,038$), % de adecuación de PCT ($r = 0,208$; $p = 0,029$), AMB_c ($r = 0,391$; $p < 0,001$); hemoglobina ($r = 0,299$; $p = 0,016$), hematocrito ($r = 0,233$; $p = 0,014$) y albúmina ($r = 0,420$; $p < 0,001$). Se verificó correlación inversa entre AF y tiempo de internación ($r = -0,259$; $p = 0,006$) (Tabla IV).

Discusión

La población estudiada fue compuesta por pacientes cardiopatas críticos, siendo escasos en la literatura datos en cuanto a la caracterización de individuos internados en UCI coronarias, trayendo, en su gran mayoría, resultados de poblaciones heterogéneas. Con todo, se sabe que las enfermedades cardiovasculares constituyen una de las causas más comunes de internación, morbilidad y mortalidad de ancianos¹⁷, siendo responsables actualmente por el 42-52% de las admisiones en UCI's¹⁸. En cuanto a las comorbideces, se observaron elevadas prevalencia de HAS (el 60%) y DM (el 28%), siendo superior a los resultados descritos por Acuña *et al.* (2007)¹⁹ en pacientes de cuidados intensivos (el 26,6% y el 12,7%, respectivamente). Tales constataciones se deben, probablemente, al perfil de los pacientes involucrados en el estudio.

La evaluación nutricional en el paciente grave tiene como objetivos estimar el riesgo de morbilidad y mortalidad por la desnutrición, identificando e individualizando sus causas y consecuencias, con indicación e intervención más precisa de aquellos pacientes con mayor posibilidad de beneficiarse del soporte nutricional. Ahora bien, la presencia de edema y alteraciones inespecíficas en las concentraciones plasmáticas de proteínas frecuentemente dificultan y enmascaran la evaluación nutricional durante la enfermedad crítica²⁰.

Se sabe que la desnutrición puede ser preexistente, manifestarse durante la internación o desarrollarse debido al estado hipercatabólico e hipermetabólico. En los pacientes graves, que configuran amplio espectro de situaciones clínicas, respuestas metabólicas y tratamientos, la prevalencia de la desnutrición es muy elevada²⁰. Sin embargo, la literatura no trae la prevalencia de la desnutrición en esta población.

Nuestras constataciones revelan elevadas prevalencia de desnutrición y una amplia diferencia de los porcentuales entre los métodos de evaluación nutricional empleados. Se puede atribuir esa variación al hecho de que cada uno de ellos puede traducir un significado diferente. Por tanto, como un parámetro aislado no es capaz de caracterizar la condición nutricional general del individuo, se hace necesaria una asociación de varios indicadores para mejorar la precisión y la exactitud del diagnóstico nutricional. La CTL, que mide las reservas inmunológicas momentáneas, reveló el mayor porcentual de desnutridos, sin embargo, se debe subrayar que, en paciente crítico, sus valores pueden estar alterados por la situación clínica o uso de medi-

Tabla II

Caracterización antropométrica y bioquímica de los pacientes ingresados en unidades de cuidados intensivos coronarios de un hospital universitario de cardiología, Recife-PE, Brasil, 2013 (n=110)

Variables	n (%)
Anemia [‡]	65 (59,1)
Hipoalbuminemia (<3,5mg/dL)	51 (71,8)
<i>Estado Nutricional segundo CP</i>	
Desnutrición	33 (30,3)
Eutróficos	76 (69,7)
<i>Estado Nutricional segundo %CB</i>	
Desnutrición	42 (38,2)
Eutróficos	49 (44,5)
Sobrepeso	19 (17,3)
<i>Estado Nutricional segundo %PCT</i>	
Desnutrición	54 (49,1)
Eutróficos	17 (15,5)
Sobrepeso	39 (35,5)
<i>Estado Nutricional segundo AMB_c</i>	
Desnutrición	72 (65,5)
Eutróficos	38 (34,5)
<i>Estado Nutricional segundo RTL</i>	
Desnutrición	88 (81,5)
Normal	20 (18,5)

CP – Circunferencia de la Pantorrilla; CB – Circunferencia del Brazo; PCT – Pliegue Cutáneo Tricipital; AMB_c – Área Muscular del Brazo corregida; RTL – Recuento Total de Linfocitos; [‡]De acuerdo a WHO (2001).

Tabla III
Asociación entre el ángulo de fase (AF) y variables demográficas, clínicas, antropométricas y bioquímicas en pacientes hospitalizados en unidades de cuidados intensivos coronarios de cardiología de un hospital universitario, Recife-PE, Brasil, 2013 (n=110)

Variables	<AF ^o (n=47)		AF ^o normal (n=63)		p-valor
	n	%	n	%	
<i>Sexo</i>					
Hombres	26	48,1	28	51,9	
Mujeres	21	37,5	35	62,5	
<i>Edad</i>					
< 60 años	14	35,9	25	64,1	0,283
≥ 60 años	33	46,5	28	53,5	
<i>Hipertensión Arterial Sistémica</i>					
Sí	25	37,9	41	62,1	
No	22	50,0	22	50,0	
<i>Diabetes Mellitus</i>					
Sí	14	45,2	17	54,8	
No	33	41,8	46	58,2	
<i>Insuficiencia Renal</i>					
Tratamiento Conservador	4	50,0	4	50,0	< 0,001*
Diálisis	19	76,0	6	24,0	
Sin enfermedad renal	24	31,2	53	68,8	
<i>Estado Nutricional segundo CP[§]</i>					
Desnutrición	18	54,5	15	45,5	0,131
Eutróficos	28	36,8	48	63,2	
<i>Estado Nutricional segundo %CB</i>					
Desnutrición	24	57,1	18	42,9	0,028*
Eutróficos	17	34,7	32	65,3	
Sobrepeso	6	31,6	13	68,4	
<i>Estado Nutricional segundo %PCT</i>					
Desnutrición	27	50,0	27	50,0	0,043*
Eutróficos	9	52,9	8	47,1	
Sobrepeso	11	28,2	28	71,8	
<i>Estado Nutricional segundo AMB_c</i>					
Desnutrición	22	57,9	16	42,1	0,033*
Eutróficos	25	34,7	47	65,3	
<i>Estado Nutricional segundo RTL</i>					
Desnutrición grave	41	46,6	47	53,4	0,177
Desnutrición leve/moderada	6	30,0	14	70,0	
Normal	47	43,5	61	56,5	
<i>Anemia[‡]</i>					
Sí	33	50,8	32	49,2	0,012*
No	14	31,1	31	68,9	
<i>Hipoalbuminemia (<3,5mg/dL)</i>					
Sí	29	56,9	22	43,1	0,042*
No	6	30,0	14	70,0	
<i>Ventilación Mecánica</i>					
Sí	27	50,0	27	50,0	0,130
No	20	35,7	36	64,3	
<i>APACHE II (score) categorizado</i>					
<20	23	33,8	45	66,2	0,012*
≥20	24	58,5	17	41,5	
<i>Resultado Clínico</i>					
Alta de la UCI	26	37,7	36	62,3	0,130
Muerte	21	51,2	27	48,8	

<AF - <5° ♂ <4,6° ♀; CP – Circunferencia de la Pantorrilla; CB – Circunferencia del Brazo; PCT – Pliegue Cutáneo Tripital; §Personas mayores; ‡Segundo WHO (2001); APACHE II - *Acute Physiology and Chronic Health Evaluation II*; UCI - Unidad de Cuidados Intensivos; p-valor por el test Chi-cuadrado; *p<0,05.

Tabla IV

El coeficiente de correlación (r) y la significación estadística (p-valor) entre el ángulo de fase (AF) y las variables demográficas, clínicas, antropométricas y bioquímicas de los pacientes ingresados en unidades de cuidados coronarios de un hospital universitario de cardiología, Recife-PE, Brasil, 2013 (n=110)

Variables	AF	
	r	p-valor
Edade	-0,139	0,148 [#]
CP	0,194	0,043 ^{*†}
Adecuación CB	0,199	0,038 ^{*†}
Adecuación PCT	0,208	0,029 ^{*#}
AMB _c	0,391	<0,001 ^{*†}
Recuento Total de Linfócitos	0,066	0,499 [#]
Hemoglobina	0,299	0,016 ^{*†}
Hematócrito	0,233	0,014 ^{*†}
Albúmina	0,420	<0,001 ^{*†}
APACHE II	-0,026	0,787 [†]
Tiempo de Ventilación Mecánica	0,046	0,730 [†]
Duración de la estancia	-0,259	0,006 ^{*#}

CP – Circunferencia de la Pantorrilla; CB – Circunferencia del Brazo; PCT – Pliegue Cutáneo Tripital; AMB_c – Área Muscular del Brazo corregida; APACHE II – *Acute Physiology and Chronic Health Evaluation II*; *p< 0,05; †coeficiente de correlación de Pearson; #coeficiente de correlación de Spearman.

camentos²⁰, siendo su uso como marcador de estado nutricional aún demasiado controverso²¹. La CP y CB fueron los parámetros que identificaron menor número de desnutridos, diferentemente de otras investigaciones que apuntan esas medidas como indicadores sensibles de masa muscular¹⁹. Aunque la presencia de edema haya sido adoptada como criterio de exclusión, se sabe que esta es una condición comúnmente encontrada en la evolución clínica de pacientes críticos. Como la evaluación se realizó en las primeras horas de la admisión, es posible que existiera edema subclínico, y la redistribución de fluidos no haya sido detectada al examen físico.

Recientemente, el AF viene siendo utilizado como indicador nutricional^{8,11,22} y como indicador de pronóstico y predictor de sobrevida en algunas situaciones clínicas, tales como en pacientes portadores del Virus de la Inmunodeficiencia Adquirida (HIV+)²³, oncológicos^{5,24}, nefropatas²⁵, hepatopatas⁴, quirúrgicos²⁶ y sépticos⁷. Ahora bien, aún son escasos los estudios que evalúan la utilización del AF en pacientes críticos.

Aunque el significado biológico del AF no sea completamente comprendido, él refleja la masa celular corporal y, por ese motivo, viene siendo utilizado como un indicador nutricional^{1,22}. Además de eso, es uno de los mejores indicadores de la función de la membrana

celular, relacionado a la razón entre agua extracelular y agua intracelular^{1,11,27}.

Bajos valores de AF están relacionados a la disminución de integridad celular, a la reducción de masa magra y al aumento de morbimortalidad^{6,13}. El bajo AF estuvo presente en el 29,8% de pacientes admitidos en un hospital de Ginebra en 2012⁸, utilizando el mismo punto de corte del presente estudio. No obstante, nuestras constataciones traen una mayor prevalencia (el 42,7%). En pacientes sépticos, ese porcentual fue todavía mayor (el 58%), considerando bajo AF < 5° para hombres y mujeres²⁸. Se sugiere, por tanto, que pacientes críticos presentan mayores porcentuales de lesión celular.

La CB y AMB_c son métodos muy utilizados para evaluar el estado nutricional del paciente gravemente enfermo por el hecho de la CB estimar la proteína muscular esquelética total y la AMB_c evaluar la reserva de tejido muscular con corrección del área ósea, reflejando más adecuadamente los cambios de tejido muscular²⁹. La asociación de esos parámetros con el AF puede reforzar la indicación de este método como predictor del estado nutricional en pacientes críticos. Otro hecho relevante que merece ser subrayado fue el de que pacientes con exceso de peso, según la PCT, presentaron menor prevalencia de bajo AF. Literatura reciente tiene indicado que una mayor reserva adiposa puede representar una condición protectora y de sobrevida en la enfermedad crónica³⁰. Luego, se puede sugerir que la PCT, medida más ampliamente utilizada y responsable por evaluar la masa gorda periférica²⁹, fue factor protector para la lesión celular en este estudio.

Hasta el momento, no existen publicaciones que investigaron la asociación entre el estado nutricional y el AF en pacientes críticos, siendo el presente trabajo pionero en la temática. Algunos estudios traen la asociación entre estado nutricional y AF en otras situaciones. Estudio retrospectivo de Gupta *et al.* (2008)⁵ sugirió que el AF es un indicador nutricional potencial en cáncer colorrectal avanzado. Se evaluaron 73 pacientes adultos, clasificados como bien nutridos o desnutridos usando la Evaluación Subjetiva Global (ESG). Pacientes bien nutridos tuvieron una mediana de AF significativamente mayor (6,12°), en comparación con aquellos que estaban desnutridos (5,18°). Kyle *et al.* (2012)¹¹ evaluaron a 983 adultos, de ambos sexos, admitidos en el Hospital Universitario de Ginebra, y observaron que valores abajo de 5,0° para los hombres y 4,6° para las mujeres estuvieron asociados a riesgo nutricional grave y desnutrición severa en la admisión hospitalaria, de acuerdo con Selección de Riesgo Nutricional (NRS-2002) y ASG, respectivamente. Diferentemente, un estudio transversal con 98 pacientes admitidos para cirugía gastrointestinal o de hernia, en el que se evaluó el estado a través de la NRS (2002), ASG, Índice de Masa Corpórea (IMC) y CTL, presentó una débil concordancia del AF con los métodos de evaluación nutricional, así como baja especificidad, no recomendando su uso como indicador

del estado nutricional, pese a haber encontrado valores más bajos de AF en pacientes desnutridos²⁷.

A lo que se refiere a los parámetros bioquímicos, la anemia es una condición de acaecimiento extremadamente común en pacientes críticos³¹, y como lo esperado también fue prevalente en este estudio. Su importancia pronóstica es bien reconocida, incluso en una serie de enfermedades cardiovasculares, como el infarto agudo de miocardio y más recientemente la insuficiencia cardíaca³². Aunque haya sido encontrada asociación entre anemia y bajo AF en este estudio, la literatura aún es escasa en cuanto al análisis de esa relación. Estudio transversal realizado en México³³, en 132 individuos cardiopatas, también observó esa asociación, sugiriendo que el AF sería un buen marcador pronóstico.

A pesar de la limitación de la albúmina como indicador del estado nutricional, varios estudios correlacionan sus bajas concentraciones séricas con la aumentada incidencia de complicaciones clínicas y morbilidad²⁰. La hipoalbuminemia se correlacionó positivamente con el AF, corroborando con constataciones anteriores^{8,11}; sin embargo, se debe señalar que las poblaciones estudiadas previamente no constituyen pacientes críticos.

Un estudio transversal, realizado en los Estados Unidos, comparó 913 pacientes en diálisis con 10.263 individuos no institucionalizados que se sometieron a BIA por la NHANES III (Third National Health and Nutrition Examination Survey), y reveló que los pacientes dialíticos presentan un menor AF ($p < 0,001$)³⁴. Mayor prevalencia de bajo AF en pacientes en tratamiento dialítico también se encontró en este estudio. Tal constatación sugiere que pacientes nefropatas dialíticos poseen menor integridad de la membrana celular.

La tasa de óbito esperada en las UCI, guardando las debidas particularidades de cada sector, se encuentra entre el 25 a 30%¹⁴. El porcentual encontrado, en este estudio, fue superior (el 37,3%), lo que se puede justificar por la gravedad de los pacientes admitidos. Diversos autores tienen sugerido que menores valores de AF están asociados a una menor sobrevida en diversas situaciones clínicas^{8,10,24}. Ahora bien, contrariando esas constataciones, no se observó asociación entre AF y desenlace clínico, resultado semejante a un estudio reciente de Berbigier *et al.* (2013)²⁸, que investigó a 50 pacientes sépticos en UCI de un hospital de Poto Alegre/RS.

Índices pronósticos como el APACHE II son herramientas de evaluación muy utilizadas en UCI y están relacionadas a la evolución clínica del paciente, alteraciones fisiológicas y de laboratorios que orientan la atención al fornecer parámetros para el acompañamiento clínico y pronóstico del paciente³⁵, cuanto más alto sea este valor mayor será el riesgo de mortalidad³⁶. La asociación del AF con la puntuación APACHE II y la correlación inversa con el tiempo de internación hospitalaria fortalecen las evidencias del papel del

AF como importante herramienta de valor pronóstico. Norman *et al.* (2010)²⁴ investigaron a 399 pacientes oncológicos en Alemania y también verificaron que bajos valores de AF fueron predictores de un mayor tiempo de internación hospitalaria.

El estudio de Berbigier *et al.* (2013)²⁸, con población con características más semejantes al perfil de pacientes de este estudio, no encontró relación entre el AF con los índices pronósticos (APACHE II y SOFA – *Sequential Organ Failure Assessment*), variables bioquímicas (albúmina, proteína C reactiva) y evolución clínica (tiempo de internación), lo que se atribuyó a la homogeneidad de la muestra, compuesta exclusivamente por individuos con sepsis.

Conclusiones

El AF presentó asociación con indicadores importantes del estado nutricional, variables con valor de pronóstico y tiempo de internación. Pese al AF ser considerado como predictor de sobrevida en varias situaciones clínicas, no se encontró resultado semejante en los pacientes críticos.

Por ser un método rápido y práctico, su utilización en UCI parece ser útil para identificar a pacientes desnutridos precozmente y, así, auxiliar el diagnóstico nutricional. No obstante, más estudios son necesarios para respaldar su utilización como predictor del estado nutricional.

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Original/*Valoración nutricional*

Late referral for chronic kidney disease patients: nutritional point of view

Daiane Cristina Guerra¹, Larissa Rodrigues Neto Angélico¹, Wander R Furtado¹,
Eduardo Barbosa Coelho¹ and Paula Garcia Chiarello¹

¹Medical School of Ribeirão Preto, University of São Paulo. Brazil.

Abstract

The prevalence of late referral of patients with chronic kidney disease (CKD) is high and has been associated with a worse CKD prognosis, however few studies have been conducted from a nutritional perspective.

Objective: Characterize the nutritional status of patients with CKD at first attendance in a nephrology service, with early (ER) and late referral (LR).

Methodology: It was a cross-sectional study with patients older than 18 years referred to the Nephrology service of a University Hospital. The referral groups were classified according to estimated glomerular filtration rate (eGFR) as: LR (eGFR<15ml/min/1.73m²) or ER (eGFR>15 ml/min/1.73m²) based on the Kidney Disease Outcomes Quality Initiative. Nutritional evaluation included subjective global assessment (SGA), anthropometric, laboratory and bioelectrical impedance data. The SAS® software was used for statistical analysis.

Results: Seventy-five patients were evaluated, 29% of them belonging to the LR group. This group showed a greater previous weight loss (-7.0 ± 3.5 versus -2.8 ± 7.0 Kg) and lower values for all anthropometric and body composition variables. In general, the laboratory results of the LR group also were worse. According to the SGA, all LR patients had some degree of malnutrition (50% with severe malnutrition against 28.8% in ER), showing significantly lower results for GFR (21.4 ± 12.2 ml/min/1.73 m²), albumin (3.9 ± 0.3 g/dL), serum bicarbonate (22.8 ± 5.1 mmol/L) and phase angle (5.3 ± 0.6 θ). Renal function was positively correlated with percent adequacy of arm circumference (r=0,40; p<0,01) and albumin (r=0,45; p<0,01).

Conclusion: The LR group showed a worse nutritional status showing that, for the nutritional point of view, the delayed referral brings substantial losses that can make difference in future treatment, thus demonstrating the importance of early nutritional monitoring for this population.

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Key words: *Nutritional status. Chronic kidney disease. Late referral.*

Correspondence: Larissa Rodrigues Neto Angélico.
lari_neto@hotmail.com

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LATE REFERENCIA DE LOS PACIENTES CON ENFERMEDAD RENAL CRÓNICA: PUNTO DE VISTA NUTRICIONAL

Resumen

La prevalencia de la referencia tardía de los pacientes con enfermedad renal crónica (ERC) es alta y se ha asociado con un pronóstico peor ERC, sin embargo pocos estudios se han llevado a cabo desde una perspectiva nutricional.

Objetivo: Caracterizar el estado nutricional de los pacientes con ERC con la primera cita en un servicio de nefrología, con temprana (ER) y la remisión tardía (LR).

Metodología: Se realizó un estudio transversal con pacientes mayores de 18 años a que se refiere el servicio de Nefrología del Hospital Universitario. Los grupos de referencia se clasificaron de acuerdo a la tasa estimada de filtración glomerular (TFG) como: LR (TFG <15 ml / min / 1.73m²) o ER (TFG> 15 ml / min / 1.73m²), basado en la Kidney Disease Outcomes Quality Initiative. Evaluación nutricional incluyó la evaluación subjetiva global (SGA), antropométricas, de laboratorio y los datos de impedancia bioeléctrica. El software de SAS ® se utilizó para el análisis estadístico.

Resultados: Fueron evaluados setenta y cinco pacientes, el 29% de ellos pertenece al grupo LR. Este grupo mostró una pérdida mayor de peso anterior (-7,0 ± 3,5 frente a -2,8 ± 7,0 Kg) y los valores más bajos para todas las variables antropométricas y de composición corporal. En general, los resultados de laboratorio del grupo LR también eran peores. De acuerdo con el SGA, todos los pacientes tenían LR algún grado de desnutrición (50% con desnutrición severa contra 28,8% en ER), que muestra resultados significativamente más bajos de la TFG (21,4 ± 12,2 ml / min / 1,73 m²), albúmina (3,9 ± 0,3 g / dL), bicarbonato sérico (22,8 ± 5,1 mmol / L) y ángulo de fase (5.3 ± 0,6 θ). La función renal se correlacionó positivamente con el porcentaje de adecuación de la circunferencia del brazo (r=0,40; p<0,01) y albúmina (r=0,45; p<0,01).

Conclusión: El grupo LR mostró un peor estado nutricional muestra que, para el punto de vista nutricional, la remisión tardía trae pérdidas sustanciales que pueden hacer la diferencia en el tratamiento futuro, lo que demuestra la importancia de la vigilancia nutricional precoz para esta población.

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Palabras clave: *Estado nutricional. Enfermedad renal crónica. La referencia tardía.*

Introduction

Chronic Kidney Disease (CKD) is a clinical syndrome characterized by renal damage and progressive and irreversible loss of kidney function¹. The increased prevalence of CKD has led to its recognition as a public health problem in Brazil and in the world, especially due to the high costs for the health system, the high morbidity and mortality of this population, and the adverse consequences for affected individuals².

In order to control the complications caused by CKD, to attenuate the progression of the disease and to optimize its treatment, in addition to preparing the patients for dialysis or kidney transplantation, international guidelines recommend that patients with CKD be referred early to a nephrologist for the assessment and management of the disease³.

Many studies have indicated that late referral is associated with a poorer prognosis for CKD^{4,5}. It involves higher rates of progression to renal dysfunction, higher complication rates and a higher risk to require emergency dialysis, resulting in increased morbidity-mortality, higher treatment costs, and a worse quality of life^{6,7,8,9}. Despite this recognized health impairment due to late referral, few studies have been conducted using a nutritional perspective^{10,11,12}.

Starting from a glomerular filtration rate (GFR) of 60 mL/min/1.73 m², the patients should be regularly submitted to assessment of nutritional status. The ideal way to monitor the nutritional status of these patients includes a combination of various clinical, laboratory and anthropometric parameters in order to circumvent the limitation of each method when employed separately^{13,14}.

Among the complications of CKD to which late referral may contribute is protein-energy malnutrition (PEM). The causes of this condition are multifactorial, being mainly related to the dietary restrictions of pre-dialysis treatment, the clinical conditions determined by the disease itself (anorexia, gastrointestinal and hormonal disorders, and metabolic changes), and polymedication^{15,16,17,18}.

Most of the patients who start dialysis treatment without previous nutritional monitoring have symptoms of malnutrition such as weight loss and changes in anthropometric and laboratory parameters¹⁹. Thus, the application of a nutritional care plan seems to be the main protective factor against the worsening of PEM, since nutritional monitoring and education are key factors in order to secure motivation and adherence to the diet^{20,21}.

Considering nutritional status as an important prognostic factor in the evolution of CKD and in view of the lack of information about the patients referred to nephrology services, it is essential to be aware of the nutritional status of these patients in order to improve the nutritional care provided to them. Thus, the main objective of the present study was to characterize the nutritional status of patients with CKD under conser-

vative treatment with early or late referral to a nephrology service.

Subjects and Methods

Design

An observational cross-sectional study was conducted between October 2009 and December 2010 on 75 patients with pre-dialysis CKD referred to the Nephrology Service of a University Hospital in Ribeirão Preto, São Paulo, Brazil for the first time and aged 18 years or older. Individuals with acute kidney injury, prior kidney transplantation or dialysis and those for whom the disease could not be differentiated as acute or chronic according to their medical records were excluded.

The study was approved by the Research Ethics Committee of the University Hospital, Medical School of Ribeirão Preto, University of São Paulo, and all patients gave written informed consent to participate.

Sample size was calculated from a pilot sample previously obtained from a CKD population. The formula of Singer (1997) was used and the level of significance was set at 0.05. For a test power of 0.8, the result of the calculation was a total sample of 70 patients²².

Time of referral

The classification of late referral was based on the definition of the K/DOQI Guidelines, using as a criterion a GFR of <15 mL/min/1.73 m², estimated from the formula of Cockcroft-Gault, which uses age, current weight and plasma creatinine concentration²³. On this basis, the patients were assigned to two groups, i.e., those with a late referral (GFR <15 mL/min/1.73 m²) and those with an early referral (GFR >15 mL/min/1.73 m²).

Anthropometric measures

The same trained nutritionist performed the anthropometric evaluation of all patients under fasting conditions. Weight was measured with a scale with 0.1 kg precision and height with a stadiometer with 0.1 cm precision (Filizola S/A, São Paulo, Brazil). Body mass index (BMI) was calculated as weight divided by height squared. A cutoff point of ≥ 24.9 kg/m² was used to classify excess weight for adults and a cutoff point of ≥ 27.0 kg/m² was used to classify excess weight for elderly subjects²⁴.

The following anthropometric indices were assessed: the patient's current weight expressed as a percentage of ideal weight (%); measurement of the arm circumference (AC) expressed as a percentage of adequacy in relation to the ideal values for gender and age^{25,26}; and waist circumference (WC) classified according to the World Health Organization (WHO)²⁷.

The percentage of weight change was calculated based on the current weight in relation to the habitual weight and classified as gain, significant loss (<10%) or severe loss (> 10%) in the last 6 months²⁸. Patients whose clinical condition did not permit anthropometric assessment were only submitted to subjective global assessment and to laboratory work-up.

Body composition was evaluated by tetrapolar bioelectrical bioimpedance analysis (BIA) (Biodynamics 450, Biodynamics Corporation, Seattle, WA, USA) which provides data regarding body water, lean mass, phase angle and fat mass, using a current of 800 μ A and 50 kHz. The measurements were performed according to manufacturer instructions.

A researcher experienced in using the scored Subjective Global Assessment (SGA) assessed all subjects²⁹. Each subject was classified as well-nourished (SGA A), moderately or suspected of being malnourished (SGA B), or severely malnourished (SGA C). The scored SGA consists of the four medical components (weight loss, nutrition impact symptoms, intake and functional capacity) and a physical examination assessing fat, muscle stores and fluid status plus global assessment of nutritional status.

Biochemical evaluation

Blood samples were collected from the patients after a 12-h overnight fast. Biochemical evaluation included the determination of lipid profile, serum albumin, total protein, urea, creatinine, calcium, phosphorus, blood count, glucose and venous blood gases (pH and bicarbonate - HCO_3^-). All exams were carried out in the Central Laboratory of the University Hospital of the institution.

The lipid profile, consisting of total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL-c) and high density lipoprotein (HDL-c), was determined. The following desirable reference values were considered: <200 mg/dL TC, <150 mg/dL TG and < 100 mg/dL LDL-c, and for HDL-c, values higher than 40 mg/dL for men and higher than 50 mg/dL for women³⁰.

The reference value used for serum albumin was ≥ 4.0 g/dL (K/DOQI, 2000) and the reference value used for glucose was > 100 mg/dL³¹. Metabolic acidosis was defined as serum bicarbonate concentrations of less than 22 mmol/L³².

Statistics

Data are reported as mean and standard deviation for continuous variables and as frequencies and percentages for categorical variables. Spearman correlation was used to determine associations between estimated GFR and nutritional parameters. The nonparametric Wilcoxon test was applied to analyze

differences between the late referral (LR) and early referral (ER) groups regarding the continuous variables, and the Fisher exact test was used to analyze differences regarding the categorical variables. The level of significance was set at 5%. ANOVA was used to compare the patients according to SGA classification, followed by the Tukey post-test when the null hypothesis was rejected. The SAS[®] software (version 9.2, 2008, SAS Institute Inc. Cary, NC, USA) was used for all analyses.

Results

Seventy-five patients under conservative treatment were assessed, 29% of them belonging to the LR group and 71% to the ER group. Mean patient age was 64.8 $\pm$ 11.6 years and 73% were elderly persons (> 60 years). Patient distribution according to kidney function is presented in table I.

According to BMI, most subjects (63%) were overweight and obese. When each group was considered separately, the percentage of overweight in ER patients was even higher (68%). Concerning abdominal circumference, 75% of the patients were found to be at higher risk for metabolic complications associated with obesity.

Nutritional assessment revealed that 54% of the patients had suffered a weight loss of up to 10% in the last 6 months. The LR group showed lower values for all the anthropometric and body composition variables, except for the percentage of weight change, which indicated a greater weight loss in this group (Table II). In agreement with the anthropometric assessment, in general the laboratory data for the LR group were worse than those for the ER group (Table III).

The lipid profile showed changes in large part of the subjects compared to reference values. Hypertriglyceridemia was present in 47% of cases, elevated LDL-c in 57% and hypercholesterolemia in 40%. It is important to point out that 37% of the patients showing normal serum TC levels were taking lipid-lowering drugs. Fasting glycemia levels were higher than the reference values in 44% of the patients.

Table I
Patient distribution according to CKD staging

Stage	Glomerular filtration rate* (ml/min/1.73 m ²)	n (%)
II	60-89	7 (9.3%)
III	30-59	20 (26.7%)
IV	15-29	26 (34.7%)
V	<15	22 (29.3%)

*Glomerular filtration rate estimated using the formula of Cockcroft-Gault²³.

Table II
Comparison of the anthropometric variables between groups according to late or early referral

Variables	Sample (n=75)	Late referral (n=22)	Early referral (n=53)	p-value
Change in weight (%)	-3.9 ± 6.5	- 7.0 ± 3.5	- 2.8 ± 7.0	<0.01
Adequacy of IMW (%)	126.1 ± 23.8	113.5 ± 16.6	131.3 ± 24.4	<0.01
BMI (kg/m ²)	27.3 ± 5.2	24.5 ± 3.6	28.4 ± 5.3	<0.01
Adequacy of AC (%)	97 ± 14.1	89.4 ± 10.9	99.4 ± 14.2	0.01
AbC (cm)	97.2 ± 13.3	86.6 ± 11.1	100.7 ± 12.1	<0.01
Phase angle (°)	5.7 ± 0.9	5.2 ± 0.7	5.9 ± 0.9	0.01
Fat mass (%)	20.4 ± 8.3	23.7 ± 6.8	29.6 ± 7.6	0.02

*Nonparametric Wilcoxon test. Data are reported as mean ± SD. IMW: ideal mean weight; BMI: body mass index; AC: arm circumference; AbC: abdominal circumference.

Table III
Comparison of the laboratory variables between groups according to late and early referral

Variables	Late referral (n=22)	Early referral (n=53)	p-value
Hemoglobin (g/dl)	10.7 ± 1.53	13.1 ± 2	<0.01
Hematocrit (%)	32.9 ± 4.10	39.6 ± 5.7	<0.01
Lymphocytes (10 ³ mm ³)	1.7 ± 0.86	2.1 ± 0.6	0.03
TIBC	186 ± 51.45	223.2 ± 84.5	0.02
Glycemia (mg/dl)	105.1 ± 51.6	127.2 ± 60	0.04
Albumin (g/dl)	3.92 ± 0.26	4.2 ± 0.3	<0.01
Total proteins (g/dl)	6.6 ± 0.5	6.9 ± 0.4	0.04
Urea (mg/dl)	107.2 ± 42.3	75.4 ± 41.1	<0.01
Creatinine (mg/dl)	5.6 ± 2.3	2.3 ± 1.1	<0.01
Phosphorus (mg/dl)	5.6	4.05	<0.01
Total calcium (mg/dl)	8.5	9.5	<0.01
Blood pH	7.3 ± 0.1	7.6 ± 0.1	<0.01
Serum bicarbonate	20.7 ± 4.3	26.4 ± 4.3	<0.01

*Nonparametric Wilcoxon test. Data are reported as mean ± SD. TIBC: Total iron-binding capacity.

There were associations between kidney function and parameters of nutritional assessment. There was a significant positive correlation between GFR and phase angle (Figure 1) and between renal function and albumin (Figure 2). The prevalence of hypoalbuminemia in the total sample was 37%.

Metabolic acidosis was identified in 28% of the patients. Significant positive correlations were observed between serum bicarbonate levels and nutritional status variables such as albumin (Figure 3).

Patient classification according to the SGA is presented in table IV. Half the patients in the LR group had severe malnutrition and no patient was classified as well nourished.

When the laboratory and anthropometric variables were compared according to SGA, the patients classified as malnourished were found to have significantly lower GFR, albumin, serum bicarbonate and phase angle values and a greater weight loss. However, only albumin differed between categories B and C and only phase angle and GFR differed between categories A and B (Table IV, Table V).

Discussion

The main findings of the present study were a high prevalence of patients with late referral (LR) to the

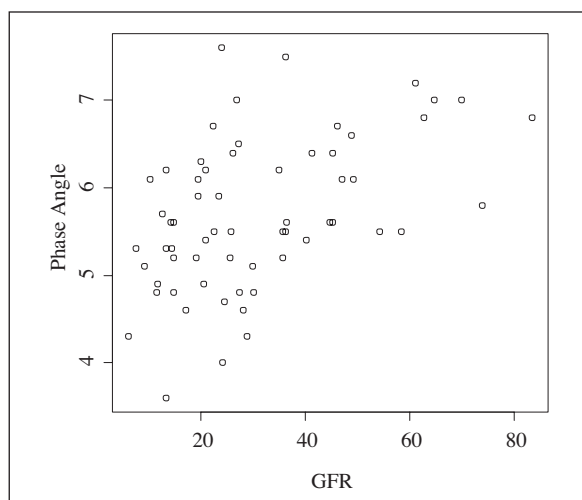


Fig. 1.—Correlation Spearman between GFR and phase angle (CCS=0,48; $p<0,01$).

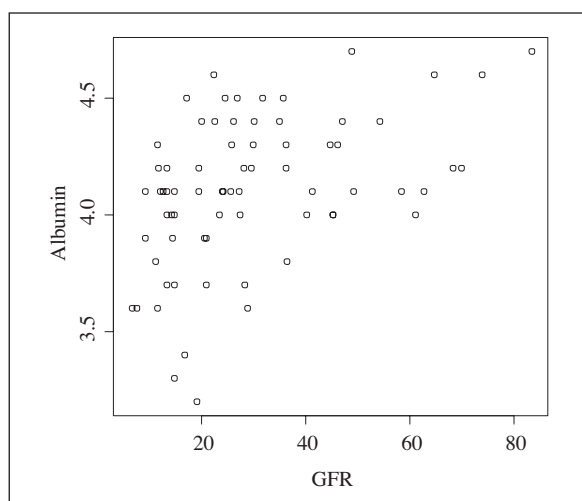


Fig. 2.—Correlation Spearman between renal function and albumin (CCS=0,45; $p<0,01$).

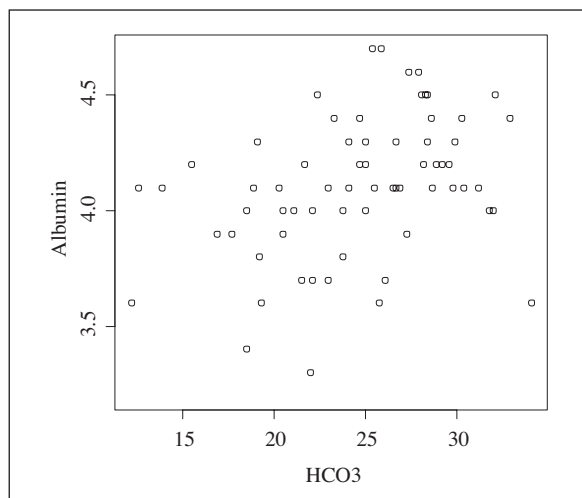


Fig. 3.—Correlation Spearman between serum bicarbonate levels and albumin (CCS=0,4; $p<0,01$).

nephrology service of a university hospital and the fact that these patients showed a worse nutritional status according to the SGA and most of the anthropometry, laboratory and body composition parameters compared to the ER group.

The definition of “late referral” is somewhat arbitrary and quite heterogeneous. Most studies usually assess the prevalence of LR on the basis of the difference in time between referral to the nephrologist and beginning of dialysis treatment. However, since there is no established definition, different times are used as cut-off points, among them 1, 3, 4, 6 or even 12 months before dialysis treatment^{4,33,34,35,36,37}.

This criterion based on the difference in time is used in prospective or retrospective studies. However, due to the cross-sectional nature of our study, we could not use this classification. For this reason, we selected the LR criterion considered in the guidelines of the K/DOQI based on stage 5 of CKD (GFR<15 ml/min/1.73 m²)³. According to the systematic review study of Navaneethan et al. (2008), this diversity of criteria is responsible for the wide variation in the prevalence of LR reported in the literature (15 to 80%), impairing a possible comparison between studies⁹.

The high percentage of LR patients detected in the present study (29%) agrees with literature data. Navaneethan et al. (2007), in a retrospective US study on 204 patients, compared the two classifications of LR and detected a value of 22% according to the criterion of kidney function (GFR<15 ml/min/1.73 m²) and a value of 26% according to the time criterion (6 months before dialysis)¹². Similar results were obtained in a study conducted in Italy on 673 patients³³. Recently, Hommel et al. (2012) detected an even higher LR percentage (38%)³⁷. Thus, the literature shows that up to 64% of CKD patients are still referred late⁴.

Our findings show that kidney function was positively correlated with phase angle, with LR patients showing lower phase angle values. This reduction has been considered to reflect damage to the cell membrane, cell death, increased ratio between intra- and extracellular water, and decrease body cell mass^{38,39}. From

Table IV

*Classification of nutritional status of groups late and early referral according to Subjective Global Assessment**

Classification	Late referral (n=22)	Early referral (n= 53)	Sample
A	0	17 (32.7%)	17 (22.9%)
B	11 (50%)	20 (38.5%)	31 (41.9%)
C	11 (50%)	15 (28.8%)	26 (35.2%)

* Detsky, 1987 (29) A: Well nourished; B: Mild to moderate malnutrition; C: Severe malnutrition.

Table V
Comparison of the nutritional variables according to classification by the Subjective Global Assessment*

Variables	Classification SGA			p-value
	A	B	C	
eGFR (ml/min/1.73 m ²)	47 + 16 ^a	26.3 + 16.7 ^{b,c}	21.4 + 12.2 ^b	p<0.01
Albumin (g/dl)	4.3 + 0.2 ^a	4.1+0.2 ^{a,c}	3.9 + 0.3 ^b	p<0.01
Serum bicarbonate (mmol/L)	28.0 + 2.9 ^a	24.7+ 5.1 ^{a, b}	22.8 + 5.1 ^b	p<0.01
Change in weight (%)	-1 + 5.2 ^a	-3.8 + 6.5 ^{a, b}	-6.1 + 6.7 ^b	p<0.01
Phase angle (°)	6.4+ 0.7 ^a	5.6+ 0.9 ^{b,c}	5.3+ 0.6 ^b	p<0.01

Data are reported as mean ± SD. ANOVA: p-value < 0.01; Tukey post-test.

SGA: Subjective Global Assessment; eGFR: Estimated glomerular filtration rate.

*Detsky, 1987 (29). A: Well nourished; B: Mild to moderate malnutrition; C: Severe malnutrition.

a clinical viewpoint, the phase angle is considered to be an important marker in the determination of increased risk of morbidity in various pathological conditions^{11,40}, particularly in CKD patients before dialysis. Caravaca et al. (2011) established that a phase angle of 5.3° is of prognostic value for survival⁴¹.

BMI assessment revealed a high percentage of overweight and obesity (63%), especially in the ER group. Brazilian studies have detected lower percentages of excess weight in CKD patients, of the order of 25 to 50%^{10,42}. There still is controversy about the best measure for the determination of obesity in these patients. Some studies that evaluated the relationship between obesity and adverse outcome in CKD using BMI obtained conflicting results, which were partially due to the determination of total body mass without differentiating between fat and lean mass^{43,44,45}. Evidence suggests that abdominal circumference is a more reliable tool for the detection of visceral adiposity, being a better predictor of morbidity and cardiovascular risk compared to BMI⁴⁶. When the abdominal circumference was analyzed in the present population, most individuals were found to be at higher risk to develop metabolic complications.

Positive correlations were detected between kidney function and anthropometric variables. GFR was correlated with BMI and with percent adequacy of arm circumference, indicating that the progressive loss of kidney function is accompanied by a decline of nutritional status markers and is intimately linked to an increased risk of malnutrition, as also reported by Campbell et al. (2008)²⁰. In agreement with these results, considering all the anthropometric variables measured, the LR group showed a worse nutritional status than the ER group.

Herget-Rosenthal et al. (2010) also observed that LR patients had a poorer nutritional status when assessed according to serum albumin concentration (< 3.5 g/dl) and BMI (<20 kg/m²), and identified malnutrition as an independent factor associated with mortality⁴⁷. Thus, during the pre-dialysis phase, malnutrition seems to be a predictor of increased number of hos-

pitalizations and deaths and of progression to dialysis therapy regardless of GFR²⁰.

Another clinical tool with established prognostic value for CKD and used to assess nutritional status is the SGA, which is commonly used to determine the prevalence of malnutrition and to identify patients at higher risk for morbidity and mortality⁴⁸. Stenvinkel et al. (2002) reported that CKD patients classified as malnourished according to the SGA showed significantly higher mortality rates than patients classified as well nourished when the data were adjusted for age, diabetes and cardiovascular diseases¹⁶.

The beginning and the severity of PEM are related to the level of kidney function, with a higher prevalence of nutritional damage being usually observed below a GFR of 60 ml/min/1.73 m² and being reflected on lower albumin, serum bicarbonate and cholesterol values³. These changes were present in our study, in which malnutrition detected according to the SGA was associated with the more advanced phases of CKD and with significantly lower levels of albumin, serum bicarbonate and phase angle and a greater weight loss.

LR patients also showed worse laboratory results characterizing nutritional status compared to ER patients. In particular, metabolic acidosis, which is a common complication of CKD especially when GFR reaches levels close to 20 ml/min/1.73 m², was present in almost one third of the patients, a result lower than those reported in the literature considering the same cut-off point. Leal et al. (2009) observed a 50% frequency of metabolic acidosis in a sample with characteristics similar to those of the subjects studied here⁴².

The reduction of serum bicarbonate levels is associated with various adverse effects including bone disease, hypoalbuminemia and increased risk of death^{42,49}. In addition, it plays an important role in the pathogenesis of PEM, which involves increased protein degradation of skeletal muscle in the presence of acidosis, with its correction possibly contributing to

a reduction of this degradation⁵⁰. In the present study we observed various significant positive correlations between serum bicarbonate level and nutritional status variables such as albumin, total proteins, fat mass, percent fat and percent adequacy of arm circumference. When we compared the bicarbonate levels according to SGA classification, we noted that category A patients had significantly higher levels than category C patients.

Hypoalbuminemia was present in 37% of the subjects and its frequency was significantly higher in the LR group compared to the ER group. It is important to remember that low albumin levels may reflect not only the deterioration of nutritional status, but also the presence of inflammation, proteinuria, systemic diseases, advanced age, and degree of hydration. Thus, albumin should be used in combination with other parameters for the assessment of nutritional status¹⁶.

Regarding the lipid profile, a high percentage of patients with dyslipidemias as well as significantly lower HDL levels was observed in the LR group. However, this prevalence may be even higher since 37% of the patients with normal serum cholesterol levels were taking lipid-lowering medication. Recently, Chen et al. (2013) demonstrated that increases in TC and LDL-c are associated with a more rapid progression of CDK, being considered risk factors for renal replacement therapy in stage 3-5 patients⁵¹.

There is evidence that pre-dialysis nephrology care independently affects the clinical outcomes^{8,52,53}. The main objective of nutritional treatment during this phase is to maintain and/or recover the nutritional status, to attenuate the uremic symptoms, to control the metabolic disorders, and to delay the rate of kidney disease progression⁵⁴. Thus, it is extremely important to maintain these patients under nutritional monitoring throughout CKD treatment, since this is a period that must be used to offer the patient the best possible conditions for the beginning of dialysis.

However, since most epidemiological investigations are devoted to the study of patients kept under dialysis treatment, it is essential to start new studies, mainly during earlier CKD phases in order to provide better nutritional care to this population.

Conclusion

Despite the limitations of the present study such as a small sample size and the use of a LR criterion little employed in the literature, the results obtained demonstrated that patients with late referral presented a greater deterioration of nutritional status. Thus, it is essential for patients with CKD to receive an earlier diagnosis during the pre-dialysis period and to be referred in a timely manner to multiprofessional nephrology teams, in order to delay dialysis or to start dialysis program in a better health condition.

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Original/*Valoración nutricional*

Body composition assessment of paddle and tennis adult male players

Alejandro Martinez-Rodriguez, Enrique Roche Collado and Néstor Vicente-Salar

Biochemistry and Cell Therapy Unit, Institute of Bioengineering, University Miguel Hernandez, Elche, Spain.

Abstract

Introduction: Racket sports require athletes to constantly improve and progress in their physical qualities in order to maintain competitive standards. This includes achieving and maintaining an optimal body composition. However, few studies have been published addressing this topic.

Objective: This study tries to provide a complete anthropometric profile, including somatotype and body composition, of paddle and tennis male adult players.

Methods: Anthropometric parameters including weight, height, skinfolds, girths and breadths were measured in 21 paddle and 26 tennis players, and the results were compared between the two groups as well as a control group, who did not play racket-based sports.

Results: No significant differences in any body composition variable were found comparing tennis vs paddle players, with both groups showing a meso-endomorphic somatotype. The athletes presented lower muscle mass, and therefore less mesomorphic component, compared to the control group.

Conclusion: Since body composition is a major determinant in racket sport performance, it is instrumental to control fat and muscle body mass by using adequate dietetic and nutritional tools as well as optimal training programs.

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Key words: *Racket sports. Paddle. Tennis. Body composition. Somatotype.*

ESTUDIO DE LA COMPOSICIÓN CORPORAL DE JUGADORES ADULTOS DE PÁDEL Y TENIS

Resumen

Introducción: los deportistas que practican disciplinas deportivas de raqueta necesitan mejorar constantemente sus cualidades físicas con el fin de competir al máximo nivel. Por lo tanto, es necesario conseguir y mantener en dichos jugadores una óptima composición corporal, pero no obstante, existen pocos estudios publicados relacionados con esta temática.

Objetivo: el presente trabajo trata de ofrecer un perfil antropométrico completo, incluyendo el somatotipo y la composición corporal de jugadores varones adultos de pádel y tenis.

Material y métodos: se realizaron diversas medidas antropométricas, incluyendo peso corporal total, estatura, pliegues cutáneos, perímetros y diámetros, en 21 jugadores de pádel y 26 jugadores de tenis. Los resultados obtenidos de cada grupo de jugadores se compararon entre ellos y frente a un grupo control que no practicaba deportes de raqueta.

Resultados: no se encontraron diferencias significativas en cuanto a las variables de composición corporal analizadas entre los grupos de jugadores de pádel y tenis, mostrando ambos grupos un somatotipo meso-endomórfico. Los jugadores presentaron una menor masa muscular, y por tanto un menor componente mesomórfico, cuando se compararon con el grupo control.

Conclusión: ya que la composición corporal es determinante en el rendimiento de los jugadores de deportes de raqueta, es imprescindible realizar un control de la grasa y masa muscular mediante herramientas dietético-nutricionales así como de programas de entrenamiento adecuados.

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Palabras clave: *Deportes de raqueta. Pádel. Tenis. Composición corporal. Somatotipo.*

Abbreviations

BMI: body mass index or Quetelet index. Measure that links weight and height (weight (kg)·height (m)⁻²) and with a correlation with the body fat.

DXA: dual-energy X-ray absorptiometry. Technique used primarily to evaluate bone mineral density and based in the X-ray absorption by different tissues.

Correspondence: Néstor Vicente Salar.
Biochemistry and Cell Therapy Unit.
Institute of Bioengineering, University Miguel Hernandez.
Av. De la Universidad s/n, 03202, Elche (Alicante). Spain.
E-mail: nvicente@umh.es

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ISAK: International Society for the Advancement of Kinanthropometry. Organization that works on the standardization of anthropometric techniques and applications.

MRI: magnetic resonance imaging. Non invasive technique used in medicine based in magnetic fields and image treatment.

SAM: somatotype attitudinal mean. The average of the distance in three dimensions between the somatopoints from the mean somatopoint of a sample.

TEM: technical error of measurement. Represents the measurement quality and control dimension in anthropometry.

Introduction

Anthropometric measurements provide useful information concerning body composition parameters, making them a useful tool and a practical alternative to other costly methods based on image technology, in competitive sports. Competition at the highest level is in close correlation with specific phenotypic characteristics of the athletes, which are obtained in part by analyzing their anthropometric profile¹⁻⁴. Current advances allow us to obtain reliable results in terms of body composition through the use of magnetic resonance imaging (MRI) or dual-energy X-ray absorptiometry (DXA) techniques⁵⁻⁶. However, these techniques are not as portable or inexpensive as anthropometry, which can be used directly in the field. Therefore, anthropometry is a very fast method to obtain information of the athlete's nutritional and body composition, which can be reproduced and compared to other athletes of the sport discipline as well as track their own values throughout the season.

Paddle is a racket-based sport that is generally played in double matches on a 50 m² court for each player, surrounded by walls that can be used during the match. This allows a wide range of movements during paddle matches, although the physiological determinants remain to be analyzed in this particular discipline.

On the other hand, tennis is another racket-based sport where the player's movements are performed in a 98 (single-match) or 130 m² (double-match) court. Therefore, many movements on court are based on short sprints of 2-10 s covering distances of 8-12 m⁷⁻⁸. The different types of surfaces (grass, clay, hard, etc.) and tennis balls force the athletes to adapt to different physiological requirements, and therefore, energetic demands⁹. Regarding metabolic energy expenditure during a tennis match, the players normally reach an average heart rate of 70-85% with respect to their maximum level, using both aerobic and anaerobic metabolic pathways to obtain energy¹⁰⁻¹¹. Anaerobic pathways may entail 32% of the total energetic expenditure during the match, being 95% during the hit of the ball¹². Blood lactate levels remain constant around 1.8-2.8 mmol·L⁻¹¹³⁻¹⁵, increasing to 8 mmol·L⁻¹ in long and high intensity matches¹⁶. Re-

garding glycemia, blood glucose levels are maintained without alterations in matches that last between 90-180 min^{13,17}. Since the match duration and the different neuromuscular intensity phases are very variable, energy recovery is influenced by many factors¹⁸.

All the above mentioned parameters can be conditioned by a non-optimal body composition. In this context, fat mass excess may impair sports performance¹⁹, thus many authors study the correlation of sports results, along with technical and tactical abilities, with body composition²⁰⁻²². In addition, a high body fat level increases the possibility of developing injuries²³. Therefore, racket sports should not be an exception to these premises, suggesting the importance of reaching an adequate somatotype through diet and training.

Several publications have studied the somatotype and anthropometric parameters in adolescent tennis players, however none have been thoroughly studied in adult athletes. Furthermore, there is no information concerning anthropometric characteristics of paddle players and the present study intends to fulfill this gap.

Objectives

The present work tries to provide a complete anthropometric profile, including somatotype and body composition, of paddle and tennis male adult players; offering an useful information about the average profile of each sport discipline and serving as tool to evaluate athletes of these disciplines.

Method

Participants

A total of 21 Caucasian adult male paddle players were recruited from a national university paddle championship in the modality of doubles. Twenty-six Caucasian adult male tennis players (4 professional and 22 university-level) participated in this study. The 4 professional tennis players were ranked in the ATP's top 50. The remaining (n =22) tennis players were recruited from the national university tennis championship in the modality of singles, who were in the top 150 of the national ranking. Lastly, 25 Caucasian adult male athletes that did not practice racket-based sport disciplines were used as control group, chosen from the same university as the other candidates.

Participants were informed about the objective of the study and gave their written consent to participate. The study was in accordance with local legal requirements and the Helsinki Declaration for research on human beings, and approved by the Ethics Committee of University Miguel Hernandez (reference IB.ER.06.13). Anonymity was preserved for all participants.

Data collection

Anthropometric measurements were performed in the student tennis and paddle players on the first day of the championship before the matches. In the case of the professional tennis players, the measurements were performed during routine supervision sessions between ATP tournaments. The control group was measured throughout the school year. The restricted profile of ISAK I (International Society for the Advancement of Kinanthropometry) methodology was used by two ISAK accredited anthropometrists with an individual technical error of measurement (TEM) of 0.76% for skinfolds and 0.12% for the remaining parameters, both in the range of ISAK accreditation (<7.5% for skinfolds and <1.5% for the rest of measurements). Anthropometric parameters included weight in kg, height in m, eight skinfolds in mm (triceps, subscapular, biceps, suprailiac, supraspinal, abdominal, medial thigh and medial calf), four girths in cm (relaxed arm, flexed and tensed arm, waistline, hip, thigh and maximum calf) and three breadths in cm (femoral biepicondylar, humeral epicondylar and bistyloid of the wrist)²⁴. Skinfolds, girths and breadths were measured with a caliper, flexible metallic tape and pachymeter, respectively (Holtain, Crymych, UK). A calibrated digital scale (Tanita, Tokyo, Japan) was used to obtain the weight.

Body composition analyses

Bone and muscle mass were obtained through Rocha's equation²⁵ and Lee's formula²⁶, respectively. Fat mass was estimated using Siri's formula²⁷, obtaining the corporal density value through Withers' equation²⁸. Residual mass was calculated from the difference between the total body weight minus the sum of the bone, muscle and fat masses.

Somatotype components were obtained from the analysis of different body compartments, including muscle mass for mesomorphy, fat mass for endomorphy and thinness and relative bone linearity for ectomorphy. Somatochart was obtained from these components²⁹. The differences between each individual somatopoint with respect to the mean value was calculated using the somatotype attitudinal mean (SAM)³⁰.

Statistical analysis

SPSS Statistics V.20 package (Illinois, USA) was used to process the anthropometric data obtained from the volunteers. Standard descriptive statistics were presented as mean $\pm$ standard deviation (SD) and range. One-sample K-S test (Kolmogorov-Smirnov test) and Homoscedasticity Levene test were performed in order to assess if each variable fitted a normal distribution. Parametric and non-parametric tests for inde-

pendent samples (T test and Mann-Whitney test) were used to compare the anthropometric data between paddle and tennis players. A two-way analysis of variance (ANOVA) was used to test the differences between paddle, tennis and control groups. Values with a $p < 0.05$ were considered significant. A profile chart with norms, using percentiles (p values of 5, 10, 25, 50, 75, 90, 95) was constructed.

Results

Table I shows age and anthropometric characteristics of tennis, paddle and control groups monitored. The body mass index (BMI) ranged between 23.5-23.6 $\text{kg}\cdot\text{m}^{-2}$ and a distribution of muscle mass and fat percentage were 32.4-39.2 kg and 16.2-18.3% respectively in players of both sport disciplines. Therefore, no significant differences were detected between tennis and paddle players regarding the different anthropometric parameters. However, significant differences were detected in muscle mass, mesomorphic content and suprailiac skinfold value when compared to the control group.

However, when the data obtained from anthropometric measurements of both sports disciplines were calculated in percentiles following a normal distribution of frequencies, some tendencies were observed (tables II and III). At the 50th percentile, the tennis players presented a lower but not significant fat mass percentage than paddle players. These small differences were in accordance with the somatotype calculated at the 50th percentile, presenting higher mesomorphic and ectomorphic values in tennis than in paddle players.

The mean somatotype of tennis and paddle players was located in the meso-endomorphy area when the data were displayed in a somatochart (Fig. 1). However, and despite maintaining the mean somatotype in this area, paddle players tended to stay in the endomorphic component in a non-significant manner. Furthermore, SAM results were not significant.

Discussion

To our knowledge, this is the first report studying anthropometric parameters in adult paddle players. Regarding tennis players, previous studies have been published in adolescent tennis practitioners (under 18 years of age)^{31,32} and in adults using DXA³³ but only to study body fat percentage. Therefore, this report is the first presenting complete anthropometric data of adult tennis players, including 4 individuals in the top 50 of the ATP ranking.

The main observation was that there were no significant differences when comparing anthropometric parameters in players from both sports. Skinfold values were similar between tennis and paddle players, indicating very similar body fat contents (tables I-III).

Table I
Descriptive anthropometric characteristics for adult tennis (*n* =26), paddle players (*n* =21), and university athletes (control) (*n* =25)

	Tennis		Paddle		Control		<i>p</i> Value
	mean	<i>s</i>	mean	<i>s</i>	mean	<i>s</i>	
Age (years)	23.0 ± 3.7		23.1 ± 3.6		21.0 ± 1.9		0.008*
Body mass (Kg)	74.7 ± 7.5		74.3 ± 8.6		74.0 ± 6.9		ns
Height (m)	1.8 ± 0.1		1.8 ± 0.1		1.8 ± 0.1		ns
BMI (kg·m ⁻²)	23.5 ± 1.7		23.6 ± 2.1		23.6 ± 2.3		ns
Sum of 7 skinfold (mm)	92.3 ± 28.6		104.3 ± 34.8		87.3 ± 28.1		ns
Subscapular skinfold (mm)	11.0 ± 2.6		12.2 ± 4.6		11.8 ± 3.7		ns
Triceps skinfold (mm)	12.4 ± 4.3		13.3 ± 5.0		10.6 ± 3.9		ns
Biceps skinfold (mm)	5.8 ± 2.3		6.2 ± 2.2		5.9 ± 2.9		ns
Suprailiac skinfold (mm)	19.9 ± 6.2		21.2 ± 7.5		15.4 ± 5.1		0.006**
Supraspinal skinfold (mm)	10.6 ± 4.4		13.0 ± 6.0		12.0 ± 5.1		ns
Abdominal skinfold (mm)	18.1 ± 8.0		20.5 ± 9.0		16.1 ± 6.1		ns
Thigh skinfold (mm)	14.5 ± 5.4		17.8 ± 6.6		15.5 ± 6.8		ns
Calf skinfold (mm)	9.8 ± 4.0		10.8 ± 5.1		9.5 ± 4.1		ns
Upper arm girth relaxed (cm)	30.8 ± 2.5		30.9 ± 2.5		31.4 ± 2.5		ns
Upper arm girth flexed and tensed (cm)	32.7 ± 2.3		32.9 ± 2.4		33.4 ± 2.6		ns
Thigh girth (cm)	52.4 ± 3.2		52.2 ± 3.6		54.0 ± 3.8		ns
Calf girth (cm)	37.5 ± 1.8		37.1 ± 1.9		37.7 ± 1.8		ns
Humeral breadth (cm)	7.2 ± 0.4		7.1 ± 0.3		7.0 ± 0.5		ns
Wrist breadth (cm)	5.8 ± 0.3		5.8 ± 0.2		5.8 ± 0.4		ns
Femoral breadth (cm)	10.0 ± 0.6		9.8 ± 0.4		9.9 ± 0.5		ns
Endomorphy	3.3 ± 1.0		3.7 ± 1.2		3.3 ± 1.2		ns
Mesomorphy	4.3 ± 1.2		4.1 ± 0.9		5.6 ± 1.1		<0.001**
Ectomorphy	2.5 ± 0.9		2.4 ± 0.8		2.4 ± 1.2		ns
SAM	1.6 ± 7.9		1.6 ± 7.1		1.7 ± 8.7		ns
Muscle mass (kg) (Lee. 2000)	33.2 ± 3.6		32.4 ± 3.0		39.7 ± 3.3		<0.001**
Fat mass (%) (Siri. 1961)	16.2 ± 5.0		18.3 ± 6.2		11.4 ± 4.2		ns
Waist perimeter (cm)	80.6 ± 4.6		80.3 ± 4.3		80.1 ± 3.9		ns
Hip perimeter (cm)	97.2 ± 4.3		97.0 ± 5.7		96.3 ± 5.0		ns
Waist·Hip ⁻¹	0.8 ± 0.0		0.8 ± 0.0		0.8 ± 0.0		ns
Sum of 3 skinfold (mm)	34.0 ± 10.2		38.6 ± 13.7		34.4 ± 11.5		ns
Sum of 6 skinfold (mm)	86.4 ± 26.7		98.1 ± 32.9		81.4 ± 26.3		ns
Sum of 8 skinfold (mm)	102.0 ± 31.5		115.0 ± 38.5		96.7 ± 30.4		ns

(mean±*s*), ns = not significant; * = Control vs Paddle; ** = Control vs Paddle and Tennis.

As a difference, tennis players tended to the ectomorphism in a non-significant manner than paddle players, coinciding with value distribution at the 50th percentile (tables II and III). This similarity in body composition for both sport disciplines could be due to the fact that many tennis players can leave tennis practice and

start a new career in paddle or combine both disciplines. This is the case of the paddle players monitored in this study. The comparison with a control group, using volunteers of similar age than the athletes, indicated significant differences in the muscle component. This indicates an imbalance between lean mass and body

Table II
Anthropometric profile chart for the total adult tennis players (n =26)

<i>Percentiles</i>	<i>5</i>	<i>10</i>	<i>25</i>	<i>50</i>	<i>75</i>	<i>90</i>	<i>95</i>
Age (years)	18.4	19.0	19.8	22.5	27.0	28.3	29.7
Body mass (Kg)	63.3	64.7	68.1	74.6	81.4	84.0	88.3
Height (m)	1.7	1.7	1.7	1.8	1.8	1.9	1.9
BMI (kg·m ⁻²)	20.7	21.3	22.5	23.0	24.7	25.4	27.8
Sum of 7 skinfold (mm)	51.3	56.0	62.7	90.5	117.4	135.0	139.3
Subscapular skinfold (mm)	6.8	7.7	9.2	10.8	12.4	14.9	16.7
Triceps skinfold (mm)	5.5	6.4	9.0	11.9	17.0	18.1	19.8
Biceps skinfold (mm)	3.1	3.3	4.1	5.4	7.6	9.3	11.2
Suprailiac skinfold (mm)	10.0	11.5	14.7	19.0	24.4	27.8	31.7
Supraspinal skinfold (mm))	5.1	5.3	6.2	10.4	13.4	16.6	20.1
Abdominal skinfold (mm)	7.4	9.0	11.4	16.3	26.0	29.7	32.6
Thigh skinfold (mm)	6.9	7.4	10.3	13.6	18.5	23.1	25.6
Calf skinfold (mm)	4.2	4.9	6.0	9.5	12.0	15.3	19.4
Upper arm girth relaxed (cm)	26.4	27.4	28.4	31.1	32.4	34.0	35.4
Upper arm girth flexed and tensed (cm)	28.7	29.7	31.0	33.0	34.0	35.2	38.1
Thigh girth (cm)	46.7	48.4	50.8	52.4	54.0	57.2	59.5
Calf girth (cm)	34.7	35.0	36.0	38.0	38.7	40.0	41.2
Humeral breadth (cm)	6.4	6.6	6.9	7.2	7.5	7.6	7.7
Wrist breadth (cm)	5.4	5.5	5.6	5.8	6.0	6.3	6.5
Femoral breadth (cm)	9.1	9.3	9.7	10.0	10.2	10.5	11.5
Endomorphy	1.5	1.7	2.4	3.5	4.0	4.4	5.2
Mesomorphy	1.9	2.2	3.6	4.5	4.9	5.9	6.1
Ectomorphy	0.5	1.3	1.9	2.6	3.1	3.7	3.9
Muscle mass (kg) (Lee, 2000)	27.2	29.3	31.0	32.8	35.0	37.6	42.7
Fat mass (Siri, 1961) (%)	9.0	9.9	11.0	15.8	20.6	23.8	24.5
Waist perimeter (cm)	71.8	75.0	76.0	80.3	84.9	87.0	88.4
Hip perimeter (cm)	88.7	90.0	93.9	98.3	100.4	101.7	104.5
Waist·Hip ⁻¹	0.8	0.8	0.8	0.8	0.9	0.9	0.9
Sum of 3 skinfold (mm)	17.8	19.4	25.6	34.8	41.9	46.9	53.6
Sum of 6 skinfold (mm)	47.7	52.7	57.8	86.1	110.6	127.9	129.5
Sum of 8 skinfold (mm)	55.7	60.8	72.8	100.5	132.4	147.0	151.9

fat in tennis and paddle players, which may be due in part to a poor control in diet³⁴. These athletes tend to travel frequently to compete in different tournaments around the world and one of the major difficulties is to control the intakes and manage adequate diet plans.

Compared to studies performed in adolescents^{31,32}, adult tennis players presented lower muscle mass percentages, around 44.6% (table I) vs 47%³². On the other hand, body fat percentage in adults was approximately 16.2% (table I), while adolescents presented

values ranging 14.6-15.8%^{31,32}. These differences determine the BMI values and somatotype of both types of players. The BMI of adolescent tennis players ranged 21.5–22.3 kg·m⁻²^{31,32}, while in adults the values were approximately 23.5 kg·m⁻² (table I). In this regard, endomorphic values in young players were lower than the mean value detected in adults: 2.4³² and 3.3 (table I) respectively. The endomorphia values were also higher in adults (5.2, see percentile 95th in table II) compared to adolescents (4.3³²). However the

Table III <i>Anthropometric profile chart for the total adult paddle players (n =21)</i>							
<i>Percentiles</i>	<i>5</i>	<i>10</i>	<i>25</i>	<i>50</i>	<i>75</i>	<i>90</i>	<i>95</i>
Age (years)	18.1	19.0	21.0	23.0	24.5	27.6	34.3
Body mass (Kg)	62.6	65.2	68.2	73.0	79.0	91.0	96.1
Height (m)	1.7	1.7	1.7	1.8	1.8	1.8	1.9
BMI (kg·m ⁻²)	21.0	21.0	22.0	23.4	24.7	27.6	28.5
Sum of 7 skinfold (mm)	49.3	66.2	76.4	95.8	134.1	151.0	179.1
Subscapular skinfold (mm)	7.4	8.1	8.9	11.3	13.6	17.9	27.0
Triceps skinfold (mm)	5.4	6.7	9.0	13.8	16.5	20.0	25.2
Biceps skinfold (mm)	4.0	4.2	4.4	5.6	8.1	10.0	11.7
Suprailiac skinfold (mm)	9.9	11.5	14.6	19.3	29.3	32.9	33.4
Supraspinal skinfold (mm))	5.4	7.6	8.5	10.7	16.5	23.0	28.1
Abdominal skinfold (mm)	8.8	9.2	13.9	19.0	27.6	33.9	38.7
Thigh skinfold (mm)	6.7	8.8	13.3	16.2	24.4	25.6	30.5
Calf skinfold (mm)	4.2	5.6	6.7	9.2	13.0	20.7	21.3
Upper arm girth relaxed (cm)	25.3	28.0	29.3	31.1	32.3	34.6	36.2
Upper arm girth flexed and tensed (cm)	28.2	29.9	31.0	33.5	35.0	35.7	37.8
Thigh girth	46.8	48.1	49.0	52.0	55.1	56.9	60.0
Calf girth (cm)	33.1	34.1	35.8	36.9	38.9	39.4	40.0
Humeral breadth (cm)	6.3	6.7	7.0	7.2	7.4	7.5	7.8
Wrist breadth (cm)	5.1	5.5	5.7	5.8	5.9	6.2	6.2
Femoral breadth (cm)	9.0	9.4	9.6	9.8	10.2	10.2	10.6
Endomorphy	1.7	2.3	2.8	3.5	4.6	5.7	6.3
Mesomorphy	2.2	3.0	3.5	4.0	4.9	5.5	5.8
Ectomorphy	0.8	1.2	1.8	2.2	3.3	3.6	3.8
Muscle mass (kg) (Lee, 2000)	26.8	27.5	30.8	32.7	34.6	36.7	38.4
Fat mass (Siri, 1961) (%)	8.7	11.6	13.4	16.8	23.6	26.7	31.9
Waist perimeter (cm)	71.8	73.8	77.5	80.0	83.7	85.7	89.2
Hip perimeter (cm)	90.1	91.1	93.1	96.0	100.3	103.7	113.9
Waist·Hip ⁻¹	0.8	0.8	0.8	0.8	0.9	0.9	0.9
Sum of 3 skinfold (mm)	18.4	24.5	28.5	36.2	47.8	60.8	72.6
Sum of 6 skinfold (mm)	44.6	61.5	71.8	91.6	126.0	142.4	168.9
Sum of 8 skinfold (mm)	53.7	73.0	83.1	103.6	145.5	169.8	198.0

ectomorphic values were very similar in both populations (2.5, see table I), similar to that observed in previous studies³². Several factors could explain these anthropometric differences, including diet composition³¹ together with an increase of hormonal levels and neuromuscular activation^{35,36}. However, more studies are necessary to confront these questions and determine the role of diet in these observations.

Overall, this is the first report to study average tennis somatotype, located in the meso-endomorphic

area. In a previous study using DXA assessment, the percentage of body fat in adult tennis players was calculated at approximately 10.3%³³, which is lower than the anthropometric measurements provided in this study (16.2%; table I). Indeed, DXA analysis is more accurate than kinanthropometry, since the formulas to develop equations from anthropometric measurements are not specific to sports disciplines. However, DXA is not a suitable technique for outdoor use. In addition, the population studied in the

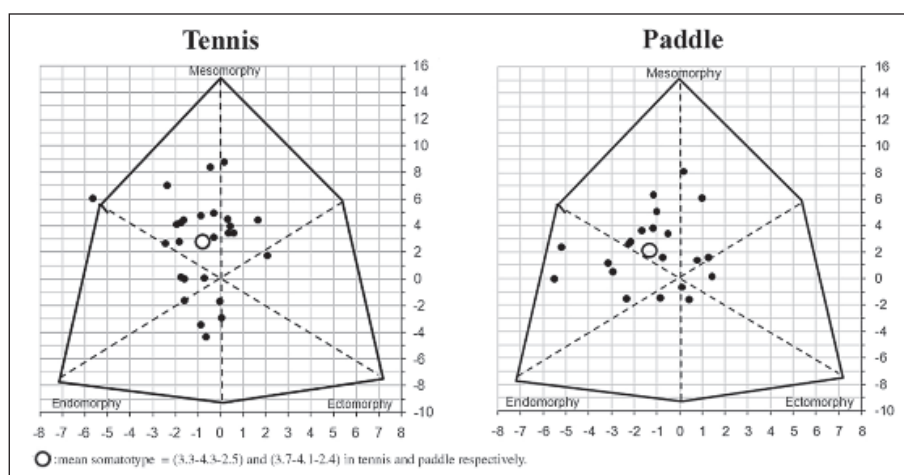


Fig. 1.—Somatotype distribution of adult tennis players ($n=26$) and adult paddle players ($n=21$).

previous work using DXA was not the same used in this study. In any study, it is necessary to take in account both methodology and data treatment so that data comparisons may be performed between studies. In this context, anthropometry presents a distinct advantage over other techniques, as it is regularly used in numerous studies from a wide range of sport disciplines. Furthermore, kinanthropometry is the most suitable and reliable method to control body composition changes over time in athletes.

Compared to other racket-based sports, tennis and paddle players presented higher height, weight and body fat percentages than adult badminton players: 1.7 ± 0.4 m, $64.8-67.5 \pm 6.9-8.7$ kg and $12.1 \pm 3.4\%$ respectively^{37,38} and adult squash players: 1.7 ± 0.4 m, 67.7 ± 6.9 kg and $7.4 \pm 3.4\%$ respectively³⁹.

Finally, it is possible to hypothesize the implication that these results may have on the training and diet management of tennis and paddle players. First of all, it is mandatory to establish if a relationship between body composition and daily diet exists. In fact, diet is an instrumental component, together with training, to modulate anthropometric parameters. However, diet is a source of regulatory molecules that help to control body homeostasis. In this respect, it has been described that excess protein and lipid intakes were observed in adolescent tennis players, which may present deficiencies in certain nutrients such as fiber, or micronutrients such as calcium, potassium, magnesium and folic acid³¹. Furthermore, racket sport players, and particularly tennis players, compete abroad during long periods of time, being exposed to a high risk of imbalanced diets, due to problems of food availability and suitable meals, changes in schedule and duration of matches. These issues could affect body composition and increase the risk of fat mass accumulation together with muscle mass decrease throughout time. In addition, performance in speed and capacity to respond would decrease when body fat accumulates, increasing the risk of developing injuries. A previous report indicated that 35-65% of the injuries occur in

the lower limbs⁴⁰. Part of the cause for these injuries may be due to excess weight, although additional studies must be performed to confirm this point. Therefore, the results presented in this study can be used as a standard reference for tennis professionals, including coaches, doctors and dietitians.

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Original/*Valoración nutricional*

Nutritional content of foods offered and consumed in a Spanish university canteen

Ángela Fernández Torres¹, Rafael Moreno-Rojas¹ and Fernando Cámara Martos¹

¹*Food Science and Technology, Cordoba's University, Córdoba. Spain.*

Abstract

Objective: The prime objective of our work was to study the eating habits at lunchtime of staff and students at a University of “hidden due to confidentiality” of Spain. The second one was to attempt to reduce the energy consumption of cholesterol and fat in the diet of those groups.

Setting: The study was made between 2010 and 2012 in the main canteen serving food at this university, focusing on food intake at lunch, the main meal of the day, containing between 35 and 40% of the total calories ingested throughout the day.

Subjects: A total of 9530 observations were made, each one corresponding to the nutritional valuation of food eaten (a complete lunch) per person, by students, teachers and service personnel.

Design: The study was carried out in 5 intervention stages and a previous non-intervention one to establish the habitual food intake of these groups. In each stage the nutritional information supplied to canteen users was increased to that in the final stage a modification of the price of the menus served was made.

Analysis: The food choices freely made by the groups were converted into the amount of nutrients by means of a prior nutritional evaluation of the dishes offered via their calculation using the database Nutriplato®. This permitted the evaluation of 29 nutrients which, taking the user data observed, were converted into % of contribution to the RDA (per each population group), which produced a standardization of the data, permitting a subsequent statistical study by the GLM (SPSS v15) procedure to assess the effect of the different factors contemplated.

Main Outcome Measure(s): The following were taken into account as classification factors (independent variables): sex, age group and level of body fat, as well as the intervention stage. The dependent variables were: energy, protein, lipid, carbohydrate, fiber, Ca, Mg, P, Na, K, Fe, Cu, Zn, Mn, I, Se, vitamins: B1, B2, B3, B5, B6, B8, B9, B12, C, A, D, E and cholesterol.

CONTENIDO NUTRICIONAL DE ALIMENTOS OFRECIDOS Y CONSUMIDOS EN UNA CANTINA UNIVERSITARIA ESPAÑOLA

Resumen

Objetivo: El primer objetivo de nuestro trabajo fue estudiar los hábitos alimentarios durante el almuerzo en la Universidad de Córdoba. En segundo término se trató de reducir el consumo energético de colesterol y grasa en la dieta de dicho colectivo.

Marco: El estudio se realiza entre los años 2010 al 2012 sobre la principal cantina en la que se sirve comida en esta Universidad, centrándonos en la toma de alimento del almuerzo, que es la principal toma alimentaria a lo largo del día, suponiendo entre el 35 y 40% del total de calorías ingeridas a lo largo del día.

Muestras: Se han abordado un total de 9530 observaciones que corresponden cada una de ellas a la valoración nutricional de una toma de alimento (almuerzo completo) por estudiantes, profesorado y personal de servicios.

Diseño: El estudio se desarrolló en 5 fases de intervención y una previa en la que no se intervino, esta última se utilizó para establecer las ingestas habituales alimentarias del colectivo. En cada fase se incremento la información nutricional suministrada a los usuarios de la cantina, para en la fase final, desarrollar también una modificación del precio de los menús servidos.

Análisis: Las elecciones alimentarias que realizaban los universitarios de forma libre fueron transformadas en cantidad de nutrientes mediante la valoración nutricional previa de los platos, desarrollada por cálculo mediante la base de datos Nutriplato®. Esto permitió evaluar 29 nutrientes que a partir de los datos observados de los usuarios se transformaron en % de aporte a la RDA (de cada grupo de población) lo que produce una estandarización de los datos que permitió un estudio estadístico posterior, mediante el procedimiento GLM (SPSS v15) para evaluar el efecto de los diferentes factores contemplados.

Principales medidas tomadas: Se tuvieron en cuenta como factores de clasificación (variables independientes): sexo, grupo de edad y nivel de grasa corporal, así como la fase de intervención. En cuanto a las variables dependientes fueron: energía, proteína, lípidos, carbohidratos, fibra dietética, Ca, Mg, P, Na, K, Fe, Cu, Zn, Mn, I, Se, vit: B1, B2, B3, B5, B6, B8, B9, B12, C, A, D, E y colesterol.

Correspondence: Rafael Moreno-Rojas
Dpto. Bromatología y Tecnología de los Alimentos.
Campus de Rabanales, Ed. Darwin.
Universidad de Córdoba. 14014-Córdoba. Spain.
E-mail: rafael.moreno@uco.es

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Result: The mean energy and cholesterol intake was significantly reduced in the individuals investigated in the last two intervention stages. Moreover, those last two stages were statistically differentiated, the last one being that which presented the lowest intake of those nutrients. As positive collateral effects, although this was not a priority objective in the study, a greater statistically significant intake of vitamin D, B9, dietetic fiber, and calcium and a lower intake of sodium with respect to the initial stages were noted.

Conclusions and implications: Our conclusions go in two directions: the positive effect of the nutritional information and the need to complement that information with economic measures that encourage still further food changes in population groups whose purchasing power is not very great.

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DOI:10.3305/nh.2015.31.3.8006

Key words: *Canteen lunch. Young adults. Food choice. Catering. Healthy eating.*

Abbreviations

RDA: Recommended Dietary Allowance.

Introduction

The university is a place for intellectual and professional training but it also has to concern itself with other spheres of human qualities in favor of the users of its facilities. The Andalusian Network of Andalusian Universities (RAUS), which encompasses all the universities in the Autonomous Government of Andalusia, promotes several actions oriented towards improving the health habits of both university teachers and students.

One of these initiatives is the Healthy Food program at our University of "hidden due to confidentiality". The latter has over 18000 students, over 1500 teachers and about 750 administration and services staff. Nearly a third of these three groups carries out its activities in the main Campus. In this campus there are four catering centers, out of which the classroom canteen, for its size and location, serves approximately half the meals available in the campus. The Campus is located at 6 km from the city of "hidden due to confidentiality" and there is only an industrial estate in its surroundings so that eating options are very limited. Moreover, the degree subjects offered are taught both mornings and afternoons, so that many students, teachers and other personnel need to eat lunch at the Campus. For this they usually either bring food from home or eat in the Campus canteens. According to a survey conducted prior to the study, 85% of the respondents ate in the canteens at least 3 times a week and the remaining 15% ate home-cooked food.

Resultados: La ingesta media de energía y colesterol se redujo significativamente en los individuos investigados en las dos últimas fases de intervención, pero además estas dos últimas fases se diferenciaron estadísticamente, siendo la última la que presentaba la ingesta de estos nutrientes más bajas. Como efectos positivos colaterales, aunque no era un objetivo prioritario del estudio se observó una estadísticamente significativa mayor ingesta de vitamina D, B9, fibra dietética, calcio y una menor ingesta de sodio, respecto a las fases iniciales

Conclusiones e implicaciones: Nuestras conclusiones son en dos sentidos: el efecto positivo que tiene la información nutricional y la necesidad de complementar dicha información con medidas económicas que incentiven aún más los cambios alimentarios en poblaciones cuyo poder adquisitivo no es muy elevado.

(Nutr Hosp. 2015;31:1302-1308)

DOI:10.3305/nh.2015.31.3.8006

Palabras clave: *Almuerzo. Cantina. Adultos jóvenes. Elección alimentaria. Catering. Alimentación saludable.*

During the study period the mean daily affluence of users of the classroom canteen in which the study was made was of 150 people daily.

Papadaki et al.¹, reported that when students left home to study at university the quality of their diet deteriorated. According to Durá Travé and Castroviejo Gandarias², 76% of the college students investigated by them in another Spanish region needed to improve their eating patterns, and these authors suggested that nutritional education programs for college students should be instigated. More alarming data were supplied by Nilufer Acar Tek et al.³ who, in a study on somewhat lower age groups, indicated that 43% of the young people presented bad eating habits and the rest needed to improve theirs. Among the bad habits, one which stood out was skipping lunch according to Neslisah and Akal Emine⁴ by up to 25% of students between 19 and 24 years of age; these authors also declared the need for an intervention in this group. Lachat et al.⁵ checked the selection of foods in Belgian universities and verified that the nutrient profile of food eaten was highly correlated with what was offered and proposed changes in that offer, increasing supplies of vegetables and fruit and reducing fat and salt intake. Nedaa & Al-Khamees⁶ in an intervention study proved the efficacy of nutritional information on eating habits in college students. The effects of good dietary guidelines at university were demonstrated in the work of Guagliardo et al.⁷, who reported that 33% of students of between 18 and 24 who ate regularly at the university obtained adequate amounts of fruit, vegetables, fish and meat. This study also showed that the strata with a lower economic level had a less suitable diet.

In view of the above, the current study had two aims: to study the eating habits of the population at "hidden due to confidentiality" University when making use of the canteens, and, besides that, to interve-

ne in that consumption in order to improve the food's nutritional quality based on three criteria: total calory intake, contribution and quality of fat, and the contribution of cholesterol. For this purpose, the food consumed was evaluated with data selected in the queue of the self-service buffet in the classroom canteen.

Material and methods

The study was conducted at "hidden due to confidentiality". It began in 2010 and ended in 2012, in the area of the college catering establishments, with a total of 9530 observations each one corresponding to the complete consumption of luncheon food per person and per day. Lunch is the main meal in Spain and it represents approximately 30-35% of the daily calory intake of young people⁸.

It is important to note that the canteen customers can choose between eating mixed platters or sandwiches, or, conversely, going through the canteen buffet. Given that it is less possible to act on either mixed platters or sandwiches, this study focused on the canteen buffet, in which there are two options: the "menu of the day" in which two choices of the first course and two choices of the second one are offered; and the "student's menu" with a special low price but in which only one first and one second course are offered. In both menu types a drink, bread and a dessert are included. In the annotations of each observation, information was collected on which choice each individual made of each component of his/her menu: first course, second course (with main item and its garnish), bread, dessert, drinks and sauces or supplements (for example, (extra French fries) which made up that lunch. In each observation the individual studied is classified in terms of gender, age group (18-25 years >25 years) and according to their visible fat reserve (-1: slim/0: normal weight/+1 overweight).

Prior to carrying out the study, the users had no nutritional information on the dishes or had any design of the menus based on their nutrient supply.

Actions prior to conducting the study

Gathering information about the dishes served: We collected details of all the ingredients and of the preparation of the dishes usually served in the canteen, both the meals and snacks, and the food in the buffet. The information collected was transformed into nutrients through the program Nutriplato⁹. Battistini et al.¹⁰ came to the conclusion, in their study on college students from Modena, that the use of computing tools for nutritional assessment of this population is an effective and cost saving alternative compared to laboratory analysis.

A classification of the nutritionally evaluated dishes was made depending on their nutritional contributions.

This classification was based on nutritional adequacy criteria taking the total intake of calories, fat, and type of fat, cholesterol and sodium. Thus, all the dishes were encompassed within one of the four following categories: "highly recommended", "recommended", "not recommended" and "occasional consumption". This classification was used only to provide nutrition information, in some of the phases, to users but not as a tool for nutritional study.

Data Collection

Data collection consisted of taking notes of the choice each user made in the self-service queue, as if a mere accounting or administrative control was being carried out. Each observation consisted of a starter, main course (main ingredient and its garnish), bread, dessert, drink, coffee and extra elements (sauces: ketchup, mayonnaise, etc., serving of French fries, etc). Along with consumer data classification, data including gender, body fat assessment (assigning -1 to the people who were underweight, 0 people of normal weight and +1 to people who were overweight), age group (making a group of 18-25 year olds and people over 25 years) were also collected.

Consumption data were crossed with the composition of the dishes using MS-Access, to obtain the nutrient intake of each individual. They were given a subroutine for processing each ingredient of the menu depending on its nutritional contribution. Later, calculations of the ingredient aggregation were performed per individual / day for nutrient intake data in each observation.

Development and intervention study

Between 2010 and 2011, a food consumption sampling of all users of the canteen in the self-service section was carried out on the days established previously by design phases described below. The total number of individuals / shots made was 9530.

- Phase 0: annotations were only made about which food people selected in the self-service section, without their knowing that the investigation was being made and why they were being asked for such information.
- Phase 1: the annotations of food consumption continued, but during this period a survey on adherence to the Mediterranean diet and anthropometric assessments were made simultaneously. In addition, the leftovers that remained in the trays after lunch was eaten were assessed. Although at no time was a direct link between these actions and consumer data collection expressed, we believe that it exerted a psychological pressure on

the importance of healthy eating. Furthermore, these data were used as the basis for comparing the consumption information collected.

- Phase 2: continued with the annotation of food consumption but provided relevant information on the self-service section in the form of a logo that identified nutritionally recommended dishes (only the category “highly recommendable” of the four that were classified from all the foods tested). The possibility of composing a menu of highly recommended healthy food was ensured, but it did not propose the whole menu and only pinpointed items among the eligible ones.
- Phase 3: the annotation of food consumption was accompanied on this occasion by more nutrition information in the self-service queue, identifying dishes that belonged to the three most favorable categories (obviously the non-labeled dishes were not recommended, but this rejection of them was not expressed). Simultaneously, on some television screens placed in the dining room during the meal, the nutritional profile of all the dishes offered that day in the self-service section was shown, indicating the most important nutritional characteristics in accessible language and clarifying the benefits of foods recommended as opposed to nutritional disadvantages in the less desirable dishes
- Phase 4: the food consumption score was complemented by a healthy menu proposal designed to be nutritionally adequate. Therefore, menus consisted of a starter and a main course, bread, a drink and dessert / coffee. In this phase, the nutritional information was still provided daily through the TV screen and logos identifying the nutritional recommendation grade of each dish using the 4 categories designed.
- Phase 5: The annotation was made on the basis of two menus: the daily menu that was again the traditional normal price, and the healthy and reduced price menu which was the only one that the students could enjoy at such a low price. The nutritional information continued to be provided daily through the TV screen and recommendation logos based on the nutritional intake with 4 categories. At this stage, the swapping of food between menus was allowed, but in this case there was no price reduction.

The idea behind the design of the healthy menus was to reduce caloric, lipid, cholesterol and also salt intake. Basically, both the first and main courses were selected with these criteria, the usual offer of French fries was changed for various other options such as plain rice, sauteed vegetables, cooked or baked potatoes, or lettuce and tomato salad. The drink choices were water, jui-

ce, isotonic drinks, tea, beer, wine or gazpacho (tomato and water-based drink, typical of southern Spain); for dessert, the choices were fruit, yogurt and coffee.

The data collected were not comparable between the different gender and age groups, as their nutritional recommendations were different. Moreover, in using different quantification units for different nutrients, we were not able to make direct comparisons between them. Therefore, we proceeded to standardize the data by calculating the input of each nutrient with respect to the IDR recommended in the Spanish population¹¹. For a better fit, we used nutrient ratio data corresponding to a regular lunch intake obtained from the Spanish Nutritional Dietary Intake Study¹². Applying both standardization criteria, if values close to 100% were obtained this indicated the fitness of the nutrient contribution to the IDR of the lunch for the population group; values clearly below 100% were indicative of a deficiency in the supply; and, on the contrary values exceeding 100% showed an excessive input of the nutrient. Obviously, these inputs must be understood as being in the context of the effects of the lack and excess of every nutrient investigated.

Results and discussion

The results obtained have permitted an evaluation of the content of nutrients provided by food selections made by canteen users in the different phases of the study.

Food choices for college lunch have been converted into nutrients by calculation using Nutriplato[®] and therefore, each observation actually comprises 29 nutrients, which were then transformed into % RDA.

We used the GLM procedure (SPSS v15) to evaluate the impact of different effects on the variables. First, a multivariate study was conducted by 4 classical tests: Pillai, Wilks Lambda, Hotelling's Trace and Roy's largest root applied to all variables (% of RDI for all nutrients) as a whole as opposed to factor classification. The results show that all the rating factors (stage, gender, age group and classification) and their interactions gave significant differences ($p < 0.01$), except for some 3rd level interactions, which were only $p < 0.1$.

After evidencing the effect of the factors on the variables globally, we proceeded to study the effect of these factors on each of the % RDI of nutrients individually. Again, we used the GLM procedure that gave the results reported in table I. As can be seen, the phase factor provided statistically significant differences in most of the contributions to the recommended daily intake of nutrients. Next was the gender factor, and the one least statistically represented was the ranking factor.

With regard to the interaction of these factors, only some significant differences were found in the case of phase vs. gender group interaction for Ca, Fe, Zn and Cu, B8, Vitamin D and Vitamin E. In the case of the in-

Table I
Significance levels obtained from the application of the GLM procedure to nutrients studied based on the rating factors used

Nutrient	Phase	Sex	Age group	Assessment
Kcal	***	***	n.s.	n.s.
Protein	***	***	***	n.s.
Lipid	***	***	n.s.	n.s.
Carbohydrate	***	***	n.s.	n.s.
Fiber	***	***	***	n.s.
Ca	***	***	***	n.s.
Mg	***	***	n.s.	n.s.
P	***	**	n.s.	n.s.
Na	***	**	n.s.	n.s.
K	**	n.s.	n.s.	n.s.
Fe	***	***	***	n.s.
Cu	***	*	n.s.	*
Zn	***	***	n.s.	n.s.
Mn	n.s.	n.s.	**	n.s.
I	***	n.s.	***	n.s.
Se	n.s.	**	*	n.s.
B1	n.s.	n.s.	n.s.	n.s.
B2	n.s.	n.s.	n.s.	n.s.
B3	***	***	n.s.	n.s.
B5	***	**	***	n.s.
B6	***	***	n.s.	n.s.
B8	***	**	***	n.s.
B9	***	n.s.	**	n.s.
B12	*	n.s.	n.s.	n.s.
VitC	***	n.s.	***	n.s.
VitA	***	***	***	n.s.
VitD	***	n.s.	n.s.	n.s.
VitE	***	*	**	n.s.
Cholesterol	**	n.s.	n.s.	n.s.

*** p<0.001
** p<0.01
* p<0.05
n.s. p>0.05

teraction phase x age group, the differences were found mainly in the group of fat soluble vitamins and water soluble ones except for B1, B2 and B3. The remaining interactions were, with one exception, not significant.

From the results of the GLM studies it was easy to extract the groups that had a higher or lower% RDI, by making a simple observation of the means in the case of the Gender and Age Group, due to presenting only

two classification groups. In contrast, for the intervention factor, Tukey Post hoc studies ($p < 0.05$) were necessary for each nutrient. In general, it was found that the last two phases of the intervention (4 and 5) formed an independent homogeneous group presenting lower levels of energy intake, lipids and cholesterol, which was the fundamental objective of the study and intervention. Namely, the energy, lipid and cholesterol intake was significantly lower in individuals investigated in these last two intervention phases. Simultaneously, there were other beneficial side effects that, although they were not the fundamental objective of the intervention, also had an influence on its improvement. For instance, the last three intervention phases differed significantly ($p > 0.05$) with a greater intake of vitamin D, the last two phases displayed a higher intake of vitamin B9, the fifth phase a lower sodium intake and increased fiber intake, and phases 2-5 a greater input of Ca with respect to 0 and 1 that were different homogeneous groups.

% RDA results of energy, lipids, cholesterol and sodium are shown in table II, for classification factors exhibiting a greater differential effect (stage, gender and age group).

Our results agree with those indicated by Lachat et al.⁵, who postulate that a significant impact on food supply selection is made in university canteens. Moreover, they also match those given by Burton et al.¹³, who observe that consumers of the quick service restaurant menu, have a scant capacity to estimate the quality of their meals in terms of calories, fat and sodium, which is more marked in the less healthy menus, with nutrition labeling of food having an unequal effect on the choice made by those consumers. According to Riddell et al.¹⁴ the perception of students is that they usually eat a healthy diet, which, however, is usually not fulfilled in terms of saturated fat and sodium; in our survey of adherence to the Mediterranean diet by Kidmed test¹⁵ we also obtained high adhesion results (between 6.40-7.28 on average per year) even higher than those reported by Dura Trave & Castroviejo Gandarias². However, simply improving their nutritional training in our study showed itself to be insufficient; Blades & Al-Khamees¹⁶ report that simple nutritional knowledge does not necessarily mean the choice of a healthy menu. This argument is also supported by Hoefkens et al.¹⁶, who say that, indeed, the posting of nutritional information in university canteens did not change meal choices and nutrient intakes; despite the intervention, meal choices were largely determined by the meals offered. Therefore, nutrition-information interventions in canteens may be more effective with a healthier meal supply. Our idea of providing nutritional information and offering healthier menus at a reasonable cost may be the best way of improving the nutrition at our university. In any case, this economic aspect should not be overlooked, because, as indicated by Guagliardo et al.⁷, this issue is an influential factor in college student food quality.

Table II
Percentage of the RDA for the lunch food selection covers the university students for energy, fat, cholesterol and sodium

	Man			Woman			Total
	adult	young	total	adult	young	total	
Phase 0							
Kcal	89,2%	88,0%	88,3%	109,0%	111,2%	110,9%	96,9%
Lipid	84,4%	83,1%	83,4%	99,0%	109,2%	107,8%	92,8%
Cholesterol	247,3%	210,9%	219,3%	220,6%	204,0%	206,4%	214,3%
Na	417,9%	366,8%	378,6%	381,7%	365,9%	368,2%	374,6%
Phase 1							
Kcal	88,6%	85,8%	86,5%	103,8%	105,1%	104,8%	93,9%
Lipid	89,0%	81,4%	83,4%	123,4%	104,2%	108,5%	93,5%
Cholesterol	203,3%	200,7%	201,4%	207,1%	202,0%	203,1%	202,1%
Na	286,8%	270,8%	275,0%	216,8%	231,7%	228,4%	256,2%
Phase 2							
Kcal	87,5%	85,7%	86,1%	105,7%	114,1%	113,0%	96,0%
Lipid	94,4%	87,1%	88,7%	110,7%	126,6%	124,5%	102,0%
Cholesterol	205,4%	196,9%	198,8%	194,2%	209,2%	207,2%	201,9%
Na	333,1%	342,6%	340,5%	326,9%	305,6%	308,5%	328,6%
Phase 3							
Kcal	91,7%	87,9%	88,6%	117,3%	113,2%	113,5%	97,7%
Lipid	98,9%	82,9%	85,8%	122,6%	115,5%	116,0%	96,8%
Cholesterol	242,2%	198,0%	206,0%	192,9%	190,8%	191,0%	200,5%
Na	322,6%	299,3%	303,5%	313,3%	269,0%	272,0%	292,1%
Phase 4							
Kcal	82,3%	80,9%	81,2%	103,8%	101,0%	101,5%	88,8%
Lipid	72,3%	70,4%	70,9%	93,1%	95,4%	95,0%	80,1%
Cholesterol	186,7%	196,9%	194,5%	193,7%	188,0%	188,9%	192,4%
Na	346,8%	335,2%	338,0%	338,5%	319,6%	322,5%	332,2%
Phase 5							
Kcal	81,4%	75,9%	77,3%	102,5%	101,5%	101,7%	86,6%
Lipid	72,8%	72,0%	72,2%	96,9%	91,1%	92,0%	79,5%
Cholesterol	193,2%	179,3%	182,8%	165,8%	194,6%	189,2%	185,3%
Na	310,2%	296,5%	299,9%	284,0%	268,5%	271,3%	288,9%

Conclusions

The conclusion reached was that, to achieve any substantial change in the eating habits of college students, it is not enough to merely provide nutritional information on the meals, but there should be some intervention in the food supply accompanying that information. We have also deduced that the financial aspect is crucial in the selection of food made by the student, so, for it to be effective, no nutritional action should entail any economic overhead.

Implications for reference and practise

It can be concluded that to achieve any substantial change in the eating habits of college students it is not enough to provide nutritional information, but there should be some intervention in the food supply accompanying that nutritional information. We have also concluded that the economic aspect is crucial in the selection of foods made by the student, so, for it to be effective, any nutritional action should not incur any economic overhead.

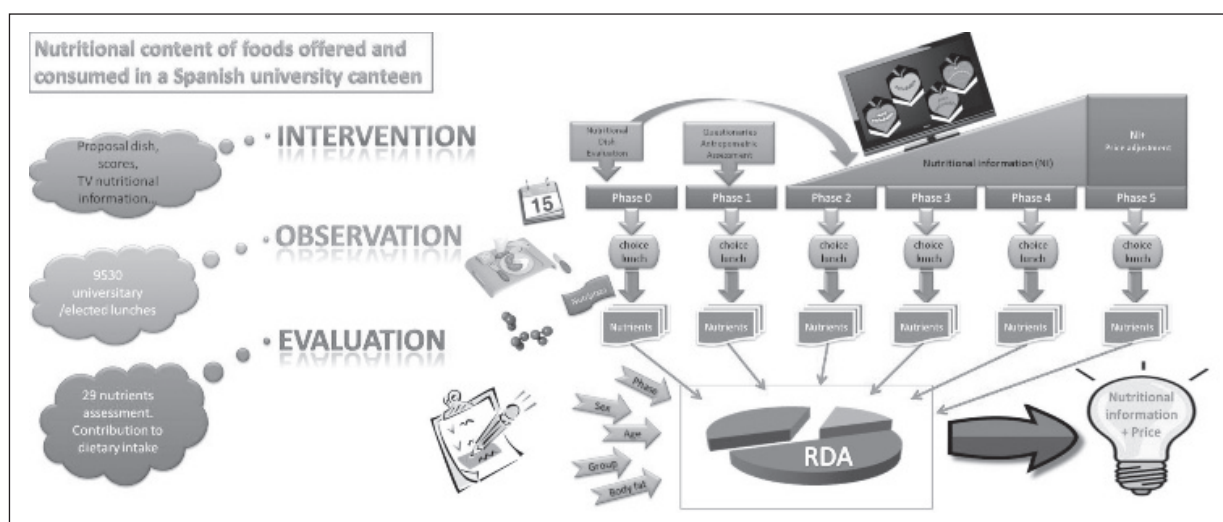


Fig. 1.

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Original/*Valoración nutricional*

Características nutricionales de los menús escolares en Bizkaia (País Vasco, España) durante el curso 2012/2013

Patricia Sancho Uriarte, Francisco Borja Cirarda Larrea y Santiago Valcárcel Alonso

Delegación Territorial de Bizkaia, Departamento de Salud del Gobierno Vasco, País Vasco, España.

Resumen

Introducción: Uno de los elementos abordados desde la Estrategia para la Nutrición, Actividad física y prevención de la Obesidad y Salud (NAOS) es la alimentación en el medio escolar.

Objetivo: Evaluar, tomando como referencia el conjunto mínimo de indicadores y recomendaciones de la Estrategia NAOS, una muestra de menús distribuidos en varios comedores escolares de Bizkaia.

Métodos: Estudio descriptivo transversal basado en la revisión teórica de los menús basales distribuidos por siete cocinas centrales que abastecen a 324 centros escolares (80.969 alumnos). Se determinó y valoró la frecuencia semanal de varios grupos de alimentos; los documentos de referencia fueron “Evaluación y Seguimiento de la Estrategia NAOS: Conjunto de Indicadores” y las recomendaciones del “Documento de Consenso sobre la alimentación en los centros educativos”.

Resultados y discusión: El 100% de los comedores cumple con los mínimos relativos a legumbres, pescados y precocinados y con las recomendaciones relativas a carne y productos cárnicos. Si bien se aproximan bastante, ninguno cumple con los mínimos de fruta, verdura o con la información nutricional complementaria. Se han evidenciado diferencias entre las recomendaciones de La Estrategia NAOS y las condiciones exigidas por el Departamento de Educación, así como dificultades en la cuantificación y clasificación de varios alimentos.

Conclusiones: Se recomienda incrementar el contenido en frutas, verduras, huevos y pescado azul de los menús escolares, así como ofrecer a las familias una información de los menús más detallada.

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Palabras clave: *Nutrición. Estrategia NAOS. Evaluación. Comedor escolar. Indicador.*

NUTRITIONAL CHARACTERISTICS OF SCHOOL LUNCH MENUS IN BISCAY (BASQUE COUNTRY, SPAIN) IN 2012/2013

Abstract

Introduction: One of the areas of intervention of the Spanish strategy for nutrition, physical activity and prevention of obesity (NAOS) is school nutrition.

Objectives: To evaluate, taking as reference the minimum set of indicators and recommendations of NAOS Strategy, a sample of school lunch menus distributed in several school dining rooms of Biscay.

Methods: A descriptive cross sectional study was conducted, based on the theoretical information of the basal menus distributed by seven catering enterprises to 324 schools (80,969 pupils). Weekly frequency of several types of food groups was determined and evaluated; reference documents were “Evaluation and Monitoring of NAOS Strategy: set of indicators” and recommendations of the “Consensus document of feeding in school”.

Results and discussion: The 100 per cent of the school dining rooms meets minimums concerning legumes, fish and pre-cooked meals and with the recommendations of meat and meat products. However, although being close to guidelines, none meets the minimum of fruit, vegetables or of additional nutritional information. Differences among NAOS Strategy recommendations and requirements of the Department of Education have been found, and also difficulties in the quantification and classification of several foodstuffs.

Conclusions: It is recommended to increase the content of fruits, vegetables, eggs and oily fish in school menus as well as offering more detailed description of menus to families.

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Key words: *Nutrition. NAOS Strategy. Evaluation. School dining room. Indicator.*

Introducción

Anualmente, en todo el mundo, se producen 36 millones de muertes¹ por enfermedades no transmisibles cuyos factores de riesgo son, entre otros, la dieta inadecuada y la falta de ejercicio. Se estima que la falta

Correspondencia: Patricia Sancho Uriarte.
E-mail: p-sancho@ej-gv.es

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de ejercicio ocasiona 3,2 millones de muertes y el bajo consumo de verduras y frutas 1,7 millones¹. En respuesta a esta situación, la OMS en el año 2004 aprobó la Estrategia Mundial sobre Régimen Alimentario, Actividad Física y Salud (DPAS)², y, posteriormente, para su vigilancia, el Marco de Seguimiento y Evaluación del DPAS³.

En línea con la DPAS, en el año 2005 el Ministerio de Sanidad y Consumo de España aprobó la Estrategia NAOS (Estrategia para la Nutrición, Actividad física y prevención de la Obesidad y Salud)⁴ con los objetivos de concienciar del problema que supone la obesidad y de impulsar iniciativas que fomenten una alimentación equilibrada y una práctica regular de ejercicio. En 2011, en España, de los/as niños/as de 6-9 años el 26,2% sufría sobrepeso y el 18,3% obesidad⁵, unas de las cifras más altas de Europa⁶. Las causas externas del exceso de peso son varias, pero destacan, por ser modificables, la dieta inadecuada y la inactividad física⁷. La Estrategia pretende enfrentarse a dicha situación de forma integrada con actuaciones en diversos ámbitos (laboral, industrial, escolar, etc.) y presta una atención especial a la población joven. Asimismo, se han definido para su evaluación y seguimiento un conjunto mínimo de indicadores⁸.

En este contexto, la alimentación saludable en el medio escolar es uno de los elementos clave dentro de la Estrategia NAOS. Los comedores escolares cubren parte de las necesidades nutricionales de la población infanto-juvenil y son potenciales promotores de hábitos alimentarios saludables⁹ en un periodo durante el que comienzan a fijarse ciertas conductas. Diferentes países han puesto en marcha intervenciones en el medio escolar, y si bien los resultados no son siempre coincidentes, muestran cierto efecto positivo¹⁰.

La relevancia adquirida por los comedores ha traído consigo el control y evaluación de los menús escolares. Algunos estudios han evidenciado, entre otras, deficiencias tales como la insuficiente descripción de los platos¹¹ y una cantidad de hortalizas inferior a lo recomendado^{11, 12}. Sin embargo, dada la heterogeneidad en la metodología y en los límites de referencia de cada estudio, la comparación e interpretación de los resultados es compleja.

En la actualidad, según datos del Departamento de Educación del Gobierno Vasco, en la Comunidad Autónoma del País Vasco (CAPV) durante el curso 2012-2013, el 56% de los alumnos/as de educación infantil, primaria y secundaria utilizaron el servicio de comedor escolar. En dicha Comunidad, el propio Departamento de Educación establece una serie de requisitos nutricionales de obligatorio cumplimiento (recogidos en un pliego de condiciones) a las empresas que dan servicio de comedor a los centros de titularidad pública.

El presente trabajo tiene como objetivo evaluar, por primera vez, los menús escolares basales de siete cocinas centrales que operan en el Territorio Histórico (TH) de Bizkaia tomando como referencia el conjunto mínimo de indicadores⁸ y las directrices del Documen-

to Consenso sobre alimentación de los centros Educativos¹³ desarrollado dentro de la Estrategia NAOS.

Materiales y métodos

Estudio descriptivo transversal de las características nutricionales teóricas de los menús escolares de Bizkaia. La tabla I recoge el tipo de gestión de los diversos centros del TH que se realiza bien directamente, o bien mediante la contratación de una empresa de restauración colectiva.

El Departamento de Educación del Gobierno Vasco facilitó el censo de población escolar y de usuarios de los comedores escolares del curso 2012/2013 de Bizkaia. Tras la revisión teórica de los menús de varios centros, se asumió que la comida transportada o cocinada "in situ" por una misma cocina central a diferentes centros no implica modificaciones sustanciales en la composición del mismo, por lo que se decidió realizar el estudio a partir de la información de las cocinas centrales. Se seleccionaron siete cocinas centrales (C1, C2, C3, C4, C5, C6, C7) que abastecen a 227 centros públicos y 97 de titularidad privada y dan servicio a 80.969 escolares, el 75% de los 108.376 usuarios de Bizkaia. Se revisaron los menús basales, no las dietas especiales por cuestión de ideología, religión o de alergias, intolerancias u otras patologías, que se estima suponen el 2,8% del total de los menús¹⁴.

Se seleccionaron menús de temporada fría (otoño/invierno) y templada (primavera/verano) de 8 de las 37 semanas (21,62%) del curso escolar 2012-2013. Para la temporada fría se seleccionaron los menús de las 4 semanas comprendidas entre el 5 y el 30 de noviembre de 2012 y para la temporada templada, las 4 semanas comprendidas entre el 6 y el 31 de mayo de 2013.

Se valoraron los siguientes grupos de alimentos: cereales y derivados (arroz, pasta, pan); legumbres; verduras; patatas; carnes y preparados o productos cárnicos; pescados (pescado azul, blanco y otros productos del mar); huevos; platos precocinados; fruta (fresca y preparada); postres lácteos y de otro tipo. En el subgrupo del pescado blanco se incluyeron los platos denominados genéricamente "pescado". Los postres lácteos, a su vez, se subdividieron en dos grupos: los de mayor componente lácteo (yogures, cuajadas, etc.) y otros con menor componente lácteo (flan, natillas, etc.). Asimismo, se cuantificó el número de frituras del segundo plato, de la guarnición y su coincidencia.

Tomando en consideración las directrices del Documento de Consenso sobre la Alimentación en los Centros Educativos¹³, cuatro personas cuantificaron el número de raciones de los diversos grupos de alimentos. La evaluación fue teórica y no se valoró la cantidad servida ni consumida por el alumno. No se consideraron los ingredientes en cantidades inferiores a una guarnición (el pollo del arroz, el tomate del arroz, etc.) ni las salsas.

Tabla I
Tipo de gestión (propia, contratación de cocina central, desconocida) del comedor escolar, número de centros y comensales. Bizkaia, curso 2012/2013

<i>Tipo de gestión del comedor escolar</i>	<i>Nº centros</i>	<i>Nº comensales</i>
Cocina central 1 (C1)	2	206
Cocina central 2 (C2)	38*	7.946
Cocina central 3 (C3)	58	16.466
Cocina central 4 (C4)	55	13.431
Cocina central 5 (C5)	52	11.895
Cocina central 6 (C6)	84	21.818
Cocina central 7 (C7)	36*	9.207
Otras cocinas centrales	17	7.540
Cocina propia	34	17.678
Desconocido	28	2.189

*Un mismo centro abastecido por dos empresas de restauración colectiva.

Dado que la contribución de las guarniciones al cómputo total de raciones de verduras depende de la edad del alumnado, se creó una “guarnición estándar”. Para cada grupo de edad, se estimó el valor medio en gramos de la ración y guarnición de cada grupo de alimentos¹³. Posteriormente, para cada grupo de alimentos, se determinó la contribución de una “guarnición estándar” como el porcentaje que supone ésta sobre una ración. Asimismo, se definió un “centro escolar estándar” como aquél que oferta ciclos de educación infantil (de 3 a 6 años), primaria (de 7 a 12 años) y secundaria (de 13 a 16 años). Se asumió que todos los centros escolares son “centros escolares estándar”. Para cada grupo de alimentos, se calculó el valor de la “guarnición estándar” como el valor medio ponderado por el número de cursos de cada ciclo de educación (4 cursos en infantil, 6 en primaria y 4 en secundaria). Para cada cocina central, se calculó la frecuencia de consumo semanal de cada grupo de alimentos como la media aritmética de las valoraciones de las cuatro semanas de cada temporada. Asimismo, se determinó la frecuencia media semanal de cada grupo de alimentos de los menús distribuidos por las siete cocinas centrales como una media de las valoraciones de cada cocina central ponderada por la proporción de menús de cada cocina respecto al total de menús servidos.

Los valores de referencia fueron los indicadores de “Evaluación y Seguimiento de la Estrategia NAOS: Conjunto de Indicadores”¹⁸ y las recomendaciones del “Documento de Consenso sobre la alimentación en los centros educativos”¹³.

Resultados

Todos los menús analizados constan de dos platos (primero y segundo), guarnición y postre. Las raciones

semanales de cada grupo de alimentos se recogen en la tabla II y son desglosadas a continuación.

1. Verduras y hortalizas

La media de las siete cocinas centrales es de 3,58 raciones. Desde la Estrategia NAOS¹³ se recomienda incluir semanalmente al menos cuatro raciones de verduras en los menús escolares. Aisladamente, ninguna cocina alcanza el mínimo, si bien todas incluyen más de tres raciones (ver tabla III) y la cocina 5, C5, lo roza. Las guarniciones aportan el 56% del total de verduras y tubérculos, un predominio que se mantiene en, prácticamente, todas las cocinas centrales.

Dado que en nuestro ámbito, el consumo de patatas es habitual y a que su contenido en hidratos de carbono (en torno a un 16%) y calórico (68 kcal/100 g) es mayor al de otras verduras, especialmente de las llamadas verduras de hoja verde, se analizó por separado la oferta de patatas que constituye, como término medio, el 17% del conjunto de verduras y tubérculos, con unos valores extremos del 11% (C4) y 23% (C3). Excluyendo las patatas, tres cocinas (C4, C5 y C7) superan las tres raciones semanales de verduras. Independientemente de que se incluyan o no las patatas, el indicador veinte de la estrategia NAOS (porcentaje de comedores que en su menú incluyen un mínimo de cuatro raciones de verdura a la semana) es igual a cero.

2. Legumbres

En la Estrategia NAOS se aconsejan de una a dos raciones semanales de legumbres y un mínimo de seis mensuales. El 100% de las cocinas cumplen la primera recomendación y todas menos C5 el mínimo mensual;

Tabla II

Frecuencia (raciones semanales) recomendadas de varios grupos de alimentos en la Estrategia NAOS y las observadas en los menús escolares de siete cocinas centrales de Bizkaia. Valor medio, mínimo y máximo. Curso 2012/2013

Grupo de alimentos		Frecuencia recomendada Estrategia NAOS (raciones/semana)	Frecuencia observada en las cocinas centrales		
			Media	mínimo	máximo
Verduras y tubérculos*		≥4	3,58	3,37	3,97
Legumbres		1-2	1,70	1,38	1,88
Cereales y derivados		2	1,36	1,15	1,54
Carnes y derivados	Carne	1-3	1,73	1,50	2,13
	derivados**	≤1	0,60	0,38	0,75
Pescados y mariscos		≥1	1,43	1,25	1,54
Huevos		1-2	0,59	0,50	0,75
Platos precocinados		≤1	0,41	0,25	0,50
Fruta fresca		≥ 4 piezas	3,00	2,88	3,13
Lácteos	yogur, queso	≤1 si se incluye en postre	1,61	1,13	2,00
	otros		0,23	0,13	0,63

*Incluye patatas

**Referido a productos y preparados cárnicos

Tabla III

Raciones semanales de verduras y patatas y su distribución (primer plato o guarnición) en el menú de siete cocinas centrales. Bizkaia. Curso 2012/2013

Cocina	Raciones semanales de verduras y patatas				Total
	Verduras		Patatas		
	Primer plato	Guarnición	Primer plato	Guarnición	
C1	1,38	1,59	0,25	0,29	3,51
C2	1,13	1,79	0,50	0,22	3,64
C3	1,13	1,46	0,63	0,15	3,37
C4	1,17	1,86	0,38	0,00	3,41
C5	1,38	2,05	0,25	0,29	3,97
C6	1,13	1,66	0,38	0,29	3,46
C7	1,13	2,05	0,38	0,22	3,78
Media	1,20	1,78	0,39	0,21	3,58

si bien, dado que un mes no está constituido estrictamente por cuatro semanas, el valor teórico de C5 (5,52 raciones/mes) pudiera estar ligeramente infravalorado.

lo es al analizarlas de forma individual. No se ha hallado información relativa a la oferta de pan y la mención integral aparece una única vez.

3. Cereales y derivados

Desde la Estrategia NAOS se indica que arroz, pasta y pan han de formar parte del menú escolar, siendo la oferta de pan diaria y dos las raciones semanales de arroz y pasta (una de arroz y una de pasta). El valor medio de las siete cocinas es inferior (1,36) y también

4. Carne y preparados o productos cárnicos

En la Estrategia NAOS se indican de una a tres raciones semanales de carne (preferentemente poco grasas) y se limitan las preparaciones cárnicas a un máximo de una. Los menús de las siete cocinas cumplen con las recomendaciones, la media semanal es de 1,73 raciones

de carne y de 0,6 raciones de preparados o productos cárnicos. El cumplimiento se mantiene al analizar individualmente cada cocina. Pese a que ninguna cocina supera el límite de preparados o productos cárnicos, que constituyen como término medio el 26% del total del grupo, se observan diferencias entre las cocinas con unos valores extremos de un 33% (C7) y del 17% (C1).

5. Pescado

Desde la Estrategia se aconseja incluir semanalmente al menos una ración de pescado. Las siete cocinas cumplen con el mínimo (ver tabla IV) y el indicador 22 (porcentaje de comedores que incluyen en su menú al menos una ración de pescado) es del 100%. Pese a que se indica alternar el pescado blanco y el azul, la mayoría de lo ofrecido es blanco y el azul es anecdótico.

6. Huevos

Desde la Estrategia NAOS se recomienda incluir semanalmente de uno a dos huevos; la media global es de 0,59 huevos, claramente inferior, y analizadas individualmente ninguna cocina alcanza tampoco el mínimo.

7. Platos precocinados

Todas las cocinas se ajustan a la recomendación de ofertar, como máximo, una ración semanal de precocinados y el indicador 23 (porcentaje de comedores escolares que incluyen menos de un plato precocinado a la semana) es del 100%.

8. Técnicas culinarias: fritura

La fritura es la única técnica culinaria restringida desde la Estrategia NAOS y se limita, semanalmente, a un máximo de dos en los segundos platos y de una única en las guarniciones, evitando la coincidencia de ambas. La media de las siete cocinas para los segundos platos alcanza el máximo, y la de las guarniciones es inferior (0,38). Analizadas individualmente, dos de las siete cocinas superan el límite en los segundos platos. En C6 y C7 coincide la fritura del segundo plato y de la guarnición.

No se ha podido determinar el tipo de aceite utilizado en las frituras dado que en ninguna de las hojas informativas se menciona.

9. Fruta fresca:

Desde la Estrategia NAOS, se aconseja incorporar semanalmente, al menos, cuatro piezas de fruta fresca, mínimo que ninguna de las cocinas cumple. El indicador 19 de la Estrategia NAOS es por lo tanto del cero por ciento. Las preparaciones de fruta (zumos, compotas etc.), que han de incluirse menos de una vez a la semana, son muy puntuales, ajustándose a la indicación (ver tabla V).

10. Lácteos y derivados

Se recomienda desde la Estrategia NAOS incorporar productos lácteos. En caso de incluirlos como postre, se limitan a uno semanal y nunca en sustitución de piezas de fruta fresca. Asimismo, se priorizan los yogures frente a otros productos de mayor valor calórico

Tabla IV
Raciones semanales de pescado blanco, azul y total incluidas en los menús de siete cocinas centrales.
Bizkaia. Curso 2012/2013

Cocina	Raciones semanales de pescado		
	Pescado azul	Pescado blanco	Total*
C1	0,25	1,17	1,42
C2	0,25	1,17	1,42
C3	0,25	1,13	1,50
C4	0,38	1,13	1,51
C5	0,38	0,88	1,26
C6	0,13	1,41	1,54
C7	0,00	1,41	1,41
Media	0,23	1,18	1,43

*incluye mariscos y crustáceos

Tabla V
Raciones semanales de fruta fresca (piezas) y de fruta preparada incluidas en los menús de siete cocinas centrales. Bizkaia. Curso 2012/2013

<i>Cocina</i>	<i>Raciones semanales de fruta</i>		
	<i>Piezas de fruta fresca</i>	<i>Fruta preparada</i>	<i>Total</i>
C1	3,00	0,13	3,13
C2	2,88	0,25	3,13
C3	3,00	0,25	3,25
C4	3,00	0,25	3,25
C5	3,00	0,00	3,00
C6	3,13	0,25	3,38
C7	3,00	0,00	3,00
Media	3,00	0,16	3,16

(natillas, helados, etc.). La media conjunta de las siete cocinas es superior: 1,84 raciones, e individualmente todas las cocinas rebasan también el límite. Prácticamente la totalidad de los lácteos se concentran en el postre y es el yogur el más común.

11. Información nutricional

Las familias de los usuarios del comedor escolar reciben con antelación información relativa a los platos que constituyen los menús. En la Estrategia se indica, además, incluir información complementaria (aclaraciones relativas a los ingredientes y a la técnica culinaria de cada plato). Tras analizar la información de las siete cocinas, se constata que no existe un modelo común; todas informan (vía web y/o en soporte papel) de los platos que componen los menús, del valor calórico y de la composición en macronutrientes (% proteínas, glúcidos y lípidos). Seis de las cocinas, además, emiten sugerencias para elaborar cenas y meriendas nutricionalmente complementarias y cuatro de ellas consejos nutricionales generales. En ningún caso se acompaña de una relación de ingredientes ni de la técnica culinaria de cada plato, por lo que el indicador 24 (comedores que incluyen información complementaria) es igual a cero.

Discusión

El trabajo examina las características nutricionales de los menús de siete cocinas centrales, cuyo volumen de distribución hace que los resultados sean, en gran medida, extrapolables al total de alumnos de Bizkaia.

Una de las limitaciones del trabajo es que los centros de titularidad privada están menos representados, ya que la muestra incluye el 92% de los centros públicos y el 62% de los de titularidad privada. Desde

la Estrategia NAOS se recomienda evaluar las características nutricionales de los menús de una muestra de centros educativos, pero no se establece el tamaño o representatividad y se otorga el mismo valor a los comedores escolares independientemente del número de comensales. Otra de las limitaciones es que se trata de una evaluación teórica, no de ingesta real; un trabajo previo realizado también en Bizkaia¹² estimó que el 71% del alumnado consume el primer plato en su totalidad, el 68% el segundo plato, el 33% la guarnición y el 77% la fruta del postre.

En lo que respecta a la adecuación nutricional, tomando como referencia las directrices del Documento de Consenso sobre la Alimentación en los Centros Educativos de La Estrategia NAOS¹³, las raciones de verdura de los menús analizados es insuficiente (ver tablas II y III). Se trató de averiguar si existía alguna razón que explicara por qué ninguna de las cocinas cumplía con el mínimo; así se constató la discrepancia entre las recomendaciones de la Estrategia NAOS y las condiciones exigidas por el Departamento de Educación, que obligaba a incluir al menos un primer plato y tres guarniciones de verdura, lo que supondría, aproximadamente, dos raciones y media de verduras semanales. Sería aconsejable por ello, unificar los criterios, así como especificar los alimentos incluidos en el grupo de las verduras y hortalizas para evitar la disyuntiva de sumar o no las patatas, de consumo muy común. Dos de las cocinas (C3 y C4) cuya oferta semanal de verduras es cuantitativamente similar (C3: 3,35 raciones; C4: 3,40 raciones), es cualitativamente diferente y en C3 las patatas suponen el 23% de las verduras y tubérculos frente al 11% de C4. Tras revisar la bibliografía, se constata que no existe unanimidad en la clasificación de las patatas; la Encuesta Nacional de Salud las incluye junto a arroces y pastas, el Documento de Consenso sobre la Alimentación en los Centros Educativos¹³ en el grupo de verduras y hortalizas, y conforman una entidad propia en la Encuesta Nacional de Ingesta Dietética

Española. Otro aspecto a considerar es que, al contrario de lo que pudiera pensarse, los primeros platos no contribuyen más que las guarniciones al total de verduras y tubérculos; se trata de un aspecto a tener en cuenta dado que el 33% de los comensales consume la guarnición¹².

Los cereales se consideran la base de la pirámide alimentaria, pero ninguna de las cocinas aporta las dos raciones semanales de arroz y pasta indicadas. Al igual que con las verduras, la frecuencia de consumo propuesta por el Departamento de Educación (de una a dos raciones semanales) es diferente a la de la Estrategia NAOS (al menos dos raciones). Dicha situación, sin embargo, no tiene por qué significar un aporte insuficiente de glúcidos ya que si se consideran las patatas dentro del grupo de arroz y pasta, prácticamente se alcanzarían las dos raciones en todas las cocinas. Otro aspecto a evaluar es la oferta de cereales integrales que se mencionan una única vez. La pobre oferta de dicho tipo de cereales confirmaría resultados previos relativos a su consumo¹⁵; quizá una menor oferta, precio más elevado y una hipotética peor aceptación de este tipo de alimentos explique dicha situación. En lo que respecta al pan, ninguna cocina central hace referencia en sus páginas informativas ni a la cantidad ni al tipo. Investigaciones posteriores permitieron determinar que se ofertan diariamente 60 g de pan para cada alumno/a.

El cumplimiento de las directrices establecidas desde la Estrategia NAOS para el grupo de carne y preparados/productos cárnicos es total, a lo que sin duda contribuyen las más restrictivas exigencias del Departamento de Educación (dos raciones mensuales de preparados de carne picada y una de embutidos).

En lo que respecta al pescado, fuente de ácidos grasos omega-3, vitaminas liposolubles y proteínas de alto valor biológico, el cumplimiento de las recomendaciones es total. Sin embargo, la oferta de pescado azul es pobre, inexistente en algún caso, pese a que desde la Estrategia NAOS se recomienda alternarlo con el pescado blanco. Esta situación puede responder a que la oferta de pescado blanco congelado y fileteado es mayor que la de azul. Además, los pescados azules que pueden filetearse y congelarse tienden a ser especies de gran tamaño (atún, pez espada...), de precio más elevado y cuyo consumo, por su contenido en mercurio, se recomienda sea moderado especialmente en la población infantil.

Los huevos tienen un elevado valor nutricional y sus proteínas son consideradas las de mayor valor biológico. Pese a ello, la oferta es pobre (0,59 huevos/semana) y ninguna cumple con lo aconsejado desde la Estrategia NAOS (1-2 huevos/semana); sí cumplen, por el contrario, las condiciones del Departamento de Educación, que no establece un consumo mínimo sino un máximo de dos huevos a la semana.

Los platos precocinados se caracterizan, en general, por un elevado contenido lipídico y calórico y se aconseja consumirlos con moderación (uno semanal como máximo). Todas las cocinas analizadas cumplen con

el límite, si bien las guarniciones de patatas fritas no se han contabilizado como precocinado ya que no se pudieron determinar sus características; en cualquier caso, aun considerándolas como precocinado no se sobrepasaría el límite. El buen cumplimiento posiblemente se deba a que el criterio del Departamento de Educación es más restrictivo (máximo de dos precocinados mensuales) que el de la Estrategia NAOS.

La fritura, pese a su popularidad, es la única técnica culinaria regulada desde la Estrategia NAOS. Durante la misma, los alimentos absorben una parte del aceite e incrementan su contenido graso y valor calórico. Dos de las siete cocinas superan el máximo, y en una de ellas, además, coincide la fritura del segundo plato y de la guarnición. No existe riesgo de sobreestimación ya que únicamente se contabilizaron aquellos platos manifiestamente sometidos a fritura (rebozados, empanados etc.). El horneado de alimentos como el pescado podría ser una alternativa para reducir la frecuencia. Por las temperaturas elevadas que se alcanzan, en la fritura es importante el tipo de aceite utilizado y desde la Estrategia NAOS se recomienda el aceite de oliva o, en su defecto, el de girasol con alto contenido en oleico. El contenido de las páginas informativas no ha permitido definir el tipo de aceite.

La fruta fresca se considera clave en una alimentación equilibrada por su elevado contenido en fibra, vitaminas y antioxidantes. Pese a ello, ninguna cocina central cumple con el mínimo debido a que la mayoría incluye dos postres lácteos semanales y a que la oferta de fruta se restringe al postre. Al igual que en casos anteriores, sí que se adecúan al mínimo establecido por el Departamento de Educación (tres piezas a la semana).

Los productos lácteos por tratarse de una importante fuente de calcio, vitamina A y proteínas de elevada calidad, son recomendados desde la Estrategia NAOS, si bien no se establece un consumo mínimo. La totalidad de las cocinas centrales incluyen dos lácteos semanales como postre e imposibilitan cumplir con el mínimo de frutas. Una posible solución sería no incluir los lácteos únicamente en el postre y añadirlos como ingredientes secundarios del primer-segundo plato (tacos de queso poco graso por ejemplo) y adicionar una pieza más de fruta, o bien ofertar fruta fresca con yogur. Ha sido positivo comprobar que los lácteos con mayor contenido en grasa y azúcar (helados, natillas etc.) son anecdóticos.

Todas las cocinas centrales aportan periódicamente a las familias información de los menús que, en los casos estudiados, incluye la denominación de los platos y el contenido calórico y en macronutrientes. Sin embargo, ayudaría a las familias a complementar de forma equilibrada el resto de comidas, que además se definieran los ingredientes y la técnica culinaria. También sería útil, entre otros, incluir el contenido en sal, tipo de aceite y de pan. Es lógico pensar que toda esa información pueda ser difícil de recoger en el díptico o tríptico que se remite a las familias, pero sí podría estar disponible a través de las páginas web, de uso cada vez más común.

No ha de ser sencillo cumplir las recomendaciones dietéticas y, paralelamente, ofrecer menús atractivos para el alumnado; de hecho, uno de los escollos referido por las cocinas centrales es la significativa peor aceptación de las verduras, pescados y frutas. Se requiere, por lo tanto, mejorar la aceptación de ciertos alimentos para que las recomendaciones nutricionales resulten útiles y efectivas en su objetivo de mejorar la salud de los/as usuarios/as. Pueden ser opciones válidas la modificación de texturas (purés), *camuflar* verduras, frutas y pescados como ingredientes secundarios, hacer más deseables las guarniciones de verduras con la adición de ingredientes como queso, maíz, frutos secos etc., y variar la presentación de las frutas: fruta fresca troceada, en brochetas, mezclada con yogur etc. Es indudable que buscar fórmulas que mejoren la aceptación de los platos puede en algunos casos suponer mayor esfuerzo e incrementar la mano de obra; sin embargo, el resultado beneficiaría a la salud del alumnado.

Para finalizar, hay que resaltar que es determinante mantener una relación y cooperación estrecha entre todos los agentes que integran la cadena. En el caso de Bizkaia, se han identificado varios actores principales: quince empresas de restauración colectiva, el Departamento de Salud y el Departamento de Educación, cuyo pliego de condiciones no sólo delimita la oferta en los centros públicos, sino que también dirige en buena medida la oferta de los centros privados abastecidos por aquellas empresas de restauración colectiva que también distribuyen a los centros públicos.

Asimismo, con la finalidad de eliminar las numerosas incertidumbres a las que está sujeto el proceso de evaluación de los menús, habría que trabajar en la unificación de criterios, tomando unos únicos estándares o límites; además, se necesita disponer de una clasificación clara y concreta para cada alimento que evite situaciones como la de las mencionadas patatas; también sería de gran ayuda disponer de información más detallada de la composición de los menús, de forma que puedan cuantificarse los ingredientes secundarios no considerados en este estudio. La estandarización del proceso de evaluación supondría obtener datos comparables en el tiempo y entre diferentes regiones que en estos momentos es difícil de realizar.

Conclusiones

El 100% de las cocinas centrales analizadas cumplen con los indicadores de la Estrategia NAOS relativos a legumbres, pescado, carne y platos precocinados; también cumplen con las directrices relativas a carne y productos cárnicos. No cumplen, por el contrario, los indicadores relativos a fruta fresca, verduras e información complementaria a las familias; si bien se aproximan bastante a las recomendaciones. Se han observado diferencias entre los requerimientos establecidos por el Departamento de Educación y la Estrategia NAOS que explicaría el no cumplimiento de ciertos

indicadores. Tomando en consideración los resultados, se recomienda incrementar el contenido en frutas, verduras, huevos y pescado azul de los menús, así como incluir los ingredientes y la técnica culinaria en las hojas informativas que reciben las familias. Por otro lado, se considera necesario establecer unos mismos criterios y unificar recomendaciones y límites; considerando la información que existe hasta el momento, parece necesario mejorar la aceptación de los platos de verdura, fruta y pescado para que la teoría y la realidad se aproximen al máximo y confieran sentido y utilidad a las recomendaciones nutricionales.

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Original/*Valoración nutricional*

Estudio de la albúmina sérica y del índice de masa corporal como marcadores nutricionales en pacientes en hemodiálisis

Angel I. Quero Alfonso¹, Rafael Fernández Castillo¹, Ruth Fernández Gallegos² y Francisco Javier Gómez Jiménez¹

¹Universidad de Granada. Facultad de Ciencias de la Salud. Campus de Ceuta. ²Servicio de Nefrología Unidad de Hemodiálisis. Hospital Universitario Virgen de las Nieves. Granada. España.

Resumen

Introducción: La malnutrición proteico calórica así como la inflamación sistémica y metabólica son trastornos frecuentes entre los pacientes con insuficiencia renal crónica sometidos a tratamiento renal sustitutivo (Hemodiálisis), lo que contribuye a su morbilidad y mortalidad.

Objetivos: El objetivo de este trabajo fue evaluar el estado nutricional de los pacientes de una unidad de hemodiálisis mediante la valoración de parámetros bioquímicos nutricionales como la albúmina, y parámetros antropométricos de índice de masa corporal durante diez años de seguimiento.

Métodos: En este trabajo se ha seguido a 90 pacientes de ambos sexos con insuficiencia renal crónica que fueron tratados con hemodiálisis periódicamente en nuestra unidad durante diez años. A todos los pacientes se le realizaron mediciones trimestrales de albúmina plasmática (Alb), y otras determinaciones bioquímicas, y se les efectuaron mediciones antropométricas de peso, altura e índice de masa corporal calculado mediante la fórmula peso/talla², agrupada en IMC < 23 kg/m² y niveles de albúmina < 3,8 g/dl según el consenso del panel de expertos de la International Society for Renal Nutrition and Metabolism.

Resultados: Durante los 10 años todos los pacientes manifestaron un importante descenso de los parámetros bioquímicos y de la albúmina, en cambio el IMC no presentó cambios significativos en relación a la desnutrición.

Conclusiones: La desnutrición de los pacientes en diálisis es un hecho patente, el IMC no se corresponde con los parámetros bioquímicos observados, por lo que el deterioro nutricional de estos pacientes se manifiesta principalmente mediante la albúmina sérica.

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Palabras clave: Índice de masa corporal. Hemodiálisis. Nutrición renal. Antropometría. Enfermedad renal.

Correspondencia: Rafael Fernández Castillo.
Universidad de Granada. Facultad de Ciencias de la Salud.
Campus de Ceuta, C/ Cortadura del Valle SN.
C.P. 51001, Ceuta, Spain.
Email: rafaelfernandez@ugr.es

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STUDY OF SERUM ALBUMIN AND BMI AS NUTRITIONAL MARKERS IN HEMODIALYSIS PATIENTS

Abstract

Background: Protein calorie malnutrition as well as systemic inflammation and metabolic disorders are common among patients with chronic renal failure undergoing renal replacement therapy (haemodialysis), which contributes to its morbidity and mortality.

Aims: The aims of this work was to evaluate the nutritional status of patients in a hemodialysis treatment through the assessment of biochemical parameters nutritional as albumin, and anthropometric parameters of body mass index during ten years of follow up.

Methods: In this work has been followed 90 patients of both sexes with chronic kidney disease who were treated with hemodialysis regularly on our unit for ten years. All patients were conducted quarterly measurements of plasma albumin (Alb), and other biochemical determinations, and anthropometric measurements of height, weight and body mass index calculated by the formula weight/height², grouped in BMI < 23 kg/m² and albumin levels < 3.8 g/dl according to the consensus of the panel of experts of the International Society for renal Nutrition and metabolism.

Results: During the 10 years all patients showed a significant decline in the biochemical parameters and the albumin, change in BMI does not presented significant changes in relation to malnutrition.

Conclusions: Malnutrition in patients on dialysis is a fact patent, BMI does not correspond with the biochemical parameters were observed, for what nutritional impairment in these patients is mainly expressed by serum albumin.

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DOI:10.3305/nh.2015.31.3.8084

Key words: Body Mass Index. Hemodialysis. Renal nutrition. Anthropometry. Renal disease.

Introducción

La desnutrición proteico-calórica está presente en un alto porcentaje de pacientes con enfermedad renal crónica (ERC) y esta asociado con un aumento en las tasas de morbi-mortalidad. Los factores que contribuyen directamente en la malnutrición son principalmente las alteraciones en el metabolismo proteico y energético, alteraciones hormonales, infecciones así como reducción de la ingesta de alimentos a causa de la anorexia, náuseas y vómitos, causados por la toxicidad urémica.

Después del comienzo del tratamiento renal sustitutivo, la mayoría de los síntomas evidentes de la uremia se reducen o desaparecen y los pacientes suelen experimentar un mayor bienestar y mejor apetito. Sin embargo, varios estudios muestran que la prevalencia de la malnutrición proteico-energética en pacientes en diálisis se mantiene elevada. El 23-76% de los pacientes en hemodiálisis (HD) suelen presentar desnutrición¹⁻³.

En los últimos años, varios estudios en pacientes en HD han mostrado una asociación entre los signos de malnutrición, particularmente la disminución de la albúmina sérica, y el aumento de la morbilidad y la mortalidad^{4,5}. La albúmina sérica es un indicador fiable de la proteína visceral y es el más ampliamente estudiado de los marcadores nutricionales. Los bajos niveles de albúmina en suero son altamente predictivos de pobres resultados clínicos en todas las etapas de la ERC, por lo tanto, la albúmina en suero se considera un marcador fiable del estado clínico general^{6,7}. Además, la aterosclerosis (agravada por la hipertensión y el tabaquismo), así como diferentes mecanismos implicados como estrés oxidativo, la inflamación y la malnutrición, junto a un índice de masa corporal bajo, perfiles lipoproteicos alterados y niveles elevados de LDL, son predictores de una baja supervivencia de estos pacientes⁸⁻¹¹.

El objetivo de este trabajo fue evaluar el estado nutricional de los pacientes de una unidad de hemodiálisis mediante la valoración de parámetros bioquímicos nutricionales como la albúmina, y parámetros antropométricos de peso, altura e índice de masa corporal y determinar si en el periodo de diez años de seguimiento, estos pacientes sufren alteraciones que sugieran deterioro nutricional del paciente directamente relacionado con el tiempo en tratamiento.

Materiales y métodos

Sujetos

La muestra estuvo formada por 90 pacientes de ambos sexos con insuficiencia renal crónica que realizan diálisis periódicamente en la Unidad de Hemodiálisis. Hospital Universitario Virgen de las Nieves, no fueron seleccionados mediante procedimientos de muestreo aleatorio y su participación en el estudio viene deter-

Tabla I
Causas de Enfermedad Renal Crónica en la población de estudio

Causas	%
Desconocida	17.8
Diabetes	17.8
Intersticial	15.1
Glomerular	20.5
Vascular	15.1
Poliquística	9.6
Nefroesclerosis	2.7
Lupus	1.4

minada por la asistencia al centro de diálisis en las fechas en que se realizó el estudio (Enero de 2002 a Enero de 2013). Las edades estaban comprendidas entre 32 y 83 años, 47 hombres y 43 mujeres. El tiempo medio de estancia en hemodiálisis fue de 10.5 ± 5.2 Años. La etiología del fallo renal se refleja en la tabla I.

Métodos

A todos los pacientes se realizaron mediciones coincidiendo con los controles analíticos establecidos en nuestra unidad (desde el 1º año hasta el 10º año) de: trimestrales de albúmina plasmática (Alb), creatinina sérica (Cr), colesterol total (CT), colesterol LDL, colesterol HDL, proteínas totales (PT), urea (Ur), ácido úrico (Aur), triglicéridos (TR), proteína C reactiva (PCR) y homocisteína (Hcy). Las muestras de sangre se obtuvieron directamente del acceso vascular para hemodiálisis antes del inicio del tratamiento dialítico y antes de la administración de heparina.

Las muestras de sangre periférica se extrajeron entre las 8.30 y las 9 de la mañana: bioquímica: 6 ml de sangre en tubo Venojet® II (Terumo; autosep®). Las determinaciones de bioquímica se realizaron a 37°, se empleó el analizador automático de química clínica Roche/ Hitachi 747, y los reactivos correspondientes, todos ellos suministrados por la compañía Roche. Todas las determinaciones se realizaron en laboratorio general del Hospital General Virgen de las Nieves de Granada.

Además a todos los pacientes se les efectuaron mediciones antropométricas de peso y altura. El peso se midió por una balanza tallímetro Perperson 113481 en kilogramos y la altura en centímetros. El índice de masa corporal fue calculado mediante la fórmula peso/talla², y agrupada según la clasificación de la OMS en IMC < 18.50 infrapeso, 18.50 a 24.99 normal, 1.25 a 29.99 sobrepeso y >30 del IMC s/OMS.

Se considero para el estudio como desnutrición un IMC < 23kg/m² y niveles de albúmina <3,8 g/dl según

el consenso del panel de expertos de la International Society for Renal Nutrition and Metabolism¹².

Análisis estadístico

El análisis se realizó mediante el paquete estadístico SPSS 15.0.1, para valorar las diferencias entre Índice de Masa Corporal, parámetros bioquímicos y años en grupos, se utilizó el análisis de varianza (ANOVA). Además se usó el análisis de Kaplan Meier para valorar la supervivencia del paciente con respecto a la albúmina y el IMC. Todos los datos se expresan en valor medio + desviación estándar ($X \pm DS$), considerándose significación estadística con valores de $p < 0,05$.

Resultados

Cuando comparamos los valores medios de IMC durante los diez años de seguimiento observamos que no arrojan diferencias estadísticamente relevantes ($p < 0.605$), pero podemos observar que desde el inicio del estudio todos los pacientes se mantienen en estadios de sobrepeso moderado (Tabla II). Cuando observa-

Tabla II <i>Evolución de los valores medios anuales del IMC en la población de estudio</i>				
Años	Media	Desviación St.	Mínimo	Máximo
1º	25.60	3.82	18.2	31.6
2º	25.01	3.62	17.2	31.4
3º	25.37	3.46	18.2	37.8
4º	25.04	3.94	16.3	37.6
5º	25.16	4.04	16.1	37.2
6º	25.37	4.29	17.9	35.6
7º	25.05	4.48	16.1	35.6
8º	24.51	4.73	17.2	39.3
9º	24.49	4.86	16.5	40.6
10º	25.31	5.16	18.2	40.8

Tabla III <i>Evolución de los valores medios anuales de las categorías de IMC según OMS en la población de estudio</i>										
IMC	Años									
	1º	2º	3º	4º	5º	6º	7º	8º	9º	10º
< 18,5 Bajo Peso	14.3%	14.6%	5.5%	9.2%	10.5%	8.7%	14.8%	12.3%	19.4%	12.9%
18,5 a 25 Normal	26.2%	37.1%	50.5%	46.8%	44.7%	46.4%	40%	58%	43.8%	48.4%
25 a 30 Sobrepeso	54.8%	47.2%	34.9%	35.5%	31.6%	24.6%	27.8%	18.5%	25%	25.8%
>30 Obeso	4.8%	5.6%	9.2%	8.5%	13.2%	20.3%	17.4%	11.1%	11.8%	12.9%

mos los valores medios de IMC clasificados según la OMS y los comparamos por año de estudio observamos como va disminuyendo cada año la proporción de pacientes con sobrepeso, aumentado la proporción de paciente con valores normales de peso y aumentando aunque en menor proporción de pacientes con obesidad (Tabla III).

Cuando clasificamos a los pacientes por grupo según el panel de expertos de la International Society for Renal Nutrition and Metabolism, obtenemos que un total de 33 pacientes presentan desnutrición y 57 no presentan desnutrición, como se puede observar en la tabla IV los pacientes con desnutrición presentan una media mas baja y estadísticamente significativa de ($p < 0.05$) de peso, IMC, albúmina, urea, ácido úrico, proteínas, proteína c reactiva y homocisteína que los pacientes que no presentan desnutrición. Así mismo las medias de creatinina sérica, triglicéridos, colesterol total, colesterol LDL y LDL son también mas bajas en el grupo de pacientes desnutridos que en la de no desnutridos aunque no son estadísticamente significativos.

Así mismo y como se puede observar en la en los grafico de supervivencia (Fig. 1: A y B), en el estudio de los pacientes con $IMC < 23 \text{ kg/m}^2$ y niveles de albúmina $< 3,8 \text{ g/dl}$ con desnutrición presentan una supervivencia mucho menor que los pacientes no desnutridos.

Discusión

La malnutrición es muy común en la ERC, especialmente en las etapas avanzadas cuando los pacientes están en tratamiento renal sustitutivo, y la valoración del estado nutricional de los pacientes en hemodiálisis ha sido siempre una cuestión difícil de evaluar, debido a la falta de criterios únicos que puedan ser utilizados para identificar un estado de desnutrición proteico-calórica, así como debido al carácter multifactorial del mismo^{13,14}. La desnutrición proteico-calórica conlleva la disminución de los contenidos proteicos y grasos del organismo, en los pacientes en diálisis. Suele ser frecuente y las causas son numerosas, ya que el procedimiento de diálisis provoca pérdidas de nutrientes a través del líquido de diálisis así como la disminución de la síntesis de proteínas durante el tratamiento¹⁵⁻¹⁷. No

Tabla IV
Comparación de parámetros antropométricos y bioquímicos entre pacientes que presentaron desnutrición, y pacientes que no presentaron desnutrición

Parámetros	Pacientes con desnutrición n=33	Pacientes sin desnutrición n=57	P
Peso	54,48	65,43	0,000
IMC	20,88	26,04	0,000
Alb	3,45	3,83	0,000
Crs	9,66	10,18	NS
Ur	136,41	146,51	0,000
Aur	7,23	7,62	0,000
Tr	139,71	149,12	NS
CT	154,19	157,89	NS
LDL	82,71	84,46	NS
HDL	42,96	43,51	NS
PT	6,34	6,71	0,019
PCR	1,85	1,22	0,023
Hcy	17,95	21,44	0,000

obstante el tratamiento dialítico mejora sustancialmente estos parámetros inmediatamente después de su inicio, cuando aumentan la albúmina sérica, prealbúmina, reactantes de fase aguda y la concentración sérica de creatinina aumentan^{18,19}. Todo esto favorece el apetito y la mejoría del estado de nutrición. Sin embargo, con el tiempo de tratamiento, la malnutrición vuelve a ser un problema frecuente por la pérdida de apetito derivada de la uremia y la técnica de hemodiálisis^{20,21}.

El mejor marcador para definir pacientes con alto riesgo de desnutrición está aún por determinar. En el

presente análisis, entre un gran número de marcadores nutricionales relacionados con la supervivencia de los pacientes, se encontró que la albúmina sérica, mantiene una estrecha relación con otros parámetros bioquímicos nutricionales y la supervivencia y calidad de vida del paciente.

En cuanto a la evaluación de los distintos parámetros bioquímicos utilizados para valorar la situación nutricional de los pacientes, hemos observado que en general están bajos o en los límites de los valores normales de referencia de nuestro laboratorio, así mismo se ha establecido que los niveles de proteínas totales se relacionan significativamente con el riesgo de muerte²². Por otra parte varios estudios señalan que existe correlación entre los niveles de proteínas totales séricas y de albúmina sérica con lo que se acepta que ambos parámetros valoran el estado nutricional reflejando la masa proteica visceral²³⁻²⁴.

La albúmina en suero es un marcador nutricional importante utilizado para identificar la desnutrición en pacientes con enfermedad renal crónica; así mismo varios estudios han reflejado que niveles de albúmina sérica inferiores a 3,5 g/dl son un importante predictor de la tasa de mortalidad y hospitalización en pacientes crónicos en hemodiálisis fundamentalmente por problemas cardiovasculares²⁵.

El IMC fue propuesto como un índice de malnutrición proteico calórica (Chazot, 2001) comparable a la circunferencia del brazo²⁶ pero en pacientes en diálisis su estudio parece no ser un factor nutricional muy a tener en cuenta. La mayoría de los estudios que han analizado el IMC como factor de desnutrición, o bien no han encontrado relación directa con esta considerando como factor débil para analizar la supervivencia del paciente²⁷⁻²⁹, o han discutido la importancia de la conservación de la masa muscular y el aumento de índice de masa corporal para reducir la tasa de mortalidad considerando un factor poco determinante del estado

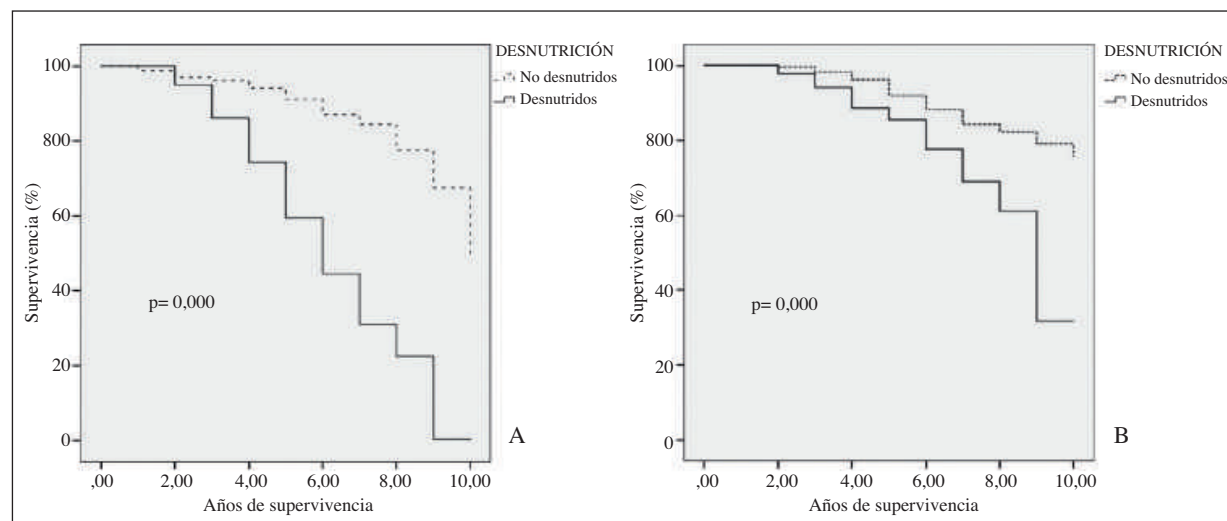


Fig. 1.—A: Gráfico de Supervivencia de Kaplan Meier entre pacientes con albúmina <3,8 g/dl con y sin desnutrición. B: Gráfico de Supervivencia de Kaplan Meier entre pacientes con IMC <23kg/m² con y sin desnutrición

nutricional³⁰⁻³². En este estudio, se considera que la albúmina sérica representa un riesgo nutricional para una población de diálisis, cuando se define mediante el uso de los criterios según el panel de expertos de la International Society for Renal Nutrition and Metabolism.

En nuestro estudio no hemos encontrado diferencias estadísticamente significativas que reflejan la importancia del IMC en general como factor antropométrico y predictor de desnutrición, solo adquiriendo importancia cuando se define según criterios al igual que en la albúmina sérica.

Conclusiones

Tras diez años de evaluación se puede observar en los paciente en hemodiálisis una disminución significativa de los parámetros bioquímicos nutricionales: Proteínas totales, albúmina, colesterol total y transferrina, poniendo de manifiesto el deterioro nutricional de los pacientes con el tratamiento, y mostrando la necesidad de abordar la nutrición del paciente en hemodiálisis desde el inicio en programa de hemodiálisis como parte fundamental de la terapia. Durante los diez años de seguimiento es de destacar la elevada prevalencia de valores bajos de marcadores bioquímicos. En este estudio, se considera que la albúmina sérica representa un riesgo nutricional para una población de diálisis, cuando se define mediante el uso de los criterios según el panel de expertos de la International Society for Renal Nutrition and Metabolism.

Como hemos visto el IMC no se corresponde con los parámetros bioquímicos observados por lo que el deterioro nutricional de los pacientes con IRC en tratamiento renal sustitutivo, se manifiesta principalmente en los parámetros bioquímicos que hemos estudiado, sin que se refleje en los datos antropométricos.

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Original/*Valoración nutricional*

Design and development of a nutritional assessment application for smartphones and tablets with Android® OS

Miguel Carnero Gregorio¹, Montserrat Blanco Ramos², Gerardo Andrés Obeso Carillo²,
Eva García Fontán², Miguel Ángel Álvarez González³ y Miguel Ángel Cañizares Carretero²

¹Departamento de Bioquímica, Genética e Inmunología – Universidade de Vigo. ²Thoracic Surgery Department. Complexo Hospitalario Universitario de Vigo. ³ALERT Life Sciences Computing S.L. Ourense. España.

Abstract

Background & Aims: To design and develop a nutritional application for smartphones and tablets with Android® operating system for using to in- and outpatients that need a nutritional assessment. To check the validity of the results of such software.

Methods: The application was compiled for version 2.1 of the Android® operating system from Google®. A cohort of 30 patients was included for evaluating the reliability of the application. The calculations were performed by staff of the Nutrition Unit of the Complexo Hospitalario Universitario de Vigo, manually and through e-Nutrimet® software on a smartphone and a tablet.

Results: Concordance was absolute between results of different methods obtained using e-Nutrimet® on a smartphone and a tablet (Fleiss index $\kappa = 1$). The same level of concordance was obtained by comparing handmade and e-Nutrimet® made results.

Conclusions: The degree of correlation is good, and it would be extended to all healthcare staff who wants to determine whether a patient has malnutrition, or not. The nutritional assessment software e-Nutrimet® does not replace healthcare staff in any case, but could be an important aid in assessing patients who may be in risk of malnutrition, saving time of evaluation.

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Key words: Nutrition. Nutritional assessment. Mobile phone. Medical informatics applications. Personal electronic health records.

DISEÑO Y DESARROLLO DE UNA APLICACIÓN DE VALORACIÓN NUTRICIONAL PARA SMARTPHONES Y TABLETS ANDROID®

Resumen

Introducción y objetivos: Diseñar y desarrollar una aplicación nutricional para smartphones y tablets con Sistema operativo Android® para realizar las valoraciones nutricionales de pacientes ambulatorios y hospitalizados. Verificar y comprobar la validez de los resultados de la aplicación.

Métodos: La aplicación se compila para la versión 2.1 del Sistema operativo Android® de Google®. Para evaluar la fiabilidad de la aplicación se incluyeron a 30 pacientes, a los que se le realizó una valoración nutricional. Todos los cálculos fueron efectuados por personal de la Unidad de Nutrición del Complejo Hospitalario Universitario de Vigo, de forma manual y a través del software e-Nutrimet®, tanto usando un Smartphone como una tablet.

Resultados: Se obtuvo una concordancia absoluta entre los resultados de los diferentes métodos obtenidos utilizando la aplicación e-Nutrimet® en smartphones y en tablets (Fleiss index $\kappa = 1$). El mismo nivel de concordancia se obtuvo comparando el método manual como el automatizado mediante el software e-Nutrimet®.

Conclusiones: El grado de correlación es muy bueno, permitiendo extender la valoración nutricional usando e-Nutrimet® a todo el personal sanitario que quiera determinar si un paciente presenta malnutrición o no. La aplicación de valoración nutricional e-Nutrimet® no sustituye al personal sanitario en ningún caso, pero podría ser de gran ayuda a la hora de valorar pacientes que pudieran estar en riesgo de malnutrición, ahorrando tiempo en estas valoraciones.

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Palabras clave: Nutrición. Valoración nutricional. Dispositivos móviles. Aplicaciones informáticas médicas. Registros de salud electrónicos.

Correspondence: Miguel Carnero Gregorio.
Departamento de Bioquímica, Genética e Inmunología –
Universidad de Vigo. Lg Prexigueiro. 70.
32418 Ribadavia (Ourense).
E-mail: miguel.carnero.gregorio@hotmail.com

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Introduction

Smartphones have become a part of our daily lives. The number of smartphone users worldwide is expected to exceed one billion in 2013¹. Nowadays, 64% of U.S. physicians have a smartphone, and it is expected that this figure will increase to 81% in the year 2012².

Currently, there are two operating systems (OS) that dominate the smartphone market: Android® (developed by Google®) and iOS® (developed by Apple®), according to the marketing research company Canalis (http://www.ditic.luz.edu.ve/index.php?option=com_content&task=view&id=200&Itemid=217). In Spanish mobile phones' market, the use of smartphones is approximately 23%³ and it continues to grow according to an analysis of TomiAhonen Consulting (<http://communities-dominate.blogs.com/brands/2011/12/smartphone-penetration-rates-by-country-we-have-good-data-finally.html> - December, 2011).

These devices allow to make a lot of alternatives tasks to traditional mobile phones, partially due to the use of mobile applications and Internet connectivity through different communication networks (WiFi technologies, 3G, Bluetooth, etc.) which ease a fast interconnection, enabling access to the latest news in medical research, even in the point of patients caring⁴.

Increase in computing power coupled with mobility and multimedia capabilities make them ideal for software development oriented to health professionals⁴. Anyone may dispose in its hands a powerful computer available in any situation.

Most of healthcare professionals want to have information as current as possible and a support to everyday clinical decisions².

Most common utilities in such devices (e-mail and text messaging software, browser, camera and multimedia player/recorder) are already used in clinical practice for the exchange of information between health professionals and serves for supporting to make decisions, in a practical way. Increasingly development of medical applications for these devices is in benefit of clinicians and might reduce costs of local resources in many cases, which is a great advantage^{5,6}. In addition to bibliographic reference managers in health field, there are specific applications in different areas such as medicine, surgery, neurosurgery, ophthalmology, infectious diseases, pharmacology or psychology⁷.

Within the nutrition field, software tools as Gerinut® (Abbott Laboratories SA - Madrid, Spain) are more specific in geriatric nutrition⁸. Also, there are some applications for iPhone® as Nutri'Calc (Nestlé Clinical Nutrition France - Noisiel, France), which is more specific for a catalog of products and nutritional supplements. This application allows a simple calculation of some nutritional parameters. It is available in the Apple®'s iTunes App Store®.

Persistent work overload of health professionals in their daily practice does not let for an improvement in the quality of patient care, extending the attention time

of patients and prolonging hospital stays for caring, delaying full recovery of these patients and causing a higher bed occupancy and cost per inpatient.

In the current health care context, it is necessary to develop new processes with the aim of reducing hospitalization time of inpatients and improving in the cost-effectiveness ratio. Mobile devices may help in this task through the development of applications that imply time saving for making decisions of health professionals.

From Nutrition Unit and Thoracic Surgery Department, at Complejo Hospitalario Universitario de Vigo (Vigo University Hospitals, Vigo, Spain), we have launched a protocol for a preoperative nutritional study in primary lung neoplasms since 2009. Patients are assessed for their nutritional status before surgery intervention, among other tests. Several communications support its effectiveness and usefulness⁹⁻¹¹.

The e-Nutrimet® software has been developed to make faster the process of nutritional assessment and try to avoid work overload in the Nutrition Unit, where currently all patients candidates for lung resection are assessed.

The present study shows the design and development of e-Nutrimet®, a software that allows the nutritional assessment of inpatients.

Materials and Methods

Integrated Development Environment (IDE) used for developing the application was Eclipse® Java® Enterprise Edition (J2E) version 3.7.2 with Android® Development Tools (ADT) plugin version r21.1 and Apple® Java® Virtual Machine (JVM) version 1.6.0_41. Android® Software Development Kit (SDK) r21.1 was also used and compiled for Android® version 2.1 Eclair®, Application Programming Interface (API) 7.

This application has been developed for Android® versions later than 2.1 Eclair®, according to data shown by Google® Inc. (<http://developer.android.com/about/dashboards/index.html> - collected in November 2012).

The software was based on different nutritional assessment methods described in several scientific publications, and whose daily clinical practice has been proven.

One of them is Chang method^{12,13} which is an objective, cheap and reliable nutritional assessment method¹⁴. This method was qualified as most useful than Patient-Generated Subjective Global Assessment (PG-SGA) in target patients to lung resection¹⁰ at Complejo Hospitalario Universitario de Vigo. e-Nutrimet® also implements patients nutritional assessment by other methods, such as Controlling Nutritional status (CONUT)¹⁵ and PG-SGA¹⁶, as well as the daily total calorie value (TCV) due to the addition of several algorithms: Harris Benedict¹⁷, Ireton Jones¹⁸, Mifflin-St Jeor¹⁹, Roza²⁰, Owen^{21,22} and FAO/WHO²³. Chang's method use several anthropometric and biochemical parameters. Among the anthropometric parameters are used height, weight,

percentage of weight loss of the patients with respect to their ideal weight, (mid-)upper arm circumference ((M)UAC), the triceps skin fold (TSF) and (mid-)upper arm muscle area ((M)UAMA calculated from (M)UAC and TSF variables according to the formula:

$$(M)UAMA (mm) = (M)UAC (mm) - (3,14 * TSF (mm))$$

To determine the ideal weight for males and females were used Hammond algorithms²⁴. These algorithms make an estimation of the patient's ideal weight based on the height. Thus, taking the weight and height of the patient measured on a weighing and height scale respectively, the program computes the ideal weight for that patient.

It has been incorporated to e-Nutrimet® an option for those cases where it is very difficult to take values of height and weight due to the patient's situation (bedridden, in intensive care, etc...). This option estimates the height and weight of the patient from other anthropometric values, such as knee-heel length (KHL)²⁵ and the calf circumference (CC)²⁶. This will avoid the stress to the patient, as far as possible, during nutritional assessment.

Finally, the e-Nutrimet® software also allows for weight estimation using the height value and an approximate patient's anatomical image. This is specially useful in those isolated individuals whose contact must be minimized. Thus, e-Nutrimet® application allows an estimation of the Body Mass Index (BMI) using height values and a estimated weight extracted from a scale of figures²⁷.

Biochemical parameters used by the Chang's method are albumin and lymphocyte count, measured in serum samples.

All variables used by e-Nutrimet® application for assessing through Chang's method are shown in table I.

PG-SGA method¹⁶ consists of a questionnaire that must be filled with different aspects of patients feeding and other parameters related to their health status and their health care conditions.

CONUT is a screening method that uses biochemical parameters to determine if the patient is at risk of malnutrition, or otherwise is in a good nutritional status¹⁵. It is a method that warns in case of possible malnutrition, in a specific degree, so a monitorization will be necessary in patient's nutritional status if the result is positive. Biochemical parameters, in serum samples, used with CONUT algorithm are albumin, lymphocyte count and cholesterol.

e-Nutrimet® application, as discussed above, computes the daily total calorie value (TCV) through several equations. Depending on the equation, variables to be used will be different, but the program allows selecting various options to get the results in Kcal/day of needs for an individual patient based on their particular conditions. Mifflin-St Jeor algorithm, which seems of consensus for some authors, is the most fitted to the metabolic requirements, when is compared to data quantified by indirect calorimetry²⁸⁻³⁰. Also, Ireton-Jones equation would be the best choice in intensive care unit (ICU) patients¹⁸.

All variables used by e-Nutrimet® application to determine the TCV by different equations are shown in table II.

For determining the effectiveness of the e-Nutrimet® application, a random sample of 30 patients was selected, who were assessed at the Nutrition Unit of the Department of Endocrinology of the Complejo Hospitalario Universitario de Vigo (NU-CHUVI, Vigo, Spain). All patients underwent nutritional assessment by different methods (Chang, PG-SGA and CONUT), and TCV was calculated using different equations (Harris Benedict, Ireton-Jones, Roza, Mifflin-St. Jeor, Owen, FAO/WHO), either manually or by using the e-Nutrimet® software.

All measurements were made by qualified health staff at NU-CHUVI. Harpenden® caliper (*Baty International – West Sussex, Great Britain*) was used to measure TSF, and a standard tape-measure was used for measuring (M)UAC parameter through the International System. SECA® model 700 (Seca GMHB & CO. KG - Hamburg, Germany) scale was used for measuring patients' weight with an accuracy of ± 0.1 kg. A telescopic measuring rod SECA® model 220 (Seca GMHB & CO. KG - Hamburg, Germany) was used for measuring patients' height with an accuracy of ± 5 mm. Various biochemical parameters were collected from bodily fluids samples of patients, performed at CHUVI's medical laboratory.

e-Nutrimet® was tested on a Sony Ericsson Xperia Arc® smartphone (Sony Mobile Communications AB -

Table I
Variables requested by e-Nutrimet® through Chang's algorithm

LIST OF USED VARIABLES	
Concept	Type of variable
<i>Patient</i>	
Patient ID	Alphanumeric
Age (years)	Numerical
Date of birth	Date
Gender	Male / Female
<i>Anthropometry</i>	
Current weight (kg)	Numerical
Usual weight (kg)	Numerical
Height (cm)	Numerical
TSF (mm)	Numerical
(M)UAC (mm)	Numerical
KHL (cm)	Numerical
CC (cm)	Numerical
BMI image number	Numerical
<i>Biochemical parameters</i>	
Albumin (g/dl)	Numerical
Lymphocyte Count (linf/μl)	Numerical

Table II
*Variables requested by e-Nutrimet®
for TCV determination*

LIST OF USED VARIABLES	
Concept	Type of variable
<i>Patient</i>	
Patient ID	Alphanumeric
Age (years)	Numerical
Date of birth	Date
Gender	Male / Female
<i>TCV</i>	
Mechanical ventilation	Yes/No
Bedrest	Yes/No
Burns	Yes/No
Injuries	No/Cranial/Other type
Infections	No/Low/Medium/High
Surgery	No/Lesser/Higher
Current weight (kg)	Numerical
Height (cm)	Numerical
TSF (mm)	Numerical
(M)UAC (mm)	Numerical
KHL (cm)	Numerical
CC (cm)	Numerical

Tokyo, Japan) and on a Primux Zonda® tablet (Primux Trading S.L. - Galicia, Spain). Smartphone and tablet specifications may be found on respective manufacturer websites (www.sonymobile.com; www.primux.es). OS for testing was Android®: for smartphone with

version 2.3.4 Gingerbread®, and for tablet with version 4.0.3 Ice Cream Sandwich®.

Statistical analysis

For statistical analysis of data, we used IBM Statistics Package for Social Sciences (IBM SPSS Statistics®) version 19.0 for Windows®. Fleiss' kappa index was used to assess the concordance level of the nutritional assessment computed with e-Nutrimet®, in comparison with manually performed.

Results and discussion

Below, various figures are shown with different sections and corresponding outputs of e-Nutrimet®.

In figure 1 is found the main screen. Various modules are accessed from there, as well as other options such as “Bibliography”, in which scientific articles are included, that describes different methods and techniques implemented in e-Nutrimet®. Other options are “Acknowledgements” and “Help/About...”. This latter is a brief summary of characteristics of the application and which indicates the current version.

In figure 2 is found the output of Chang's method. In this figure, a patient shows a moderate mixed malnutrition, according to types and degrees included in mentioned method^{12,13}, between other relevant information. “Save Patient” option will be used for keeping information.

In the nutritional assessment by PG-SGA algorithm, as shown in figure 3, some variables consist of a dropdown menu in which the clinician may choose the appropriate option. Other variables are logical, for



Fig. 1.—e-Nutrimet® main screen.methods.



Fig. 2.—Example of output screen after Chang's method application.

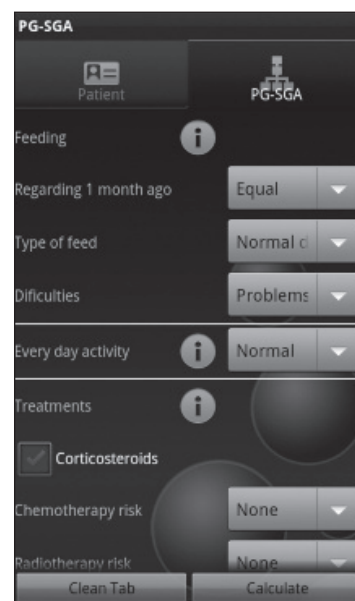


Fig. 3.—Input screen for PG-SGA algorithm.

Fig. 4.—Input screen for CONUT algorithm.

Fig. 5.—Input screen for TCV algorithm.

TCV	
Input Data	Recommended products
Other Results	
TCV according	
	Kcal/day
Harris-Benedict	1657,0
Harris-Benedict (with corrections)	2953,0
Ireton-Jones	1994,0
Owen	1593,0
Mifflin-St. Jeor	1611,0
Roza	1658,0
FAO/WHO	1691,0

Fig. 6.—Example of output screen with TCV results.

clicking on/off in the check box. All variables have a help button (“i” button) that explains what is each variable and with a brief description for using it.

The CONUT nutritional screening tool consists of a warning system, which indicates whether the patient has nutritional risk, and what kind is it¹⁵. It uses three biochemical variables (albumin, lymphocytes count and cholesterol), as shown in figure 4.

TCV is a module in which is possible to select different health conditions of the patient, and introduce a series of anthropometric variables such as weight or height, for computing the number of Kcal that one patient need every day. Results output is obtained using different verified equations of use in clinical hospitals. These results are well suited for computing an indirect calorimetry. Figure 5 and figure 6 show data input and output screens, respectively.

To verify the reliability of the calculations using the application on smartphones or tablets in comparison with the traditional method (handmade method), we used a set of statistical tests to check for significant differences. 30

patients has been nutritionally assessed using the Chang’s method, which is the most used in hospital environment, in handmade mode and by applying e-Nutrimet.

Paired Wilcoxon Signed-Rank test had a p value of 0.000, indicating a strong statistically significant difference between the 2 methods.

In the figure 7, different times needed to perform nutritional assessment are shown by the Chang’s method, using e-Nutrimet application and by the handmade method in the 30 patients.

The figure 8 shows the same data in which 2 regions are shown clearly separated between them. The X axis represents the time needed to perform nutritional assessment by the Chang’s method using e-Nutrimet application, and the Y axis represents the time needed to perform nutritional assessment by the handmade method. Four distinct groups are observed, two directly and two inversely proportional.

The correlation between these data, using the Pearson statistic, had a p-value of 0.731.

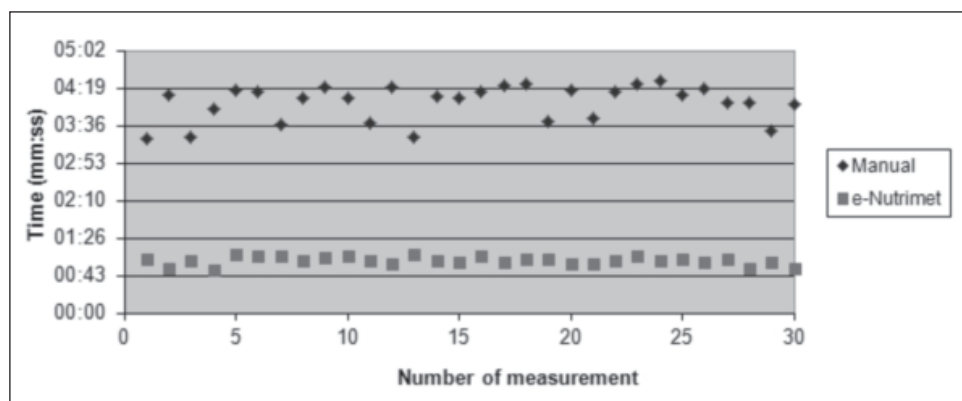


Fig. 7.—eNutrimet® and classic method time values needed to perform nutritional assessment. eNutrimet® and classic method time values needed to perform nutritional assessment.

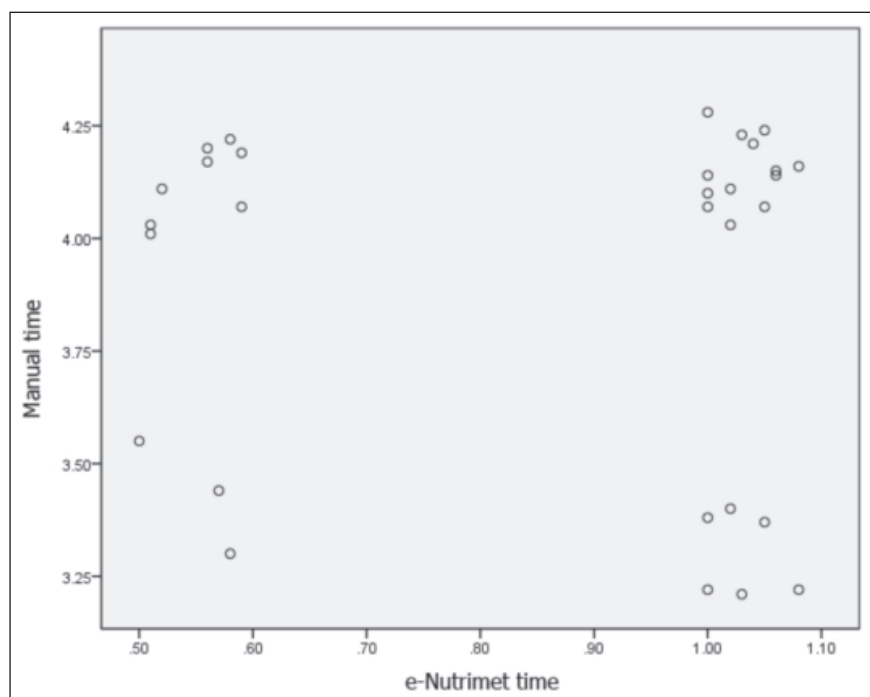


Fig. 8.—Graphic comparing nutritional assessment time values using both methods.

Conclusions

We have already spoken of the great importance of mobile devices like smartphones and tablets in health care daily work. The use of mobile devices does not replace the work of the clinician, but they are a great help to save time in the assessment of patients. Furthermore, these devices reduce possible errors when measuring a patient in comparison with handmade calculations. Another advantage of using a mobile device is derived of having in the palm of the hand an important assessment tool, not being necessary the use of a personal computer, which in many cases is not immediately available.

In the design and making of e-Nutrimet® software for nutritional assessment, implemented on smartphones and tablets, we have achieved a level of absolute concordance, with top reliability for nutrition evaluation. In this sense, the clinician will have more time for interpretation of results and performing other health care tasks, reducing the assessment time of patients in the medical office.

Further studies are necessary to determine if e-Nutrimet® application might to save health system resources, establishing it as a new standard assessment tool in the future.

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Original/ *Valoración nutricional*

Clinical-nutritional evolution of older women submitted to roux-en-y gastric bypass

Mayanne Ribeiro de Moraes¹, Bruna Lúcia de Mendonça Soares², Regiane Maio³ and Maria Goretti Pessoa de Araújo Burgos⁴

¹Nutritionist, Nutrition Residency Program, Federal University of Pernambuco (UFPE), Brazil. ²Specialist in Clinical Nutrition; Master's student, Nutrition Department, UFPE, Brazil. ³PhD, Professor, Nutrition Department, UFPE, Brazil. ⁴PhD, Professor, Nutrition Department, UFPE, Brazil.

Abstract

The aim of the present study was to describe the clinical-nutritional evolution of older women submitted to Roux-en-Y gastric bypass surgery. A concurrent, retrospective study was conducted involving a sample of 16 older women with morbid obesity submitted to Roux-en-Y gastric bypass surgery between 1997 and 2010. Weight, body mass index (BMI), percentage of weight loss (%WL) and percentage of excess weight loss (%EWL) were evaluated three, six and 12 months after surgery. Preoperative comorbidities, postoperative clinical-nutritional manifestations and peri-operative mortality were also investigated. Mean age was 62.02 ± 2.02 years. A progressive reduction was found in mean body weight (116.04 ± 22.99 to 80.96 ± 21.43 Kg) and BMI (47.13 ± 8.19 to 33.42 ± 9.31 Kg/m²), with a consequent %WL of $28.60 \pm 8.59\%$ and %EWL of $64.79 \pm 3.99\%$ throughout the one-year follow-up period ($p < 0.05$). All patients has diseases associated with obesity, the most frequent of which were arterial hypertension ($n = 16$), arthropathy ($n = 11$), dyslipidemia ($n = 9$) and diabetes ($n = 7$). The following clinical-nutritional symptoms were reported: alopecia ($n = 9$), nausea/vomiting ($n = 7$), constipation ($n = 5$) and food intolerance ($n = 4$). One patient was diagnosed with malnutrition one year after surgery. No deaths occurred within 30 days after surgery. At the one-year evaluation, surgical success was evidenced by the significant reductions in mean weight and BMI and the more than 50% loss of excess weight.

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Key words: *Bariatric surgery. Gastric bypass. Elderly. Weight loss.*

EVOLUCIÓN CLÍNICO-NUTRICIONAL DE MUJERES MAYORES SOMETIDAS A BYPASS GÁSTRICO EN Y DE ROUX

Resumen

El objetivo de este estudio fue la descripción de la evolución clínico-nutricional de mujeres mayores sometidas a cirugía de bypass gástrico en Y de Roux. Se desarrolló un estudio concurrente, retrospectivo, que incluyó una muestra de 16 mujeres mayores con obesidad mórbida sometidas a bypass gástrico en Y de Roux entre 1997 y 2010. Se evaluó el peso, índice de masa corporal (IMC), porcentaje de pérdida de peso (%WL) y porcentaje de pérdida de peso excesivo (%EWL) tres, seis y doce meses después de la cirugía. También se investigó las comorbilidades preoperatorias, manifestaciones clínico-nutricionales postoperatorias y mortalidad perioperatoria. La edad media fue $62,02 \pm 2,02$ años. Se detectó una reducción progresiva en el peso medio corporal ($116,04 \pm 22,99$ a $80,96 \pm 21,43$ Kg) e IMC ($47,13 \pm 8,19$ a $33,42 \pm 9,31$ Kg/m²), con un consecuente porcentaje de pérdida de peso (%WL) de $28,60 \pm 8,59\%$ y %EWL de $64,79 \pm 3,99\%$ a lo largo del periodo de seguimiento de un año ($p < 0,05$). Todas las pacientes tenían enfermedades relacionadas con obesidad, siendo la más frecuente hipertensión arterial ($n = 16$), artropatía ($n = 11$), dislipidemia ($n = 9$) y diabetes ($n = 7$). Se comunicaron los siguientes síntomas clínico-nutricionales: alopecia ($n = 9$), náusea/vómitos ($n = 7$), estreñimiento ($n = 5$) e intolerancia a la comida ($n = 4$). Una paciente fue diagnosticada de malnutrición un año después de la cirugía. No se registraron muertes tras 30 días de la cirugía. En la evaluación a un año, el éxito quirúrgico quedó constatado por las reducciones significativas en peso medio e IMC, además de más de un 50% de pérdida de peso excesivo.

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Palabras clave: *Cirugía bariátrica. Bypass gástrico. Mayores. Pérdida de peso.*

Correspondence: Bruna Lúcia de Mendonça Soares.
Rua Emiliano Braga, nº 635, Várzea, Recife-PE, Brazil.
Apartamento 1207. CEP: 50670-380.
E-mail: bruna-luc@hotmail.com

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Introduction

Overweight and obesity are defined as an abnormal, excessive buildup of fat tissue that is harmful to one's health. The prevalence of obesity has more than doubled throughout the world since 1980 and it is estimated that more than 1.5 billion individuals will be obese by 2015¹.

The multifactor etiology of obesity is complex and results from a combination of genetic, environmental, emotional and lifestyle factors. One's energy balance is altered by an increase in calorie intake and/or a reduction in energy expenditure². Based on data from a household survey conducted by the Brazilian Institute of Geography and Statistics, overweight and obesity (as determined by the body mass index [BMI]) in Brazil increases with age until the 45-to-54-year-old range for men and the 55-to 64-year-old range for women, declining thereafter³.

The population of older adults has been growing throughout the world. The World Health Organization considers older adults to be those aged 65 years or older in developed countries and those aged 60 years or older in developing countries⁴. According to censuses conducted by the Brazilian Institute of Geography and Statistics, individuals aged 60 years or older accounted for 7.3% of the Brazilian population in 1991 and 8.6% of the population in 2002. Thus, the population of older adults increased by nearly four million individuals in the period as a result of the gradual increase in mean life expectancy⁵.

Among older adults, obesity aggravates the diminished physical function related to the ageing process and causes frailty or sarcopenic obesity. It is therefore particularly important to encourage weight loss as a means for improving physical function among obese older adults and preventing or ameliorating clinical and metabolic complications associated with obesity⁶. Due to the increased risk of disease and death among individuals with morbid obesity, patients who are unable to achieve significant weight loss with a change in life style and/or drug therapy may benefit from surgical treatment^{2,6}. The best results are achieved with gastric bypass surgery⁷. Studies report the effectiveness of bariatric surgery in elderly patients for the resolution of comorbidities, significant weight loss and an improvement in quality of life^{8,9,10,11,12}. However, divergent opinions are found regarding what constitutes adequate treatment for older adults. While weight loss following bariatric surgery leads to a reduction in health risks, such weight loss may have harmful effects on older adults, such as an increased risk of mortality, the aggravation of the loss of muscle mass related to the ageing process and the loss of bone mineral density^{13,14}.

Considering the lack of studies on the effects of gastric bypass surgery in older adults, the aim of the present study was to describe the clinical-nutritional evolution of older women submitted to Roux-en-Y gastric bypass surgery.

Methods

A concurrent, retrospective study was conducted involving a sample of 16 older women (aged 60 years or older) with morbid obesity submitted to Roux-en-Y gastric bypass surgery at the hospital of the Federal University of Pernambuco (Brazil) between 1997 and 2010. Data were collected from the patient charts, which contained the results of the follow-up evaluations of the multidisciplinary healthcare team. Information was collected on socio-demographic characteristics (age, ethnicity, schooling, marital status and occupation), clinical history of weight gain, preoperative comorbidities, postoperative clinical-nutritional signs and symptoms and the occurrence of peri-operative death (defined as death due to any cause within 30 days following bariatric surgery).

Nutritional status was determined based on height (m), preoperative weight (Kg) and current weight (Kg). The BMI was calculated as weight/height². Evaluations were conducted in the preoperative period as well as three, six and 12 months after bariatric surgery for the determination of absolute weight loss (Kg), postoperative BMI, percentage of weight loss (%WL) and percentage of excess weight loss (%EWL) using the following formulas: 1) postoperative BMI = (current weight/height²); 2) %WL = (preoperative weight – current weight)/preoperative weight x 100; 3) %EWL = (preoperative weight – current weight)/(preoperative weight – ideal weight) x 100. Ideal weight was calculated using a specific formula described by Deitel and Greenstein (2003) for individuals with morbid obesity: $53.975 + [(height - 1.524) \times 53.5433]$ for the female gender¹⁵. For %EWL, a modified version of the classification proposed by Reinhold (1982)¹⁶ was used, which considers more the 75% excess weight loss to be excellent and 50 to 75% to be good, whereas less than 50% indicates treatment failure¹⁷.

Statistical analysis

The descriptive analysis was performed with the aid of the Sigma Stat program for Windows (version 3.5). The data were presented in tables. Continuous variables with normal distribution were expressed as mean and standard deviation. Variables with non-normal distribution were expressed as median and 25th to 75th percentiles. Categorical variables were expressed as whole numbers. The level of significance was set to 5% ($p < 0.05$).

This study received approval from the Human Research Ethics Committee of the Federal University of Pernambuco (Brazil) under process number and was conducted in compliance with Resolution n°466/12 of the Brazilian National Board of Health for research involving human subjects. The patients received clarifications regarding the procedures, risks and benefits of the study and agreed to voluntary participation by signing a statement of informed consent.

Table I

Preoperative socio-demographic characteristics of older women submitted to Roux-en-Y gastric bypass surgery, Federal University of Pernambuco hospital, Recife, Brazil, 1997 - 2010

<i>Variables and categories</i>	<i>n</i>
Ethnicity	
Caucasian	16
Marital status	
Single	2
Married	6
Divorced	1
Widowed	7
Schooling	
Primary school	9
High school	5
University	1
Illiterate	1
Occupation	
Actively employed	2
Unemployed/homemaker	4
Retired/receiving pension	10

Number of patients (n = 16)

Results

Table I displays the socio-demographic characteristics of the 16 older women submitted to gastric bypass surgery. Mean age was 62.06 ± 2.02 years, mean weight was 116.04 ± 22.99 Kg, mean height was 1.57 ± 0.06 m and mean preoperative BMI was 47.13 ± 8.19 Kg/m². Six patients reported that the excessive gain in weight occurred during or after a pregnancy, five reported becoming obese in adulthood, four reported becoming obese in childhood and one reported becoming obese during adolescence. All patients had diseases related to obesity (Table II). Table III displays the most frequent clinical-nutritional signs and symptoms recorded during the 12-month follow-up period.

A statistically significant progressive reduction in body weight and BMI occurred throughout the follow-up period (3, 6 and 12 months), along with a significant increase in both %WL and %EWL, with the exception of %EWL between the three-month and six-month evaluation, in which the increase did not achieve statistical significance (Table IV). Despite the significant reduction in mean weight, only one patient had reached her ideal weight by the 12-month evaluation. Based on the %EWL at the 12-month evaluation (n = 12), one patient achieved excellent results, five achieved good results, five achieved insu-

Table II

Preoperative comorbidities among older women submitted to Roux-en-Y gastric bypass surgery, Federal University of Pernambuco hospital, Recife, Brazil, 1997 - 2010

<i>Comorbidities</i>	<i>n</i>
Hypertension	16
Arthropathy	11
Dyslipidemia	9
Diabetes mellitus	7
Gastritis	7
Steatosis	5
Cholelithiasis	4
Dyspnea	3
Gastroesophageal reflux disease	3
Depression	3
Sleep apnea	2

Number of patients (n = 16)

fficient results and one patient had excess weight loss of 144.1%, with a BMI of 17.89 Kg/m², and was diagnosed with malnutrition. An increase in mean %EWL occurred throughout the study (Fig. 1).

There were no occurrences of death within 30 days following gastric bypass surgery. However, after six months, one patient suffered complications during orthopedic surgery for the placement of a prosthetic knee, leading to malnutrition, septic shock and death.

Table III

Postoperative clinical-nutritional signs and symptoms among older women submitted to Roux-en-Y gastric bypass surgery, Federal University of Pernambuco hospital, Recife, Brazil, 1997 - 2010

<i>Signs and symptoms</i>	<i>n</i>
Alopecia	9
Nausea/vomiting	7
Constipation	5
Food intolerance	4
Diarrhea	3
Epigastralgia	3
Brittle nails	3
Flatulence	2
Dry skin	2
Dumping syndrome	1

Number of patients (n = 16)

Table IV
Anthropometric variables in preoperative period and at three-month, six-month and 12-month evaluations among older women submitted to Roux-en-Y gastric bypass surgery, Federal University of Pernambuco hospital, Recife, Brazil, 1997 - 2010

Variables	Preop	3 months	p	6 months	p	12 months	p
Weight (Kg)	116.04 ± 22.9	95.30 (79.32-97.95)	0.015*	91.13 ± 23.34	0.011*	80.96 ± 21.43	<0.001*
BMI (Kg/m ²)	47.13 ± 8.19	39.08 ± 9.28	0.025*	36.657 ± 10.033	0.006*	33.42 ± 9.31	<0.001*
%WL	-	15.95 ± 4.60	-	22.51 ± 8.13	0.031*	28.60 ± 8.59	<0.001*
%EWL	-	33.53 (24.71-39.85)	-	41.51 (28.09-71.51)	0.264	59.85 (38.36-72.09)	0.018*

BMI: body mass index; %WL: percentage of weight loss; %EWL: percentage of excess weight loss; preoperative: n = 16; 3-month and 6-month postoperative evaluations: n = 11; 12-month evaluation: n = 12; data expressed as mean and standard deviation or median and 25th to 75th percentiles; weight and BMI at 3, 6 and 12 months compared to preoperative weight and BMI; %WL and %EWL at 6 and 12 months compared to values at 3 months; * p < 0.05 (Student's t-test or Mann-Whitney test).

Discussion

The increase in the elderly population has been accompanied by an increase in the prevalence of overweight and obesity in this age group¹⁸. Thus, researchers have reassessed the possibility of bariatric surgery for older adults, who were once considered too old to benefit from this procedure¹⁹. While previous reports expressed concerns due to higher rates of complications, recent studies have demonstrated that bariatric surgery can be performed safely on older adults with satisfactory results and that age *per se* should not be considered an absolute contraindication for surgery^{14,19,20,21,22}.

In a review of the literature on obesity among older adults, Houston et al. (2009)¹⁸ found that most bariatric patients are women and Roux-en-Y gastric bypass (RYGB) is the most frequent type of bariatric surgery. The present findings are in agreement with these data, as women accounted for 16 of the 17 patients operated during the study period and RYGB was the procedure

performed. Older adults accounted for only 2.95% of the total number of bariatric surgeries performed in the study period. Similar findings are described in previous studies, such as the 2.7% rate described by Varella et al. (2006)⁶ and the 1.3% rate described by Nelson et al. (2006)²¹.

According to the Brazilian Obesity Guidelines², obesity is more prevalent in populations with a greater degree of poverty and lower educational level, which may be explained by the better palatability and lower cost of high-calorie foods, such as sugar and fat. All patients in the present study depended on the Brazilian public healthcare system. Moreover, the majority (n = 9) only had a primary school education and one was illiterate, which partially confirms that data described in the aforementioned guidelines.

The increase in the duration of obesity is accompanied by an increase in the incidence of comorbidities and the use of medications¹⁰. The most frequent preoperative diseases were systemic arterial hypertension, dia-

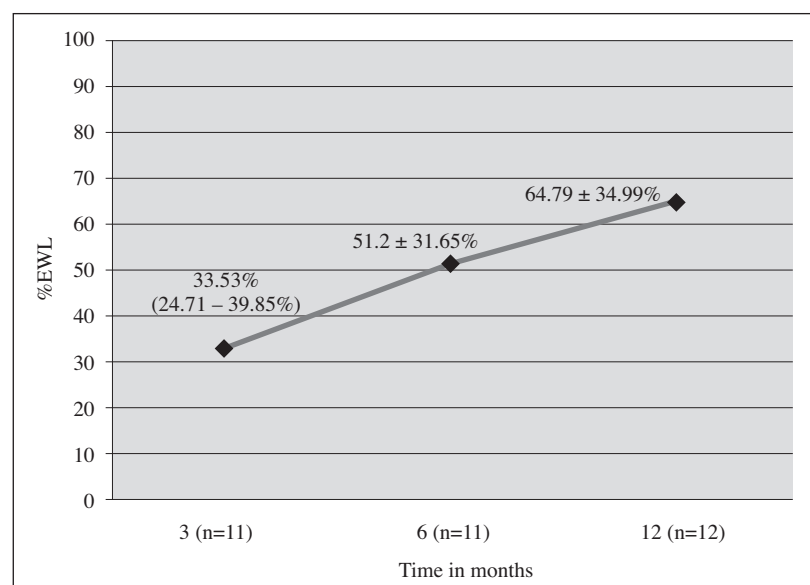


Fig. 1.—Evolution of %EWL throughout postoperative evaluations of older women submitted to Roux-en-Y gastric bypass surgery, Federal University of Pernambuco hospital, Recife, Brazil, 1997 - 2010 p ≤ 0.001.

betes mellitus, arthropathy, dyslipidemia, sleep apnea and gastroesophageal reflux disease, which is in agreement with data described in previous studies on older adults submitted to gastric bypass surgery^{10,11,22}. The diagnosis of depression in three patients is in agreement with data reported by O'Keefe et al. (2010)²², who report a 37.9% prevalence rate of depression in the sample analyzed.

Although morbidity and mortality rates are higher among older adults^{14,23}, bariatric surgery is considered as safe as other gastrointestinal procedures in this age group, as the mortality rate following bariatric surgery is lower than the expected mortality rate⁸ and can be as low as 0% in the 30 days following surgery^{19,20}, as occurred in the present study. Fátima et al. (2006)⁸ report a peri-operative mortality rate of 0.7% in a group of 127 patients aged 60 years or older. According to Papasavas et al. (2004)⁹, the use of laparoscopic techniques and the improvement in peri-operative care have made bariatric surgery a safer procedure for older patients.

The most frequent clinical-nutritional manifestations following gastric bypass surgery were alopecia, vomiting, constipation, food intolerance, diarrhea, brittle nails and dumping syndrome, which is in agreement with data reported for the adult population submitted to gastric bypass surgery^{24,25,26,27}. However, no previous papers were found reporting these data only on older adults. Postoperative nutritional and multidisciplinary follow up is essential to avoiding nutritional deficiencies and corrected bad eating habits before and after surgery as well as potentiating the results and patient adherence to treatment^{26,27}.

One patient received a diagnosis of malnutrition. This is a risk associated with all types of bariatric surgery and is largely avoidable through adequate patient selection, preoperative nutritional education, postoperative follow up and patient adherence to treatment²⁸.

As suggested by Deitel et al. (2007)²⁹, the determination of the percentage of excess weight loss is a way to standardize measures when comparing weight loss following bariatric surgery. In the present study, mean %EWL was $64.9 \pm 34.99\%$ at the one-year evaluation, which is considered indicative of surgical success and is in agreement with data reported in the literature for older adults submitted to RYGB. In a series of 80 patients aged 60 years or older treated predominantly with open gastric bypass surgery (65%), Sugerman et al. (2004)¹¹ report 57% excess weight loss in one year of follow up. Analyzing 27 patients aged 65 years or older, Quebbemann et al. (2005)¹⁰ found 72% excess weight loss in the group submitted to gastric bypass surgery ($n = 13$). In a retrospective analysis of 197 patient aged 65 years or older submitted predominantly to gastric bypass surgery (79.3%), O'Keefe et al. (2010)²² report a higher %EWL in comparison to other bariatric techniques, reaching 59.8% one year after surgery. In the present study, the reduction in the

number of patients in the follow up period was due to failure to appear for the evaluations or insufficient information on the patient chart.

The reduction in BMI from 47.13 ± 8.19 to 33.42 ± 9.31 Kg/m² and the $28.60 \pm 8.59\%$ weight loss are similar to data described by Sugerman et al. (2004)¹¹, who report a reduction in BMI from 49 ± 7 to 34.5 ± 7 Kg/m² and 30% weight loss in one year of follow up. Weight loss can reach a mean of 35 to 40% of initial weight between the 12th and 24th months following surgery.²⁹

Conclusion

The present findings demonstrate that older adults account for a very small percentage of bariatric surgeries, despite the occurrence of morbid obesity in this age group. The significant reductions in weight and BMI as well as the greater than 50% loss of excess weight in the first 12 months following gastric bypass surgery indicate good results. However, only one patient reached her ideal weight. The clinical-nutritional signs and symptoms were similar to those reported for the adult population. Multidisciplinary follow up is important to potentiating the beneficial effects of gastric bypass surgery and avoiding complications, such as malnutrition. Further studies are needed to assess the safety and efficacy of bariatric surgery for older adults.

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Original/*Valoración nutricional*

Vectores de impedancia bioeléctrica de referencia para la población española

Ximena Atilano-Carsi¹, María Auxiliadora Bajo², Gloria Del Peso², Rafael Sánchez² y Rafael Selgas²

¹Departamento de Nefrología. Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán. Distrito Federal, México.

²Servicio de Nefrología. Hospital Universitario La Paz. IdiPAZ. IRSIN. REDinREN. Madrid, España.

Resumen

Fundamento y objetivo: El análisis de vectores de impedancia es útil para la determinación de la composición corporal en pacientes con alteración del estado de hidratación. Las elipses de tolerancia originales fueron hechas en individuos sanos italianos. Debido a las diferencias en composición corporal entre poblaciones, el objetivo del estudio fue establecer elipses de tolerancia específicas para la población española y compararlas con las elipses realizadas en la población original de referencia.

Material y método: Se estudiaron 311 sujetos sanos españoles de ambos sexos, entre 18 y 80 años, con IMC entre 18 y 31 Kg/m², a los cuales se les realizaron mediciones de peso, estatura e impedancia bioeléctrica. Los valores de resistencia y reactancia estandarizadas por la estatura (R/E y Xc/E) derivados de la medición de impedancia, fueron utilizados para determinar la composición corporal y realizar las elipses de referencias específicas para dicha población.

Resultados: Las características de composición corporal fueron diferentes entre sexos y grupo etario. Se graficaron los valores de R/E y Xc/E de la población española sobre las elipses de tolerancia italianas, encontrándose que los vectores se situaban en los cuadrantes izquierdos, indicando diferente composición corporal, por lo que se construyeron elipses de tolerancia específicas para la población española a partir de los valores de R/E y Xc/E. Las elipses de tolerancia españolas fueron estadísticamente diferentes a las italianas.

Conclusiones: Los vectores de la población española fueron diferentes a los de la población italiana, de ahí la importancia de tener un patrón de referencia propio.

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Palabras clave: *Composición corporal. Impedancia bioeléctrica. Valores de referencia. Resistencia, reactancia.*

NORMAL VALUES OF BIOIMPEDANCE VECTOR IN SPANISH POPULATION

Abstract

Background and objective: The bioelectrical impedance vector analysis is useful for the determination of body composition in patients with altered hydration status. The original tolerance ellipses were made in Italian healthy individuals. Due to differences in body composition between populations, the aim of the study was to establish specific tolerance ellipses for the Spanish population and compare them with those ellipses made in the original reference population.

Methods: We studied 311 Spanish healthy subjects of both sexes, between 18 and 80 years old, with a BMI between 18 and 31 Kg/m², who underwent measurements of weight, height and bioelectrical impedance. The values of resistance and reactance standardized by height (R/H and Xc/H) derived from the impedance measurement, were used to determine the body composition and construct the specific tolerance ellipses for this population.

Results: The characteristics of body composition were different between sex and age groups. We plotted values of R/H and Xc/H of the Spanish population on the Italian tolerance ellipses finding that vectors were placed in left quadrants, indicating different body composition. We therefore built specific tolerance ellipses for Spanish population based on values of R/H and Xc/H. Spanish tolerance ellipses were statistically different from the Italian.

Conclusions: The vectors of the Spanish population were different from those of the Italian, hence the importance of having a self-reference pattern.

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Key words: *Body composition. Bioelectric impedance. Reference values. Resistance. Reactance.*

Correspondencia: Ximena Atilano-Carsi.

Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán. Departamento de Nefrología y Metabolismo Mineral. Vasco de Quiroga No. 15, Col. Sección XVI, Delegación Tlalpan, México DF. CP14000
E-mail: xime1879@hotmail.com

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Introducción

La composición corporal es de gran utilidad en la evaluación del estado de nutrición y en el seguimiento de la composición de tejidos y líquidos corporales asociados a diferentes patologías¹. Los métodos de composición corporal utilizan ecuaciones de predicción, obtenidas con base en datos sobre población sana, que asumen relaciones entre cantidades cuantificables y funciones matemáticas que las relacionan².

Las técnicas de estimación de composición corporal de referencia (dilución de isótopos, activación de neutrones, etc) son poco accesibles en la práctica clínica, costosas y difíciles de aplicar en pacientes hospitalizados³⁻⁴. En el ámbito clínico se encuentran disponibles técnicas relativamente baratas, sencillas y que pueden ser llevadas a cabo en la cama del paciente como la antropometría y la impedancia bioeléctrica. No obstante son menos exactas, particularmente en pacientes con patologías que condicionan alteraciones importantes en la composición corporal, ya sea por exceso o disminución de tejidos y/o líquidos corporales³.

Los pacientes con enfermedad renal crónica presentan frecuentemente desgaste energético proteico⁵⁻⁶ y alteraciones en el estado de hidratación, lo cual tiene un gran impacto en la mortalidad. Debido a lo anterior, la evaluación de la composición corporal es de vital importancia para garantizar un adecuado tratamiento médico y nutricio con la finalidad de mejorar la supervivencia de los pacientes⁷. El uso de la impedancia bioeléctrica (IBE) en pacientes con enfermedad renal es muy frecuente y está siendo establecida como parte fundamental de su manejo médico y nutricional^{3,8-9}.

La IBE se basa en la conducción de una corriente alterna de baja intensidad a través del organismo. Dicha corriente es conducida a través de los líquidos corporales por medio del campo eléctrico asociado a los iones; la oposición a su flujo es dependiente de la frecuencia de la propia corriente en aquellos tejidos carentes de agua^{3-4,9}. La impedancia está representada por dos componentes, la resistencia (R) y la reactancia (Xc), ambas, propiedades eléctricas del cuerpo. La resistencia se define como la oposición de los tejidos al flujo de la corriente y determina el 98% de la impedancia, mientras que la reactancia solo representa el 2% y es el resultado del cambio de la corriente eléctrica producto de la polarización de las membranas celulares que actúan como un capacitor. Así, el significado biológico de la resistencia es inversamente proporcional al volumen de líquidos corporales y la reactancia refleja la integridad de las membranas celulares y en cierta manera, la cantidad de masa magra. Finalmente, un tercer elemento, derivado de la asociación entre estos dos componentes, es el ángulo de fase, que se define como el arco tangente entre la R y Xc y refleja el cambio de fase de la corriente eléctrica. Se considera un indicador de la masa celular, de la distribución de agua en los espacios extra e intracelular y se ha relacionado con la supervivencia de pacientes en diversas patologías¹⁰⁻¹¹.

La IBE convencional estima la composición corporal (masa grasa, masa libre de grasa y líquidos corporales) mediante ecuaciones de predicción, derivadas del peso, talla y de valores de resistencia y reactancia, de una población sana de referencia. En el desarrollo de dichas ecuaciones se toman en cuenta varias asunciones, donde se considera al cuerpo como un conductor eléctrico uniforme, una relación estándar entre la longitud de las piernas y el tronco y una hidratación normal (73%) de la masa libre de grasa. Principalmente esta última premisa, representa un problema en la estimación de la composición corporal en enfermos renales^{10,12-13}.

Debido a que la impedancia bioeléctrica es un método de estimación de la composición corporal ampliamente utilizado en la práctica clínica por su costo y practicidad, se han buscado nuevos enfoques, basados en la misma técnica, que eludan los errores asociados al uso de ecuaciones de predicción e independientes del peso corporal, con la finalidad de ser aplicables a pacientes con composición corporal extrema, ya sea por alteración en la cantidad de tejidos blandos o en líquidos corporales¹⁴. Al respecto, se ha reportado como una mejor estrategia el uso de vectores de impedancia, ya que son independientes de ecuaciones de predicción y es más fácil y útil su uso en la práctica clínica^{8,10}.

El análisis de vectores de impedancia, formulado por Piccoli et al, se basa en el análisis de la distribución bivariada del vector de impedancia, conformado por tres componentes, la resistencia, reactancia y ángulo de fase, tanto en población sana como en pacientes con un incremento en el peso corporal debido a obesidad o edema¹⁵.

La resistencia y reactancia estandarizadas por la estatura (R/E y Xc/E) forman una distribución normal bivariada que se expresa en percentiles. La correlación entre estas dos variables determina la forma elipsoidal de la distribución, a lo que se llama gráfica RXc. Esta distribución normal está realizada en población sana, de la cual se desprenden tres percentiles de referencia o elipses de tolerancia al 50, 75 y 95%¹⁴. Sobre la gráfica RXc, y con base en los valores de resistencia y reactancia, se puede plasmar el vector de impedancia de un nuevo sujeto o grupo con la finalidad de contrastarlo con la normalidad. De acuerdo a esta metodología, se considera una composición corporal normal cuando el vector se sitúa dentro de las elipses del 50 y 75%, pues son las acotadas por la media ± 2 desviaciones estándar de las variables que conforman al vector^{7,16}.

La situación del vector sobre las elipses de referencia puede indicar cambios tanto en los líquidos como tejidos corporales. El desplazamiento del vector a lo largo del eje mayor indica variaciones en la hidratación, mientras que el movimiento de este sobre el eje menor, se asocia a cambios en tejidos blandos. Las variaciones simultáneas de hidratación y tejidos, se relacionan con migración del vector a lo largo de ambos ejes¹⁵⁻¹⁶.

Por lo anterior, el método permite conocer, simultáneamente y de forma cualitativa el estado de hidra-

tación y de nutrición de los pacientes, así como hacer evaluaciones, tanto de vectores individuales y su seguimiento, como de grupos de los mismos.

La población de la cual se derivaron las elipses de referencia originales, fueron sujetos sanos italianos. Teniendo en cuenta las diferencias de composición corporal entre las poblaciones, se han llevado a cabo diversos estudios con el fin de realizar elipses de tolerancia con distintas poblaciones de ambos sexos. De tal manera que, hasta este momento, existen elipses de referencia para población italiana¹⁵, norteamericana¹⁷, hindú¹⁸, mexicana¹⁹, para ancianos²⁰, entre otras.

El análisis de vectores de impedancia, es una herramienta útil que puede ser utilizada para la estimación de la composición corporal de pacientes con alteraciones en el estado de hidratación, sin embargo está concebido originalmente en una población italiana de referencia, por lo que es de vital importancia contar con valores de referencia específicos para la población española, con lo cual se evaluará de manera más precisa la composición corporal, principalmente de aquellos sujetos con estados de composición corporal extrema, ya sea por retención de líquidos o exceso/depleción de masa grasa y/o muscular.

El objetivo del estudio fue establecer elipses de tolerancia específicas para la población española y compararlas con las elipses realizadas en la población original de referencia.

Material y métodos

El presente es un estudio transversal, donde se realizaron mediciones de impedancia bioeléctrica en un grupo de sujetos sanos con el propósito de elaborar elipses de referencia específicas para la población española entre Julio y Diciembre de 2008.

Población

Se incluyeron sujetos sanos que voluntariamente aceptaron participar en el estudio reclutados en el Hospital Universitario La Paz y en el centro de donación de sangre del mismo. Todos los sujetos fueron informados sobre los objetivos y desarrollo del estudio.

Se incluyeron sujetos sanos de ambos sexos que no presentaran problemas clínicos que condicionaran alteraciones en el estado de hidratación con una edad entre 18 y 80 años, índice de masa corporal (IMC) entre 18 y 31 Kg/m² y que hubieran firmado el consentimiento informado. Se excluyeron a sujetos con hipertensión arterial, diabetes mellitus, diarrea o cualquier otro padecimiento con afección directa al estado de hidratación y se eliminaron aquellos que no cumplieron con los requerimientos necesarios para las mediciones de impedancia bioeléctrica o con errores en la medición.

Mediciones

Se realizaron mediciones de peso, talla e impedancia bioeléctrica a todos los pacientes incluidos en el estudio, las cuales siempre fueron realizadas por el mismo investigador.

Para poder llevar a cabo las mediciones, los pacientes debieron haber cumplido ciertas condiciones necesarias para asegurar, tanto una adecuada medición, como un correcto estado de hidratación, a saber: ayuno nocturno o de 4 horas previas al estudio, no tener ningún objeto metálico en el cuerpo, no haber realizado ejercicio extenuante 24 horas antes de la medición, no haber ingerido bebidas alcohólicas el día anterior y en el caso de las mujeres, no estar en su periodo menstrual.

El peso se midió en una báscula digital con precisión de 100 gramos. Los sujetos se colocaron de pie, sin zapatos y con el mínimo de ropa en el centro de la plataforma de la báscula. La talla se midió sin zapatos, con un estadiómetro de pared al 0.5 cm más próximo. La impedancia bioeléctrica se midió con un impedanciometro monofrecuencia (50kHz) modelo BIA-101 de Akern Systems (Florence, Italia). Los sujetos permanecieron en posición supina sobre una superficie no conductora con los brazos y piernas paralelos, separados del cuerpo y las palmas de las manos hacia abajo. Se colocaron dos pares de electrodos desechables en las extremidades derechas, el primer par se situó en el dorso de la mano próximo a la tercera articulación falange-metacarpal y en la apófisis estiloides la muñeca, el segundo par sobre la tercera articulación falange-metatarsal y entre el maléolo medial y lateral del tobillo.

Tras la medición, el equipo de impedancia arroja los valores crudos de resistencia y reactancia a 50 kHz, con los cuales se calculó, a través del programa Bodygram 1.31 de Akern, el ángulo de fase, masa grasa (MG), masa libre de grasa (MLG), masa muscular (MM), masa celular (MC), agua corporal total (ACT) y agua extra (AEC) e intracelular (AIC).

Los vectores de impedancia de los sujetos de estudio se construyeron con base en los valores de R y Xc estandarizados por la estatura (R/E y Xc/E) y se representaron sobre las elipses de referencia de la población italiana diferenciadas por sexo (gráfica RXc) con el programa BIVA software 2002 (BIVA Tolerance file)²¹, con el propósito de evaluar si dichos vectores caían dentro de la normalidad (percentiles 50 y 75%).

Debido a que se encontraron diferencias entre las poblaciones, se decidió construir elipses de referencia específicas para la población española. Se utilizaron la media y desviación estándar de la R/E y Xc/E, así como su correlación para elaborar las elipses al 50, 75 y 95% diferenciadas por sexo, mediante el programa antes mencionado. La longitud e inclinación de los ejes mayor y menor de las elipses elaboradas con base en los valores de R/E y Xc/E, se calcularon con el programa BIVAPLOT 1998²².

Todas las mediciones fueron realizadas de acuerdo a las buenas prácticas médicas y a las recomendaciones de la Declaración de Helsinki sobre estudios en humanos.

Análisis estadístico

Los valores de masa grasa, masa libre de grasa, masa celular y muscular, así como el agua corporal total, extra e intracelular se expresan en porcentaje.

Debido a que las variables cumplían con una distribución normal, los datos se expresan como media y desviación estándar. Para la comparación de medias entre sexos, se realizó una *t* de Student. El análisis de correlación entre los valores de resistencia y reactancia estandarizadas por la estatura, se realizaron por el coeficiente de Pearson. Para la comparación de los vectores de impedancia se utilizó la prueba *T*² de Hotelling.

Todos los análisis fueron llevados a cabo con el programa SPSS versión 16 (SPSS Inc., Chicago, Illinois, USA) y se consideró significativa una *p* < 0.05.

Resultados

Se estudiaron 350 sujetos sanos, de los cuales 39 se eliminaron debido a errores en la medición, no cumplir con el ayuno requerido, estar en el periodo menstrual o haber consumido diuréticos. La muestra final quedó conformada por 311 sujetos, 162 hombres y 149 mujeres, con una edad promedio de 38.9 ± 10.9 años (18 – 64) y de 39.2 ± 12.5 años (18 – 74) respectivamente.

En relación a las características antropométricas de los sujetos, se encontró que el peso (84.72 ± 13.46 vs. 66.3 ± 11.85 Kg), talla (1.74 ± 0.07 vs. 1.62 ± 0.06 m) e IMC (27.66 ± 3.8 vs. 25.15 ± 4.53 Kg/m²) fueron significativamente mayores en los hombres (*p* < 0.0001 en todos los casos).

La resistencia y la reactancia fueron significativamente mayores en las mujeres en comparación con los hombres, a diferencia del ángulo de fase que fue mayor en el grupo masculino (Tabla I).

Tabla I <i>Características de impedancia de la población diferenciadas por sexo</i>			
	Hombres <i>n</i> = 162	Mujeres <i>n</i> = 149	<i>p</i>
Resistencia (<i>Ohm</i>)	465.59 ± 51.84	601.55 ± 70.76	< 0.0001
Reactancia (<i>Ohm</i>)	57.7 ± 8.8	61.36 ± 8.35	< 0.0001
Ángulo de fase (°)	7.07 ± 0.75	5.87 ± 0.72	< 0.0001

Tabla II
Características de composición corporal de la población diferenciadas por sexo

	Hombres <i>n</i> = 162	Mujeres <i>n</i> = 149	<i>p</i>
Masa grasa (%)	22.97 ± 6.9	33.85 ± 8.88	< 0.0001
Masa libre de grasa (%)	77.03 ± 6.9	66.15 ± 8.88	< 0.0001
Masa muscular (%)	51.29 ± 6.07	41.58 ± 6.19	< 0.0001
Masa celular (%)	54.52 ± 5.85	50.24 ± 4.88	< 0.0001
Agua corporal total (%)	56.41 ± 3.77	49.73 ± 4.92	< 0.0001
Agua extracelular (%)	40.38 ± 3.22	45.95 ± 2.72	< 0.0001
Agua intracelular (%)	59.62 ± 3.22	54.05 ± 2.72	< 0.0001

El grupo masculino se caracterizó por tener mayor cantidad de MLG, MM y MC en comparación con las mujeres que tuvieron mayor porcentaje de MG. En cuanto a líquidos corporales, los hombres tuvieron mayor cantidad de ACT, con predominio de AIC, mientras que las mujeres tuvieron mayor cantidad de AEC (Tabla II).

De acuerdo a la edad de los sujetos de estudio, se puede observar que en el grupo de los hombres, la reactancia y el ángulo de fase disminuyen conforme avanza la edad. El agua corporal total se mantiene constante a lo largo de los grupos etarios, sin embargo su distribución cambia, observándose una significativa disminución del agua intracelular en los grupos de mayor edad. La masa grasa se mantiene constante hasta los 60 años, cuando incrementa de manera importante, mientras que la masa muscular disminuye a partir de la sexta década de vida (Tabla III). Los cambios en la composición corporal son similares en las mujeres, sin embargo se encontró que a diferencia de los hombres, el agua corporal total disminuye constantemente a lo largo de los años, manteniéndose la distribución entre compartimentos hasta los 60 años, momento a partir del cual, disminuye el agua intracelular y aumenta la extracelular. La masa grasa en las mujeres aumenta de manera constante conforme avanza la edad, a diferencia de los hombres que lo hace a partir de los 60 años, paralelamente a la disminución de la masa muscular (Tabla IV).

Al graficar los valores de R/E y Xc/E de la población española sobre las elipses de tolerancia de la población italiana (Fig. 1), se encontró que los vectores de los hombres españoles se encontraban desplazados hacia la izquierda, situándose en el cuadrante superior e inferior izquierdo y los vectores de las mujeres españolas se encontraban principalmente en los cuadrantes superiores izquierdo y derecho, indicando que la composición corporal de las poblaciones es distinta en am-

Tabla III
Características de impedancia y composición corporal de hombres por grupo etario

<i>Hombres</i>						
	< 30 n=20	30-39 n=61	40-49 n=47	50-59 n=22	>60 n=12	<i>p</i>
Resistencia (Ohm)	486.4 ± 68.4	470.9 ± 57.9	451.3 ± 41.1	455.6 ± 67.0	452 ± 28.9	ns
Reactancia (Ohm)	61.5 ± 6.4	58.5 ± 10.7	58.09 ± 7.4	53.7 ± 9.6	46.5 ± 6.2	0.002
Ángulo de fase (°)	7.25 ± 0.7	7.1 ± 0.6	7.33 ± 0.8	6.72 ± 0.5	5.8 ± 0.5	< 0.0001
Agua corporal total (%)	57.3 ± 4.7	55.9 ± 2.9	56.4 ± 3.0	56.4 ± 2.9	56.5 ± 4.7	ns
Agua extracelular (%)	38.0 ± 3.6	39.7 ± 2.6	39.4 ± 3.1	40.9 ± 2.1	45.9 ± 3.9	<0.001
Agua intracelular (%)	62.0 ± 3.6	60.3 ± 2.6	60.6 ± 3.1	59.1 ± 2.1	54.1 ± 3.9	<0.001
Masa libre de grasa (%)	80.1 ± 7.4	77.2 ± 4.3	77.8 ± 4.2	77.7 ± 4.5	66.1 ± 17.3	<0.001
Masa grasa (%)	19.9 ± 7.4	22.8 ± 4.3	22.2 ± 4.2	22.3 ± 4.53	33.9 ± 17.3	<0.001
Masa celular (%)	51.9 ± 4.7	53.3 ± 5.7	53.8 ± 6.4	50.8 ± 5.2	48.4 ± 4.8	ns
Masa muscular (%)	50.4 ± 5.8	50.0 ± 5.1	50.9 ± 6.2	48.2 ± 3.7	43.6 ± 6.3	0.01

Tabla IV
Características de impedancia y composición corporal de mujeres por grupo etario

<i>Mujeres</i>						
	< 30 n=42	30-39 n=35	40-49 n=38	50-59 n=23	>60 n=11	<i>p</i>
Resistencia (Ohm)	631.5 ± 74.6	597.0 ± 59.8	571.5 ± 61.0	607.5 ± 89.9	560.2 ± 48.2	0.016
Reactancia (Ohm)	64.9 ± 9.7	61.4 ± 7.1	58.7 ± 6.6	61.4 ± 6.8	52.2 ± 7.7	0.002
Ángulo de fase (°)	5.8 ± 0.81	5.9 ± 0.7	5.8 ± 0.6	5.8 ± 0.6	5.3 ± 0.6	ns
Agua corporal total (%)	52.2 ± 3.9	50.2 ± 5.5	49.2 ± 5.0	45.9 ± 4.0	46.6 ± 4.6	<0.0001
Agua extracelular (%)	45.1 ± 2.6	45.0 ± 2.4	45.7 ± 2.4	45.9 ± 2.0	49.1 ± 3.0	0.004
Agua intracelular (%)	54.9 ± 2.6	55.0 ± 2.4	54.3 ± 2.4	54.1 ± 2.0	50.9 ± 3.0	0.004
Masa libre de grasa (%)	70.1 ± 6.3	68.1 ± 8.1	62.7 ± 11.8	58.6 ± 8.7	59.8 ± 7.8	<0.0001
Masa grasa (%)	29.9 ± 6.3	31.9 ± 8.1	37.3 ± 11.8	41.4 ± 8.7	40.2 ± 7.8	<0.0001
Masa celular (%)	49.3 ± 4.7	50.6 ± 5.8	48.9 ± 5.4	47.3 ± 4.4	46.5 ± 2.7	ns
Masa muscular (%)	42.9 ± 5.4	42.4 ± 6.0	39.8 ± 6.7	35.5 ± 4.8	35.1 ± 5.1	<0.0001

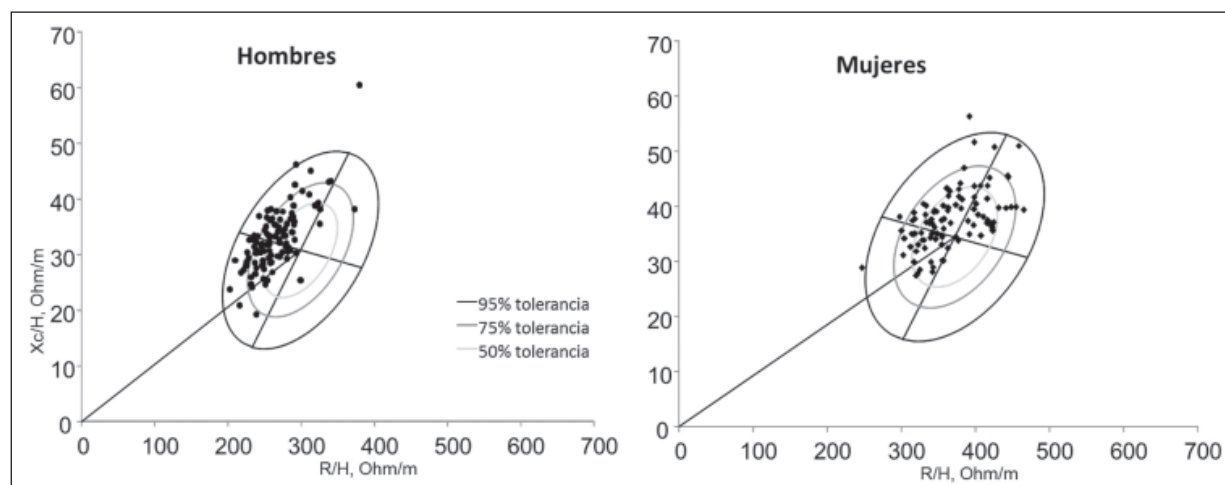


Fig. 1.—Vectores de impedancia de la población española sobre las elipses de referencia de origen italiano.

Tabla V
Valores de resistencia y reactancia estandarizadas por estatura en ambos sexos

	Mujeres (n = 149)	Hombres (n = 162)
Resistencia/ Estatura (Ohm/m)	368.4 ± 43.5	264.9 ± 31.7
Reactancia/ Estatura (Ohm/m)	37.6 ± 5.2	32.7 ± 5.6
Correlación (r)	0.55	0.71

bos sexos. Debido a lo anterior se construyeron elipses de tolerancia específicas para la población española a partir de los valores de la media, desviación estándar y coeficiente de correlación de la R/E y Xc/E. Los valores utilizados para la creación de las elipses, así como la longitud de los semiejes e inclinación de las elipses se muestran en las tablas V y VI.

Las nuevas elipses de tolerancia para la población española se compararon con las originales en población italiana, encontrándose en ambos sexos diferencias significativas (Fig. 2 y 3).

Tabla VI
Longitud de los semiejes e inclinación de las elipses de tolerancia en hombres y mujeres españoles

	Longitud del semieje mayor (Ohm/m)				Longitud del semieje menor (Ohm/m)			
	Inclinación	95%	75%	50%	Inclinación	95%	75%	50%
Hombres	65.11°	153	103	73	- 24.89°	51	35	24
Mujeres	54.03°	151	101	72	- 35.97°	79	53	37

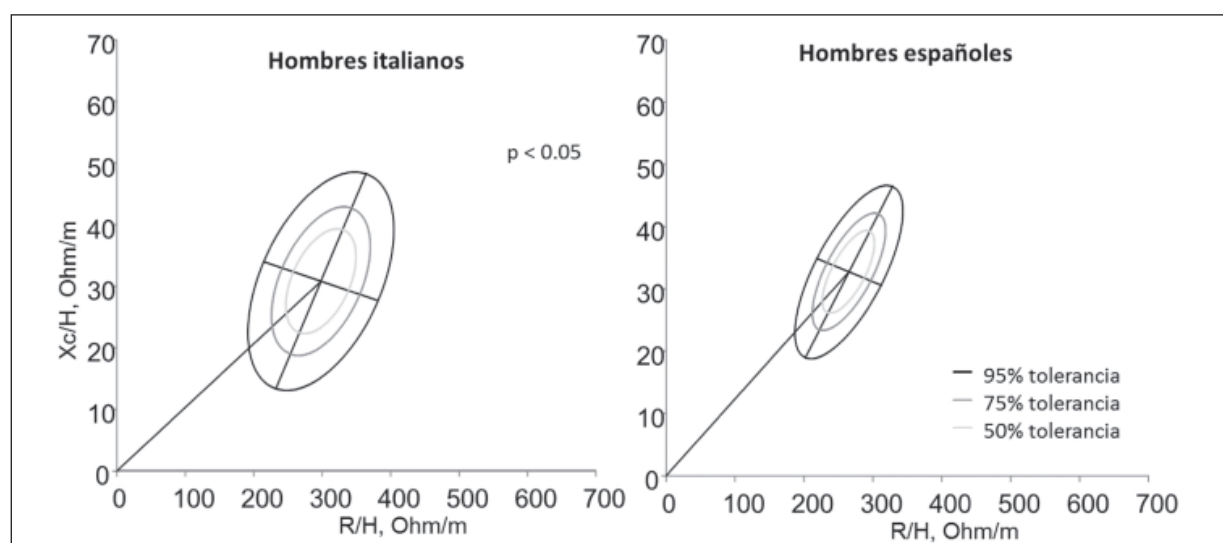


Fig. 2.—Comparación de las elipses de tolerancia españolas e italianas en hombres.

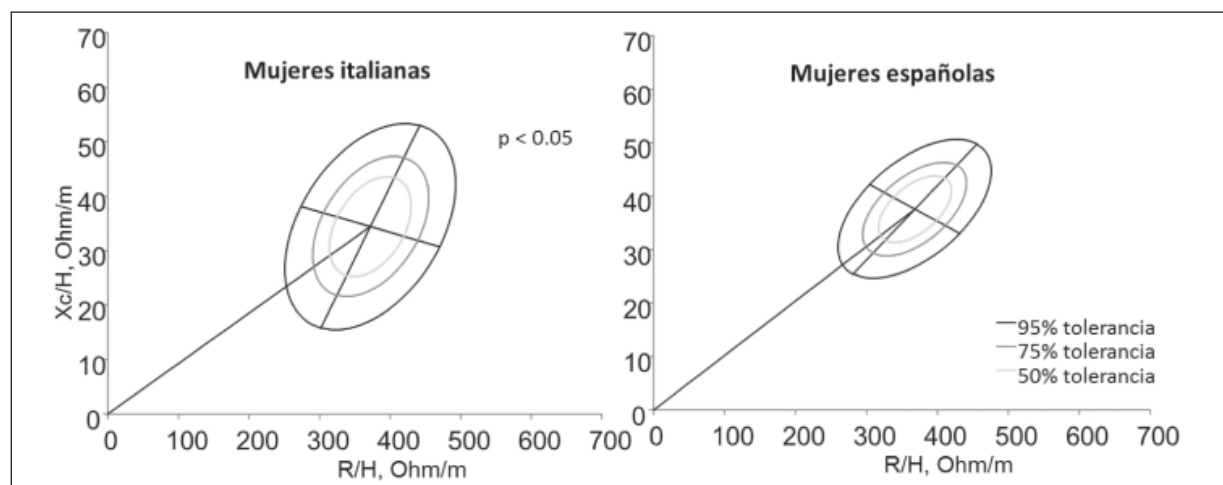


Fig. 3.—Comparación de las elipses de tolerancia españolas e italianas en mujeres.

Discusión

La impedancia bioeléctrica es un método de determinación de la composición corporal rápido, sencillo, que se puede aplicar en la cama del paciente, lo cual lo hace una excelente opción en la práctica clínica. Además, en diversos estudios se ha demostrado su utilidad en la estimación de la composición corporal, principalmente de líquidos corporales, en sujetos con alteración en la hidratación corporal, como pacientes con insuficiencia cardíaca, alteraciones hepáticas o enfermedad renal. En estos pacientes, el análisis de vectores de impedancia brinda una oportunidad importante para determinar, sin los problemas que representa la impedancia convencional asociados al uso de ecuaciones de predicción, tanto el estado de nutrición como de hidratación.

La utilidad de los vectores de impedancia bioeléctrica en pacientes con composición corporal extrema se ha probado en diversos estudios con resultados alentadores^{18,23-26}. Las elipses de referencia originales fueron realizadas en población italiana y, debido a que las características de composición corporal son diferentes entre poblaciones y a la importancia clínica del uso de este método, es fundamental la realización de elipses de referencia específicas para la población española.

Este estudio establece entonces, valores de composición corporal de sujetos sanos derivados de mediciones de impedancia bioeléctrica, así como elipses de referencia de un grupo poblacional que no se había estudiado hasta el momento.

Dentro de las características antropométricas, se observó que el peso, talla e IMC fueron mayores en los hombres, lo que coincide con lo encontrado en otras poblaciones²⁷⁻²⁸. La resistencia y reactancia fue mayor en el grupo femenino, mientras que el ángulo de fase lo fue en los hombres, lo que coincide con lo encontrado en otros estudios^{11,17-20,27-29}, sin embargo el ángulo de fase fue menor a los valores de referencia para población estadounidense sana (5.48% menor en hombres y 10.1% en mujeres)¹⁷. El contenido de agua corporal total en ambos sexos, fue similar al reportado en la literatura¹⁸.

En cuanto a cantidad de tejidos blandos, la masa grasa fue mayor y la masa libre de grasa, masa celular y masa muscular, menor en el grupo femenino en comparación con el grupo masculino, dicha diferencia por sexos, también ha sido encontrada en dos grandes estudios^{18,27}. En comparación con los resultados de la cohorte suiza, los valores de masa grasa en mujeres y hombres fueron mayores, en 5% y 3% respectivamente²⁷. La masa celular y muscular de los hombres españoles en comparación con su contraparte india fue 11.3% y 12.2% mayor respectivamente, mientras que en las mujeres españolas fue mayor en un 11.7% y 10.3% respectivamente¹⁸. Las diferencias cuantitativas de tejidos corporales entre las poblaciones, exponen la heterogeneidad de composición corporal entre razas, lo cual corrobora la necesidad

de establecer valores de referencia particulares para cada población.

Barbosa-Silva en población norteamericana encontró que el ángulo de fase disminuye significativamente conforme avanza la edad en ambos sexos, sin embargo en el presente estudio solo se observó este comportamiento en los hombres, mientras que en las mujeres el ángulo de fase permaneció sin cambios en los diferentes grupos de edad. Dichos resultados pueden atribuirse al menor número de muestra en nuestro estudio. En comparación con este mismo estudio, el ángulo de fase en todas las edades fue menor, tanto en hombres como en mujeres, aproximadamente un 10% y un 13% respectivamente¹¹. La disminución del ángulo de fase en edades avanzadas puede indicar, como se ha reportado en la literatura, una pérdida de funcionalidad y estado de salud²⁰.

En nuestra población se encontró que el porcentaje de masa grasa aumenta significativamente conforme avanza la edad, siendo más evidente en el grupo de sexo femenino, mientras que en los hombres, la masa grasa permanece constante hasta la sexta década de la vida, cuando se presentan un claro aumento. El contenido de masa grasa encontrada en nuestra población es mayor, sobretodo en mujeres, que la reportada en otra cohorte de sujetos sanos españoles, en todas las décadas de la vida³⁰.

Los valores de resistencia y reactancia estandarizados por la estatura, son similares a los de otras poblaciones sanas¹⁸⁻²⁰, sin embargo la mayor diferencia radica en los valores de reactancia, siendo mayores que los de la población italiana original.

A pesar de que nuestra población tenía las mismas características de edad e IMC que las del estudio de Piccoli, los vectores de hombres y mujeres españoles se situaban en los cuadrantes superior e inferior izquierdo de las elipses originales²⁰, lo que indica que la población italiana es más delgada y/o magra en comparación con la población española, a pesar de ser ambas, poblaciones mediterráneas con características similares.

Las longitudes del eje mayor y menor de las elipses de tolerancia de la población española, fueron menores en ambos sexos en comparación con los de la población italiana. En cuanto a la inclinación de las elipses, en el caso de los hombres no hay diferencias con la población italiana, no obstante la inclinación del eje menor de las elipses de mujeres es mayor, mientras que el eje mayor tiene una menor inclinación que las elipses derivadas de las mujeres italianas²⁰.

En nuestra población, las elipses del grupo masculino fueron más pequeñas que las elipses de las mujeres, dicho fenómeno ha sido reportado por otros autores^{18-20,28} y se ha atribuido a la variabilidad de composición corporal en las mujeres a lo largo de la vida, como se observó en el presente estudio. Dichas variaciones se han asociado al cambio hormonal que se produce durante el periodo perimenopáusico, así como a la diferencia en la geometría troncal y de extremidades

existente entre sexos¹⁸. Es importante resaltar las diferencias con los hombres, que tienen una composición corporal estable a través de los años, lo que se traduce en elipses de tolerancia más compactas, indicativas de homogeneidad.

El método de vectores de impedancia, además de proveer información cualitativa acerca de la composición corporal de los individuos, puede ser utilizada como una prueba para la correcta aplicación de las ecuaciones de predicción asociadas a la impedancia. Los valores de composición corporal, derivados del uso de ecuaciones de predicción, de un paciente cuyo vector se sitúa fuera de la elipse del 75%, no son confiables²⁰.

El acortamiento o alargamiento de los vectores de impedancia indican sobrehidratación o deshidratación respectivamente, mientras que una disminución progresiva del ángulo de fase se asocia a desnutrición y un aumento del mismo a ganancia de tejidos corporales. Por lo anterior, el análisis de vectores de impedancia puede ser usado para evaluar el estado de hidratación en personas con alteraciones en el compartimento hídrico como pacientes hepatopatas, cardiopatas o con enfermedad renal.

Algunos de los factores que pudieron haber contribuido a la diferencia de composición corporal y por lo tanto de los valores de las elipses de tolerancia entre la población italiana y española, además de los condicionantes de raza, alimentación y estilo de vida, son la edad y el reclutamiento de la población. En cuanto a la edad, la población española es más joven; mientras que la media de edad para los hombres italianos fue de 48 años y para las mujeres de 50 años, la de los hombres y mujeres españoles fue de 38 años. El reclutamiento de los sujetos sanos españoles, siendo una de las principales limitaciones del estudio, se llevó a cabo con los integrantes del Servicio de Nefrología del Hospital Universitario La Paz, así como con sujetos que acudían al Centro de Donación de Sangre en calidad de donadores, lo cual hace que la población de estudio tenga unas características determinadas. Si bien es cierto que dentro de los donantes tuvimos representatividad de distintas provincias de España, el presente estudio no fue concebido para ser llevado a cabo en diferentes provincias, por lo que probablemente no sea representativo de todo el país^{17,20,25}. En un futuro, la presente investigación puede ser mejorada al incrementar el número de muestra con población de diferentes provincias para que tenga representatividad nacional.

En el presente trabajo se presentan valores de composición corporal y elipses de tolerancia de una población sana española de referencia. Podemos concluir que los vectores de la población española fueron diferentes a los de la población italiana, de ahí la importancia de tener un patrón de referencia propio.

Las nuevas elipses de referencia son una herramienta útil para la evaluación de la composición corporal tanto en población española sana como en pacientes con alteraciones del estado de hidratación.

Conflictos de interés

Ninguno

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Original/Valoración nutricional

Can we improve the birth weight prediction? the effect of normal BMI using a multivariate model

R. Vila-Candel¹, J. M. Martin-Moreno², S. Alamar³, F. J. Soriano-Vidal⁴, F. G. Naranjo de la Puerta⁵ and M. Murillo⁶

¹PhD, Midwifery, Hospital Universitario de la Ribera, Spain. Director of Department of Nursing, Universidad Católica de Valencia. ²MD, PhD, DrPH is a Full Professor at the Department of Preventive Medicine and Public Health, Universitat de Valencia, Spain. Director, Programme Management World Health Organization-EUROPE. ³PhD, Senior Nursing Lecturer, Universidad Católica de Valencia, Spain. ⁴Midwifery, Hospital Lluís Alcanyis, Spain. Senior Nursing Lecturer, Universidad Católica de Valencia. ⁵MD, PhD, Director of Department of Obstetric and Gynaecology, Hospital Universitario de la Ribera, Spain. Associate Professor at Universidad Católica de Valencia. ⁶Nursing, MSc, Senior Nursing Lecturer, Universidad Católica de Valencia, Spain.

Abstract

Objective: The construction of a predictive model that improves the estimation of the fetal weight (EFW).

Study Design: a comparative, descriptive study. One hundred forty pregnant women were recruited at two-stage sample in health department in Spain. They were classified in four groups depending on the pre-gestational BMI. Fetal weight at term was estimated by ultrasound at 33-35 weeks (EFW40w) by one gynecologist. A regression model was created with the variables that reacted to the newborn's weight, symphysis-fundal height (SFH), EFW40w, gestational age (GA), ferritin level and cigarettes smoked.

Results: A multivariate model was created for the NW group to estimate the fetal weight (EFWme), resulting in $R^2=0.727$ ($p<0.001$). The differences of the averages obtained between EFW40w and EFWme, with the newborn's weight were significant ($p<0.001$). EFWme underestimates birth weight by 0.07 g (mean error 0.53%), and EFW40w overestimates it by 300.89 g (mean error 10.12%). In order to evaluate the predictive model and verify the predictions we used the Bland-Altman analysis. The average error in estimating the birth weight with EFWme was 1.94% underestimating the result, whereas the ultrasound error overestimated the result 10.93%.

Conclusion: The multivariate model created for the NW group improves the accuracy of the ultrasound.

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Key words: Birth weight. Pregnancy. Ultrasound. Anthropometry. Multivariate analysis.

Correspondence: Rafael Vila Candel
Hospital Universitario de la Ribera.
Crtra Corbera, Km 1 Alzira, 46600. Spain.
E-mail: rvila@hospital-ribera.com

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¿PODEMOS MEJORAR LA PREDICCIÓN DEL PESO AL NACER? EL EFECTO DEL IMC PREGESTACIONAL NORMAL USANDO UN MODELO MULTIVARIANTE

Resumen

Objetivo: construir un modelo predictivo que mejore la estimación del peso del recién nacido (PFE).

Material y Métodos: Estudio observacional dónde 140 gestantes fueron estudiadas mediante un muestreo bietápico en un Departamento de Salud en España. Fueron clasificadas en cuatro grupos dependiendo del IMC pregestacional materno. El peso proyectado al nacer fue estimado por la ecografía realizada entre las 33-35 semanas de gestación (PP40s). Se construyó un modelo de regresión con las variables que se reaccionaban con el peso al nacer, altura uterina (AU), PP40s, edad gestacional (EG), nivel de ferritina y cigarrillos consumidos.

Resultados: Se construyó un modelo multivariante para el grupo Normo-peso para estimar el peso al nacer (PFm) obteniendo una $R^2=0.727$ ($p<0.001$). Las diferencias de las medias obtenidas entre PP40s y PFm, con el peso del recién nacido, fueron significativas ($p<0.001$). El PFm infravalora el peso al nacer en 0,07 g (error medio 0,53%) y la PP40s lo sobrestima en 300,89 g (error medio 10,12%). Para evaluar el modelo predictivo y verificar las predicciones realizadas se utilizó el análisis de Bland y Altman. El error medio de la estimación del peso al nacer mediante modelo multivariante fue de 1,94% infraestimando el resultado, en cambio el error cometido por la ecografía sobrestima el resultado en 10,93%.

Conclusiones: El modelo multivariante construido, para el grupo NW, mejora la precisión de la ecografía.

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Palabras clave: Peso al nacer. Embarazo. Ecografía. Antropometría. Análisis multivariante.

Introduction

The analysis of birth weight must be addressed from a multifactor perspective¹. Unfortunately, birth weight is unknown until birth takes place². The use of ultrasound fetal measurements have been extended and the measurements have been combined to estimate fetal weight by regression analysis or physically methods³. Fetal weight estimation is inaccurate, with poor sensitivity for prediction at term.⁴ It is already known that the absolute error average in predicting birth weight varies from 6 to 12% of the actual weight. Several authors⁴⁻⁶ have shown that the level of intra/interobserver variability in fetal measurement as well as the impact of errors on growth assessment are unacceptable. Different studies⁷⁻⁹ have compared, with discrepancies, the accuracy between clinical and ultrasound methods in order to estimate fetal weight in the third trimester. Birth weight depends on many factors i.e. maternal, genetic and environmental ones.¹⁰

This study raises the hypothesis that some factors are not distributed randomly, but according to a profile that determines the weight of a newborn at birth. It could let us create a better predictive model of infant weight at birth, rather than the actual birth weight estimation by third trimester routine sonogram, when applied to women depending on their pre-gestational body mass index (BMI).

Material and methods

Design

We performed an observational and prospective study. Based on the WHO ranges, pregnant women were allocated in four different groups depending on their pre-gestational BMI: underweight (UW <18.5 Kg/m²), normal weight (NW 18.5-24.9 Kg/m²), overweight (OW 25.0-29.9 Kg/m²), obese (OB >30 Kg/m²). A sample of 159 pregnant women was collected from February 2011 to March 2012.

A two-stage sampling study was performed. In the first stage, two surgeries (Carlet and Benimodo) were chosen using a simple random probability sampling from among all Primary Care Centres of La Ribera Health Department (Spain). In the second stage, pregnant women were selected using a probability sampling with random start and systematic monitoring depending on the number of pregnancies per year obtained in both of them.

Inclusions criteria were based on maternal age between 18 and 36 years, first prenatal appointment between 5 and 12 weeks of pregnancy and single-fetus pregnancy with no fetal deformities.

Exclusions criteria included refusal to participate in the study, language barrier, an adverse obstetric history during previous pregnancies, medical conditions that modify fetal growth, maternal infection or any other maternal chronic pathology.

We estimated that for a 95% Confidence Interval (CI) and a 4% precision, we needed a minimum sample size of n=147.

Ethical questions

This study was performed according to the basic principles for all medical research set out in the Declaration of Helsinki. The study was previously evaluated and approved by the Research Committee of the Ribera University Hospital.

Variables

Six categories of variables were selected: anthropometric, demographic, hematologic, ultrasound, obstetric-neonatal, and toxic variables.

Anthropometric variables included in the study were pre-pregnancy weight and height, BMI and symphysis-fundal height (SFH). Pre-pregnancy weight and height were self-reported and recorded during the initial prenatal examination after enrolment. Pre-pregnancy BMI was calculated as weight in kilograms divided by the squared height in meters (kg/m²). SFH was measured in centimetres with nonelastic measurement tape from the upper border of the symphysis pubis to the top of the uterine fundus, or reversed direction.

Demographic variables gathered during the study were maternal age, marital status, education and occupation.

Haematological variables collected included haemogram and serum ferritin. They were measured in each trimester of pregnancy (<12, 24 and 34 weeks).

Ultrasound variables collected included biparietal diameter (BPD), femur length (FL), and abdominal circumference (AC) of the ultrasound done in the third trimester, between 33 and 35 weeks. They were collected in order to calculate a standardized method⁷ used to estimate the birth weight at 40 week (EFW40w). We used the equation devised by Hadlock II, for carrying out their routine obstetric sonograms.

Obstetric and neonatal variables collected were parity and gestational age in weeks (obtained from last menstrual period remembered by women). Regarding to the newborn, we recorded gender and weight at birth.

Toxic variables collected were pre-gestational tobacco consumption and the number of cigarettes smoked per day in each trimester of pregnancy.

Statistical analysis

Basic descriptive statistics are presented comparing pre-gestational BMI groups. Afterwards, it was found normal for each of the continuous variables with the Kolmogorov-Smirnov test. The defined level of statistical significance was $p < 0.05$.

In the bivariate analysis, the Student t-test was used to compare the means of two quantitative, normalized variables. Each variable was calculated and compared between the group of pre-gestational BMI test using χ^2 , and the analysis of variance (Scheffe's honestly significant differences test). In order to estimate the birth weight, a multivariate regression equation (EFWme) using only variables which statistical significance, was used. Correlation between both estimation methods (EFW40w and EFWme) with birth weight were adjusted by gestational age (38-42 weeks). Accuracy of birth weight estimation was determined by calculating the absolute error of each estimation method ([estimated fetal weight - actual birth weight] / actual birth weight). The Student t test was used to determine if this mean was significantly different from zero. Differences between both methods in the mean absolute error were assessed by the paired *t* test. The mean error represents the sum of the positive (overestimation) and negative (underestimation) deviations from the ac-

tual birth weight, approximating zero in a method with very low or no systematic error. In order to evaluate the difference between EFW40w and EFWme an analysis of the individual differences proposed by Bland-Altman¹¹ was used. Then bias (mean absolute error) and precision (SD percentage error) were obtained.

Data were analyzed using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL), Version 15.0, and Analyse-it 3.7.

Results

A total of 140 pregnant women were approached for inclusion in the study.

A comparison of demographic and clinical variables among the four groups showed significant differences in occupation, type of work, social status, and parity (table I).

Table I
Demographic and clinical characteristics of the study sample by pre-pregnancy body mass index

Variable	UW (n=10)		NW (n=95)		OW (n=30)		OB (n=5)		Total (n=140)		p-value
	n	%	n	%	n	%	n	%	n	%	
Maternal Age (years)											
<25	4	40.0	13	13.7	4	13.3	0	0.0	21	15.0	0.365*
26-29	3	30.0	28	29.5	5	16.7	1	20.0	37	26.4	
30-34	3	30.0	39	41.1	16	53.3	3	60.0	61	43.6	
>35	0	0.0	15	15.8	5	16.7	1	20.0	21	15.0	
Mean (S. D.)	29.91 (4.62)										
Marital Status											
Married	7	70.0	78	82.1	25	83.3	5	100	115	82.1	0.548*
Single	3	30.0	17	17.9	5	16.7	0	0.0	25	17.9	
Education											
8th grade	5	50.0	33	34.7	14	46.7	3	60.0	55	39.3	0.544*
High school	4	40.0	36	37.9	11	36.7	2	40.0	53	37.9	
University	1	10.0	26	27.4	5	16.7	0	0.0	32	22.9	
Occupation											
Employed	3	30.0	74	77.9	15	50.0	2	40.0	94	67.1	0.001*
Unemployed	7	70.0	21	22.1	15	50.0	3	60.0	46	32.9	
Pre-gestational weight (Kg)											
Mean (S. D.)	10	48.4 (4.49)	95	57.3 (6.60)	30	68.6 (7.41)	5	93.2 (8.40)	140	60.4 (10.7)	0.30*
Parity											
0	7	70.0	59	62.1	6	20.0	1	20.0	73	52.1	0.000**
≥1	3	30.0	36	37.9	24	80.0	4	80.0	67	47.9	
Birth weight (g)											
Mean (S. D.)	10	3176.50 (456.63)	95	3216.37 (451.39)	30	3343.67 (507.62)	5	4153.00 (648.48)	140	3274.25 (498.95)	0.000**

S. D., standard deviation; UW, underweight, BMI<18.5; NW, normal weight, BMI: 18.5-24.9; OW, overweight, BMI:25-29.9; OB, obese, BMI≥30.0.

* χ^2 test

** t-test

Multivariate models of maternal categories UW, OW and OB showed no statistically significant differences with respect to EFW40w in predicting birth weight, and therefore were eliminated.

The variables that showed statistical significance with birth weight in the NW were:

SFH 35-40 weeks ($R=0.74$, $p<0.001$), EFW40w ($R=0.63$, $p<0.001$), GA ($R=0.47$, $p<0.001$), Ferritin ($R= -2.84$, $p=0.007$) and number of cigarettes smoked at third trimester (3T) ($R= -2.82$, $p=0.006$). The difference between the groups (ANOVA) was not significant. Linear regression analysis between birth weight and NW group with these five predictors explains its 72% variance. This and multivariate regression equation are shown in table II.

Then it was decided to study the differences for the actual weight of the newborn between EFW40w and EFWme. T-test was applied for the samples related and the differences were statistically significant ($p<0.001$) between both.

EFW40w, adjusted by gestational age, had a correlation of 0.59 ($p=0.01$) at 40 weeks, and 0.69 ($p=0.002$) for EFWme.

Comparing the mean differences between EFW40w, EFWme and birth weight, we observe that the weight of ultrasound overestimates all birth wei-

ghts. In contrast, the estimation of the multivariate equation underestimates the birth weights at weeks 38 and 41, and overestimates it at week 39, 40 and 42 (Figure 1).

The differences in averages obtained from both EFW40w and EFWme with birth weight were statistically significant ($p<0.001$). The EFWme underestimated birth weight by 0.07 g, and the EFW40w overestimated it by 300.89 g. Therefore, prediction absolute error was 0.53% (95% CI: -2.19-1.12) compared to 10.12% (95% CI: 12.81-7.43).

In order to evaluate the predictive model, an observational and retrospective study was designed. From the initial one, 138 normal weight pregnant women who met criteria were selected. Next, differences between EFW40w and EFWme as well as the absolute error with respect to birth weight were calculated. To verify the consistency of the predictions we used the Bland-Altman analysis (Figure 2). The birth weight values provided by EFW40w are higher than the EFWme, with a difference of 398.6 g (95% CI: 450.5-346.7) (table III). The average error in estimating the birth weight with EFWme was 1.94% (95% CI: 0.8-30.0) underestimating the result, whereas the ultrasound error overestimated the result 10.93% (95% CI: -8.9-12.5).

Table II

Linear regression analysis showing predictors of birth weight by pre-pregnancy body mass index (NW)

Adjusted R2 0.727 Variables	B	S. E.	Sig.
(Constant)	-5667.22	850.46	0.000
SFH 35-40w	109.21	15.78	0.000
FERRITIN 3T	-3.35	1.561	0.035
EFW40w	0.35	0.09	0.001
GA	13.81	3.08	0.000
Cigarettes smoked 3T	-20.78	7.29	0.006

Normal weight (NW), BMI³ 18.5 but <24.9; SFH, symphysis-fundal height; EFW40w, estimated fetal weight at term (40 weeks); GA, gestational age. B, unstandardised regression coefficient; S.E., Standard Error of the estimate.

Multivariate regression equation= -5667.22+.35*EFW40w+109.21*SFH+13.81*GA-3.35*Ferritin 3T 20.78*Cigarettes smoked 3T.

Table III

Analysis of birth weight differences between multivariate model and ultrasound scan EFW in pregnant women (n=138) with normal BMI

	Value	CI (95.0 %)**
Mean of differences	-398.61	-450.50 -346.72
SD of differences	308.28	
Mean -2SD*	-1002.84	-1091.74 -913.94
Mean +2SD*	205.61	116.71 294.51

*SD= Standard Deviation

**CI (95 %)= Confidence Interval stated at the 95% confidence level

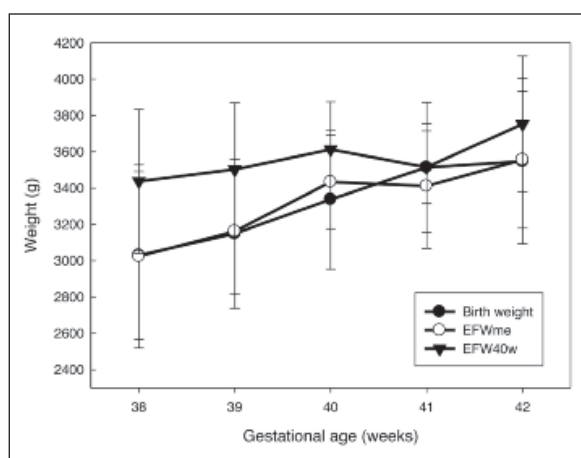


Fig. 1.—Difference birth weight between EFW40w and EFWme By Normal-Weight of Pre-Pregnancy Body Mass Index (n=95).

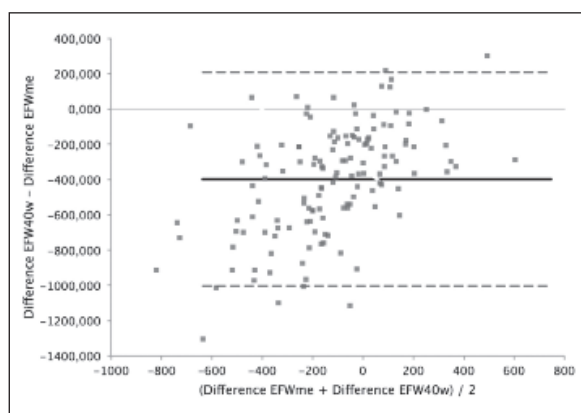


Fig. 2.—Difference birth weight between EFW40w and EFWme By Normal-Weight of Pre-Pregnancy Body Mass Index (n=138).

Discussion

In our study there were a number of variables related to birth weight in the bivariate analysis. Those were subsequently used to construct the multivariate models. Eventually we have shown, in the NW category, that there is a statistically significant difference in predicting birth weight when it is compared to EFW40w.

In a bivariate form, SFH measured between 35-40 weeks was associated with birth weight for the maternal category NW. It got the highest coefficient of determination of all the variables studied, even higher than EFW40w at the third trimester. Rogers et al.¹² correlated SFH with small-for-gestational-age (SGA) infants and 73% were detected by measuring 3 cm or even below the average in pregnancy. In normal-weight mother, adjusting the SFH for gestational week Meler et al.¹³ obtained a normal curve, and an SFH below 10th percentile was related to a low birth weight (LBW). In contrast, Buchmann et al.¹⁴ described a SFH higher

than 40 cm as associated with an increased number of fetal macrosomia, cephalo-pelvic disproportion and/or shoulder dystocia. In our case, fundal height measured between 35 and 40 weeks, and in the presence of the other variables in the multivariate model, indicates that birth weight increases 109.21 g for every centimeter of uterine height (95% CI: 77.6-140.6).

EFW40w was associated with birth weight for the maternal category of NW. In presence of the other variables, the coefficient of determination was higher than the obtained by Ben-Haroush⁵. The use of ultrasound as a diagnostic method is well documented^{5,14-17}. Depending on the formula used, predicted weight differs in its accuracy⁵⁻¹⁶. In our multivariate model, and in the presence of the other adjusted variables, for each gram of target weight at 40 weeks in the third trimester ultrasound, birth weight increases 0.35 g (95% CI: 0.15-0.54).

Gestational age showed statistically significant correlation with birth weight. The average delivery GA was 278 days in primiparous mothers and 279 days for multiparous mothers. Our multivariate analysis showed that for every extra day, there is a fetal weight gain of 13.81 g. This is slightly higher than data obtained by Nahum et al.¹⁶, with 9.66 g and 9.15 g for boys and girls respectively, but it is lower than Carvalho et al.¹⁸ with 28.21 g.

The smokers' ratio before pregnancy was 35.0%, and 20.7% in the last trimester, similar to other studies reviewed¹⁹⁻²¹. Our results specially indicate that smoking during the third trimester of pregnancy, is associated with birth weight. It is a negative correlation where increasing numbers of cigarettes consumed decreases weight at birth. Consequently, smoking during the third trimester seems to have the greatest impact on birth weight. In fact, it is known that women who gave up smoking in the third trimester have babies with birth weights similar to those of nonsmokers²¹. This matches with our results, as smoking in the first two trimesters showed no statistical significance in the adjusted model. The newborn with low birth weight becomes important with this toxic habit, and there is a possible relationship with the children's health deterioration because of the cytotoxic effect²². Petridou et al.²³ described reduced newborn weight, by 190.8 g respectively, as compared to the newborns of non-smoking mothers. Our results are somewhat lower: birth weight is reduced about 21 g for every cigarette smoked; the average number of cigarettes smoked per day was 5, so total decrease was about 105 g, the same results obtained by Gupta et al.²⁴.

The amount of ferritin in the third trimester had an inverse relationship with birth weight in Normal Weight category mothers, so that the less ferritin, the higher the birth weight. In studies reviewed, we found the opposite effect in both cases: high ferritin levels were associated with preterm birth, LBW and premature rupture of membranes^{25,26}. Other authors tried to explain a possible association between high levels of

ferritin and fetal growth restriction²⁷, arguing that ferritin may be a vascular response to both infectious and non-infectious inflammatory diseases. Further studies are needed to confirm this. Hämäläinen et al.²⁸ observed that anemia and low ferritin level during the first trimester was associated with LBW, while anemia in the second and third trimester was not associated with preterm birth, fetal loss or risk of perinatal complications. The effect found in our study could be explained as a relation between depletion of maternal iron stores and increase of iron transfer to the fetus, although this increase may be limited²⁹. The depletion of iron in the second and third trimester of pregnancy in the NW category women, physiologically declines from the first trimester. At the same time, iron-carrying capacity increases (transferrin), even when the deficit is eliminated by oral supplementation³⁰. In our multivariate model, as a negative relation, for each ferritin unit that dropped (ng/dl), there was a gain of 3.35 g in birth weight.

The limitations of the multivariate model (NW) have to do with the accuracy of the ultrasound and the GA at birth, due to the estimated weight, which should be accurate at 40 weeks. All the newborns aged less than 280 days will be overestimated.

Nowadays the prediction of the birth weight through ultrasounds (EFW40w) has an absolute error that varies from 6% to 12%³⁻⁵. Accuracy can be improved in two different ways: first, by controlling the limitations of the technique and second, by adding maternal variables from the multivariate model to the ultrasound measurement. Considering this pattern, error can be reduced up to 1.9%.

We decided to implement what can be considered a test of predictive validity, through the use of a multivariate equation to improve the estimation of birth weight in women with a normal pre-gestational BMI.

Then, in order to evaluate the equation, the model was used to analyze the correlation with another different group of pregnant women in a retrospective study. In this case, 138 pregnant women, belonging to the BMI group of NW, and meeting all inclusion/exclusion criteria of the initial study, were selected. The average error with our multivariate model underestimated the birth weight, whereas the ultrasound at the third trimester overestimated the result.

Thus, we positively evaluate the multivariate model obtained, and so that we suggest the study has an important practical application. Therefore, we should continue by extending this study to the rest of the maternal pre-gestational BMI groups, which showed no statistical significance, to develop a new model for each one.

Conclusion

The SFH is the variable, which most affects the prediction of weight at birth.

The multivariate model created improves the ultrasound measurement by 8.99%.

The accuracy of the clinical method must be determined in situations which can alter the evaluation of weight birth in atypical women, and it should be studied in future ways of investigation.

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Original/Valoración nutricional

Assessment of the reliability and consistency of the “Malnutrition Inflammation Score” (MIS) in Mexican adults with chronic kidney disease for diagnosis of protein-energy wasting syndrome (PEW)

Ailema Janeth González-Ortiz^{1,2}, Celene Viridiana Arce-Santander², Olynka Vega-Vega², Ricardo Correa-Rotter² and Maria Angeles Espinosa-Cuevas^{2,3}

¹Fac. de Medicina, Universidad Nacional Autónoma de México.²Departamento de Nefrología y Metabolismo Mineral, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán.³Departamento de Atención a la Salud, Universidad Autónoma Metropolitana-Xochimilco, México DF. México.

Abstract

Background: The protein-energy wasting syndrome (PEW) is a condition of malnutrition, inflammation, anorexia and wasting of body reserves resulting from inflammatory and non-inflammatory conditions in patients with chronic kidney disease (CKD). One way of assessing PEW, extensively described in the literature, is using the Malnutrition Inflammation Score (MIS).

Objective: To assess the reliability and consistency of MIS for diagnosis of PEW in Mexican adults with CKD on hemodialysis (HD).

Methods: Study of diagnostic tests. A sample of 45 adults with CKD on HD were analyzed during the period June-July 2014. The instrument was applied on 2 occasions; the test-retest reliability was calculated using the Intraclass Correlation Coefficient (ICC); the internal consistency of the questionnaire was analyzed using Cronbach's α coefficient. A weighted Kappa test was used to estimate the validity of the instrument; the result was subsequently compared with the Bilbrey nutritional index (BNI).

Results: The reliability of the questionnaires, evaluated in the patient sample, was ICC=0.829. The agreement between MIS observations was considered adequate, $\kappa = 0.585$ ($p < 0.001$); when comparing it with BNI, a value of $\kappa = 0.114$ was obtained ($p < 0.001$). In order to estimate the tendency, a correlation test was performed. The r^2 correlation coefficient was 0.488 ($P < 0.001$).

Conclusion: MIS has adequate reliability and validity for diagnosing PEW in the population with chronic kidney disease on HD.

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Key words: Protein energy wasting. Nutritional assessment. Dialysis. Validation. Reliability.

Correspondence: Maria Angeles Espinosa-Cuevas. Departamento de Nefrología y Metabolismo Mineral. Instituto Nacional de Ciencias Médicas y Nutrición SZ. Vasco de Quiroga No. 15, Col. Sección XVI. Deleg. Tlalpan, CP 14000, México DF, México. E-mail: angeles.espinosac@quetzal.innsz.mx

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EVALUACIÓN DE FIABILIDAD Y CONSISTENCIA DE LA HERRAMIENTA “MALNUTRITION INFLAMMATION SCORE (MIS)” EN ADULTOS MEXICANOS CON ENFERMEDAD RENAL CRÓNICA PARA DIAGNÓSTICO DEL SÍNDROME DE DESGASTE PROTEÍNICÓ ENERGÉTICO (DPE)

Resumen

Antecedentes: El síndrome de desgaste proteínico-energético (DPE) se refiere a una condición de desnutrición, inflamación, anorexia, y emaciación de reservas corporales resultante de las condiciones inflamatorias y no inflamatorias que prevalecen en pacientes con enfermedad renal crónica (ERC). Una forma ampliamente descrita en la literatura para evaluar el DPE es el Malnutrition Inflammation Score (MIS).

Objetivo: Valorar la fiabilidad y consistencia del MIS en adultos mexicanos con ERC en Hemodiálisis (HD) para Diagnóstico de DPE.

Métodos: Estudio de pruebas diagnósticas. Se analizó una muestra de 45 adultos con ERC en HD, Durante el periodo Junio-Julio 2014. El instrumento se aplicó en 2 ocasiones, la fiabilidad test-retest se calculó mediante el Coeficiente de correlación Intraclass (CCI), la consistencia interna del cuestionario se analizó mediante el Coeficiente α de Cronbach. Se calculó una prueba de Kappa ponderada para estimar la validez del instrumento, posteriormente se comparó con el índice nutricional de Bilbrey (IB).

Resultados: La fiabilidad entre cuestionarios valorada en la muestra de pacientes fue de CCI = 0.829. La concordancia entre observaciones MIS es considerada como adecuada $\kappa = 0.585$ ($p < 0.001$), al compararlo con IB se obtuvo un valor de $\kappa = 0.114$ ($p < 0.001$). Para conocer la tendencia se realizó una correlación $r^2 = 0.488$ ($P < 0.001$).

Conclusión: El MIS presenta una adecuada fiabilidad y validez para diagnosticar DPE en la población con enfermedad renal crónica en HD.

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Palabras clave: Desgaste proteínico energético. Evaluación nutricional. Diálisis. Validación. Fiabilidad.

Abbreviations

PEW: Protein-energy wasting.
CKD: Chronic kidney disease.
MIS: Malnutrition Inflammation Score.
HD: Hemodialysis.
ICC: Intraclass Correlation Coefficient.
BNI: Bilbrey nutritional index.
ISRNM: International Society of Renal Nutrition and Metabolism.
SGA: Subjective Global Assessment.
BMI: Body Mass Index.
TIBC: Total iron binding capacity.
GI: Gastrointestinal symptoms.

Introduction

Protein-energy malnutrition has been identified as a common problem in patients with chronic kidney disease (CKD), with a current prevalence of 18 to 70%¹⁻⁵. In 2010, Espinosa *et al.* found that the prevalence of nutritional status in hemodialysis patients was as follows: 35.5% were within the normal range; 40.8% had mild malnutrition; 13.2% had moderate malnutrition; and 10.5% had severe malnutrition, meaning that 64.5% of the hemodialysis population had some degree of malnutrition⁶ as diagnosed by a composite nutritional index called Bilbrey Nutritional Index (BNI)⁷. Other values have been reported in other parts of the world using different diagnostic methods. Considering the different terminologies and the confusion that arose after the creation of these diagnostic systems, the International Society of Renal Nutrition and Metabolism (ISRNM) convened an expert panel to review and develop standard terminology and definitions related to cachexia, malnutrition and inflammation in patients with chronic kidney disease⁸⁻¹⁰, giving rise to the concept of PEW¹¹⁻¹⁶, which has been associated with increased mortality in this population^{8,12,17-19}.

It is suggested that a better way to assess the nutritional status of these patients is by using composite nutritional indices²⁰, since the diagnosis of nutritional status becomes more understandable when including several indicators. Since the introduction of Subjective Global Assessment (SGA) in 1987, we have witnessed many nutritional assessment tools. In 1999, Kalantar *et al.* proposed a modified and quantitative SGA called "Dialysis Malnutrition Score" that included seven components: weight changes, changes in dietary intake, gastrointestinal symptoms, functional capacity, comorbidities, analysis of subcutaneous fat and presence of muscle wasting. With the recognition of the role of inflammation in PEW, and in an attempt to create a more complete and quantitative scoring system, the same group proposed adding three new components to the "Dialysis Malnutrition Score": Body Mass Index (BMI), concentration of serum albumin, and total iron binding capacity (TIBC), changing the name to "Mal-

nutrition Inflammation Score" (MIS)^{8,15,21-23}. Another proposed way for assessing these patients was established by the ISRNM, which recommends diagnosing PEW using four readily available categories: 1. Biochemical Parameters (serum albumin, prealbumin and cholesterol). 2. Anthropometric Parameters (BMI, total unintentional loss of weight and body fat). 3. Measurements of Muscle Mass (average arm circumference, muscle circumference, creatinine). 4. Dietary intake (daily caloric and protein intake)⁸. That is why the use of MIS is proposed as a tool for the diagnosis of PEW in CKD patients, as it is generally practical and easy to apply^{14,21,24}, given that all the variables analyzed by it are usually found in patient records or can be obtained directly from the patient by means of a brief nutritional screening, without any additional treatment cost. In addition, it has been reported that the predicting power of MIS equals that of the serum concentration of IL-6 and is somewhat higher than PCR. This finding implies that the concentrations of PCR and IL-6 can be easily replaced by MIS in daily clinical practice as a way to determine the nutritional and inflammatory status of the patient^{8,11,14,22,25}.

Besides being a predictor of mortality, it has been shown that MIS captures most of the main criteria suggested by ISRNM for the diagnosis of PEW. Considering the relationship between MIS, inflammatory markers, diagnostic markers of PEW and mortality, one could speculate that MIS has a wide range of clinical utility, from the assessment of nutritional status to the diagnosis of inflammation in patients with CKD, besides being an specific tool that can be used in both inpatient and outpatient settings; however, there is little evidence of its use in the Mexican population. Therefore, the aim of this study is to assess the reliability and consistency of MIS for the diagnosis of PEW in Mexican adults with CKD on HD.

Material and methods

Overview of the instrument

MIS specifies the choice responses for each variable (Fig. 1):

Medical History: 1. Changes in dry weight after dialysis (3-6 months): No change in dry weight or loss <0.5kg; minor loss; loss of more than 1 kg but <5%; loss greater than 5%. 2. Dietary intake: good or unchanged appetite; suboptimal diet; moderate intake; hypocaloric diet. 3. Gastrointestinal symptoms: no symptoms and a good appetite; few symptoms, poor appetite and occasional nausea; occasional vomiting and occasional GI symptoms; diarrhea or vomiting; severe anorexia. 4. Functional capacity: good functional capacity, the patient feels well; occasional difficulty to walk, the patient feels tired often; difficulty with independent activities (going to the toilet); patient in bed or wheelchair, with little physical activity. 5. *Comorbidity according to time on dialysis:

Evaluación de Desnutrición Inflamación

(A) Historia medica

1. Cambios en el peso seco despues de dialisis (3-6 meses)

0 Sin cambios en el peso seco o pérdida <0.5Kg	1 pérdida menor 0.5 – 1.0Kg	2 pérdida de más 1kg pero <5%	3 pérdida >5%

2. Ingesta dietética:

0 Buen apetito o sin cambios en la ingesta	1 Dieta sub optima dieta solida	2 Ingesta moderada dieta de liquidos completa	3 Dieta liquidos hipocaloricos

3. Sintomas gastrointestinales:

0 No hay sintomas buen apetito	1 Pocos sintomas, poco apetito y nauseas ocasionalmente	2 Vómito ocasional y sintomas GI ocasionales	3 Diarrea ó vómito. Anorexia grave.

4. Capacidad funcional

0 Buena capcidad funcional. El paciente se siente bien.	1 Dificultad ocasional para deambular. Se siente cansado frecuentemente.	2 Dificultad con actividades independientes. (Ir al baño)	3 Paciente en cama, o silla de ruedas. Con poca o sin AF.

5. Comorbilidad según el tiempo en dialisis. *

0 Menos de 1 año en dialisis. Sin comorbilidades	1 Dializado de 1 a 4 años. Baja comorbilidad	2 Dializado por más de 4 años. moderada comorbilidad	3 Cualquier comorbilidad severa o múltiples comorbilidades que tenga.

(B) Examen fisico

6. Pérdida de los depositos de grasa o perdida de grasa subcutanea; debajo del ojo, biceps, triceps.

0 Normal (s/cambios)	1 Leve	2 Moderado	3 Grave

7. Signos de pérdida de masa magra; clavivula, escapula, hombros, cuadriceps.

0 Normal (s/Cambios)	1 Leve	2 Moderado	3 Grave

(C) Índice de Masa corporal

8. IMC (Kg/m²)

0 >20kg/m ²	1 18 – 19.9Kg/m ²	2 16 – 17.9Kg/m ²	3 <16 Kg/m ²

(D) parametros bioquimicos:

9. Albumina

0 >4.0g/dl	1 3.5 – 3.9g/dl	2 3.0 – 3.4g/dl	3 <3.0g/dl

(E) Capacidad total de fijación de Hierro (CTFH) o Transferrina

0 CTFH >250mg/dl o Tranferrina >200 mg/dL	1 CTFH 200-249mg/dl o Tranferrina 170 – 200	2 CTFH 150 – 199mg/dl o Tranferrina 140 – 170	3 CTFH <150mg/dl o Tranferrina <140 mg/dL

Puntaje total: (0-30Pts) Normal = <3 Leve= 3 – 5 Moderado= 6 – 8 Grave = >8

Fig. 1.—Components of the comprehensive MIS.

less than one year on dialysis without comorbidities; dialyzed from 1 to 4 years; low comorbidity; dialyzed for more than 4 years with moderate comorbidity; any severe comorbidity or multiple comorbidities presented by the patient. The following legend is also included: (*Greater comorbid conditions: congestive heart failure class III or IV; AIDS; coronary artery disease; moderate

to severe chronic obstructive pulmonary disease; severe neurological sequelae; neoplasias; undergoing chemotherapy or having come out of it recently).

The physical exam consists of 2 items, loss of fat stores or subcutaneous fat below the eye, in biceps and triceps, and signs of loss of lean mass in clavicle, scapula, shoulders and quadriceps. The body mass index and

biochemical parameters such as albumin and TIBC or transferrin are estimated from the results of the various evaluations.

Interpretation of MIS

The results are obtained from the simple sum of each of the items, finally expressing them into the following categories:

Normal Nutritional Status: 0,1 and 2 points; Mild Malnutrition: 3-5; Moderate Malnutrition: 6-8; Severe Malnutrition: from 9 points in the simple sum of the items.

Population and Methods

To validate the instrument, we selected 49 adults with CKD on HD, all belonging to the chronic hemodialysis unit of the National Institute of Medical Sciences and Nutrition. The data were collected during the months of June-July 2014. Those patients who were hospitalized when the measurements were taken underwent evaluation upon return. Of the original sample, it was not possible to perform a complete evaluation in 4 patients, 3 of them because they did not show up at the unit on the day of sampling and another patient because he remained hospitalized throughout the study period, leaving for analysis a total of 45 patients.

Anthropometric measurements were taken (height, weight, arm circumference and skinfold circumference of biceps, triceps, subscapular and suprailiac muscles) and the data were used to estimate body mass index, percentage of total body fat and muscle arm circumference, in order to calculate BNI. In addition, the most recent laboratory results were recorded: concentration of albumin, transferrin or TIBC, and total count of lymphocytes within the last month.

The measure of reliability is based on internal consistency and reproducibility, on the agreement between observers and/or observations. This instrument was applied on two occasions by two nutritionists from the Nutritional area of the Nephrology Department, with a lapse of three weeks between each application. The first application lasted a week and included all patients from each round of hemodialysis sessions. Only in the first round, the evaluation was applied at the end of the session; in the second and third rounds, the evaluation was applied before the sessions started. The next measurement was taken 3 weeks afterwards, at the same times, in order to achieve consistency between the diagnoses of both observers.

Data analysis

The descriptive statistics of the study are shown as mean $\pm$ standard deviation. The test-retest reliability

was calculated using the Intraclass Correlation Coefficient (ICC); the internal consistency of the questionnaire for assessing homogeneity was analyzed using Cronbach's α coefficient. The item-total correlation was also calculated; it measures the degree of association between the diagnosis and the total scale.

Regarding the reproducibility between observers and the validity of the instrument, a weighted Kappa test was used to compare the four diagnoses of MIS with each other. Subsequently, the result of the Kappa test was compared with BNI, which is currently used as a routine diagnostic tool in the Nutrition area of the Nephrology Department and which has the same diagnostic output (normal nutritional status, mild, moderate and severe malnutrition).

All analyzes were performed using SPSS version 16 for Windows.

Results

We studied 47 patients (19 men and 26 women), table I shows the characteristics of the population, the test-retest reliability of the questionnaires, assessed in the patients sample, was ICC=0.829, indicating proper homogeneity between the items. The internal consistency results of MIS are shown in table II. A consistency of $\alpha=0.669$ was obtained in the first application (test). When considering the correlation of each item with respect to the test, the variable "comorbidities and time on dialysis" was found to have the lowest value, showing little association with the final score, followed by TIBC, however, when these variables were excluded from the test, the result showed no significant change (α 0.669-0.698 for comorbidities and α 0.669-0.71 for TIBC). On the other hand, the best correlation was found for the variable "loss of muscle" ($r^2=0.534$), meaning that when this variable is excluded from the test, its reliability decreases (α 0.669- 0.611). A consistency of $\alpha=0.642$ was obtained in the second application (re-test). This time the variable "gastrointestinal symptoms" showed the lowest correlation ($r^2=0.095$), meaning that when this variable is excluded from the test, its reliability improves, but the change is mini-

Table I
Anthropometric and demographic characteristics

	Men n= 19	Women n=26	P Value
Gender (%)	42.2	57.8	0.297
Age (years)	45.3 $\pm$ 20.3	38.2 $\pm$ 18.6	0.235
Time on dialysis (months)	8.3 $\pm$ 7.2	10.0 $\pm$ 8.2	0.471
Weight (kg)	67.9 $\pm$ 15.3	53.4 $\pm$ 10.0	0.000
Height (meters)	1.6 $\pm$ 0.1	1.5 $\pm$ 0.1	0.000
BMI (kg/m ²)	23.8 $\pm$ 4.8	21.7 $\pm$ 3.6	0.119

Table II
Internal Consistency of Malnutrition Inflammation Score

<i>Cronbach's α Coefficient</i>	<i>Observer 1 0.669</i>	<i>Observer 2 0.642</i>		
	Correlation ítem-total	Cronbach's α upon excluding the ítem	Correlation ítem-total	Cronbach's α upon excluding the ítem
Body weight history				
Body weight change	.317	.661	.284	.643
Food Intake	.414	.635	.366	.612
Gastrointestinal Symptoms	.441	.637	.095	.650
Functional capacity	.482	.617	.503	.581
Comorbidities, time on dialysis	-.096	.698	-.170	.682
Physical exam				
Fat	.439	.629	.551	.576
Muscle mass	.534	.611	.464	.590
Body mass index	.439	.624	.253	.629
Albumin	.299	.658	.419	.590
TIBC	.216	.671	.371	.603

mal ($\alpha=0.642-0.650$). “Comorbidities” and “time on hemodialysis” showed negative correlation, meaning, likewise, that excluding them from the test improves its reliability ($\alpha=0.642-0.682$).

Considering the reproducibility of the tool, we evaluated the agreement between two observers using a weighted Kappa test, which gave a value of $K=0.585$ (p

<0.001) (Table III). This indicates that the agreement between observers for this tool is adequate and can be used to obtain a diagnosis. Given that BNI produces the same results than MIS, a comparison was made between their diagnoses (Table IV); we found a value of $K=0.114$ ($p <0.001$), meaning that the agreement between diagnoses was inadequate. However, in order

Table III
Agreement interobserver

		<i>Measurement 2 MIS</i>				<i>Total</i>
		Normal	Mild	Moderate	Severe	
Measurement MIS	Normal	9	3	0	0	12
	Mild	2	7	5	0	14
	Moderate	0	1	5	2	8
	Severe	0	0	1	10	11
Total		11	11	11	12	45

Table IV
Agreement interdiagnoses second measurement MIS and BNI

		<i>BILBREY</i>				<i>Total</i>
		Normal	Mild	Moderate	Severe	
MIS	Normal	4	7	0	0	11
	Mild	4	5	2	0	11
	Moderate	2	5	2	2	11
	Severe	1	2	5	4	12
Total		11	19	9	6	45

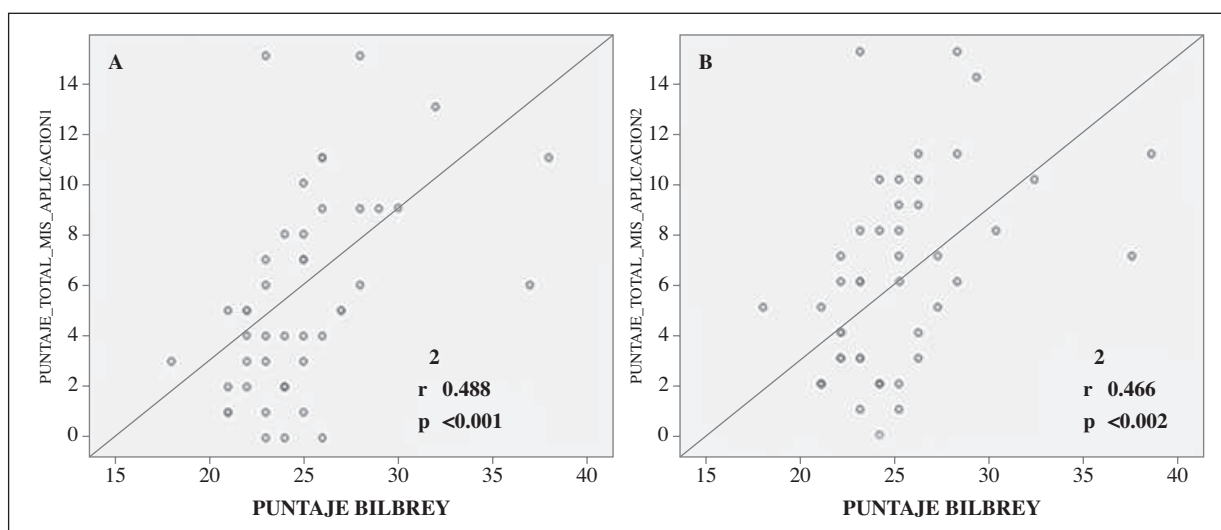


Fig. 2.—Correlation between total score of BNI to the total sum of MIS (Simple sum of ítems). A First measurement, B Second measurement.

to know if both tests show the same tendency, we carried out tests of concordance between the score of the two evaluations, obtaining a correlation of $r^2=0.488$, $p<0.001$ (Fig. 2), which indicates that the scores are consistent, but do not yield the same diagnosis. While MIS found 11 patients had normal nutritional status, 11 had mild malnutrition, 11 were moderately malnourished and 12 were severely malnourished, for BNI the numbers were 11, 19, 9 and 6, respectively, agreeing 100% only in those patients who had a good nutritional status; when the patients had some degree of malnutrition, the diagnoses did not agree.

Discussion

MIS was first used in 2001 as a complete and quantitative tool; it was used to assess malnutrition and inflammation in patients on Renal Replacement Therapy (RRT). Today, it is used to assess the nutritional status of at least 100000 patients per year. MIS has been associated with quality of life and mortality, as the risk of 1-year mortality increases significantly for patients with a score ≥ 4 ; however, there is little evidence of its use or validity in the Mexican population^{14,22,26}.

This study concerns a cultural adaptation of the instrument to the Mexican population, with a comparison between the diagnosis output of MIS and that of BNI, a tool now used routinely in our circle. The relevance of this study is that it presents results that can contribute to practice and clinical research aimed at assessing the nutritional status of patients with CKD.

The present study shows that MIS has proper internal consistency, with an ICC=0.82, which is completely acceptable, showing good accuracy and reproducibility. Its internal consistency is almost equal to that found by Fetter *et al.* when adapting it to the Portuguese language²⁷ (ICC=0.88). Furthermore, when

analyzing the correlations of the items and their association with diagnosis, it was found that all correlated significantly, with the exception of “comorbidities” and “time on dialysis”, which, besides presenting low correlation, produced a negative result. This contrasts with the results obtained in the Brazilian population, for which the lowest correlation was found in food intake²⁷.

Regarding interobserver reproducibility, a moderate reproducibility was found ($K=0.585$, $p<0.001$), similar to results found by Beberashvili (Kappa test=0.68, $p<0.001$)²⁸; however, a recently published study by Fetter showed high reproducibility (Kappa test=0.78, $p<0.001$)²⁷. One of the main strengths of this study is that it compared MIS with BNI, finding a good agreement between assessments, which means that the tendency in both instruments was significantly correlated, although they did not yield the same diagnosis when malnutrition was present.

Therefore, we can conclude that MIS has good reliability and validity for diagnosing PEW in patients with CKD on HD. It is a quick and easy tool to use and its usefulness in clinical practice is even better than that of the Bilbrey nutritional index, which requires certain mathematical formulas in order to be applied. It is also important to note that MIS takes into account all the criteria set by the International Society of Renal Nutrition and Metabolism (ISNRM) for the diagnosis of protein-energy wasting.

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Original/*Valoración nutricional*

Cross-sectional study to evaluate the associated factors with differences between city and districts secondary school students of the southeast of Spain (Murcia) for their adherence to the Mediterranean diet

Guillermo Doménech Asensi, Álvaro Sánchez Martínez and Gaspar Ros Berruezo

Nutrición y Bromatología, Facultad de Veterinaria, Universidad de Murcia, Campus de Excelencia "Campus Mare Nostrum". Murcia, Spain.

Abstract

Introduction: The "Mediterranean diet" is recognized as one of the healthiest dietary patterns but, even in Mediterranean countries it is gradually being lost. Adolescence is a crucial period for changes in dietary patterns.

Objectives: The purpose of this study was to evaluate the Adherence to Mediterranean diet (AMD) of secondary school students and evaluate possible variations between those residents in the city or in the districts.

Methods: A cross-sectional study was designed with 379 secondary school students. To assess the AMD a self-administered questionnaire KIDMED was used. They were classified according to sex and residence (city or districts).

Results: The body mass index (BMI) for the whole sample was 22.34 in boys and 20.79 in girls ($p<0.05$). Students from the city resulted more physically active than those from the districts ($p<0.05$). The average AMD score was 5.8, with 20.3% of students showing good adherence. In general, there was a low consumption of fruits, vegetables and pasta or rice, all foods included in the bottom of the dietary pyramid and the consumption of olive oil and legumes was very positive. Around 25% of students skip breakfast regularly.

Conclusions: Although BMI was in general in the range of normality, AMD of secondary school students is lower than expected attending to previous studies. Consume of fruits and vegetables several times per day, having breakfast daily and regular physical activity should be promoted. Educational and informative activities should be designed for adolescents and also for their parents since in these stages menus at home are usually established by them.

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Key words: *Mediterranean diet. secondary school students. city. districts.*

Correspondence: Guillermo Doménech-Asensi
Universidad de Murcia, Campus de Espinardo.
30100. Murcia, España.
E-mail: gdomenech@um.es

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ESTUDIO TRANSVERSAL PARA EVALUAR LOS FACTORES ASOCIADOS CON LAS DIFERENCIAS ENTRE LA CIUDAD Y LAS PEDANÍAS DE ESTUDIANTES DE LA ESCUELA SECUNDARIA DEL SURESTE DE ESPAÑA (MURCIA) PARA SU ADHESIÓN A LA DIETA MEDITERRÁNEA

Resumen

Introducción: La "dieta Mediterránea" está reconocida como uno de los patrones dietéticos más saludables pero, incluso en los países mediterráneos, su seguimiento está disminuyendo. La adolescencia es un período crucial durante el cual se producen cambios en los hábitos alimentarios.

Objetivos: El objetivo de este estudio fue evaluar la adherencia a la dieta Mediterránea (ADM) de los estudiantes de educación secundaria y evaluar las posibles diferencias entre los residentes en la ciudad o en las pedanías.

Métodos: Se diseñó un estudio transversal con 379 estudiantes. Para evaluar la ADM se facilitó el cuestionario KIDMED. Los estudiantes se clasificaron de acuerdo al sexo y la residencia (ciudad o pedanía).

Resultados: El índice de masa corporal (IMC) fue en global de 22.34 en hombres y 20.79 en mujeres ($p<0.05$). Los estudiantes de ciudad resultaron más activos físicamente que los de pedanías ($p<0.05$). La puntuación media de ADM fue de 5.8 en el total de los estudiantes, con un 20.3% que mostraron una buena adherencia. En general, hubo un bajo consumo de frutas, verduras y pasta o arroz, todos los alimentos incluidos en la base de la pirámide alimentaria y el consumo de aceite de oliva y legumbres fue positivamente elevado. Alrededor del 25% de los estudiantes no desayunan regularmente.

Conclusiones: A pesar de que el IMC, en general, se sitúa en el rango de la normalidad, la ADM de los estudiantes es menor de lo esperado atendiendo a estudios previos. Es conveniente promover el consumo de frutas y verduras varias veces al día, hacer del desayuno una práctica diaria así como la realización regular de ejercicio físico mediante el planteamiento y diseño de programas de información y actuación para los adolescentes y también para sus padres, ya que en estas etapas de la vida suelen ser los que seleccionan los alimentos que se consumen en el hogar.

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Palabras clave: *dieta Mediterránea. educación secundaria. ciudad. pedanía.*

Introduction

The Mediterranean Diet (MD) involves a set of skills, knowledge, rituals, symbols and traditions concerning crops, harvesting, fishing, animal husbandry, conservation, processing, cooking, and especially the sharing and consumption of food¹.

The traditional MD is characterized by a high intake of plant foods (legumes, cereals, olive oil, seeds, fruits, and nuts), a moderate intake of fish, seafood, and alcohol (principally wine during meals), low-to-moderate intake of dairy products (cheese and yogurt) and eggs, and a low intake of meat, accompanied by other habits such as the “siesta” or after-meal nap².

During the last few decades Spain’s dietary patterns have changed in several important aspects. While consumption of vegetables has remained steady and fruits are more popular today, other plant food as potatoes, legumes, cereals, and all their by-products have decreased considerably. Consequently, the percentage of animal food in the diet has reached almost 50%³, with a higher consumption of saturated fats and lower intake of complex carbohydrates and fibre. Other changes are less time dedicated to meals, more meals taken outside of the home, and less time for the siesta⁴.

However, some of these dietary changes also occur along an individual’s lifespan, especially during adolescence. In this period, teenagers starts to take decisions on their own as an assessment of their identities and independence, so this phase is crucial period for preventing bad dietary habits from forming^{5,6}.

In the south-east of Spain, as in most of the country, the population is concentrated in cities where changes in customs tend to be faster than in the countryside. In the rural districts, people tends to keep more in contact with the land, the “huerta”(vegetable garden or fields typical of Spain) , and traditional customs associated with MD, but there is no evidence about possible differences in dietary patterns between students in the city and in the districts.

Many studies have previously analysed the diet of secondary school students⁶⁻⁹, but we have not found any study that compares dietary patterns in the town relative to the districts or nearby rural environment.

The aim of this study is to evaluate the adherence to Mediterranean Diet (AMD) in secondary school students and demonstrate possible differences between city and districts residents.

Material and methods

Subject

The cross-sectional study was designed to evaluate and compare the eating habits among students from different territories of the Spanish city of Murcia and some surrounding districts. The sample (Table I) comprised 379 students in secondary school, 245 from the

Table I
Distribution of the sample

	Total	Gender	
		Women	Men
Total	379 (100%)	172 (45.4%)	207 (54.6%)
Districts	245 (64.6%)	101 (41.2%)	144 (58.8%)
City	134 (35.4%)	71 (53.0%)	63 (47.0%)

Alquerias and Llano de Brujas districts (144 males and 101 females) and 134 from the city of Murcia (63 males and 71 females).

This study did not need ethical approval because no invasive procedures were necessary. All students volunteered for the study.

Methods

To assess the AMD a self-administered questionnaire KIDMED was used. Development of the KIDMED¹⁰ index was based on principles that sustain Mediterranean dietary patterns and on those that undermine it. The questionnaire contains 16 questions and the index ranges from 0 to 12. Four questions denote a negative connotation with respect to the Mediterranean diet and assign a value of -1, while the rest of the questions have a positive aspect and give a score of +1. The sums of the values from the administered test were classified into three levels: good AMD (8-12), average AMD (4-7), and poor (0-3).

Apart from the KIDMED questionnaire students were asked about height, weight (in order to determine BMI), and frequency of physical activity (less than twice, 2-3 times, or more than three times per week).

Statistical analysis

The statistical software package IBM SPSS Statistics v19.0 (SPSS Inc.; Chicago, IL, USA) was used for data analysis. Chi-square analysis was performed to evaluate relationships between qualitative variables and Student-t test to compare quantitative variables between groups. Differences were considered significant at $p < 0.05$.

Results

As table II shows, the mean recorded BMI of participant is 20.79 for females and 22.34 for males; it was similar between urban and rural students but in all cases there were significant differences between sexes ($p < 0.05$).

The distribution related to BMI (Table III) shows 15.2% of females and 7.3% of males were underwei-

Table II
BMI of the sample (mean±SD)

	<i>Gender</i>	
	<i>Women</i>	<i>Men</i>
Total	20.79±2.65*	22.34±3.33*
Districts	20.93±2.60*	22.19±3.43*
Ciudad	20.45±2.77*	22.55±3.20*

*significant statistical differences by T-Student test at $p<0.05$ between gender.

ght, while the percentage of students with overweight was higher in boys than in girls (14.6% vs. 4.2%). In both cases results were significantly different between sexes ($p<0.05$). Analysing results in different territories, they were similar in both sexes and no significant differences were found.

About physical activity (Table IV) we found that, in general, boys are more active than girls, practicing more than 3 times per week 52.4% vs. 27.9% respectively ($p<0.05$), and in the opposite side, 10.4% of boys and 20.4% of girls ($p<0.05$) present sedentary lifestyle (less than twice per week). This pattern was also found in the city, where only 11.6% of boys but 32.8% of girls were sedentary ($p<0.05$), while 56.5% of boys exercised more than 3 times a week vs. 23.0% of girls ($p<0.05$). Comparing physical activity between areas, we found a more sedentary way of life (less than twice per week) in students from the city than from the districts (21.5% vs. 12.8%; $p<0.05$) caused largely by the girls (32.8% vs. 15.0%;

$p<0.05$), as the figures for urban and rural boys were similar (11.6% vs. 9.5%).

Regarding dietary patterns, the KIDMED index (Table V) came out to be 5.8 in the overall sample (5.6 for girls and 6.0 for boys). In the city it was 5.8 (5.6 for girls and 6.0 for boys) and in the districts 5.8 (5.6 for girls and 6.0 for boys). There was thus no significant difference in AMD between city and districts or between boys and girls. 20.3% of students had good adherence to the optimal MD (23.1% in the city and 18.8% in the districts) while 15.6% had poor adherence (17.2% vs. 14.7%). No significant differences were found either between area or residence or sex with respect to dietary patterns.

If we use the whole sample to analyse the differences between sexes on each question of the test separately, we find that boys consumed more pasta and rice (50.6% vs. 39.1%; $p<0.05$) and nuts (51.7% vs. 41.5%; $p<0.05$), while girls consumed more sweets and candies (30.4% vs. 18.6%; $p<0.05$).

In the city, girls were greater consumers of sweets (38.8% vs. 18.3%; $p<0.05$) and commercial bakery products for breakfast (33.3% vs. 18.3%; $p<0.05$) than boys and consumed one portion of vegetables daily more frequently (71.4% vs. 53.5%; $p<0.05$). On the other hand, in the districts boys consumed more fish 2-3 times per week than girls (60.4% vs. 46.5%; $p<0.05$).

Comparing the two areas of residence, students from the city consumed commercial bakery products for breakfast more often than students from the districts (25.4% vs. 14.3%; $p<0.05$), a difference largely attributable to girls' habits (33.3% vs. 13.9%; $p<0.05$).

Table III
Distribution of the sample by categories of BMI

	<i>Total</i>		<i>City</i>		<i>Districts</i>	
	<i>Women</i>	<i>Men</i>	<i>Women</i>	<i>Men</i>	<i>Women</i>	<i>Men</i>
Underweight	29 (15.2%)*	12 (7.3%)*	10 (17.9%)*	4 (5.8%)*	19 (14.1%)	8 (8.4%)
Normoweight	153 (80.1%)	124 (75.6%)	42 (75.0%)	55 (77.5%)	111 (82.2%)	69 (72.6%)
Overweight	8 (4.2%)*	24 (14.6%)*	4 (7.1%)	7 (10.1%)	4 (3.0%)*	17 (17.9%)*
Obese	1 (0.5%)	4 (2.4%)	0	3 (4.2%)	1 (0.7%)	1 (1.1%)

*significant statistical differences at $p<0.05$ by chi-square between gender.

Table IV
Distribution of the sample according to physical activity practice

	<i>Total</i>			<i>Ciudad</i>			<i>Districts</i>		
	<i>Total</i>	<i>Women</i>	<i>Men</i>	<i>Total</i>	<i>Women</i>	<i>Men</i>	<i>Total</i>	<i>Women</i>	<i>Men</i>
<2 times/week	15.9	20.4*	10.4*	21.5 ^{&}	32.8 ^{&*}	11.6*	12.8 ^{&}	15.0 ^{&}	9.5
2-3 times/week	45.2	51.7*	37.2*	37.7 ^{&}	44.3	31.9	49.4 ^{&}	55.0*	41.1*
>3 times/week	38.9	27.9*	52.4*	40.8	23.0*	56.5*	37.9	30.0*	49.5*

*significant statistical differences at $p<0.05$ by chi-square between gender in the same category (Total, city, Districts)

[&]significant statistical differences at $p<0.05$ by chi-square between different categories (City, Districts).

Table V
Results for KIDMED test for total students and by categories

		Total			City			Districts		
		Total	Women	Men	Total	Women	Men	Total	Women	Men
Takes a fruit or fruit juice every day		76.3	76.8	75.6	76.9	84.1	70.4	75.9	73.6	79.2
Has a second fruit every day		40.4	41.5	39.0	42.5	39.7	45.1	39.2	42.4	34.7
Has fresh or cooked vegetables regularly once a day		59.4	59.9	58.7	61.9	71.4&*	53.5*	58.0	54.9&	62.4
Has fresh or cooked vegetables more than once a day		22.2	23.2	20.9	18.7	17.5	19.7	24.1	25.7	21.8
Consumes fish regularly (≥ 2 –3 times per week)		54.6	50.2	59.9	59.0	58.7	59.2	52.2	46.5*	60.4*
Likes legumes and eats them more than once a week		88.1	90.3	85.5	87.3	88.9	85.9	88.6	91.0	85.1
Consumes pasta or rice almost every day (≥ 5 per week)		44.3	39.1*	50.6*	47.8	42.9	52.1	42.4	37.5	49.5
Has cereals or grains (bread, etc.) for breakfast		64.4	62.3	66.9	70.1	73.0&	67.6	61.2	57.6&	66.3
Consumes nuts regularly (≥ 2 –3 times per week)		46.2	41.5*	51.7*	44.0	39.7	47.9	47.3	42.4	54.5
Uses olive oil at home		94.7	94.2	95.3	95.5	93.7	97.2	94.3	94.4	94.1
Has breakfast everyday		75.2	72.9	77.9	73.9	69.8	77.5	75.9	74.3	78.2
Has a dairy product for breakfast (yoghurt, milk, etc.)		81.3	77.8	85.5	79.9	74.6	84.5	82.0	79.2	86.1
Has commercially baked goods or pastries for breakfast		18.2	19.8	16.3	25.4&	33.3&*	18.3*	14.3&	13.9&	14.9
Goes more than once a week to a fast-food (hamburger)		28.0	27.1	29.1	23.9	27.0	21.1	30.2	27.1	34.7
Takes two yoghurts and/or some cheese (40 g) daily		52.5	55.6	48.8	47.0	49.2	45.1	55.5	58.3	51.5
Takes sweets and candy several times every day		25.1	30.4*	18.6*	27.6	38.1*	18.3*	23.7	27.1	18.8
KIDMED index		5.8 $\pm$ 2.1	5.6 $\pm$ 2.2	6.0 $\pm$ 2.1	5.8 $\pm$ 2.2	5.6 $\pm$ 2.2	5.9 $\pm$ 2.2	5.8 $\pm$ 2.1	5.6 $\pm$ 2.1	6.0 $\pm$ 2.0
Adherence to Mediterranean Diet	Poor (≤ 3)	15.6	17.4	13.4	17.2	17.5	16.9	14.7	17.4	10.9
	Average (4–7)	64.1	63.8	64.5	59.7	61.9	57.7	66.5	64.6	69.3
	Good (≥ 8)	20.3	18.8	22.1	23.1	20.6	25.4	18.8	18.1	19.8

*significant statistical differences at $p < 0.05$ by chi-square between gender in the same category (total, city, districts).

&significant statistical differences at $p < 0.05$ by chi-square between different categories (city, districts).

Discussion

The BMI results were 20.79 for females and 22.34 for males (Table II) and were similar between urban and rural students, but BMI was in all cases significantly higher in boys ($p < 0.05$). Our results are in the range of normality and they are lower than those described in other regions of Spain such as Guadalajara⁸ but significantly different than another study in the Canary Islands¹¹, where BMI in girls was higher than in boys. Classifying students according to BMI (Table III) we found a greater proportion of students with normal

weight (75.6% for boys and 80.1% for girls). The cases of overweight were higher in males (14.6% vs. 4.2%; $p < 0.05$), while underweight was more frequent in females (15.2% vs. 7.3%; $p < 0.05$). Cases of obesity were very low in both sexes, a result notably different from another study of 3rd-year secondary school students in Valencia (Spain)¹², which reported obesity in 26.3% of boys and 12.0% of girls. While girls tended to be underweight, boys tended to be overweight. We think this tendency can be explained because in these years, girls are more concerned about body shape and sometimes a “desirable” body shape can be conflated with a noticea-

ble and risky degree of thinness. Girls are surrounded by misleading messages by much of the media (sales of fashion magazines, billboard, music and video content, etc) so accurate information about healthy dietary patterns should be provided in order to discourage behaviours that are dangerous to health.

The practice of physical activity reveals that boys were more active than girls (Table 4), a result that is in line with other studies¹¹. In our study 52.4% of boys but only 27.9% of girls practice exercised more than 3 time per week ($p<0.05$). On the other hand, 10.4% of boys and 20.4% of girls, especially urban girls (32.8%), exercised less than twice a week ($p<0.05$).

We also noticed that students from the city were more sedentary than those in the districts (21.5% vs. 12.8%; $p<0.05$) especially in the case of girls (32.8% vs. 15.0%; $p<0.05$). One possible reason is that in the country there are more public places dedicated to the practice of sports so young people can engage in them easily and, in general, boys like to practice sports, like soccer or basketball, as a pastime more than girls at time that the relative influence of elite men's sports is higher than elite women's sports

After analysing the results of the KIDMED questionnaire we found a low mean adherence to the optimal MD, at 5.8 for the whole sample with a high of 6.0 for boys from the districts and a low of 5.6 in the case of girls in both territories. The level of AMD was also alarming. Most of the sample presents average AMD but only 20.3% have a good adherence to the MD with a high of 25.4% in boys from the city and a low of 18.1% in girls from the districts. That means that 79.3% of students overall (combining the 15.6% with poor and the 64.1% with average adherence) need to improve their dietary pattern. Differences between sex or territory showed no statistical significance ($p>0.05$). Our results are lower than others published on Mediterranean regions of Spain like Valencia¹² and Granada¹³. In the Valencia study, between 32.0% and 36.4% of secondary school students had good AMD, depending on the age of students, while around 50% of young people in Granada between 10 and 16 years old had good AMD.

The analyses of each question revealed several negative aspects. First of all we observed a very low consumption of fruit and vegetables. 76.3% of students consumed at least one piece of fruit daily, with the best being 84.1% in the case of girls from the city. That means that the remaining 15.9% did not consume fruit habitually being even 29.6% in the case of boys from the city. Another result that should be taken in account is that only 40.4% of students consumed fruit twice a day, which decreased to 34.7% in the case of boys from the districts. In the case of vegetables, the tendency was similar. 59.4% of students reported having one portion of vegetables daily but only 22.2% had two or more. On this question, girls from city were greater consumers of vegetables than those from the districts ($p<0.05$).

Fruits and vegetables are the main source of vitamins, minerals, and fibre and a low consumption of these foods may lead to some metabolic diseases. Some educational programs, such as "five a day," suggest consuming five portions of plant foods, have already been established, but they are not effective in certain populations. Other information techniques should be considered, since they have previously demonstrated their effectiveness^{14, 15}.

In the case of consumption of pasta or rice, the main source of carbohydrates, results were also lower than recommendations. Only 44.3% of students in general consumed them almost daily, with boys being more likely to do so than girls (50.6% vs. 39.1%; $p<0.05$). Looking at city and country residents separately, consumption was also higher in boys but the difference is not significant ($p>0.05$). Differences between sexes may be due to the relationship between pasta and high energy intake, so girls may tend to avoid it more than boys. This kind of food should be the main source of energy of any balanced diet and is located at the bottom of the food pyramid. Energy from carbohydrates should cover 50-55% of the total daily needs; using alternatives to these staples means higher consumption of fat or proteins with consequent negative aspects^{16, 17}.

Another factor to take into account is the low consumption of nuts, mainly in girls (41.5% vs. 51.7%; $p<0.05$). Despite this low result in this study in Murcia, it was slightly higher than what was described in the 2- to 14-year-old population¹⁰ and much higher than the Granada study, where almost no nut consumption was recorded in the 10- to 16-year-old population¹³. Nuts in general supply high levels of energy because of their high fat content, which may be the reason for its low consumption, especially in girls, but this food also provides many essential fatty acids and minerals and is highly recommended in the MD as it is associated with a substantial reduction in the risk of major cardiovascular events among high-risk persons¹⁸.

Skipping breakfast was another aspect that this study detected. 75.2% of students had breakfast every day, meaning that 24.8% did not usually take a meal in the morning. Skipping breakfast reached 30.2% in the case of girls from the city. Breakfast is the most important meal of the day, as it breaks the overnight fast and provides energy to start the day in good physical and intellectual condition¹⁹⁻²², both of which are even more important in teenage students. Although skipping breakfast is a typical technique for losing weight, there is a controversy about its efficacy in this regard and in some cases it has even been associated with a tendency to overweight^{23, 24}. The percentage of students that skipped breakfast on this study is much higher than those described in previous studies in Spain^{11, 13}.

There was a high percentage of students that consumed dairy products for breakfast (81.3%). The KIDMED questionnaire did not ask for more information from students who did not consume these products, but many circumstances as intolerances, allergies, or alter-

native dietary patterns such as vegans or vegetarians could be responsible for at least part of the 18.7% who did not consume dairy products at breakfast. It is recommended that a complete breakfast should include dairy products, a source of cereals, and fruit, but any alternative to this should supply energetic (carbohydrates and fat), structural (high-quality proteins), and protective nutrients (minerals, vitamins and fibre) covering 20-25% of the total daily energy needed^{25, 26}.

We also detected a significant percentage of students who consumed commercial bakery products for breakfast, with higher numbers in the city (25.4% vs. 14.3%; $p<0.05$), especially among girls (33.3% vs. 13.9%; $p<0.05$). Bakery products are an easy way to include dairy products in breakfast, but parents and children must be conscious of the negative nutritional properties of these products since they contain a high amount of simple sugars and saturated and trans fats that are partly responsible for the prevalence of overweight and obesity among children and adolescents²⁷⁻²⁹. Commercial bakery products was the only category with significant differences between the city and the districts. It may be that in the city the importance of a healthy breakfast is becoming lost, although the rest of dietary pattern revealed through KIDMED was similar in both areas.

Fast food is another question that requires analysis, since 28.0% of students reported going to fast-food restaurants more than once a week, with a high of 34.7% in the case of boys from the countryside. This kind of food is well-known for its high content of saturated and trans fatty acids, sugar, and salt with the consequent risk of metabolic disorders^{30, 31}. In recent years, it has become a common social engagement for teenagers to go out with friends to these restaurants and indeed there are not many alternatives for young people. Adolescents are attracted to inexpensive restaurants, rapid delivery of food, and predictable taste of food. Fast food offers all these options, despite its unwelcome nutritious aspects.

The study did find positive aspects. The consumption of olive oil was very high (94.7%). Almost all students used it at home, even for cooking. It is important to emphasise the use of this fat over others to increase levels of oleic fatty acid and antioxidants in diet³².

Another positive aspect was the consumption of legumes (88.1%), an important source of complex carbohydrates, including dietary fibre, and high-quality proteins which, as described in a previous study, may reduce the risk of hypertension if taken daily³³.

Conclusions

Secondary school students of Murcia present an average to low adherence to the Mediterranean diet. Although their lifestyles are different in several aspects, such as rural students being more active, urban and rural teenage dietary patterns appear to be similar

and no significant differences were found with respect to adherence to AMD except for the higher consumption of commercial bakery products for breakfast in the city. It would be valuable to know if these students choose what they eat or whether their parents take most of the decisions regarding food. A previous study in Murcia shows better AMD in university students, especially among those living on their own³⁴, which could be interpreted to mean that with information and better choices students tend to improve their dietary pattern. Information and intervention programmes on secondary school are certainly needed focused on benefits of consumption of fruits and vegetables, pasta and rice and specially the importance of having breakfast daily. Nevertheless these programmes about benefits of physical activity and healthy dietary pattern should be designed for both students and their parents in order to achieve both objectives at one time.

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Original/Otros

Conocimiento y percepción nutricional en diálisis: su influencia en la transgresión y adherencia; estudio inicial

María Teresa de las Heras Mayoral¹ y Carmen Martínez Rincón²

¹Hospital Universitario 12 de Octubre. Madrid. ²Facultad de Enfermería, Fisioterapia y Podología. Universidad Complutense. Madrid. España.

Resumen

Antecedentes: Los pacientes dializados presentan problemas a la hora de mantener una conducta correcta de adherencia a la dieta y a los líquidos prescritos en la consulta nefrológica. Lo indican la ganancia de peso interdialisis, el potasio y fósforo sérico junto con instrumentos de autoinforme, marcadores que se han utilizado como indicadores de no adherencia a la dieta. La mayor parte de las veces no se cuenta en las unidades de diálisis con dietistas-nutricionistas. Nefrólogos y enfermeros no disponen del tiempo y/o conocimientos suficientes para establecer y supervisar la adherencia a una dieta individualizada.

Objetivos: El objetivo principal es determinar la adhesión a las pautas dietéticas y de fluidos en hemodiálisis mediante el cuestionario DDFQ y establecer su relación con el hábito dietético de los pacientes, valorado mediante test de hábitos dietéticos y procedimientos culinarios. Los objetivos secundarios son medir la adherencia mediante el DDFQ y relacionar los resultados con marcadores bioquímicos de ingesta y con ganancia de peso interdialisis (GID). Establecer relaciones entre el seguimiento de la dieta y los líquidos referidos por el paciente, los marcadores bioquímicos de ingesta, la ganancia de peso interdialisis y el resultado del DDFQ. Determinar la adhesión en base al sexo, tiempo en hemodiálisis, ser diabético o haber sido trasplantado alguna vez. Y relacionar los hábitos dietéticos manifestados por los pacientes en el test de hábitos dietéticos y procedimientos culinarios con el conocimiento de los pacientes de las pautas prescritas por los nefrólogos en consulta.

Metodología: Estudio piloto descriptivo transversal. Variables sociodemográficas: edad y sexo. Variables clínicas: diabético, paciente trasplantado alguna vez, tiempo en diálisis, peso seco y GID. Marcadores bioquímicos: potasio y fósforo sérico. Variables adhesión a dieta medidas con cuestionario DDFQ. Análisis estadístico: SPSS 20. Descriptivo, pruebas correlación Spearman, prueba t-Student, prueba U Mann-Whitney y tabla contingencia.

Resultados: 42 pacientes; 59,5% hombres, 40,5% mujeres. Edad $63,64 \pm 16,17$ años. Diabéticos 11,9%. GID $1,96 \pm 0,70$ Kg. Potasio $5,08 \pm 0,86$ meq/l y fósforo $4,71 \pm 1,63$ mg/dl. Medido con DDFQ el 50% de pacientes no tiene ad-

NUTRITIONAL KNOWLEDGE AND PERCEPTION ON DIALYSIS: INFLUENCE ON ADHERENCE AND TRANSGRESSION; INITIAL STUDY

Abstract

Background: The dialysis patients have problems in maintaining proper conduct and adherence to the diet prescribed in liquid nephrology consultation. Indicate the interdialytic weight gain, serum potassium and phosphorus along with self-report instruments, markers that have been used as indicators of non-adherence to the diet. Most of the time is not counted in dialysis units with dietitians-nutritionists. Nephrologists and nurses lack the time and / or sufficient to establish and monitor adherence to an individualized diet knowledge. **Objectives:** The main objective is to determine adherence to dietary guidelines and hemodialysis fluids by DDFQ questionnaire and establish its relationship with the dietary habits of the patients, assessed by test dietary habits and cooking procedures. Secondary objectives are to measure adherence by DDFQ and relate the results to biochemical markers of intake and interdialytic weight gain (GID). Linking monitoring liquid diet and reported by the patient, biochemical markers of intake, interdialytic weight gain and the outcome of DDFQ. Determine membership based on sex, time on hemodialysis, have diabetes or have been transplanted once. And linking dietary habits reported by patients in the test of dietary habits and cooking procedures with patients' knowledge of the guidelines prescribed by nephrologists in consultation.

Methodology: Cross-sectional pilot study. Sociodemographic variables: age and sex. Clinical variables: diabetic transplant patient ever, time on dialysis, dry weight and GID. Biochemical markers: serum potassium and phosphorus. Variables adherence to diet questionnaire measures DDFQ. Statistical analysis: SPSS 20 Descriptive, Spearman correlation test, Student t test, Mann-Whitney U test and contingency table.

Results: 42 patients; 59.5% male, 40.5% female. Age 63.64 ± 16.17 years. Diabetics 11.9%. GID 1.96 ± 0.70 kg. Potassium 5.08 ± 0.86 meq / l phosphorus 4.71 ± 1.63

Correspondencia: María Teresa de las Heras Mayoral.
C/ Santa Flora nº 4 1º A.
28019 Madrid. España.
E-mail: mayteheras@gmail.com

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herencia a la dieta en 2 días de los 14 días y 50 % no tiene adherencia a líquidos en 1 día de los 14 días. Existen correlaciones entre adherencia a dieta y fósforo ($p=0,304$) y adherencia a líquidos y GID ($p=0,413$).

Conclusiones: Existe una falta de adhesión a las pautas dietéticas en los pacientes en diálisis, en contraste con la adhesión referida por los mismos. La revisión de las pautas dietéticas y de fluidos se hace necesaria en los pacientes con ERC en diálisis. De aquí la importancia de formar y apoyar a la enfermería que con ayuda de herramientas sencillas pueda detectar incumplimientos y actuar con una mayor educación dietética.

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Palabras clave: *Enfermedad renal crónica. Hemodiálisis. Adherencia. DDFQ. Cumplimiento.*

Abreviaturas

ERC: Enfermedad Renal Crónica.
ERT: Enfermedad Renal Terminal.
ONT: Organización Nacional Trasplantes.
KDOQI: Kidney Disease Outcome Quality Initiative.
NKF: National Kidney Foundation.
GID: Ganancia de peso interdiálisis.
DDFQ: cuestionario para la evaluación de fluidos y dieta en pacientes en diálisis de Vláminck.
ESRD, AQ: cuestionario de adherencia a enfermedad renal.
CEIC: Comité Ético de Investigación Clínica.
K: Potasio sérico.
P: Fósforo sérico.
CARP: conducta de adhesión referida por el paciente.

Introducción

La insuficiencia renal crónica terminal es una enfermedad progresiva que afecta cada vez más a la población con mayor edad y que degenera en una pérdida irreversible de la función renal y con ello al tratamiento sustitutivo renal¹.

La prevalencia de Enfermedad Renal Crónica (ERC) en población española es relativamente elevada, en especial los individuos de edad avanzada². Se estima que la cifra de pacientes con Enfermedad Renal Terminal (ERT) en diálisis en España está en 23.647 personas según la Memoria de Actividad de la Organización Nacional Trasplantes (ONT) 2011³. En los datos de incidencia de ERT se mantiene un ascenso paulatino⁴.

Uno de los problemas más frecuentes que presentan los pacientes con ERC es la desnutrición calórico-proteica, llegando a afectar a casi la tercera parte de los pacientes con tratamiento renal sustitutivo. Numerosa bibliografía muestra que la malnutrición es uno de los mayores problemas en los pacientes con ERC y afecta a la morbilidad, mortalidad, actividad funcional y a la calidad de vida⁵⁻⁶⁻⁷⁻⁸.

mg / dl. DDFQ Measured with 50% of patients not adhering to the diet in 2 days 14 days and 50% have no adherence to liquid in 1 day 14 days. There are correlations between adherence to diet and phosphorus ($p = 0.304$) and adherence to fluid and GID ($p = 0.413$).

Conclusions: There is a lack of adherence to dietary guidelines in dialysis patients, in contrast to the accession referred by them. The review of dietary and fluid patterns is necessary in patients with CKD on dialysis. Hence the importance of training and support for nurses using simple tools to detect breaches and act with greater dietary education.

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Key words: *Chronic renal disease. Hemodialysis. Adherence. DDFQ. Compliance.*

Las Guías para la Nutrición de la Kidney Disease Outcome Quality Initiative (KDOQI), de la National Kidney Foundation (NKF)⁹ pautan unas recomendaciones dietéticas diarias para el paciente ERC en hemodiálisis, en ellas el consumo de proteínas debe ser de 1,2 gr/Kg/día, el 60% de alto valor biológico¹⁰⁻¹¹, y se permite una ingesta hídrica diaria equivalente a la diuresis residual/veinticuatro horas, más 500 ml/día de líquido extra¹². Actualmente, estas necesidades tienden a individualizarse según la pauta dietética prescrita a cada paciente y de acuerdo con su perfil analítico.

A pesar de las recomendaciones, se ha observado que los enfermos crónicos renales en hemodiálisis cometen muchas transgresiones nutricionales y tienen mala adherencia a las pautas prescritas tanto para la dieta como para la restricción de líquidos¹³. La ganancia de peso interdiálisis (GID) entendida ésta como, la ganancia de peso entre dos sesiones de diálisis¹⁴, es una medida biológica directamente relacionada con el control en la ingesta de líquidos, la dieta y la ingesta de sal que cada paciente renal lleva como parte de sus autocuidados. La conducta de no adherencia a la dieta y a los líquidos en los pacientes renales, puede desembocar en un aumento de edema, prurito, dolores óseos, disnea y otros¹⁵. Se hace necesario que también deban restringir la ingesta de determinados alimentos ricos en sodio, potasio y fósforo.

Hay estudios que relacionan la importancia e influencia de una educación sanitaria y los cuidados enfermeros dirigidos a aumentar el conocimiento de la dieta y la restricción de líquidos con una menor transgresión, una mayor cumplimentación y una mayor adhesión al tratamiento nutricional¹⁶⁻¹⁷. En el enfermo renal en tratamiento sustitutivo de hemodiálisis, la actualización y formación periódica de los aspectos dietéticos del tratamiento y la revisión de sus pautas alimentarias influirá en una menor transgresión de la dieta, en una mayor adhesión a la misma y en una mejora de la enfermedad, aumentando su calidad de vida, mejorando sus estados ansiosos y depresivos y modulando una adecuada progresión de la enfermedad¹⁸⁻¹⁹⁻²⁰.

Con frecuencia no se cuenta en las unidades de diálisis con dietistas-nutricionistas y los nefrólogos y enfermeros no disponen del tiempo y los conocimientos suficientes para establecer y supervisar la adherencia a una dieta individualizada en estos pacientes. Cabe resaltar la enorme importancia de formar y apoyar a la enfermería nefrológica que con ayuda de herramientas sencillas puedan detectar incumplimientos y actuar sobre ellos con una mayor educación dietética.

En general, los marcadores bioquímicos potasio y fósforo séricos han sido ampliamente utilizados como indicadores de no adherencia a la dieta, sin embargo la falta de un valor de corte, universalmente aceptado para evaluar la adhesión plantea la duda de cómo hacerlos más eficaces y fiables²¹. El interrogatorio directo a los pacientes se utiliza frecuentemente para medir la adherencia a los tratamientos en otras patologías, sin embargo, pocas escalas de adherencia se han desarrollado y aplicado en pacientes con ERT. Estos instrumentos de autoinforme son valiosos para medirla, siempre que estén bien validados, sean fiables, y sean instrumentos costo-efectivos. Uno de los pocos instrumentos con vigencia establecida y fiabilidad para evaluar la adherencia en población ERC con tratamiento renal sustitutivo es el DDFQ, un diseño muy simplificado que valora adhesión a líquidos y dieta y que puede ser fácilmente utilizado en las sesiones de diálisis²².

El objetivo principal de este estudio es determinar la adhesión a las pautas dietéticas y de fluidos en hemodiálisis mediante el cuestionario DDFQ y su relación con la conducta de adhesión y hábitos dietéticos valorados mediante test de hábitos dietéticos y procedimientos culinarios. Son objetivos secundarios medir la adherencia mediante el DDFQ y relacionar los resultados con marcadores bioquímicos de ingesta y con ganancia de peso interdiálisis (GID). Establecer relaciones entre la conducta de adhesión referida por el paciente, los marcadores bioquímicos de ingesta, la ganancia de peso interdiálisis y el resultado del DDFQ. Determinar la adhesión en base al sexo, tiempo en hemodiálisis, ser diabético o haber sido trasplantado alguna vez. Y relacionar los hábitos dietéticos manifestados por los pacientes en el test de hábitos dietéticos y procedimientos culinarios con las pautas prescritas por los nefrólogos en consulta antes de iniciar diálisis.

Material y métodos

Estudio piloto descriptivo transversal sobre una muestra de conveniencia de 52 pacientes con enfermedad renal terminal (ERT) en tratamiento sustitutivo renal en hemodiálisis. La muestra se obtuvo de pacientes que acuden al Servicio de Diálisis del Hospital Universitario 12 de Octubre de la Comunidad de Madrid durante tres días alternos a la semana en horario de mañana y tarde. Para este primer estudio se reclutó la muestra durante un periodo comprendido de Marzo

a Abril de 2013, una vez obtenido el permiso por el CEIC de referencia. N° CEIC: 13/ 009.

Los criterios de selección de los pacientes fueron: mayor de 18 años, llevar en tratamiento en hemodiálisis un mínimo de tres meses, tener condiciones físicas y capacidad cognitiva suficiente para responder cuestionarios, no estar en tratamiento oncológico en el momento de realizar el estudio. De los 52 pacientes iniciales se excluyeron dos por déficit cognitivo, cuatro por tratamiento oncológico, uno por ingreso en planta, dos más por trasplante durante la investigación y por último uno no quiso participar. Finalmente 42 pacientes cumplían los criterios, a ellos se les informó de los objetivos de la investigación y del carácter confidencial de los datos asegurándoles el anonimato de los mismos. Todos los sujetos del estudio firmaron el consentimiento y completaron los cuestionarios.

Las variables sociodemográficas: *edad* y *sexo* se recogieron de la ficha de filiación del paciente. Las variables clínicas: *tiempo en hemodiálisis* (tiempo transcurrido desde el inicio del programa de hemodiálisis hasta la fecha de realización del estudio), *diabético*, *trasplante anterior* (pacientes que han sido trasplantados anteriormente pero que reciben hemodiálisis por fallo del injerto renal) (Tabla I), *peso seco* (peso del paciente después de la sesión de hemodiálisis, no presentando complicaciones inmediatas, es decir, calambres, hipotensión arterial, edemas y disnea principalmente.), *ganancia interdiálisis* (se corresponde con la ganancia de peso que trae el paciente entre dos sesiones de diálisis) se recogieron de la gráfica de tratamiento de diálisis e historia clínica. *La ganancia de peso interdiálisis (GID)* se calculó estableciendo la diferencia entre el peso medio de la semana y el peso seco. *Los pesos de la 1ª, 2ª y 3ª sesión de hemodiálisis* son pesos prediálisis. El *peso semana* es la media de los pesos prediálisis (Tabla II).

Los marcadores bioquímicos: *potasio sérico en sangre* y *fósforo sérico en sangre* se recogieron en medida única, de la analítica mensual extraída a cada paciente, los días centrales de la semana y dentro del periodo de reclutamiento (abril 2013) (Tabla I).

La falta de adhesión a pautas dietéticas y de fluidos se valoró mediante el cuestionario DDFQ (Vlaminck et al. 2001)²², cuestionario validado en Bélgica, Alemania y Turquía. (Anexo 1). Es uno de los pocos instrumentos con vigencia establecidos para evaluar la falta de adherencia a pautas dietéticas y de fluidos de los pacientes con enfermedad renal crónica (ERC) en hemodiálisis. El DDFQ es un instrumento de autoinforme que determina la frecuencia del incumplimiento, tanto de dieta como de fluidos, de los últimos 14 días. Consta de cuatro subescalas: dos en relación con la falta de adherencia a la dieta (frecuencia e intensidad) y otras dos que valoran la adherencia sobre fluidos (frecuencia e intensidad). La falta de adherencia, medida como intensidad, se califica sobre escala tipo Likert, que va desde “no” hasta “muy grave”. Para su utilización en este estudio, se realizó una adaptación del

Tabla I <i>Características sociodemográficas de la muestra a estudio y valores obtenidos para los marcadores bioquímicos de ingesta alimentaria fósforo y potasio</i>	
<i>Características sociodemográficas</i>	
Hombres	59,50%
Mujeres	40,50%
Edad de los pacientes	63,64 ± 16,17 años
Diabéticos en la muestra	11,90%
Pacientes trasplantados en diálisis por fallo de injerto	47,62%
Tiempo de permanencia en hemodiálisis	83,4 ± 94,05 meses
<i>Marcadores bioquímicos de ingesta alimentaria</i>	
Potasio sérico	5,08 ± 0,86 meq/l (valor referencia 3,5-5,0 meq/l)
Fósforo sérico	4,71 ± 1,63 mg/dl (valor de referencia 2,3-4,6 mg/dl)

cuestionario al tipo de población (española y enfermos de ERC con tratamiento renal sustitutivo), para ello se llevó a cabo una traducción hacia delante y hacia atrás por traductores externos al equipo de investigación. Se ha utilizado la traducción literal ya que la “versión objetivo” obtenida se adaptaba bastante bien a las características idiomáticas y produce un instrumento en el que el constructo teórico y el formato de respuesta son adecuados (se asume ausencia de sesgo en el método y de constructo)²³. El test fue aplicado por un único entrevistador, adiestrado en el Servicio de Nefrología, durante el tiempo de permanencia del paciente en la sesión de hemodiálisis, empleando entre diez y quince minutos para cada paciente en entrevista breve.

La conducta sobre hábito dietético y procedimientos culinarios se midió mediante un cuestionario de 12 preguntas cerradas. (Anexo 2). En dicho cuestionario se incluyó, además, una pregunta dicotómica sobre cómo percibía el paciente la adherencia a su dieta y fluidos, es decir, *la conducta de adherencia referida por el propio paciente (positiva o negativa)* Las pautas

prescritas a los pacientes sobre dieta y fluidos son las recomendadas en consulta de nefrología previa a diálisis, y que cada paciente debe cumplir en su domicilio y vida diaria.

Los criterios de no adhesión a dieta y líquidos, elegidos para el estudio fueron los siguientes: fósforo sérico (P) > 6,5 mg/dl²², potasio sérico (K) > 5,0 meq/l; GID < 3% del peso seco y GID > 5,7% de aumento con respecto al peso anterior más de una vez a la semana²²⁻²⁴⁻²⁵⁻²⁶ GID diaria ≥ 1 Kg²⁴⁻²⁷.

Análisis estadístico

Para las variables sociodemográficas y clínicas presentes en el estudio se utilizó estadística descriptiva. Las variables cualitativas se resumieron en porcentajes y las variables cuantitativas continuas se resumieron en media (M) ± desviación típica (DT) y cuartiles Q₁, Q₂ (Mediana) y Q₃.

En relación a los pesos de los pacientes se determinó si existían diferencias estadísticamente significativas entre el peso medio de los individuos en los distintos turnos de diálisis y el peso seco de los mismos. Para su comparación y bajo la asunción de normalidad, se utilizó la prueba t- Student para muestras pareadas con una significación p<0,05 y un IC 95% (1.74, 2.18). Se realizaron correlaciones de Spearman para relacionar la adhesión a las pautas dietéticas del DDFQ, con los marcadores bioquímicos y con la GID del paciente. Para relacionar “conducta de adhesión referida por el propio paciente” (CARP) respecto a dieta y líquidos, se utilizó la prueba U Mann-Whitney no paramétrica para muestras independientes. Para relacionar CARP con los marcadores bioquímicos de ingesta alimentaria y el GID se utilizó la prueba paramétrica t- Student. Del mismo modo, para determinar la CARP a dieta y líquidos y el tiempo en diálisis se utilizó una correlación de Spearman y para establecer la relación con haber tenido un trasplante anterior, ser diabético y el sexo se realizó la prueba no paramétrica U Mann-Whitney para muestras independientes. Se utilizaron porcentajes para describir hábitos dietéticos de los pacientes. Para los cálculos estadísticos se utilizó el programa in-

Tabla II <i>Pesos clínicos expresados como valores medios, desviación típica y cuartiles</i>					
	<i>M</i>	<i>DT</i>	<i>Q₁</i>	<i>Q₂</i>	<i>Q₃</i>
Peso seco(kg)	61,02	9,26	54,00	59,95	66,25
Peso 1ª sesión HD (kg)	63,36	9,30	56,00	62,65	68,37
Peso 2ª sesión HD (kg)	62,65	9,34	55,05	61,45	67,95
Peso 3ª sesión HD (kg)	62,87	9,32	56,07	61,35	67,80
Pesos semana (kg)	62,98	9,35	55,50	61,66	68,08
Ganancia interdiálisis GiD. (kg)	1,96	0,70	1,50	1,91	2,33

M: Valor medio; DT: Desviación típica; Q₁: Primer cuartil; Q₂: Segundo cuartil; Q₃: Tercer cuartil

Anexo 1
Cuestionario DDFQ para evaluación de fluidos y dieta (Vlaminck et al)

CUESTIONARIO DDFQ PARA EVALUACIÓN DE FLUIDOS Y DIETA (Vlaminck et al)

1.1. Durante las dos últimas semanas ¿Cuántos días usted no ha seguido su dieta? días.

1.2. Señale en qué grado se ha desviado de su dieta.

Sin desviación / Leve / Moderado / Severo / Muy severo.

-----0-----1-----2-----3-----4-----

2.1. Durante las dos últimas semanas ¿Cuántos días usted no ha seguido su pauta de líquidos? días.

2.2. Señale en qué grado se ha desviado de su pauta en los líquidos.

Sin desviación / Leve / Moderado / Severo / Muy severo.

-----0-----1-----2-----3-----4-----

Anexo 2
Test de hábito dietético y procedimientos culinarios de los pacientes.

1. En su casa se prepara una comida diferente para usted?
2. ¿Modifica su dieta con algún acontecimiento familiar?
3. Los fines de semana ¿modifica su dieta?
4. ¿Piensa que realiza una dieta adecuada?
5. ¿Utiliza cubitos de caldo para condimentar las comidas?
6. En mi dieta no incluyo bebidas de cola.
7. A veces tomo alimentos de los llamados “Comida rápida”.
8. En mi casa se utiliza la técnica de troceado de los alimentos.
9. En mi casa se utiliza la técnica de doble cocción.
10. En mi dieta no tomo alimentos salados.
11. Quién compra y prepara su comida?
a) Usted mismo. b) Pareja. c) Cuidador. d) Familiar.
12. Cuando está en la sesión de diálisis ¿qué toma habitualmente? Puede señalar varias opciones.
a) Fruta. b) Refrescos de cola. c) Bocado. d) Snacks y/o frutos secos. e) Nada. f) Otros (manzanilla. leche).

formático SPSS para Windows, 20 (SPSS ©, Chicago, IL). Significación estadística con un valor de $p < 0,05$.

Resultados

De los 42 pacientes ($n=42$) con ERC en tratamiento sustitutivo renal en hemodiálisis participantes, 59,5% eran hombres. La edad media fue de $63,64 \pm 16,17$ años (Q_1 : 50. Q_2 : 67,50. Q_3 : 77) y el tiempo medio en hemodiálisis $83,4 \pm 94,05$ meses. De la muestra analizada el 11,9% corresponde a diabéticos y un 47,62% a trasplantados, es decir, sujetos que por fallo del injerto han vuelto a tratamiento renal sustitutivo en diálisis (Tabla I).

Los resultados referentes a las variables clínicas se describen en la tabla I. expresándose en $M \pm DT$ y Q_1 , Q_2 y Q_3 . El valor medio para el peso seco fue de $61,02 \pm 9,26$ Kg. En la tabla II se expresan los pesos prediá-

lisis como pesos en una semana, siendo su valor medio de $62,98 \pm 9,35$ Kg. El resultado expresa la existencia de diferencias estadísticamente significativas entre peso seco y peso medio al acudir a las sesiones de diálisis siendo mayor éste último.

Para la GID el resultado obtenido fue de $1,96 \pm 0,70$ Kg. El valor del Q_2 nos muestra que el 50% de los pacientes llegan a la sesión de diálisis con una sobrecarga de aproximadamente 2 Kg. y el 75% (Q_3) por encima de este valor (2,33 Kg).

Cuando la ganancia de peso medio interdiálisis es menor del 3% del peso seco existe riesgo de malnutrición en estos pacientes y cuando es mayor de 5,7%, el riesgo de mortalidad se incrementa un 35%²⁴⁻²⁵⁻²⁸. El 42,9% de la muestra estaba en riesgo de malnutrición.

Los resultados para potasio (K) y fósforo (P) sérico, marcadores bioquímicos de ingesta alimentaria, se muestran en la tabla I. El potasio, con un valor medio de $5,08 \pm 0,86$ meq/l, es ligeramente superior respecto

al intervalo de normalidad fijado por el laboratorio de bioquímica [3,50-5,00 meq/l] y utilizado como valor de referencia de adherencia a dieta. El valor medio para el fósforo fue de $4,71 \pm 1,63$ mg/dl., siendo ligeramente superior al máximo admitido como normalidad clínica [2,3- 4,6 mg/dl] pero inferior a 6,5 mg/dl, valor de referencia utilizado para identificar la adherencia o no adherencia a la dieta.

Resultados al cuestionario DDFQ

Los resultados indican que el paciente que menos días siguió la pauta dietética fue de 0 días en contraposición al que tuvo un mayor seguimiento que lo hizo en 10 días de los 14 días encuestados (Fig. 1). Los valores de los cuartiles referentes a la variable DDFQ dieta (Q_1 : 0, Q_2 : 2 y Q_3 : 3) señalan que el 50% de la muestra no tiene adherencia a dieta en 2 días de los 14 valorados, es decir presentan adherencia en 12 días.

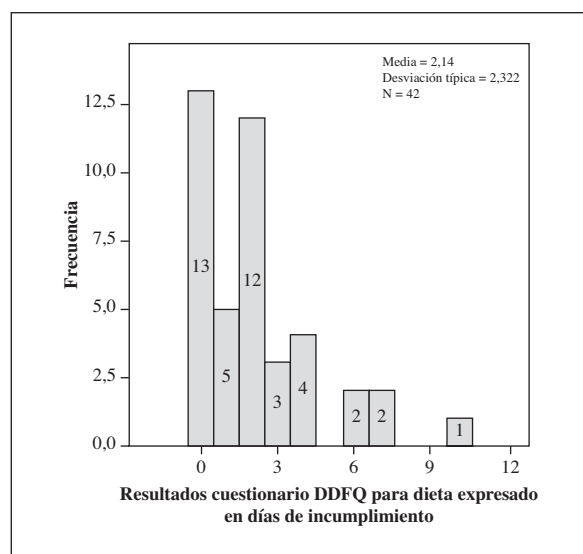


Fig. 1.—

Los resultados de adherencia a líquidos (frecuencia) muestran que el paciente que menos días siguió la pauta de líquidos fue de 0 días y el que más la cumplió fue de 6 días de los 14 días encuestados (Fig 2). Los valores en cuartiles (Q_1 : 0, Q_2 : 1 y Q_3 : 2) indican que el 50 % de los pacientes tienen una adherencia de 13 días.

El grado de intensidad de adherencia a dieta o líquidos, valorado sobre escala tipo Likert, indica que el grado de desviación es leve (40,48%) (Fig 3), mientras que para líquidos existe menos desviación puesto que un 47,62% manifiestan no desviarse de la pauta de líquidos (Fig 4).

Del mismo modo se relacionaron los marcadores de ingesta alimentaria: ganancia de peso interdiálisis (GID), potasio sérico y fósforo sérico con los resultados obtenidos en las preguntas del cuestionario DDFQ. Para ello se calculó el coeficiente de correlación de Spearman y se determinaron correlaciones superiores a 0,3 entre la adherencia a la dieta y el fósforo ($p=0,304$) y la adherencia a los líquidos con la ganancia de peso interdiálisis ($p=0,413$).

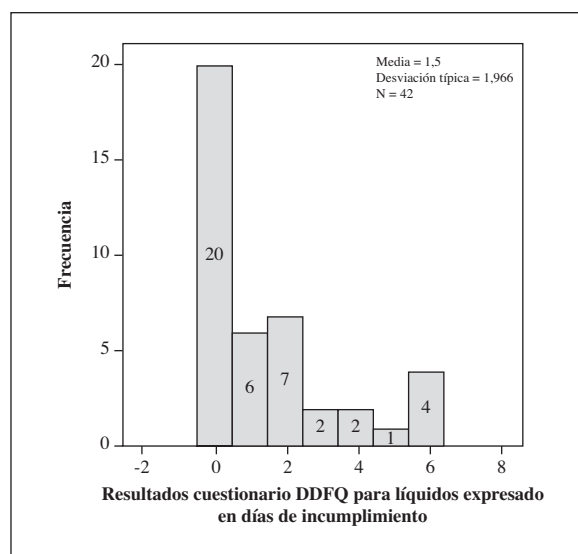


Fig. 2.—

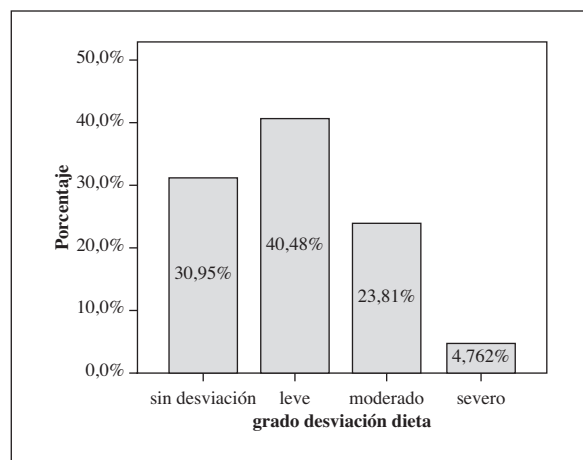


Fig. 3.—

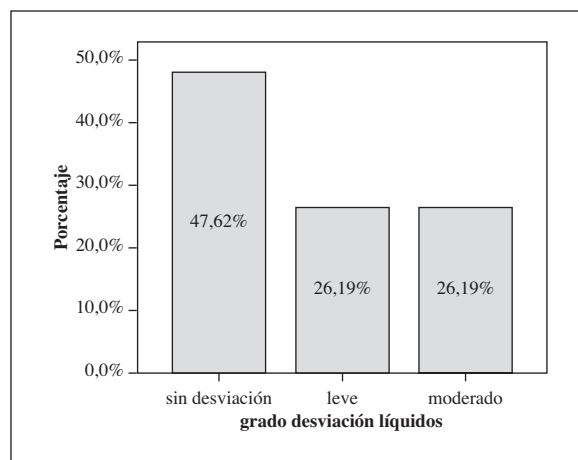


Fig. 4.—

Resultados sobre la conducta de adhesión que refiere el paciente y su relación con los resultados del DDFQ

El 80,95% de los pacientes manifiestan seguir una conducta correcta en el cumplimiento de la dieta frente a un 19,05% que perciben no la hacen adecuadamente. Para un $p < 0,05$ se obtuvieron diferencias estadísticamente significativas entre los pacientes que manifestaron un cumplimiento correcto de las pautas dietéticas prescritas según el DDFQ, con un p (0,001), frente a los que manifestaron no cumplirlas.

En relación a la conducta seguida para los líquidos, referida en el DDFQ, con un p (0,060), no existieron diferencias estadísticamente significativas entre los pacientes que cumplen con la pauta y los que la incumplen (conducta referida positiva o negativa). En la tabla III se expresan los resultados obtenidos al realizar una tabla de contingencia tanto para dieta como para líquidos, en donde destaca “no cumplir la dieta durante dos días” tanto para los pacientes que dicen seguir la dieta adhesión referida positiva (29,4%) como para los que no la siguen adhesión referida negativa (25%).

Resultados sobre la conducta de adhesión que refiere el paciente y la GID, el potasio y el fósforo sérico

Para determinar si existían diferencias estadísticamente significativas entre los pacientes que refieren seguir la dieta (adhesión positiva) y aquellos que manifiestan no seguirla (adhesión negativa) con respecto a los valores de GID, potasio sérico y fósforo sérico, se realizó una t Student, asumiendo la normalidad de las variables de interés. Se concluyó que no había diferencias entre los valores de GID, potasio y fósforo sérico en la muestra por tener una conducta referida positiva o negativa.

Resultados sobre la adhesión de los pacientes en base al tiempo en hemodiálisis, haber estado trasplantado alguna vez, ser o no diabético y el sexo

En primer lugar se relacionaron los resultados del DDFQ de dieta y el DDFQ de líquidos con el tiempo

que llevaban los pacientes en diálisis mediante una correlación de Spearman, los resultados no fueron estadísticamente significativos.

En segundo lugar se relacionó el haber estado trasplantado alguna vez con los resultados del DDFQ mediante la prueba U de Mann Whitney. De igual forma se estableció la relación por diferencia de sexo y con ser diabético. Se estableció en todos los casos una significación para $p < 0,05$ y en ninguno de los casos analizados se encontraron diferencias estadísticamente significativas.

Resultados de los hábitos dietéticos manifestados por los pacientes en referencia a las pautas prescritas

El 50% de los pacientes manifestaron que era la pareja el responsable de comprar y preparar su comida en el domicilio. Un 16,67% señaló que en el domicilio familiar se preparaba una comida diferente para él. A la pregunta sobre si los acontecimientos familiares le modificaban su dieta, un 52,38% contestó afirmativamente. Sin embargo, con respecto a los cambios que podían producirse los fines de semana, un 69% dijeron no cambiar la dieta.

Una información que se consideró relevante obtener, fue saber los alimentos y bebidas que habitualmente consumían durante las sesiones de diálisis. Los resultados más sobresalientes señalan que un 73% tomaban bocadillo y refrescos de cola conjuntamente (Tabla IV).

Cuando comenzaron su tratamiento en hemodiálisis, los pacientes fueron informados sobre las pautas prescritas de dieta y líquidos a seguir, así como de los alimentos prohibidos y a evitar. Se quiso saber en este estudio, a través de la entrevista breve y respondiendo a una serie de preguntas, cómo era el manejo del sodio, del potasio y del fósforo en su dieta (Anexo 2). Al plantearles la pregunta acerca de la inclusión de bebidas de cola en la dieta, un 28,6% sí las incluían. Y en referencia a los alimentos llamados “comida rápida” el 33,3% afirmaron consumirlos habitualmente. Con respecto al conocimiento de dos técnicas culinarias esenciales y fundamentales en la reducción de potasio (K) de algunos alimentos: troceado-remojo y doble cocción, sólo

Tabla III
Correlación valores DDFQ y días no adherencia a dieta y líquidos, por paciente

	0 Días	1 Día	2 Días	3 Días
Adherencia referida a dieta (%)				
Siguen la dieta adecuadamente	38,20	14,70	29,40	5,90
No siguen la dieta adecuadamente	0,00	0,00	25,00	12,50
Adherencia referida a líquidos (%)				
Siguen la pauta de líquidos adecuadamente	52,90	17,60	14,70	2,90
No siguen la pauta de líquidos adecuadamente	25,00	0,00	25,00	12,5

Tabla IV
Preferencias de ingesta alimentaria durante las sesiones de hemodiálisis

Bocadillo + refresco de cola	73,80%
Fruta	4,80%
Snacks / frutos secos	2,40%
Otros alimentos y/o bebidas (leche, manzanilla)	4,80%
Nada	14,30%

la mitad de los enfermos, aproximadamente, conocen las dos técnicas básicas, 52,4% el troceado-remojo y 57,1% la doble cocción.

Discusión

El objetivo principal de este estudio ha sido determinar la adhesión a las pautas dietéticas y de fluidos que presentan los pacientes con enfermedad renal crónica en hemodiálisis y su relación con la conducta de adherencia referida y con los hábitos dietéticos que siguen. La importancia en la restricción de dieta y líquidos está más que demostrada en estos pacientes crónicos por la experiencia clínica y por los trabajos realizados de investigación a lo largo de los años que apoyan estas teorías¹³. La falta de adhesión está motivada por tener que convivir con una serie de limitaciones relacionadas con los alimentos y los líquidos ingeridos. Esto supone una adaptación que a algunos pacientes les es muy difícil de conseguir y por ello transgreden su dieta poniendo en peligro su supervivencia, demostrado con estudios realizados en grandes cohortes¹³.

En este estudio se ha trabajado con el cuestionario DDFQ para la valoración de adhesión a dieta y a líquidos. Se ha utilizado, como uno de los indicadores de adherencia a líquidos, la ganancia de peso interdialisis (GID). Por los datos obtenidos sabemos que el 50% de los pacientes llegan a la sesión de diálisis con una sobrecarga de aproximadamente 2 Kg y el 75% por encima de este valor.

Los resultados del estudio, según el cuestionario DDFQ, indican que los pacientes tenían dificultad para el seguimiento de la dieta (70,05%) y para la restricción de líquidos (52,38%). Estos valores están por debajo de otros estudios que lo sitúan en un 81,4% para la dieta y en un 74,6% para los líquidos¹⁸. Sin embargo los valores obtenidos por Kim y Evangelista hablan de un 21,5% de no adhesión de líquidos y 31,8% de no adhesión a dieta. Si bien en este estudio no se utilizó el cuestionario DDFQ sino el cuestionario ESRD, AQ de adherencia a enfermedad renal²¹.

Al valorar la perspectiva de cada paciente ante su propia adhesión a las pautas dietéticas de dieta y fluidos, obtenemos que casi el 81% manifiestan seguir las pautas de dieta y líquidos correctamente. Este valor se aproxima a los resultados obtenidos por Iborra-Moltó²⁴

y colaboradores quienes valoran la adhesión a líquidos igualmente desde la perspectiva del propio paciente. Otros estudios refieren la percepción del paciente de su propia adhesión, entre el 26% y el 63%. Esta medida de autoinforme presenta una correlación significativa con el DDFQ²². Nos parece interesante reseñar este aspecto con el resultado obtenido al realizar una correlación entre la conducta referida como “adhesión positiva”, el paciente piensa que sigue correctamente las pautas sobre la dieta y los líquidos o de “adhesión negativa”, el paciente piensa que no sigue las pautas de dieta y líquidos correctamente, con los resultados del DDFQ. Se encontraron porcentajes muy similares, un 29,4% y un 25% tanto en los pacientes que creían cumplir bien las pautas dietéticas como los que pensaban que no la realizaban bien. Por lo que pensamos que algunos pacientes no dan la importancia suficiente al hecho de saltarse la dieta, dos días para unos es señal de estar adhiriéndose bien con la dieta y para otros estar adhiriéndose mal. En el caso de los líquidos, si observamos los porcentajes generales, vemos una distribución similar para ambos tipos de pacientes. Todo ello nos lleva a señalar que para los pacientes estudiados, el saltarse la pauta de líquidos sí es transgredir, mientras que no valoran de igual forma saltarse las pautas referentes a la dieta.

El estudio de Kim y Evangelista²¹ ofrece datos muy interesantes sobre la relación entre la adhesión a la dieta y la percepción que tienen los pacientes sobre su enfermedad, sin embargo no podemos contrastar sus resultados con los nuestros, puesto que ellos no miden la percepción que tienen el paciente acerca del seguimiento de la dieta. Trabajos de otros autores han relacionado la no adhesión a la dieta en este tipo de pacientes con síntomas depresivos, nivel de estudios, tabaco, edad, nivel socioeconómico, pero no se han encontrado estudios en nuestro país que relacionen la conducta de no adherencia al tratamiento con la conducta de adhesión referida por el paciente, lo que consideramos es una fortaleza de nuestra investigación.

En cuanto a los resultados de las correlaciones entre el DDFQ y el marcador bioquímico fósforo sérico, se aprecia una relación entre los valores altos de fósforo y un mayor número de días de no adherencia a la dieta, al igual que lo reflejado en el estudio de Vlainck²².

En referencia a uno de los marcadores de ingesta alimentaria y adhesión a la dieta, el potasio sérico, los pacientes de nuestra muestra tenían unos niveles ligeramente superiores al rango marcado de normalidad clínica, pero se encuentran dentro de los límites de normalidad de adherencia marcados para el estudio y también con los encontrados en otros trabajos²⁹. Es importante resaltar en este punto, que los pacientes tienen bajo conocimiento de la utilidad de las técnicas culinarias como forma de disminución del potasio de algunos alimentos, nos referimos al troceado-remojo y a la doble cocción. Respecto a las bebidas de cola, que incorporan niveles altos de fósforo en su composición, son poco utilizadas en el domicilio; sin embargo es im-

portante resaltar que la cola es la bebida preferida en las sesiones de diálisis conjuntamente con el bocadillo.

En cuanto al seguimiento de la adherencia a la dieta en el hogar, es la pareja en la mayoría de los hogares, la que asume el papel de cuidador y la que se responsabiliza tanto de la compra de los alimentos como de la elaboración de los mismos. Uno de los factores que más peso tiene en la falta de seguimiento de las pautas dietéticas prescritas por parte de los pacientes son los acontecimientos familiares.

Conclusión

Los resultados de este primer estudio de aplicación de cuestionario DDFQ, permiten concluir la existencia de una falta de adhesión en los pacientes en diálisis en contraste con la conducta percibida por el propio paciente. El marcador bioquímico fósforo está sólo ligeramente por encima de los valores de normalidad y ello pueda ser debido al riguroso control que se le aplica con novedosas técnicas de diálisis y a la toma de quelantes de fósforo en algunos casos. Los valores del marcador bioquímico de ingesta alimentaria potasio, están de igual forma, ligeramente por encima del rango de normalidad, siendo este parámetro más fácil de controlar en las sesiones de diálisis. El paciente no percibe que cuando transgrede la dieta se está saltando ambas pautas de dieta y líquidos, es más consciente que la no adhesión a los líquidos puede tener como consecuencia la ganancia de peso interdialisis ya que relaciona adecuadamente el parámetro peso con la no adherencia a los líquidos. Lo contrario ocurre con la adherencia a la dieta ya que el paciente no lo asocia tan claramente con el aumento de peso.

Dado que este tratamiento sustitutivo renal es tan largo en el tiempo se debería de revisar la educación de los pacientes a las pautas prescritas, controlar la alimentación y el aporte de líquidos y aconsejarlos en sus demandas. En este sentido cabe resaltar la enorme importancia de formar y apoyar a la enfermería nefrológica que con ayuda de herramientas sencillas puedan detectar incumplimientos y actuar sobre ellos con una mayor educación dietética.

En nuestro estudio la no significación de algunas variables como el tiempo en diálisis, haber tenido el paciente un trasplante anterior, ser diabético o no y el sexo puede ser debido a las limitaciones en el tamaño de la muestra.

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Original/Otros

Adherencia a los suplementos nutricionales orales en pacientes internados con patología clínica-quirúrgica

Anabel Villagra¹, María Cecilia Merkel¹, Julia Rodríguez Bugueiro¹, Natalia Lacquaniti¹ y Rosario Remoli¹

¹Servicio de Nutrición. Hospital de Alta Complejidad en Red "El Cruce". Buenos Aires, República Argentina.

Resumen

Introducción: Los trabajos científicos realizados respecto al uso de los suplementos nutricionales sugieren que su aceptación es en general buena, por lo que su utilización es ampliamente aceptada por los profesionales. Sin embargo en la práctica diaria hospitalaria se observa que dicha aceptación es variable. El objetivo de nuestro estudio es conocer el nivel de adherencia a los suplementos nutricionales orales y los principales motivos de no adherencia en pacientes internados por patología clínica o quirúrgica.

Métodos: Estudio observacional y prospectivo, unicéntrico. Se incluyeron pacientes consecutivos internados en un hospital de alta complejidad, con evaluación global subjetiva categoría B, entre agosto 2012 y mayo 2013. Se indicó un suplemento diario, se evaluó la adherencia y se determinaron los motivos de no adherencia. Se consideró paciente adherente cuando el consumo fue $\geq 75\%$ de los suplementos indicados.

Resultados: Sobre un total de 807 pacientes con evaluación global subjetiva, 73 pacientes tuvieron indicación de suplemento nutricional oral. La mediana de edad fue 52 años (IIC 35-62), hombres 58,9%, mediana de índice de masa corporal 24,5 (IIC 22,5-27,3). Se indicaron un total de 489 suplementos y fueron consumidos un total de 371. La mediana de tiempo de indicación de suplemento por paciente fue de 5 días (IIC 4-10) y la mediana de días consumidos fue de 4 por paciente (IIC 1-8). La adherencia fue de 58,9% (43 pacientes). Los motivos de no adherencia fueron: causas digestivas propias del paciente 5 pacientes (16,7%), intolerancia al suplemento nutricional oral 18 pacientes (60%), negativa del paciente no justificada 7 pacientes (23,3%).

Conclusiones: En pacientes internados por patología clínica o quirúrgica con evaluación global subjetiva B, la adherencia a los suplementos nutricionales orales fue insuficiente. La intolerancia al suplemento fue la causa más frecuente de no adherencia.

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Palabras clave: Suplementos nutricionales orales. Adherencia. Desnutrición. Suplementos dietarios.

Correspondencia: Anabel Alejandra Villagra
Dirección: Av. Calchaquí 5401, Florencio Varela, CP 1888.
Buenos Aires, Argentina
E-mail: lic.anabelvillagra

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ADHERENCE TO ORAL NUTRITION SUPPLEMENTS IN HOSPITALIZED PATIENTS WITH CLINICAL PATHOLOGY-SURGICAL

Abstract

Introduction: Studies about the use of nutritional supplements suggest that acceptance is good, so that it is widely recognized and used by professionals. However, in clinical daily practice it seems to be not as much accepted as I seems. The aim of our study is to know the level of adherence to oral nutritional supplements and the main reasons for non-adherence in patients admitted for medical or surgical pathologies.

Methods: An observational, prospective and single-center study was designed. Consecutive patients admitted to a high complexity hospital between August 2012 and May 2013 and with subjective global assessment category B were included. A daily supplement was indicated, the adherence was evaluated and the reasons for non-adherence were determined. Adherent patient was considered when $\geq 75\%$ of the supplements was consumed.

Results: Of a total of 807 patients with subjective global assessment, 73 patients were prescribed oral nutritional supplements. The median age was 52 years (IQR 35-62), 58.9% was male, the median body mass index was 24.5 (IQR 22.5 to 27.3). A total of 489 supplements were indicated and a total of 371 were consumed. The median days of indication for the supplements per patient were 5 days (IQR 4-10) and the median consumed was 4 days per patient (IQR 1- 8). The adherence was 58.9% (43 patients). The reasons for non-adherence were: patients own digestive reasons in 5 patients (16.7%), intolerance to oral nutritional supplement in 18 patients (60%) and unjustified patient's refusal in 7 patients (23.3%).

Conclusions: In patients admitted for clinical or surgical pathologies with subjective global assessment B, adherence to oral nutritional supplements was insufficient. Intolerance to supplements was the most frequent reason of non-adherence.

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Key words: Oral nutrition supplements. Adherence. Malnutrition. Dietary supplements.

Abreviaturas

SNO: Suplementos nutricionales orales.

EGS: Evaluación Global Subjetiva.

Introducción

La desnutrición hospitalaria sigue siendo un problema de actualidad, contribuyendo a una mala evolución clínica de los pacientes y aumentando la morbi-mortalidad¹⁻³. Por ello resulta primordial identificar a los pacientes desnutridos o con riesgo de estarlo, ya que necesitan una evaluación nutricional más exhaustiva seguida de una intervención oportuna y adecuada⁴⁻⁵. Existen diferentes estrategias dietoterápicas para corregir la desnutrición hospitalaria. La utilización de suplementos nutricionales orales (SNO) es la forma menos invasiva de iniciar un soporte nutricional⁶. Los SNO son formulaciones útiles para complementar la alimentación en pacientes con déficit nutricional, siendo completos en uno o varios nutrientes pero que muestran en su composición vitaminas y minerales en cantidades inferiores a las recomendadas por lo que no pueden ser utilizados como única fuente nutricional a largo plazo⁷. El criterio para su indicación se limita a aquellos pacientes en riesgo de desnutrición, en los cuales la alimentación oral es insuficiente para cubrir las necesidades calórico-proteicas⁷⁻⁹. Sin embargo el consumo de estos productos depende de la aceptación por parte de los pacientes, y esto es relativo a las características propias de los suplementos (sabor, olor, textura) y a la duración del tratamiento con los mismos¹⁰⁻¹¹.

En la actualidad no hay una política universalmente aceptada en relación a la indicación de SNO⁷. Los estudios previos mostraron gran heterogeneidad en relación al tipo de suplemento utilizado, la población blanco y la duración del tratamiento¹²⁻¹⁵. La observación clínica en nuestro centro nos sugiere que la adherencia a los suplementos orales es insuficiente.

Objetivo

El objetivo de nuestro estudio es conocer el nivel de adherencia a la indicación nutricional de los SNO y los principales motivos de no adherencia en pacientes internados por patología clínica-quirúrgica.

Métodos

Estudio observacional y prospectivo, unicéntrico. Se incluyeron pacientes consecutivos internados en los servicios de Clínica Médica, Cardiología y Unidad de Trasplante, en un hospital de alta complejidad con funcionamiento en red en el conurbano sur de la Provincia de Buenos Aires, entre agosto 2012 y mayo 2013.

Criterios de inclusión: edad mayor a 16 años, capaces de responder al interrogatorio, con evaluación global subjetiva (EGS) categoría B.

Criterios de exclusión: embarazadas, pacientes internados en otras áreas del hospital diferentes a las especificadas y pacientes consumiendo SNO previo a la evaluación nutricional.

Se realizó la evaluación nutricional a todos los pacientes ingresados en dicho período, mediante la EGS, método explicitado por Detsky y col.¹⁶. Ésta es una herramienta validada para evaluar pacientes quirúrgicos hospitalizados dentro de las primeras 48 hs. de internación y que establece un diagnóstico subjetivo del estado nutricional de los pacientes, clasificándolos en normonutridos (EGS A), con sospecha de desnutrición o desnutrición moderada (EGS B) y desnutrición severa (EGS C).

Se indicó un SNO diario Fortisip® o Fresubin® sabor vainilla, frío, rotulado con nombre, apellido y fecha, a las 21 hs. La duración del tratamiento de cada paciente incluido fue determinada por el profesional tratante del servicio de nutrición. El momento de la finalización del seguimiento fue determinado por la falta de adherencia a SNO, alta del paciente, muerte, finalización del tratamiento, o luego de un periodo máximo de 15 días consecutivos desde el inicio del tratamiento.

Se evaluó si la ingesta del mismo fue positiva o negativa mediante el interrogatorio y la muestra del envase al día siguiente. Se consideró ingesta positiva si el paciente consumió más de la mitad del SNO.

Se registraron los motivos de no ingesta del SNO, pudiendo ser los mismos: fatiga del sabor, intolerancias provocadas por el mismo (náuseas, diarrea y sensación de plenitud), causas gastrointestinales propias del paciente (náuseas, vómitos, diarrea, distensión abdominal), negativa del paciente a la ingesta del SNO, causas clínicas (fiebre, disnea, deterioro del sensorio), y de una adherencia insuficiente siendo los mismos: causas gastrointestinales propias del paciente, negativa al consumo, intolerancia provocada por el suplemento (en esta última se agruparon las causas de intolerancia gastrointestinal al suplemento y la fatiga del sabor) y causas clínicas. Se indicó nutrición enteral a aquellos pacientes que no adhirieron al tratamiento.

Análisis estadístico

Las variables continuas fueron expresadas como mediana e intervalo intercuartilo por presentar distribución no gaussiana. Las variables categóricas fueron expresadas como números y porcentajes. Se determinó la adherencia individual al tratamiento con SNO considerando insuficiente cuando el consumo fue inferior al 75% de los días indicados, calculada con la siguiente fórmula: días indicados/días consumidos x 100. La adherencia general se definió como variable dicotómica, y se determinó como la proporción entre pacientes con adherencia individual $\geq 75\%$ en el numerador y la

población total en el denominador x 100. Se subanalizó la adherencia general en pacientes que tuvieron indicación de SNO durante 4 o más días, como análisis de sensibilidad.

La asociación entre tipo de patología y adherencia fue evaluada mediante tablas de contingencia. Se consideró como significativo un valor de $p < 0,05$ a dos colas. Para el análisis estadístico se utilizó el programa EPI-INFO 3.5.1.

El protocolo del estudio fue aprobado por el Comité de Ética y por el Comité Científico de nuestro hospital. No se solicitó consentimiento informado a los participantes por tratarse de una intervención de uso habitual.

Resultados

Sobre un total de 807 pacientes con EGS durante el periodo del estudio, 73 pacientes tuvieron indicación de SNO y conformaron la población del estudio. La mediana de edad de la población analizada fue de 52 años (IIC 35-62), la proporción de hombres fue del 58,9%, y la mediana de IMC 24,5 (IIC 22,5-27,3). Las principales características de la población se resumen en la tabla I.

Se indicaron un total de 489 suplementos y fueron consumidos un total de 371. La mediana de indicación de SNO por paciente fue de 5 días (IIC 4-10) y la mediana de días consumidos fue de 4 (IIC 1-8) por paciente. La adherencia general en la población fue de 58,9% (43 pacientes), y la adherencia general calculada sobre 57 pacientes con indicación de SNO durante 4 o más días fue del 59,6% (34 pacientes adherentes). Los motivos de no adherencia fueron: causas digestivas propias del paciente 5 (16,7%), intolerancia al SNO 18 pacientes (60%), negativa del paciente no justificada 7 pacientes (23,3%). Dichos motivos se resumen en la tabla II.

En un análisis post-hoc evaluamos la adherencia de acuerdo al tipo de patología. Los pacientes con patología oncológica presentaron una proporción de no adherencia significativamente mayor que aquellos con otros diagnósticos clínicos (61,9% vs. 32,7%, $p=0,02$).

Discusión

La adherencia a los SNO es un tema ampliamente estudiado en la bibliografía médica. Una revisión sistemática realizada en el año 2012¹⁰ que reunió buena parte de la evidencia publicada hasta la actualidad, demostró que la adherencia a los SNO es alta; notándose un porcentaje significativamente mayor en estudios realizados en la comunidad (cumplimiento: 80.9%) que en ámbito hospitalario (cumplimiento: 67.2%). Los resultados de nuestro estudio muestran una adherencia del 58.9% siendo similar a los resultados reportados en la revisión. Sin embargo, la adherencia a SNO fue inferior al límite que consideramos necesario para cumplir con el objetivo planteado, con una proporción de pacientes no adherentes mayor al 40%. En estos pacientes, la principal causa de no adherencia fue la intolerancia al suplemento, representando más de la mitad de los casos de no adherencia. Este hallazgo confirma que, en muchos casos, el inicio de SNO no cumple con el objetivo nutricional, pudiendo retrasar en algunos casos el inicio de una terapia nutricional efectiva, como la nutrición por sonda naso-enteral.

Si bien la adherencia fue menor que el objetivo propuesto, existió un 58,9% de pacientes que adhirieron satisfactoriamente a la terapia. Ante esto, no podemos descartar el uso de SNO en la población total, ya que representa una terapia relativamente económica y no invasiva. Sin embargo, el hecho de no cumplir con los

Tabla I
Características de la población

<i>Variable</i>	<i>Mediana</i>	<i>IIC</i>
Edad	52	36-62
IMC	24,51	22,5-27,3
	N	%
Sexo		
Femenino	30	41,1
Masculino	43	58,9
Tipo Patología		
Cardiológica	22	30,1
Clínica	23	31,5
Oncológica	21	28,8
Quirúrgica	7	9,6
Antecedentes de consumo previo de SNO	12	16,4
Muerte	5	6,8

IMC: Índice de masa corporal; SNO: Suplementos nutricionales orales

Tabla II
Motivos de no adherencia a los suplementos nutricionales orales

Motivos	N	%
Causas gastrointestinales propias del paciente	5	16,7
Intolerancia provocada por el suplemento	18	60
Negativa injustificada al consumo	7	23,3

objetivos planteados en una alta proporción de pacientes a los que se les indicó SNO, nos obliga a plantear en cada paciente el beneficio de iniciar esta terapia o utilizar nutrición por sonda naso-enteral como primera estrategia terapéutica. Lamentablemente, el bajo número de pacientes incluidos en nuestro estudio no nos permitió realizar un análisis multivariado para determinar aquellos factores que se asociaron significativa e independientemente a no adherencia y, de esa manera, seleccionar aquellos pacientes con menos probabilidad de cumplir el tratamiento con SNO. En este aspecto, el subgrupo de pacientes oncológicos presentó una proporción de no adherencia significativamente mayor que los pacientes con otros diagnósticos. La evaluación multivariada de factores asociados independientemente con no adherencia deberá evaluarse en estudios de mayor magnitud.

Limitaciones

Nuestro estudio presenta limitaciones. Si bien la elección del valor de corte del 75% para definir la adherencia es arbitraria, el consumo mínimo de 3 de cada 4 suplementos indicados constituye una proporción lógica para ser considerado como suficiente.

Como estudio abierto, pudo existir algún sesgo en la determinación de adherencia, principalmente debido a que el profesional tratante es quién determina el momento de la finalización de la terapia y el seguimiento.

La palatabilidad del SNO pudo haber influido negativamente en la aceptación de los mismos, ya que no se varió el sabor del SNO utilizado en los casos de no adherencia. Los estudios publicados en la actualidad informan que el uso de una variedad de sabores de los suplementos se asocia con mayor cumplimiento¹⁷⁻¹⁹.

El subanálisis de adherencia en pacientes oncológicos debe ser tomado con recaudo, ya que presenta las limitaciones propias de un análisis de subgrupos en estudios pequeños, y de un análisis post-hoc.

Conclusiones

En pacientes internados por patología clínico-quirúrgica con EGS B, la adherencia a los SNO fue insuficiente. La intolerancia al suplemento fue la causa más frecuente de no adherencia. Estos resultados sugieren

la necesidad de replantear la indicación generalizada de SNO como primera estrategia nutricional.

Conflictos de interés

Los autores no presentan conflictos de interés.

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Original/Otros

Implementación de la rehabilitación respiratoria en las comunas de Valparaíso, Viña del Mar, Quilpué y Villa Alemana durante el año 2013

Pablo Manríquez Villarroel¹, Yasna Colines Rodríguez², Felipe Poblete Vega², Jaime Otárola Bravo², Cristhian Paredes Barrera² y Ana María Acuña Cabrera³

¹Magíster en Ciencias. Escuela de Kinesiología, Universidad Santo Tomás sede Viña del Mar. ²Licenciado en Kinesiología. Universidad Santo Tomás sede Viña del Mar. ³Licenciado en Kinesiología. Pontificia Universidad Católica de Valparaíso. Chile.

Resumen

Introducción: La rehabilitación respiratoria es un pilar fundamental en el tratamiento del paciente con Enfermedad Pulmonar Obstructiva Crónica. Reduce importantemente los costos para el sistema de salud, el uso de recursos sanitarios, disminuyendo la estadía hospitalaria y las consultas a servicios de urgencia.

Objetivo: Describir la condición actual de la rehabilitación respiratoria en los centros de atención primaria ubicados en la región de Valparaíso.

Método: Se aplicó una encuesta cerrada a cada profesional a cargo del área respiratoria en los centros de atención primaria de salud. La muestra estuvo conformada por 32 centros de salud correspondientes a las comunas de Valparaíso, Viña del Mar, Quilpué y Villa Alemana.

Resultados: 9 centros (28%) del total de la muestra realizan rehabilitación respiratoria y el mismo número tiene un programa de rehabilitación estructurado. En 15 (47%) de los centros existe un Nutricionista dentro del equipo de salud. En el 100% de los centros se evalúa a los pacientes mediante espirometría y escalas de disnea. La mayoría de los centros (89%) realiza entrenamiento de extremidades superiores e inferiores. Dentro de los factores que limitan la realización de la rehabilitación respiratoria, 20 (63%) centros refieren que el horario de atención es uno de los factores más limitantes, mientras que 23 (72%) centros refieren que no cuentan con espacio físico adecuado y 22 (69%) centros relatan no contar con los implementos mínimos necesarios.

Discusión: Los datos obtenidos indican que en la mayoría de los centros encuestados no se realiza rehabilitación respiratoria como parte del tratamiento del paciente con Enfermedad Pulmonar Obstructiva Crónica, principalmente por problemas de recursos humanos, materiales e infraestructura.

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Palabras clave: Enfermedad Pulmonar Obstructiva Crónica. Rehabilitación.

IMPLEMENTATION OF RESPIRATORY REHABILITATION IN THE MUNICIPALITIES OF VALPARAÍSO, VIÑA DEL MAR, QUILPUÉ AND VILLA ALEMANA IN 2013

Abstract

Introduction: Pulmonary rehabilitation is a keystone in the treatment of patients with Chronic Obstructive Pulmonary Disease. Significantly reduces the costs to the health system, the use of health resources by reducing hospital stay and consultations to emergency services.

Objective: Describe the current condition of respiratory rehabilitation in primary care centers located in the region of Valparaíso.

Method: A closed survey in the respiratory centers of primary health care was applied. The sample consisted of 32 health centers corresponding to the communes of Valparaíso, Viña del Mar, Quilpué and Villa Alemana.

Results: 9 centers (28%) of the total sample performed pulmonary rehabilitation and the same number have a structured rehabilitation program. In 15 (47%) of the centers there is a Nutritionist in the health team. In 100% of hospitals patients assessed by spirometry and dyspnea scales. Most centers (89%) training upper and lower extremities. Among the factors that limit the performance of respiratory rehabilitation, 20 (63%) report that the schedule are one of the most limiting factors, while 23 (72%) report that centers do not have adequate space and 22 (69%) centers relate not have the minimum equipment necessary.

Discussion: Our findings suggest that most respiratory rehabilitation center did not performed as part of the treatment of patients with chronic obstructive pulmonary disease, mainly due to problems of human, material and infrastructure.

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Key words: Chronic Obstructive Pulmonary Disease. Rehabilitation.

Correspondencia: Pablo Manríquez Villarroel
Escuela de Kinesiología, Universidad Santo Tomás
sede Viña del Mar. Chile.
E-mail: pablomanriquez@santotomas.cl

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Abreviaturas

EPOC: Enfermedad Pulmonar Obstructiva Crónica.
RR: Rehabilitación Respiratoria.
APS: Atención Primaria de Salud.
ERA: Enfermedades Respiratorias del Adulto.

Introducción

La Enfermedad Pulmonar Obstructiva Crónica (EPOC) se considera un problema de salud pública debido al deterioro progresivo, la alta prevalencia y mortalidad. Se estima que en el mundo más de 80 millones de personas padecen EPOC moderado a severo y 3 millones de personas fallecen anualmente a causa de esta enfermedad¹.

En estos pacientes el tratamiento y la prevención son de vital importancia, para ello es necesaria una intervención multidisciplinaria, siendo la Rehabilitación Respiratoria (RR) una intervención que permite a los pacientes EPOC reducir sus síntomas, disminuir la disnea, aumentar la capacidad de ejercicio, mejorando el estado funcional y la calidad de vida².

Diversos estudios internacionales indican que la RR es un pilar fundamental en el tratamiento del paciente con EPOC³⁻⁵.

En Chile, el Ministerio de Salud establece la rehabilitación respiratoria como parte del tratamiento de la enfermedad⁶, publicándose el año 2011 el primer consenso de rehabilitación respiratoria en el paciente con EPOC. En ese documento se entregan las directrices en la estructuración y características de un programa de rehabilitación para que pueda ser aplicado en todo el país⁷.

Sin embargo, se desconoce el grado de implementación del consenso en los centros de atención primaria de salud (APS). Es por este motivo que se realizó una investigación con la finalidad de conocer cuál es la realidad de la RR en la región de Valparaíso en el año 2013.

Métodos

El estudio es de tipo no experimental y exploratorio. El método de selección de la muestra es no probabilístico y por conveniencia, ya que los centros escogidos presentaron cercanía con los investigadores.

Se confeccionó una encuesta cerrada para ser aplicada al profesional a cargo de la sala de Enfermedades Respiratorias del Adulto (ERA) de cada centro. Esta encuesta contempló los componentes esenciales de un Programa de Rehabilitación Respiratoria y fue aprobada por la Escuela de Kinesiología de la Universidad Santo Tomás sede Viña del Mar.

Como criterio de inclusión fueron seleccionados aquellos centros de APS pertenecientes a las comunas de Valparaíso, Viña del Mar, Quilpué y Villa Alemana. Se excluyeron aquellos centros que no tuviesen implementada una sala ERA.

La observación de los resultados obtenidos se realizó a través de estadística descriptiva: distribución de frecuencias y porcentaje de estas según el total de la muestra estudiada. Los datos fueron almacenados y analizados mediante el programa IBM SPSS Statistics 21 y Microsoft Excel 2010.

Resultados

La muestra estuvo formada por 32 centros de APS pertenecientes a las comunas seleccionadas.

Los resultados se muestran en tablas según la pregunta indicada, con la frecuencia de las respuestas y el porcentaje respecto al total de la muestra.

En la tabla I se observa que solo 9 centros de APS realizan RR dentro del tratamiento del paciente con EPOC.

En la tabla II se observa que los únicos profesionales presentes en todos los centros que realizan RR son el Médico y el Kinesiólogo. En 8 de los centros se encuentra un Enfermero(a) y 5 centros cuentan con Psicólogo y Paramédico.

En la tabla III se observan las evaluaciones realizadas a los pacientes con EPOC. En todos los centros que realizan RR se evalúa la función pulmonar de los pacientes mediante espirometría. En 7 de estos centros se realiza test de caminata de seis minutos, evaluación de calidad de vida e índice de BODE.

En la tabla IV se observa que 8 de los centros que realizan RR se dedican a entrenar musculatura de extremidad superior e inferior.

En la tabla V se observa que el principal factor limitante de la rehabilitación respiratoria en los centros encuestados corresponde a que no existe un programa implementado de RR (24 centros). Otras causas argu-

Tabla I

Tabla de Frecuencia y Porcentaje sobre la realización de rehabilitación respiratoria como parte del tratamiento de pacientes EPOC

Alternativas	Frecuencia	Porcentaje
SI	9	28%
NO	23	72%
Total	32	100%

Tabla II
Tabla de Frecuencia y Porcentaje sobre que profesionales conforman el equipo multidisciplinario

<i>Alternativas</i>	<i>Centros que No realizan RR</i>		<i>Centros que Si realizan RR</i>	
	<i>Frecuencia</i>	<i>Porcentaje</i>	<i>Frecuencia</i>	<i>Porcentaje</i>
Médico	23	100%	9	100%
Kinesiólogo	23	100%	9	100%
Enfermero	17	74%	8	89%
Nutricionista	10	43%	5	56%
Psicólogo	8	35%	5	56%
Paramédico	7	30%	5	56%

Tabla III
Tabla de Frecuencia y Porcentaje sobre las evaluaciones que se realizan a los pacientes EPOC

<i>Alternativas</i>	<i>Centros que No realizan RR</i>		<i>Centros que Si realizan RR</i>	
	<i>Frecuencia</i>	<i>Porcentaje</i>	<i>Frecuencia</i>	<i>Porcentaje</i>
Prueba de caminata de 6 minutos	2	9%	7	78%
Aplicación escala disnea (BORG/MMRC)	10	43%	8	89%
Evaluación de Espirometría	10	43%	9	100%
Aplicación del cuestionario calidad de vida	6	26%	7	78%
Evaluación Índice de BODE	4	17%	7	78%
Evaluación Fuerza Muscular EESS	1	4%	5	56%
Evaluación Fuerza Muscular EEII	1	4%	5	56%
Evaluación Fuerza Muscular Respiratoria	2	8%	6	67%

Tabla IV
Tabla de Frecuencia y Porcentaje sobre el tipo de musculatura entrenada como parte del programa de rehabilitación

<i>Alternativas</i>	<i>Frecuencia</i>	<i>Porcentaje</i>
Extremidades superiores	8	89%
Extremidades inferiores	8	89%
Musculatura respiratoria	7	78%

Tabla V
Tabla de Frecuencia y Porcentaje sobre los factores limitantes para la realización de rehabilitación respiratoria en los centros encuestados

<i>Alternativas</i>	<i>Frecuencia</i>	<i>Porcentaje</i>
No existe un programa de RR	24	75%
Espacio físico inadecuado	23	72%
Falta de implementos	21	66%
Equipos en mal estado	5	16%
Alta demanda de pacientes	15	47%
Falta de motivación de pacientes	9	28%
Horario limitado del personal	20	63%
Falta de personal	10	31%

mentadas son que no existe un espacio físico adecuado (23 centros) o la carencia de implementos para realizar el programa (21 centros).

Discusión

A partir de los resultados obtenidos en 32 centros de atención primaria de salud, pertenecientes a la región de Valparaíso, se establece que solamente el 28% de los centros encuestados realiza rehabilitación respiratoria en el tratamiento de pacientes EPOC. Estos resultados contrastan con lo estipulado en consensos y normativas internacionales que recomiendan la RR como parte fundamental del tratamiento^{4,5}. Además de mejorar la calidad de vida, la RR disminuye de manera significativa el uso de recursos sanitarios y es costo-efectiva⁸.

La rehabilitación respiratoria debe ser un proceso multidisciplinario. En nuestro estudio solo el 56% de los nueve centros de atención primaria de salud que realizan rehabilitación respiratoria cuentan con un equipo conformado por Médico, Kinesiólogo, Enfermero, Nutricionista, Psicólogo y Paramédico. Esta cifra es un aspecto negativo ya que la EPOC es una enfermedad sistémica en la cual cada integrante del equipo de salud aporta desde su experiencia profesional para lograr la RR del paciente^{6,9,10}.

En aquellos centros en los cuales se realiza rehabilitación respiratoria, se evalúan aspectos relacionados con la función pulmonar, capacidad de ejercicio, disnea e impacto en la calidad de vida, cumpliendo según lo descrito en el Consenso Chileno de Rehabilitación Respiratoria y en la Guía Clínica de EPOC^{6,7}. Sin embargo, la espirometría es la única evaluación que se practica en el 100% de los centros de APS que realizan RR. El 78% de los centros realiza prueba de caminata de 6 minutos, un test que complementa la información obtenida en la espirometría y que permite evaluar la evolución de la enfermedad¹¹. El mismo porcentaje de centros utiliza el índice de BODE que relaciona la inactividad física del paciente EPOC con un mayor riesgo de mortalidad¹². En el 56% y 67% de los centros encuestados se evalúa fuerza de extremidades y músculos respiratorios, respectivamente. Estos resultados son preocupantes ya que la evaluación de la fuerza muscular permite establecer la carga de entrenamiento a la cual será sometido un paciente, siendo esto un aspecto individual con el fin de evitar sobrecarga de trabajo que pudiera afectar la salud del sujeto¹³.

El compromiso muscular sistémico es frecuente de encontrar en el paciente con EPOC¹⁴. Afecta su calidad de vida, limita su capacidad de ejercicio y supervivencia¹⁵. Nuestros resultados demuestran que un 89% de los centros que realizan RR entrenan musculatura de extremidades superiores e inferiores, y un 78% entrena musculatura respiratoria. Este entrenamiento ha demostrado beneficios importantes en los pacientes con EPOC. Produce incrementos en la capacidad aeróbica, reduce la fatiga muscular y mejora la capacidad de ejer-

cicio del paciente^{16,17}. Adicionalmente, cuando el entrenamiento muscular es realizado en atención primaria mejora los niveles de adherencia a la actividad física¹⁸.

Dentro de los principales factores que limitan la realización de RR en los centros de APS encuestados se encuentran la inexistencia de un programa de rehabilitación establecido (75%), espacio físico inadecuado (72%), falta de implementos (66%) y el horario limitado del personal (63%). De estos factores la mayoría hace referencia a la carencia de recursos suficientes para brindar atención al paciente respiratorio. Los pacientes con EPOC poseen limitaciones propias que les dificultan el acceso a un programa de rehabilitación en centros hospitalarios (disnea, movilización, financiamiento)¹⁹. Por este motivo es fundamental que los centros de atención primaria tengan la capacidad de recibir a estos pacientes para incorporarlos a un programa multidisciplinario de rehabilitación respiratoria. Los beneficios obtenidos para el sistema de salud permitirían disminuir la estadía y reingresos hospitalarios de los pacientes⁷, optimizando los recursos financieros asociados a la enfermedad.

Conclusiones

La rehabilitación respiratoria se encuentra escasamente implementada en los centros de atención primaria pertenecientes a las comunas Valparaíso, Viña del Mar, Quilpué y Villa Alemana. Se sugiere ampliar el estudio a otras ciudades del país con el fin de corroborar si esta realidad se mantiene en otras regiones.

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Original/Otros

Are fat acids of human milk impacted by pasteurization and freezing?

Luiz Antônio Borgo¹, Wilma Maria Coelho Araújo², Maria Hosana Conceição³, Inês Sabioni Resck³ y Márcio Antonio Mendonça¹

¹Faculty of Agronomy and Veterinary Medicine, Laboratory of Food Analysis University of Brasilia. ²Department of Nutrition, University of Brasilia. ³Institute of Chemistry, University of Brasilia. Brazil.

Abstract

The Human Milk Bank undergo human milk to pasteurization, followed by storage in a freezer at -18° C for up to six months to thus keep available the stocks of this product in maternal and infant hospitals. The objective of this study was to evaluate the effects of processing on the lipid fraction of human milk. A sample of human milk was obtained from a donor and was subdivided into ten sub-samples that was subjected to the following treatments: LC = raw milk; T0 = milk after pasteurization; T30 = milk after pasteurization and freezing for 30 days; T60 = milk after pasteurization and freeze for 60 days, and so on every 30 days until T240 = milk after pasteurization and freezing for 240 days, with 3 repetitions for each treatment. Lipids were extracted, methylated and fatty acid profiles determined by gas chromatography. The fatty acids were characterized by nuclear magnetic resonance and functional groups were identified by infrared spectroscopy. There were variations in the concentration of fatty acids. For unsaturated fatty acids there was increasing trend in their concentrations. The IR and NMR analyze characterized and identified functional groups presents in fatty acids.

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Key words: Human milk. Lipids. Pasteurization. Fatty acid. Freezing.

¿SON LOS ÁCIDOS GRASOS DE LA LECHE HUMANA AFECTADOS POR LA PASTEURIZACIÓN Y LA CONGELACIÓN?

Resumen

Los Bancos de Leche Humana someten la leche la pasteurización, seguido del almacenamiento en un congelador a -18 grados por até seis meses, para así disponerlo a los Hospitales Materno Infantiles. El objetivo de este estudio fue evaluar los efectos del procesamiento de la fracción lipídica de la leche humana. Para esto, una muestra obtenida de una donante y sometida a diez diferentes tratamientos: LC = leche cruda; TO = leche después de la pasteurización; T30 = leche después de la pasteurización y congelación por 30 días; T60 = leche después de la pasteurización y congelación por 60 días y así sucesivamente a cada 30 días hasta T240 = leche después de la pasteurización y congelación por 240 días, con tres repeticiones a cada tratamiento. Los lípidos fueron extraídos y los ácidos grasos metilados fueron determinados por cromatografía gaseosa. Los ácidos grasos fueron caracterizados por resonancia magnética nuclear y los grupos funcionales identificados por espectroscopia infrarroja. Hubo variaciones en las concentraciones de ácidos grasos. Para los ácidos grasos insaturados hubo un aumento en sus concentraciones. Sin embargo, los grupos funcionales se caracterizaron por espectroscopia infrarroja y resonancia magnética nuclear, RMN.

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Palabras clave: Leche humana. Lípidos. Pasteurización. Ácidos grasos. Congelador.

Introduction

The Brazilian Network of Human Milk Bank is considered the largest and most complex in the world by the World Health Organization. Human Milk Bank (HMB) is a specialized center, obligatorily linked to a maternal and / or children's hospital, responsible for promoting breastfeeding and execution of collection, processing and quality control of colostrum, transition milk and mature human milk, for distribution under prescription from the doctor or dietician (American

Correspondence: Luiz Antônio Borgo.
Faculdade de Agronomia e Medicina Veterinária.
Laboratório de Análise de Alimentos, Universidade de Brasília.
Campus Universitário Darcy Ribeiro.
Asa Norte – CEP 70910-900. Brasília, DF - Brazil.
E-mail: luizborgo@gmail.com.br; borgo@unb.br

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Medical Association, 2001). Regularly, the HMB undergo human milk, after physicochemical and microbiological testing, to pasteurization, followed by storage in a freezer at -18° C for up to six months to thus keep available the stocks of this product in maternal and infant hospitals.

Lipids and specially the essential fatty acids are among the nutrients that develop physiologically important functions such as the nervous system development and maturity of visual acuity, and provide energy and transport fat-soluble vitamins. The lipids are also susceptible to various types of chemical reactions, enzymatic or non-enzymatic. Oxidation is one of the main reactions; can occur in the presence or absence of oxygen and is catalyzed by light, heat, heavy metals, free radicals or irradiation, leading to the formation of toxic compounds (peroxides) (Heiman and Schandler, 2006; Hamosh, 1998; Bretillon *et al.*, 1998).

The thermal process, in a greater or lesser extent, changes in food constituents according to the intensity of the binomial time / temperature and sensitivity of the food to heat. Specifically, the lipids present in milk are, among the macronutrients, those with the largest changes during processing. Some studies show that pasteurization and sterilization promoted slow variations, significant or not, in the lipid content and fatty acid fraction of human milk (Walstra *et al.*, 2001; Fennema, 1993). But, none of these studies simulated the actual conditions of processing of milk followed by freezing and storage under freezing for eight months, thawing and heating before distribution, despite the Brazilian Network of Human Milk Bank recommending a time of 6 months.

Therefore, the objective of this study was to evaluate the effects of pasteurization and of freezing on the lipid fraction of human milk, considering the shelf life established by HMB.

Methods

This project was approved by the Ethics Committee of the Faculty of Medicine, University of Brasília (CEP-FM 072/2005 of 20/12/2005).

Analytic Sample

The sample of human milk (HM) was obtained from a single donor, without any kind of identification, and subdivided into ten sub-samples, followed these treatments: LC = raw milk; T0 = milk after pasteurization; T30 = milk after pasteurization and freezing for 30 days; T60 = milk after pasteurization and freeze for 60 days, and so on every 30 days until T240 = milk after pasteurization and freezing for 240 days, with 3 repetitions for each reference, totaling 30 samples. Pasteurization was taken to 63° C/30minutes by the Human

Milk Bank (HMB), University Hospital, University of Brasília, and the freezing temperature -18°C.

Total Lipid Extraction and Methylation of Fatty Acids

The extraction of total lipids was taken by butyrometric method Gerber - Van Gulik and fat content read on butyrometer rod directly in percent (AOAC, 1998; Christie, 1990).

For methylation were taken aliquots of 20mg of lipid were transferred to a test tube with screw cap, 1.5 mL of 0.5 N potassium hydroxide in methanol was added, followed by stirring vortexing for 1 minute and heated in a water bath at 70° C for 5 minutes and cooling immediately in running water. After cooling, 2 mL of 12% BF₃ in methanol were added and new vortexing for 1 minute was made. Then, the tube was heated in a water bath at 70° C for 5 minutes and immediately cooled in water (Fidler *et al.*, 1998).

Subsequently, 2.5 mL of saturated NaCl and 1 mL of hexane were added to the mixture, followed by centrifugation for 10 minutes at 1200 rpm. The supernatant was collected and transferred to a glass tube with 2 mL volumetric capacity, with screw cap, aluminium septum and saturated nitrogen atmosphere. The samples were stored in a freezer at -18° C until the time of analysis by chromatography, infrared spectroscopy and nuclear magnetic resonance (Fidler *et al.*, 1998).

Chromatographic Analysis

The analysis of methylated fatty acids was taken into the gas chromatograph model Varian Star 3400cx with detector FID and split / splitless injector, with a fused silica capillary column SPTM-2380 (30m x 0.25 mm x 0.2 mM), Supelco brand (Fidler *et al.*, 1998).

The chromatographic conditions were: temperatures of injector and detector equal to 260° C; initial temperature of column equal to 140° C, increase of 5° C/min up to 240° C after 30 min of chromatographic run. Carrier gas: nitrogen; 20cm/minutes flow; volume of sample injected equal 0.4 µL. Flue gases: hydrogen and medical oxygen. The total analysis time was 30 minutes and the results expressed as a percentage with respect to the area of total fatty acids. The fatty acids were identified by comparison with the retention time of the standard Supelco 37 fatty acid component FAME mix (Supelco, USA).

Analysis by Infrared Spectroscopy (IR)

The analysis by infrared spectroscopy equipment was made in the Hartmann & Braun, model Bomem (MB series). The samples were the same as used in gas chromatography after evaporation of solvent and placed as a film on sodium chloride tablet.

The nuclear magnetic resonance of hydrogen (^1H NMR) was performed on Varian Mercury plus spectrometer (300 MHz, 7.05T). The samples were the same as used in gas chromatography, but replacing the solvent (hexane) 99.8% deuterated chloroform (CDCl_3), Sigma-Aldrich.

Statistical Analyses

Statistical analyses were performed using SAS $\text{\textcircled{R}}$ V. 9.1.3 (SAS, Cary Indiana, 2003). The statistical treatment of the data considered the method of analysis and the time at which the sample was taken from the milk bank. There were three replications in a completely randomized design. The analysis of variance for the amount of each fatty acid was made using repeated measures and, when significant effects ($P < 0.05$) on the time factor, linear regression analysis was performed.

Results

Saturated Fatty Acids

The data obtained for the concentration of the saturated fatty acids in the samples indicate that there were variations, higher or lower, for the concentrations of all fat acids esters in the treatments studied (Table I).

The concentration of capric acid was almost constant between LC and T0 treatments; however, it decreased when compared to treatment T90. There was a low coefficient of determination ($r^2 = 0.16$) and correlation coefficient $r = 0.4$ (Fig. 1a); therefore, 40% of the variation in the concentration of this acid are related with the time. There was also a trend towards reduction in acid concentration with time storage of milk (Fig. 1a). The coefficient of determination indicates that 16% of the variation in the concentration of this fatty acid may be explained by the statistical model applied; 84% vary depending on other factors not accounted for by this model.

For lauric acid, there was an increase of concentration after pasteurization and during the other treatments. The quadratic regression shows that the concentration tends to remain constant with time (Fig. 1b). For myristic acid, a trend of increasing concentration with time was observed, this relationship being 47%. For stearic acid there was a slight tendency to decrease in the concentration with respect to time (14%) (Fig. 1b). The same occurred for the arachidic acid, with trend to reductions and 51% ratio with time (Fig. 1a).

The esters of capric and lauric fatty acids presented quadratic regression; myristic and arachidic, linear regression (Fig. 1a and 1b), both significant. The stearic and palmitic acids showed no significant regressions (Fig. 1b and 1c).

Unsaturated fatty acids

Regarding the fraction of unsaturated fatty acids, it appears, as for the saturated fatty acids, there were also changes in the unsaturated fatty acid profiles, but with an upward trend in their concentrations, except for linolenic acid, which decreased (Table I).

Statistical analysis showed that only the ZZ-linoleic acid showed a significant quadratic regression (Fig. 1d). For the ZE-linoleic acid linear regression was significant (Fig. 1e). The palmitoleic, oleic and linolenic acids showed no significant regression (Fig. 1d and 1e).

Infrared Spectroscopy

The stretching vibrational frequencies (2950cm^{-1} and 2850cm^{-1}) and deformation (1360cm^{-1} and 1461cm^{-1}) were observed for aliphatic CH (CH_3 and CH_2) esters of saturated and unsaturated derivatives. Only in oleic, ZE-linoleic, linolenic fat acids, which have double bonds, were identified in the band 3004cm^{-1} ; on ZZ-linolenic the absence of vibration was due to its low concentration to obtain the spectrum. The vibrations relating to acylals groups ($\text{C}=\text{O}$) esters were recorded between 1733cm^{-1} and 1743cm^{-1} and corresponding frequencies to vibrations C-O between 1169cm^{-1} and 1201cm^{-1} . The low intensity of stretch relative to $\text{C}=\text{C}$ (cis or trans) fatty acids of the studied can be related to the long carbon chain (16 to 18 carbons) that disadvantages the vibration of the double bond at 1650cm^{-1} and 600cm^{-1} - 700cm^{-1} , in which the vibrational frequency of the $\text{C}=\text{CH}$ double bond with cis stereochemistry should occur. However, for linoleic ZE the dual trans was shown in the 969cm^{-1} band. For all fatty acids, except lauric and linolenic, the presence of vibration between 720cm^{-1} and 732cm^{-1} , due to rock deformation ($> 4\text{CH}_2$), was constant in the spectra analyzed (Tables IIIa and IVa).

Resonance Spectroscopy

By spectroscopic data, it is observed that the chemical shifts (in ppm δ) are very close and the spectra are very similar, differing in relation to the numbers of hydrogen atoms coming from the integrations, obtained by means of the areas of each peak noted (Tables IIIb and IVb).

The signals related to the terminal methyl groups (CH_3) of saturated and unsaturated carbon chains are between 0.88 ppm and 0.89 ppm, with a single exception to linoleate derivative which has the methyl group at 0.98 ppm. It is common the overlapping of the methylenic hydrogen atoms ($-\text{CH}_2$)_n, which is shown with different shapes of the peaks, depending on the studied fatty acid.

The signs of the methylenic hydrogen atoms positions β ($-\text{CH}_2\text{CH}_2\text{COOCH}_3$) and α ($-\text{CH}_2\text{CH}-$

Table I
Concentration of saturated fatty acids in human milk samples for LC, T0, T90, T120, T150, T180, T210, T240 (mg% $\pm$ SD%) treatments and of unsaturated fatty acids in human milk samples, for LC, T0, T30, T90, T120, T150, T180, T210, T240 (mg% $\pm$ SD%) treatments. 2010

Fatty acids	Treatments							
	LC	T0	T90	T120	T150	T180	T210	T240
Saturated								
Capric acid	0,1740±0,0653	0,1605±0,0275	0,0313±0,0183	0,1818±0,0811	0,1354±0,0247	0,1149±0,0280	0,0873±0,0325	0,0873±0,0107
Lauric acid	0,2413±0,0381	0,3373±0,0247	0,3069±0,0521	0,4990±0,0428	0,4859±0,0543	0,4340±0,0679	0,4788±0,0603	0,4113±0,0271
Myristic acid	0,5007±0,0800	0,7416±0,0475	0,5805±0,0809	0,8496±0,0631	0,8777±0,0805	0,7171±0,1055	0,7928±0,0655	0,7809±0,0358
Palmitic acid	2,6926±0,3440	4,5001±0,2754	2,3471±0,4180	3,5613±0,2304	3,6718±0,3178	2,9540±0,4210	3,2575±0,2121	3,5979±0,2392
Stearic acid	0,7799±0,0948	1,2898±0,0818	0,5679±0,1601	0,3901±0,0255	0,9401±0,0906	0,7741±0,1113	0,8479±0,0567	0,9795±0,0610
Arachidic acid	0,0466±0,0028	0,1008±0,0052	0,0334±0,0063	0,0475±0,0020	0,0517±0,0029	0,0369±0,0039	0,0424±0,0012	0,0469±0,0028
Unsaturated								
Palmitoleic acid	0,2757±0,0338	0,3763±0,0219	0,2758±0,0444	0,3901±0,0255	0,4469±0,0341	0,3244±0,0456	0,4033±0,0271	0,3485±0,0158
Oleic acid	3,5132±0,4176	5,9298±0,3727	2,9796±0,5987	4,3029±0,2592	5,1995±0,3874	3,6860±0,5214	4,4580±0,3058	4,3102±0,3365
Linoleic (ZZ) acid	1,1375±0,1384	4,2389±0,2516	0,8206±0,2022	0,8368±0,0411	1,8560±0,1349	1,2423±0,1756	1,5919±0,1082	1,1793±0,1494
Linoleic (ZE) acid	0,0471±0,0063	0,0810±0,0079	0,0513±0,0206	0,0793±0,0029	0,1089±0,0097	0,0880±0,0106	0,0911±0,0087	0,1132±0,0401
Linolenic acid	0,0593±0,0071	0,0429±0,0019	Nd	0,0252±0,0002	Nd	0,0492±0,0083	0,0619±0,0018	0,0271±0,0021

The values for the T30 and T60 treatments were discarded because they were not consistent; probably the esterification reaction was incomplete. *(P<0,05), SD = standard deviation. Nd = not detected

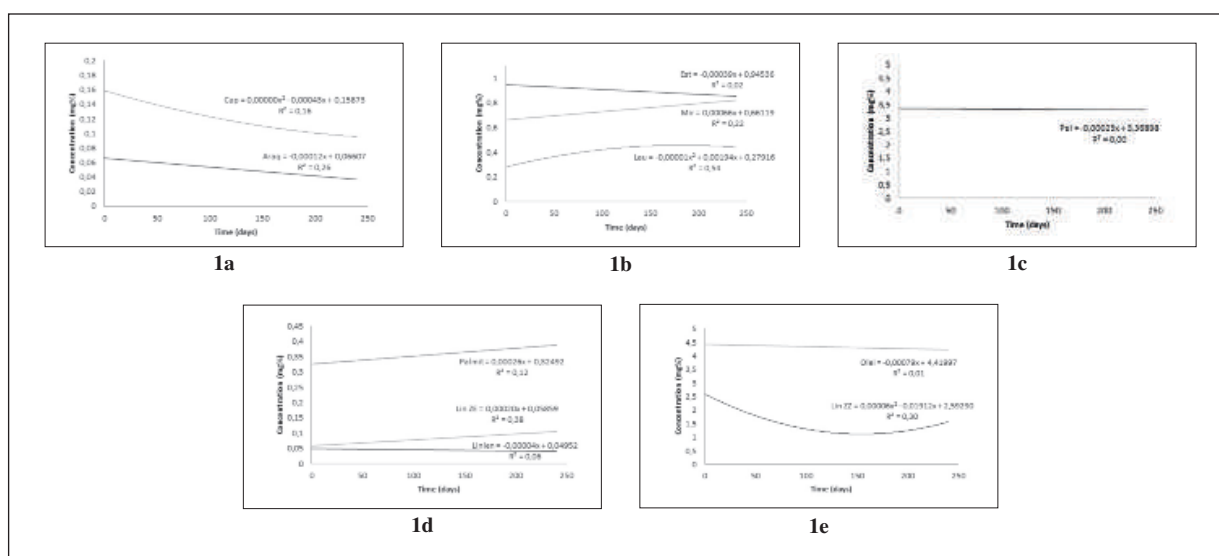


Fig. 1.—Regression of capric acid (Cap) and arachidic (Araq) (1a); of stearic acid (Est), myristic (Mir) and lauric (Lau) (1b); palmitic acid (PAL) (1c); of oleic acid (Olei) and ZZ-linolenic acid (Lin ZZ) (1d); of palmitoleic acid (Palmit), ZE-linoleic acid (Lin-ZE) and linolenic (Linlen) (1e).2010.

Table II
Concentration of unsaturated fatty acids in human milk samples, for LC, T0, T30, T90, T120, T150, T180, T210, T240 (mg% $\pm$ SD%) treatments. 2010

Treatments	Palmitoleic acid	Oleic acid	Linoleic (ZZ) acid	Linoleic (ZE) acid	Linolenic acid
LC	0,2757 $\pm$ 0,0338	3,5132 $\pm$ 0,4176	1,1375 $\pm$ 0,1384	0,0471 $\pm$ 0,0063	0,0593 $\pm$ 0,0071
TO	0,3763 $\pm$ 0,0219	5,9298 $\pm$ 0,3727	4,2389 $\pm$ 0,2516	0,0810 $\pm$ 0,0079	0,0429 $\pm$ 0,0019
T90	0,2758 $\pm$ 0,0444	2,9796 $\pm$ 0,5987	0,8206 $\pm$ 0,2022	0,0513 $\pm$ 0,0206	Nd
T120	0,3901 $\pm$ 0,0255	4,3029 $\pm$ 0,2592	0,8368 $\pm$ 0,0411	0,0793 $\pm$ 0,0029	0,0252 $\pm$ 0,0002
T150	0,4469 $\pm$ 0,0341	5,1995 $\pm$ 0,3874	1,8560 $\pm$ 0,1349	0,1089 $\pm$ 0,0097	Nd
T180	0,3244 $\pm$ 0,0456	3,6860 $\pm$ 0,5214	1,2423 $\pm$ 0,1756	0,0880 $\pm$ 0,0106	0,0492 $\pm$ 0,0083
T210	0,4033 $\pm$ 0,0271	4,4580 $\pm$ 0,3058	1,5919 $\pm$ 0,1082	0,0911 $\pm$ 0,0087	0,0619 $\pm$ 0,0018
T240	0,3485 $\pm$ 0,0158	4,3102 $\pm$ 0,3365	1,1793 $\pm$ 0,1494	0,1132 $\pm$ 0,0401	0,0271 $\pm$ 0,0021

SD = standard deviation (P < 0.05). Nd = not detected

$_2\text{COOCH}_3$) to the acyl group were identified between 1.58 ppm and 1.64 ppm and between 2.30 ppm and 2.31 ppm, respectively.

The signals esters of unsaturated groups identified between 1.97 ppm and 2.17 ppm are related to the methylene hydrogens attached to the double bonds, known as allylic hydrogens. As for the ZE-linoleate and linolenate there are methylenes between 2.66 ppm and 2.81 ppm, called bisallylic position. The methoxy groups (CH_3O) absorb all of the fatty acids at 3.67 ppm and olefinic protons ($-\text{CH}=\text{CH}-$) are only shown for the unsaturated esters between 5.30 ppm and 5.46 ppm.

Discussion

The results obtained in this study are novel because no other study was conducted in conditions approaching those that occur in HMB and because they showed the behavior of fatty acids in the same sample of human milk subjected to pasteurization and freezing for eight months.

In general, the data of infrared spectroscopy (IR) shows organic functions present in methyl esters derived from fatty acids, while spectroscopic data show the signs of the methylenic hydrogen atoms positions ($-\text{CH}_2\text{CH}_2\text{COOCH}_3$) and ($-\text{CH}_2\text{CH}_2\text{COOCH}_3$) to the

Table III
Absorption bands observed in the IR to saturated fatty acids and their assignments (3a) and ¹H NMR chemical shifts of saturated fatty acids (3b) in human milk samples. 2010

III(a)						
Assignments to Functional Groups	Capric N ^o wave cm ⁻¹	Lauric N ^o wave cm ⁻¹	Myristic N ^o wave cm ⁻¹	Palmitic N ^o wave cm ⁻¹	Stearic N ^o wave cm ⁻¹	Arachidic N ^o wave cm ⁻¹
CH ₃ _{est}	2950	2925	2924	2953	2925	2950
CH ₂ _{est}	2855	2854	2854	2850	2849	2887
C=O _{est}	1743	1742	1744	1742	1742	1743
CH ₃ _{def. ass.}	1465	1465	1466	1473	1474	-
CH ₂ _{def.}	1436	1436	1436	1464	1463	1436
CH ₃ _{def. sim.}	1363	-	1362	1383	1384	1384
C-O _{est}	1247	1169	1248	1199	1178	1227
CH ₂ _{def rock}	723	-	722	732	720	720

III(b)						
Nature of the fatty acids characterized hydrogens	Capric δ (ppm)	Lauric δ (ppm)	Myristic δ (ppm)	Palmitic δ (ppm)	Stearic δ (ppm)	Arachidic δ (ppm)
CH ₃	0,88	0,88	0,88	0,88	0,88	0,88
-(CH ₂) _n -	1,20-1,40	1,20-1,40	1,20-1,40	1,20-1,40	1,20-1,40	1,20-1,40
-CH ₂ CH ₂ OCOCH ₂ -	1,62	1,62	1,62	1,62	1,62	1,62
-CH ₂ CH ₂ COOCH ₃	2,31	2,31	2,30	2,30	2,30	2,30
-CH ₂ COOCH ₃	3,67	3,67	3,67	3,66	3,67	3,67

acyl group and the signals of unsaturated esters groups, confirming that the observed changes were, in fact, the fatty acid molecules.

Studies evaluated the effects of pasteurization and sterilization on the content of lipids and fatty acids of human milk and concluded that pasteurization does not alter the lipid content available, not its composition. On the other hand, the sterilization reduces the concentration of about 13% and may cause small reductions in the concentrations of arachidonic and linoleic acids without, however, considering them significant. However, these two processes may also induce loss of unsaturated lipids by oxidation, both in the presence of oxygen or light (Henderson *et al.*, 1998).

Another search concluded that both slow pasteurization (62.5° C/30min) and fast pasteurization (100° C/5min) did not alter the concentration of fatty acids, including the long chain unsaturated. These researchers also noted that storage of fresh milk at 4° C for 96 hours, at -20° C for 12 months and at -80° C for 12 months did not significantly alter the profile of saturated and unsaturated fatty acids (Wardell *et al.*, 1981).

The pasteurization does not affect the long-chain fatty acids due to the high antioxidant activity of human milk (Goldblum *et al.*, 1984). However, heating milk at 62.5° C caused partial hydrolysis of triglycerides and, after 30 minutes (holding time), a significant

reduction in the concentrations of myristic fatty acids (15%), stearic (6%), palmitic (8%), and oleic (8%). The percentage of constituent fatty acids of triglycerides was not changed, except that linolenate reduced its concentration by 22% after heat treatment (Lepri *et al.*, 1997).

Research indicates that the time lapse between collection and pasteurization of milk favored the hydrolysis of lipids by up to 0.5%; pasteurization (62.5° C/30min) increased lipase activity with increased hydrolysis products up 0.9%; storage at -20° C for 90 days of pasteurized milk caused further hydrolysis of lipids and small reduction in the level of triglycerides, with a decrease of 6% fat; the total procedure (pasteurization and freezing / thawing) did not alter the percentage composition of fatty acids substantially (Weber *et al.*, 2001).

Studies show that *in natura* human milk hydrolysis reactions occur mediated by bile salt-dependent lipase and that this reaction is inactivated by pasteurization (Henderson *et al.*, 1998; Romeu-Nadal *et al.*, 2008). However, it should be considered possible hydrolysis of lipids by microbial enzymes, more resistant to thermal process, and the subsequent oxidation of fatty acids by microbial enzymes or by chemical process (catalysed by light). Part of the lipase is inactive by slow pasteurization, but still allows partial hydrolysis

Table IV
Absorption bands observed in the IR for unsaturated and their assignments (4a) and ¹H NMR chemical shifts of saturated fatty acids (4b) in samples of human milk fatty acids. 2010

IV(a)					
Assignments to Functional Groups	Palm-9 N ^o wave cm ⁻¹	Oleic N ^o wave cm ⁻¹	ZZ-Linol N ^o wave cm ⁻¹	ZE-Linol N ^o wave cm ⁻¹	Linolenic N ^o wave cm ⁻¹
CH _{est} sp ²	3004	3004	-	3010	3004
CH _{3 est}	2926	2925	2950	2926	2929
CH _{2 est}	2855	2854	2858	2855	2857
C=O _{est}	1743	1744	1733	1743	1736
CH _{3 def. ass.}	1461	1463	1461	1461	1461
CH _{2 def.}	1436	1436	1438	1436	1439
CH _{3 def. sim.}	1361	1360	1366	1360	1366
C-O _{est}	1197	1197	1201	1197	1198
C=CH sp ² E	*	*	*	969	*
CH _{2 def rock}	725	723	728	725	-

* The vibrational frequency for the cis double bond (C = CH sp²Z) were not noted in the spectra due to the low intensity of the respective bands.

IV(b)					
Nature of the fatty acids characterized hydrogens	Palmitoleic δ (ppm)	Oleic δ (ppm)	Linoleic (ZZ) δ (ppm)	Linoleic (ZE) δ (ppm)	Linolenic δ (ppm)
CH ₃	0,88	0,88	0,89	0,88	0,98
-(CH ₂) _n -	1,20-1,40	1,20-1,40	1,20-1,40	1,20-1,40	1,20-1,40
-CH ₂ CH ₂ COOCH ₃	1,62	1,60	1,61	1,58-1,64	1,62
-CH ₂ CH=CHCH ₂ -	1,98-2,14	1,98-2,04	1,92-2,10*	1,97-2,04	2,01-2,17
-CH ₂ CH ₂ COOCH ₃	2,30	2,30	2,31	2,30	2,31
=CHCH ₂ CH=	-	-	2,66-2,80*	2,66-2,72	2,81
-CH ₂ COOCH ₃	3,67	3,67	3,67	3,67	3,67
-CH=CH-	5,30-5,40	5,30-5,40	5,34-5,46*	5,37-5,42	5,30-5,45

* Data cited according to Silverstein, Webster, Kiemle (2005) due to the low concentration of linoleic acid in the sample.

of lipids and release of fatty acids (Weber *et al.*, 2001).

The obtained data are not unanimous with the literature because show wide variation in the concentration of fatty acids of the samples. In addition to the operating conditions of the processes of preservation, it is still possible to judge that the storage under slow freezing conditions allow the formation of ice crystals that can pierce the fat globules resulting in the separation of molecules lipids after thawing.

To interpret the observed changes in the lipid fraction of the samples, one should also consider aspects concerning the conservation of human milk in HMB. The heat exchangers in use are not equipped with stirrers and, occasionally, the containers are manually agitated to promote homogenization of the product. Such conditions allow the formation of a surface layer of fat (cream) after cooling. The hydrolysis of lipids originating in the release of fatty acids alters the density of these acids, as well as the action of microbial

lipases, which are resistant to pasteurization, unlike endogenous lipases.

Moreover, it is also possible to consider some degree of adhesion of fat globules and free fat acids in the inner walls of the containers containing the products (glasses) acids, even after thawing under heating in a water bath at 40° C, or even adhesion caused by fat globules released during the steps of freeze / thaw by the ice crystals (large, pointy) formed during slow freezing. The lack of homogeneity of the milk before freezing can affect the fat content, as well as the different sampling techniques, since the milk is first collected and frozen at home by the donor (Weber *et al.*, 2001). Such considerations suggest that these factors may have contributed to the large variation of the samples observed month by month.

In light of the obtained results, it is possible to make the following recommendations in order to minimize the effects of pasteurization and of freezing concerning

the lipidic fraction of the human milk: a) reducing the time lapse between collection and pasteurization not to please the hydrolysis of lipids; b) choosing rapid pasteurization in order to inhibit lipolytic activity, rising of concentration of free fatty acids and reducing the exposure time to heat the milk; c) for slow pasteurization, the use of equipment with stirring system to prevent the coalescence of fat and thus their partial loss; d) during and after thawing the milk in a double boiler, stirring it until it is ready to use to prevent the adhesion of molecules of fat in the walls of the container and its nonhomogeneous distribution of the newborn mode; e) considering that the sampling techniques are a factor that implies the variation of lipid content, guiding and overseeing of the donors continuously to ensure homogeneity of the milk before processing (pasteurization and freezing), since the fat content varies according to a number of factors and mainly increases between the beginning and end of milking.

One can consider the loss of two samples (T30 and T60) as a limitation of the search; in the same way as mentioned above, it is necessary to optimize operating conditions in human milk banks, especially for the pasteurization and thawing of milk.

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Original/Otros

Análisis del contenido, posicionamiento y calidad de páginas web en español relacionadas con la nutrición y los trastornos de la conducta alimentaria

R. González-Soltero¹, M. J. Blanco¹, J. M. Biscaia¹, RB Mohedano², M. Grille-Mariscal y M. A. Blanco²

¹Departamento de Ciencias Biomédicas Básicas. Facultad de Ciencias Biomédicas. Universidad Europea de Madrid.

²Departamento de Especialidades Médicas, Psicología y Pedagogías aplicadas. Facultad de Ciencias Biomédicas. Universidad Europea de Madrid. España.

Resumen

Introducción: Los trastornos del comportamiento alimentario (TCA) son las patologías psicológicas que más se han incrementado en los últimos años. Uno de los factores que determina la elevada prevalencia de TCA en nuestra sociedad es el gran desconocimiento sobre alimentación. Este desconocimiento puede deberse a la consulta de recursos online sin validez científica.

Objetivo y ámbito: El objetivo de este trabajo ha sido analizar la calidad científica y el posicionamiento de los sitios web en español con información sobre nutrición, TCA y obesidad.

Material y métodos: Se realizó una búsqueda de páginas web en el navegador Google Chrome con las palabras clave: dieta, anorexia, bulimia, nutrición y obesidad, seleccionándose los 20 primeros resultados de cada búsqueda según los índices de posicionamiento ofrecidos por SEOquake (Page Rank, Alexa Rank y SEMrush Rank). Las variables de análisis fueron: información relacionada con dietas y hábitos alimentarios, información sobre alimentación saludable, información sobre TCA y sus criterios diagnósticos e información de carácter formativo acerca de temas profesionales de salud general.

Resultados: Sólo el 50% de las web encontradas cumplían los criterios de inclusión en el estudio. La mayoría no seguían las pautas establecidas por e-Europa sobre calidad. La mediana de Page Rank fue de 2, excepto en aquellas asociadas a instituciones sanitarias de prestigio.

Conclusiones: Dada la escasez de webs sanitarias con rigor científico, es imprescindible la revisión de las existentes y la creación de nuevos espacios on-line cuya su-

CONTENTS, POSITIONING AND QUALITY ANALYSIS IN SPANISH WEBSITES RELATED TO NUTRITION AND EATING BEHAVIOR DISORDERS

Abstract

Introduction: Eating disorders are serious psychological disorders with an increased incidence in last years. One of the factors that determine the high prevalence of eating disorders in our society is the lack of knowledge about nutrition. One of the reasons of this lack of knowledge could be the presence of online resources without scientific validity.

Objective and Scope: The aim of this study was to analyze the scientific quality and positioning of websites in Spanish that have information on nutrition, eating disorders and obesity.

Materials and Methods: For this purpose, a web search was conducted in the Google Chrome browser using the key words: diet, anorexia, bulimia, obesity and nutrition, and selecting the first 20 results of each search at the rates offered by SeoQuake positioning (Page Rank, Alexa Rank y SEMrush Rank). The variables used for the analysis were: information related to eating habits and diets, information on healthy eating, information about eating disorders and their diagnostics, and formative information about general health topics with professional criteria.

Results: Only the 50% of the webpages accomplished the inclusion criteria for this study. Most of them did not follow the guidelines established by e-Europe assessment for quality. The median of the Webpage's PageRank was 2, except those associated with health institutions.

Conclusions: Given the scarcity of healthcare websites with scientific rigor is essential to review the existing one

Correspondencia: María Ascensión Blanco
Dpto. de Especialidades Médicas, Psicología y Pedagogías Aplicadas. Universidad Europea de Madrid. C/Tajo s/n Urbanización El Bosque. 28670. Villaviciosa de Odón (Madrid).
E-mail: ascension.blanco@uem.es

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pervisión sea realizada por profesionales especialistas en salud y nutrición.

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Palabras clave: *Internet. Nutrición. Obesidad. Trastornos de la alimentación (TCA). Salud electrónica.*

Abreviaturas

TCA: trastorno de conducta alimentaria.

PR: *PageRank*.

Introducción

La información sobre la salud y, en particular, sobre la nutrición y los trastornos relacionados con la conducta alimentaria (TCA), se ha incrementado en las últimas décadas, acorde con el interés que despiertan estos temas entre la población¹. Una mayor accesibilidad a la información y el aumento del número de recursos disponibles a través de internet han sido los factores que han contribuido a este auge informativo, que ha ocurrido de manera progresiva, abriendo infinitas posibilidades de comunicación².

Sin embargo, la red constituye un medio de información tan accesible, cómodo y económico que puede ser consultado libremente y de manera muy rápida por cualquier tipo de usuario, aunque carezca de estándares científicos y éticos. Varios estudios demuestran que, cada vez con más frecuencia, los ciudadanos consultan Internet con la intención de resolver sus dudas e inquietudes en relación a la salud, siendo la alimentación y la nutrición los que ocupan el tercer puesto de los temas más consultados on-line (44%)³⁻⁶.

No obstante, los contenidos encontrados en internet pueden ser muy variables, tanto en calidad, como en formatos de presentación y procedencia de dicha información. La mayoría de ellos carecen de reseñas acerca de los autores, fuentes y objetivos que pretende conseguir el recurso on-line al poner esa información a disposición de la población en general^{2,6}. Esta situación hace aún más necesario un análisis de la información que podemos encontrar en estos repositorios puesto que el manejo de informaciones no veraces o distorsionadas en el ámbito de la nutrición y, de la salud en general, puede traer consecuencias, como puede ser, específicamente en el caso analizado, el desarrollo de un trastorno de conducta alimentaria a nivel individual o su difusión entre grupos susceptibles, constituyendo un riesgo importante para la salud poblacional.

La importancia de internet como fuente de información es bastante elevada entre los ciudadanos jóvenes (16-34 años) y de mediana edad (35-50 años)⁷, siendo todavía los adolescentes la parte de la población más vulnerable al desarrollo de un TCA^{8,9}. Por ello, es evidente que la información debe ser evaluada y cotejada

and to create new online spaces whose supervision must be carried out by specialists in health and nutrition.

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Key words: *Internet. Nutrition. Obesity. Eating disorders. E-health.*

para dar respuestas rigurosas a través de Internet¹⁰. Todos estos sitios web deberían contar con una revisión previa y ser clasificados según criterios de validez científica adecuadamente actualizados³.

La 6ª Comisión Europea puso en marcha en 1998 la iniciativa “e-Europa: Una sociedad de la información para todos⁶”. En dicha iniciativa se contempla el desarrollo de criterios para poder evaluar la calidad y autenticidad de la información sanitaria dirigida a los ciudadanos por vía digital. Para conseguirlo se hace imprescindible la colaboración estrecha y multidisciplinar entre sociedades científicas, colegiales e instituciones gubernamentales, así como la participación de asociaciones de pacientes y consumidores.

Teniendo en cuenta lo anteriormente citado, el objetivo de este trabajo ha sido analizar los contenidos, calidad y el posicionamiento de los sitios web en español que contengan información sobre nutrición, trastornos de la conducta alimentaria (TCA) y obesidad, con objeto de favorecer a cualquier tipo de usuario el acceso a una información rigurosa y veraz sobre la nutrición.

Materiales y métodos

Protocolo de búsqueda y selección de sitios web

Con fecha 14/03/2013 se realiza una búsqueda de páginas web en el navegador Google Chrome mediante palabras claves. Para ello se instaló en la barra de utilidades del navegador la herramienta SEOquake que sirve para analizar la influencia de una página frente a otra, siguiendo diferentes índices de posicionamiento establecidos por Google, que es el buscador más utilizado. Las palabras escogidas para la búsqueda fueron: “dieta”, “anorexia”, “bulimia”, “nutrición” y “obesidad”. Se seleccionaron los 20 primeros resultados de cada búsqueda, siguiendo los índices de posicionamiento ofrecidos por SEOquake que recoge tres indicadores de Google: PageRank, Alexa Rank y SEMrush Rank. El número de resultados analizados se corresponde con el seleccionado para otros estudios⁵. Los datos obtenidos fueron exportados a un fichero “.csv”.

Una vez ordenados los resultados, se procede a la selección de las páginas web que formarán parte del estudio. Para la configuración del listado final se establecieron los siguientes criterios de exclusión: videos de canales online, presentaciones en formato “.pdf”, “powerpoint” o similar de origen desconocido, y noti-

cias de periódicos y revistas generalistas. Los criterios de inclusión en el estudio fueron: portales web de servicios oficiales de salud, blogs relacionados con nutrición y salud, portales de salud sin ninguna relación oficial o médica, documentación de cursos de formación, portales web de clínicas y centros de salud y de la industria farmacéutica o alimentaria (Fig. 1).

Análisis del contenido de las páginas web en español

Para poder interpretar el contenido de las páginas web analizadas en este estudio, hemos evaluado las mismas, siguiendo los siguientes criterios: 1. Información relacionada con las dietas y hábitos alimentarios; 2. Información relacionada con la nutrición y alimentación saludables; 3. Análisis de la información contenida en la página en función de su relación con los trastornos alimentarios y con sus criterios diagnósticos; 4. Arbitrario: categoría general donde aparece información relativa a temas alimentarios pero de manera no rigurosa desde un punto de vista científico. 5. Información de carácter formativo sobre temas profesionales en salud general. Las páginas web cuyos contenidos se clasificaron como “arbitrarios” son aquellas cuyas informaciones sobre salud/nutrición/alimentación, aunque presentes, no están firmadas, ni avaladas por personal médico o científico, eludiendo por tanto la responsabilidad sobre dichos contenidos. Entendemos, por tanto, que el contenido es infundado, parcial, y subjetivo, es decir, arbitrario. Estas páginas web son a menudo páginas comerciales de contenido diverso, donde tampoco se expone claramente la descripción del equipo de profesionales que hay detrás de los contenidos.

Al tratarse de datos subjetivos, la evaluación fue llevada a cabo de manera independiente por dos investigadores que adscribieron el contenido de cada página a una de las categorías anteriormente descritas, con el objetivo de encontrar coherencia de criterios (Fig. 2).

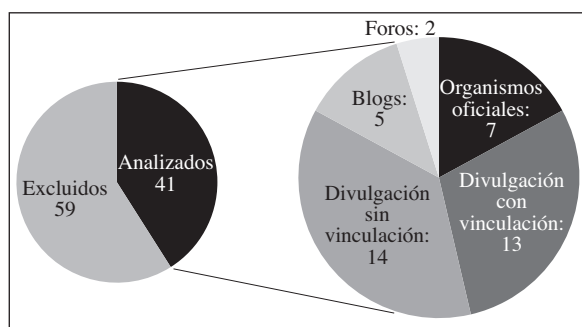


Fig. 1.—Recursos online descartados y analizados. Se indica el número de recursos online que se seleccionaron (41) y descartaron (59) siguiendo los criterios de inclusión reflejados en el texto. Además, se muestra el número y la tipología de los 41 recursos online que fueron analizados al introducir en Google los diferentes términos de búsqueda. Las páginas analizadas con sus puntuaciones pueden consultarse en el material suplementario (Tabla 1S).

Protocolo de análisis del posicionamiento y evaluación de la calidad de las páginas web

Para el análisis del posicionamiento se calculó la mediana de los valores de PageRank (PR) de todas las páginas que, siguiendo los criterios de inclusión, fueron analizadas y se calculó la mediana del PR de las mismas (Anexo; tabla 1S).

Para la evaluación de la calidad de estos sitios web se utilizó un cuestionario modificado del de Bermúdez-Tamayo (2006), que sigue los criterios europeos para la evaluación de webs sanitarias¹⁰. Se evaluaron 5 variables: transparencia y ausencia de conflicto de intereses, autoría, protección de datos personales, responsabilidad y accesibilidad (Fig. 3A).

Cada una de estas variables contiene una serie de ítems (un total de 21 nombrados de la A a la T y que se describen en la tabla 1a). Los ítems comprendidos entre A y O se valoraron con 3 niveles de *aplicabilidad* (donde 1 equivale a “no aplica”, 2 a “aplicación parcialmente dudosa” y 3 a “sí aplica”). Para cada uno de ellos se calculó la mediana de las valoraciones obtenidas. Para los ítems comprendidos entre P y T se valoró la *accesibilidad* con 5 niveles de valoración en orden creciente del 1 al 5 donde 1 equivale a “nada accesible o de muy difícil accesibilidad”, 2 a “poco accesible”, 3 “medianamente accesible”, 4 “bastante accesible” y 5 “totalmente accesible”. La escala de valoración de estos ítems es mayor debido a la valoración subjetiva de dichos ítems o gusto personal (facilidad de lectura, color y letra, lenguaje adecuado, etc) (Fig. 3A).

Análisis estadístico descriptivo:

Para el análisis estadístico de los datos se ha utilizado el programa (*GraphPad Prism*. GraphPad Software, Inc., USA). Hemos realizado gráficos de columnas que muestran porcentajes apilados para observar la distribución de páginas web según los valores alcan-

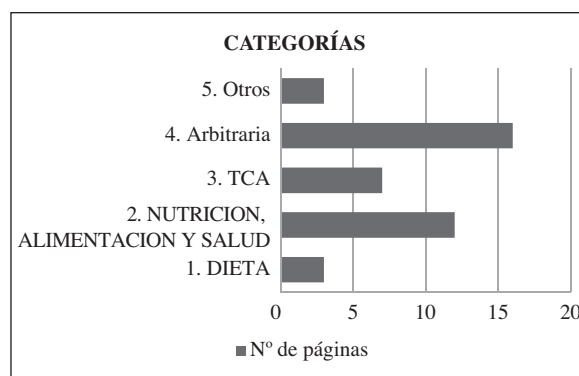
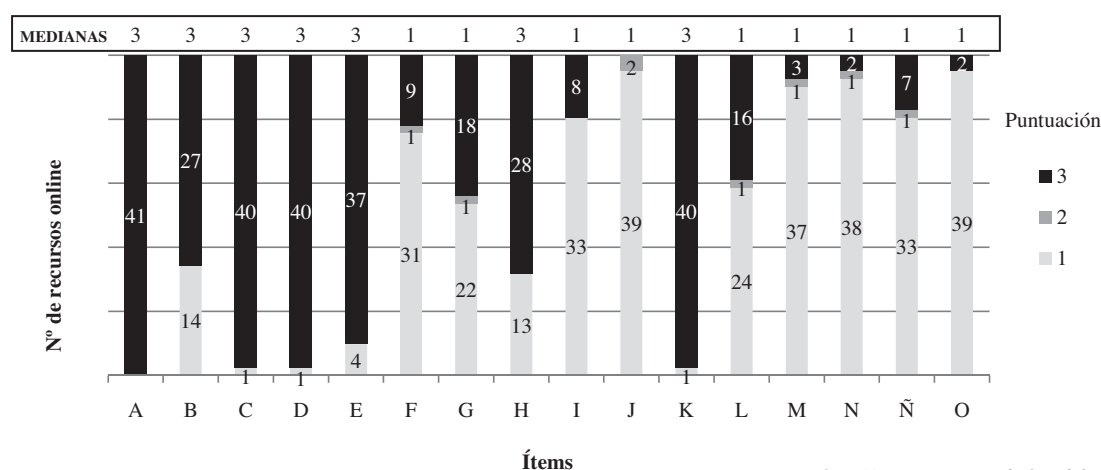


Fig. 2.—Categorías establecidas al analizar el contenido de los 41 recursos online seleccionados. Dicha categorización fue realizada, de manera independiente, por dos investigadores y posteriormente consensuada.

A

ANÁLISIS DE CALIDAD	TRANSPARENCIA Y AUSENCIA CONFLICTO INTERESES (1-3)	ITEM	DESCRIPCIÓN DE LOS ÍTEMS
		A	Nombre de la persona/organización
		B	Dirección electrónica/ física del responsable
		C	Especificación del propósito/objetivo
		D	Especificación de la población a la que se dirige
	AUTORÍA (1-3)	E	Especificación de la financiación para su desarrollo/mantenimiento
		F	Declaración de las fuentes de información de los documentos
	PROTECCIÓN DATOS PERSONALES (1-3)	G	Fecha de publicación de los documentos
		H	Indicación de la forma de protección de la información o aviso legal
		I	Se especifica la fecha de actualización de la información
	RESPONSABILIDAD (1-3)	J	Descripción del procedimiento de actualización de la información
		K	¿Hay posibilidad de contacto (email/otros)?
		L	Si hay consultas online, ¿se identifican al responder?
		M	Declaración del procedimiento usado en la selección del contenido
	ACCESIBILIDAD (Ñ-O:1-3); (P-T:1-5)	N	Indican de dónde procede/cómo se obtuvo el enlace de calidad
		Ñ	Facilidad de encontrar contenidos
		O	Facilidad de efectuar búsquedas
		P	Facilidad de lectura
		Q	Letra/color
		R	Lenguaje adaptado a destinatario
		S	Presencia de sellos de calidad
		T	Accesibilidad discapacitados

B



C

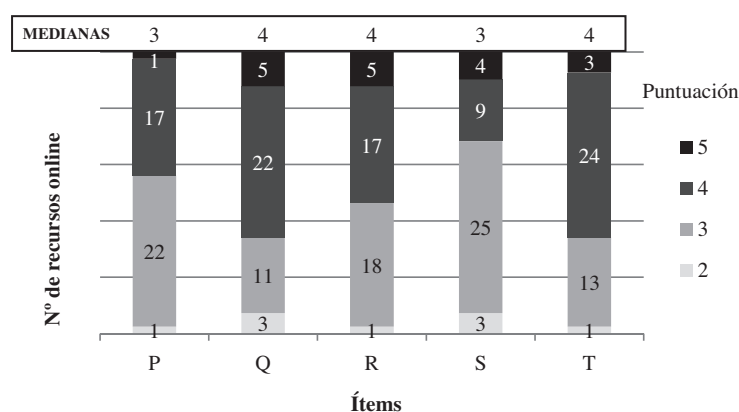


Fig. 3.—A) Descripción de los diferentes ítems analizados. Agrupados en diferentes familias, se definen todos los ítems analizados en el estudio y la escala de valor utilizada (de 1-10 para el posicionamiento PR, de 1-3 para los ítems A-O y de 1-5 para los ítems P-T). B) Aplicabilidad de los 16 ítems analizados con puntuación de 1 a 3. Se muestra para cada uno de los 16 ítems (A-O) el número de recursos online (n= 41) con esta puntuación: 1 “no aplica”, 2 “aplicación parcialmente dudosa” y 3 “sí aplica”. Además, se indica la mediana de puntuación en cada uno de los ítems analizados. C) Aplicabilidad de los 5 ítems analizados con puntuación de 1 a 5. Se muestra para cada uno de los 5 ítems (P-T) el número de recursos online (n= 41) con esta puntuación: de 1 a 5, en orden creciente de accesibilidad (nota: no hubo recursos con la mínima puntuación de 1). Además, se indica la mediana de puntuación en cada uno de los ítems analizados.

zados en el análisis de calidad. De forma paralela, se ha calculado la mediana, medida de tendencia central que estiman cuál es el valor más típico o representativo de la muestra del total de páginas web analizadas para cada uno de los ítems¹¹.

Resultados

Resultados de la búsqueda

De los 100 recursos on-line examinados se descartaron del análisis 59 por no cumplir los criterios de inclusión y se seleccionaron los 41 que sí los cumplían (Fig.1). De los 41 espacios analizados, 9 de ellos se encontraron con el término de búsqueda “dieta”, 6 con “anorexia”, 15 con “nutrición”, 7 con “bulimia” y 4 con “obesidad”. La mayor parte de los recursos excluidos se correspondían con noticias de prensa, mientras que los incluidos fueron: webs de divulgación con y sin vinculación a organismos oficiales, organismos oficiales y minoritariamente blogs y foros (Anexo; tabla Is).

Análisis del contenido de las páginas web

En la Figura 2, se muestra el número de páginas distribuidas por “Categorías”. 3 páginas fueron clasificadas dentro de la temática “dieta”, 12 como “nutrición, alimentación y salud”, 7 referidas específicamente a “TCA”, 16 páginas mostraron un contenido “Arbitrario” (sin criterios científicos, aunque dentro de las categorías analizadas) y 3 se clasificaron dentro del apartado “otros” (páginas que no tienen relación directa con la nutrición o sus trastornos asociados).

Análisis del posicionamiento y calidad de las páginas web

Los resultados de posicionamiento de Page Rank (PR) de Google de las páginas analizadas mostraron una mediana = 2. Hay que señalar que uno de los recursos no estaba posicionado (sin valor de PR), 9 recursos tuvieron un PR de 0 y otro presentó un posicionamiento de 6 (ver tabla Is en ANEXO).

En el análisis de calidad los resultados encontrados para cada una de las variables se recogen en las Figuras 3B y 3C. En la categoría “Transparencia y ausencia de conflicto de intereses” (ítems A-E) la mediana obtenida fue de 3 para todos los ítems. La “Autoría” (ítems F y G) obtuvo una mediana de 1 (sobre 3). En la “Protección de datos personales” el ítem H (aviso legal) presentó un valor de 3, mientras que el resto (I-J) tuvieron una mediana de 1. En el apartado de “Responsabilidad” (K-N), el ítem K (posibilidad de contacto por e-mail u otros) presentó una mediana de 3 y el resto una mediana de 1. Por último, en la variable “Accesibilidad”, los ítems Ñ-O (valorados en la escala

1-3) obtuvieron una mediana de 1, mientras que los ítems (P-T) (valorados en la escala 1-5) presentaban medianas de 3 y 4 (ver Métodos).

Discusión

En este trabajo se ha analizado el contenido, posicionamiento y calidad de un total de 41 páginas en español relacionadas con información sobre salud y TCA. El número de páginas analizadas es similar al utilizado en otros trabajos^{12,13}.

Análisis de Contenidos

En referencia a la clasificación de contenidos que se muestran en la figura 2, la mayoría de las páginas web analizadas (16 de 21) mostraron un contenido “arbitrario”. Estos datos indican que cuando un usuario busca información relativa a nutrición, dietas y hábitos de alimentación saludables, lo que encuentra con más frecuencia son recursos nada rigurosos sobre estos temas de interés público sanitario. Esto puede resultar peligroso de cara al uso que se haga de esta información y con qué objetivo se hace. En España, según el Instituto Nacional de Estadística (2013), el 91,9% de los menores de 10-15 años son usuarios de Internet¹⁴. Los adolescentes constituyen un grupo de riesgo en el desarrollo de un TCA⁸. Investigaciones recientes llevadas a cabo por la Universidad Estatal de Colorado (*Colorado State University*)¹⁵ en edades comprendidas entre los 14-15 años indican que estos adolescentes utilizan internet para buscar información sobre nutrición e intercambiarla entre ellos. Esto hace que un gran número de adolescentes se comuniquen muy rápidamente y a bajo coste comparado con métodos más tradicionales (consultas al médico, libros o la información proporcionada en el aula). Así, los adolescentes evitan la ansiedad asociada con las preguntas relacionadas con los profesionales y con preguntas incómodas por parte de compañeros. Un ejemplo de cómo la información relacionada con los TCA está presente en internet es el fenómeno “Ana y Mía”, que cuenta con más de 2 millones de entradas en Google y que además está presente en redes sociales como “Facebook” y “Twitter”, las más utilizadas por los adolescentes para comunicarse^{15,16}. Por supuesto, otro tipo de población no estaría exento de este riesgo, si bien, sería menos vulnerable porque suele buscar información por otros medios (i.e. consultas de atención primaria, médicos privados, etc).

Análisis del Posicionamiento y de la calidad

Resulta interesante conocer la importancia que tienen las páginas internet reflejadas en los resultados de búsqueda que se realizan cotidianamente. Actualmente, el valor de posicionamiento más aceptado es el Page-

Rank (PR), valor numérico que refleja los “links” que tiene esa página con otras páginas bien posicionadas. Según nuestros resultados, la mediana de los valores de PR de los 40 recursos online analizados es de 2, si bien existe una gran variabilidad en el posicionamiento de las páginas incluidas en nuestro estudio (ver ANEXO; tabla Is). Según algunas informaciones¹⁷, un PR2 indica que la página es interesante y tiene potencial para subir; un PR3 indica que es un buen recurso en su nicho y, de hecho, muchas páginas informativas y de negocios de calidad están en este nivel y un PR6 indica que la página tiene una autoridad indiscutible en su campo. Teniendo en cuenta estos indicadores de posición, las páginas mejor posicionadas (con valores de PR=5 y 6, N=5) durante el periodo de nuestro estudio fueron páginas web de organismos oficiales como por ejemplo los Institutos de Salud de EEUU (NIH), la Sociedad Española para el Estudio de la Obesidad (SEEDO) y la Sociedad Española de Dietética y Ciencias de la Alimentación (SE-CA). De estas 5 páginas, 2 se categorizaron dentro de la categoría de “nutrición, alimentación y salud”, 1 con “otros” y 2 con “TCA”. Es de destacar que sólo 2 de las 7 páginas cuyo contenido está relacionado con trastornos del comportamiento alimentario, pertenecieron a organismos oficiales. Las páginas no oficiales relacionadas con TCA tuvieron valores de PR=3, PR=0 y una no posicionada. Estos datos indican que los organismos oficiales presentan páginas abordando el tema de los trastornos alimentarios con un muy buen índice de posicionamiento, pero que hay pocos recursos a disposición del usuario (sólo 2 páginas). Por ello, parece conveniente proponer a los organismos oficiales realizar un esfuerzo para mejorar el índice de posicionamiento de sus páginas web relacionadas con los TCA.

En el rango de posicionamiento, las páginas con PR=4 (N=7), abordan contenidos que se han calificado como: arbitrario (ver métodos) relacionado con consejos dietéticos y sólo una de las páginas está relacionada con nutrición, salud y alimentación.

Finalmente, el resto de páginas (N=27) muestra un posicionamiento entre 0-3 y se distribuyen en cuanto a contenidos de la siguiente manera: “arbitrario” (N=14), “nutrición, alimentación y salud” (N=10) y “otros” (N=1).

Los datos indican que el usuario tiene pocas páginas con buen posicionamiento que contengan información contrastada científicamente sobre temas concretos, siendo los contenidos arbitrarios los más abundantes al realizar una búsqueda con las palabras clave “dieta”, “anorexia”, “bulimia”, “nutrición” y “obesidad”.

El análisis de calidad de las páginas web incluidas en el estudio se realizó midiendo la aplicabilidad de varios ítems (21) incluidos en 5 variables (modificación de Bermúdez et al., 2006⁹), según se muestra en la Figura 3. Por categorías, la de “Transparencia y Ausencia de Conflicto de Intereses” (ítems A-E) es la que presenta mejor valoración global, lo que significa que todos los recursos analizados presentan información básica relativa a la construcción de la página web,

como el nombre de la persona/organización, dirección electrónica/física del responsable/s, especificación del propósito/objetivo, población a la que se dirige y financiación para su desarrollo/mantenimiento.

En relación a la categoría de “Autoría”, la mayoría de las webs no muestran ni las fuentes de información, ni la fecha de publicación de los documentos (ítems F y G), datos muy relevantes de cara a realizar una nueva búsqueda de la misma información en diferentes momentos, propiciando que el usuario probablemente no vuelva a encontrarla. Por lo tanto, en nuestro estudio, en la mayoría de las páginas analizadas estos ítems no son un elemento de calidad, resultado que difiere del publicado por *Conesa y cols.* para esta misma categoría⁵ en el análisis general de web sanitarias en español, si bien dicho estudio no se centra en páginas relacionadas con el ámbito de la nutrición. Los resultados de *Conesa y cols.* También difieren de los aquí presentados respecto a la “Protección de datos personales” (ítems I-J), ya que gran parte de las webs estudiadas no ofrecían una fecha de actualización de la información, ni tampoco una descripción sobre el procedimiento de actualización de la información (mediana=1), datos importantes para obtener información actualizada y veraz. Sin embargo, la protección de la información o aviso legal y dirección de contacto, medidos relativamente por los ítems H y K, mostraron una mediana de 3. Ambos ítems son buenos indicadores de la calidad de la página, por lo tanto, las páginas analizadas se consideran adecuadas en este aspecto. No obstante, fallan abiertamente en otros indicadores como son, la declaración de dónde y cómo se ha conseguido el contenido o los enlaces de calidad que se muestran y si se responden a consultas *on line* con identificación (ítems L, M y N; mediana=1). Por lo tanto, aunque exista una dirección de contacto, el usuario no puede saber si la información que se le da es de calidad, profesional y rigurosa.

Por último, en “Accesibilidad”, los ítems Ñ y O tuvieron una mediana de 1. Esto indica que encontrar contenidos y efectuar búsquedas no es fácil en estas páginas. Esto implica 1ue la información que contienen estas páginas, en muchos casos, puede diferir del interés inicial del usuario al realizar la búsqueda, mostrándole contenidos ambiguos, confusos o difíciles de entender. Para los ítems P-T (escala de valoración de 1 a 5), los valores de las medianas, oscilan entre 3 y 4, lo que indica que la accesibilidad en cuanto a “facilidad de lectura, comprensibilidad, tipologías y sellos de calidad” es bastante adecuada. También es muy adecuada la accesibilidad para discapacitados (ítem T, mediana = 4).

Conclusiones

En este trabajo se ha analizado el contenido, el posicionamiento y la calidad de páginas web en español relacionadas con salud, nutrición y hábitos saludables, así como de algunas patologías asociadas a estas áreas.

En relación a los contenidos, hemos encontrado que casi la mitad de las páginas que cumplen los criterios

de inclusión fijados para este estudio presentan información arbitraria.

Respecto al posicionamiento de las mismas, podemos decir que las páginas proporcionadas por el buscador Google tienen una mediana de PR de 2. Esto indica que estas páginas web no están, en general bien posicionadas, salvo excepción de aquellas instituciones sanitarias de reconocido prestigio.

Las páginas institucionales que tratan los trastornos de la conducta alimentaria están bien posicionadas pero sólo aparecen 2 páginas en la búsqueda realizada con las palabras clave “dieta”, “anorexia”, “bulimia”, “nutrición” y “obesidad”.

El análisis de la calidad ha reportado que los criterios establecidos por e-Europa siguen sin cumplirse y, aunque la accesibilidad de estas páginas es buena, ni la calidad de los contenidos, ni la autoría de los mismos pueden ni deben ser una fuente de referencia para aquellos que busquen información en internet en relación a estas materias.

Considerando que los adolescentes se informan casi exclusivamente a través de la televisión e internet, como se desprende de una encuesta realizada por Unicef a 1100 adolescentes de entre 13 y 17 años, es importante prestar especial atención al papel que juega internet en la difusión de contenidos entre esta población.

Por todo ello, urge un incremento de páginas webs sanitarias con buen posicionamiento y altos estándares de calidad en esta área.

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Anexos

Tabla Is. Listado de páginas web analizadas en el estudio. Se muestran los valores de PR para cada página, así como de otros índices de posicionamiento no considerados en este estudio. La mediana del PR de todos los recursos analizados fue de 2. En la tabla se observa también la categoría asignada a cada recurso acorde a la clasificación mostrados en la figura 2.

Tabla Is

Listado de páginas web analizadas en el estudio

<i>Dirección</i>	<i>PR</i>	<i>a</i>	<i>SEM</i>	<i>Categorización por contenido</i>
http://www.dietadukan.es/	4	240900	661705	1.- DIETA
http://es.wikipedia.org/wiki/Dieta_(alimentaci%C3%B3n)	4	6	1	1.- DIETA
http://www.ocu.org/alimentacion/adelgazar/noticias/10-preguntas-dieta	3	30318	500569	1.- DIETA
http://www.enfemenino.com/adelgazar/dietas-som481.html	3	2302	11194	4.- ARBITRARIO
http://perder-peso.euroresidentes.com/2012/11/dieta-hormonal.html	4	3224	2895	4.- ARBITRARIO
http://perder-peso.euroresidentes.com/2013/01/dieta-alcaina.html	4	3224	2895	4.- ARBITRARIO
http://www.teinteresa.es/Microsites/Pregunta_al_medico/Alimentacion/dieta-adecuada_0_797921996.html	2	22286	1201416	2.- Nutrición/Alimentación y salud
http://www.vitonica.com/dietas/dieta-5-2-analisis-de-dietas-milagro-xxiv	0	18410	116635	4.- ARBITRARIO
http://es.wikihow.com/ayudar-a-una-persona-con-anorexia	3	424	92	3.- TCA
http://www.familiasalud.es/salud-joven/mi-mente/anorexia-nerviosa-todos-alertas	0	850325	3012795	3.- TCA
http://www.salud180.com/jovenes/causas-psicologicas-de-la-anorexia	1	34153	197325	4.- ARBITRARIO
http://salud.doctissimo.es/enfermedades/anorexia/anorexia-terapia-familiar.html	2	59432	248864	2.- Nutrición/Alimentación y salud
http://www.enfemenino.com/consejos/como-superar-la-anorexia-d20305c270668.html	0	2302	11194	4.- ARBITRARIO
http://www.nlm.nih.gov/medlineplus/spanish/ency/article/000341.htm	5	370	19	2.- Nutrición/Alimentación y salud
http://salud.doctissimo.es/enfermedades/bulimia/bulimia-reconocer-la-enfermedad.html	2	59432	248864	2.- Nutrición/Alimentación y salud
http://suite101.net/article/bulimia-causas-consecuencias-sintomas-tratamiento-y-efectos-a81208	2	20008	588402	4.- ARBITRARIO
http://sintomas.com.es/bulimia	1	301918	708518	4.- ARBITRARIO
http://www.setcabarcelona.com/blog/tag/bulimia-hombres/	n/a	n/a	n/a	3.- TCA
http://www.fundacionpunset.org/apo1/21933/bulimia/	1	340584	3246605	2.- Nutrición/Alimentación y salud
http://www.nutricion.org/	5	691268	1248055	2.- Nutrición/Alimentación y salud
http://www.nutricion.pro/	4	102393	1353047	4.- ARBITRARIO
http://www.seen.es/nutricion/presentacion.aspx	0	1485549	2368707	2.- Nutrición/Alimentación y salud
http://www.uspceu.com/admision/que-estudiar/facultad-farmacia/grado-nutricion-humana-dietetica/presentacion.htm	0	441137	3495815	5.- OTROS
http://www.saludterapia.com/articulos/terapias-y-tecnicas/168-terapias-medicadas/1220-definicion-nutricion.html	2	355750	1657015	2.- Nutrición/Alimentación y salud
http://www.fimut.org/paginas/actividades/congreso-mundial-de-nutricion-2013-granada	2	20136140	n/a	2.- Nutrición/Alimentación y salud
http://www.clubmetropolitano.net/nutricion-y-dietetica	3	349335	4663378	4.- ARBITRARIO
http://nutricionalas6.blogspot.com/	1	18537584	n/a	2.- Nutrición/Alimentación y salud
http://blogs.periodistadigital.com/gastronomianavarra.php/2012/11/19/alimentacion-y-nutricion-definicion-	0	10121	545936	4.- ARBITRARIO
http://www.dir.cat/es/nutricion	0	268489	5851272	4.- ARBITRARIO
http://www.ugr.es/pages/departamentos/nutricion_bromatologia	5	16829	106122	5.- OTROS
http://www.curso.coinsa.com/cursos/magister-nutricion-dietetica-promo-salud/1.html	4	12512280	8584294	5.- OTROS
http://www.umhspiens.com/salud/la-educacion-en-nutricion-planta-cara-a-las-dietas-milagro/	0	24454287	11971070	2.- Nutrición/Alimentación y salud
http://www.nutricionespecial.com/	2	n/a	n/a	4.- ARBITRARIO
http://www.antena3.com/elestiron/coles-activos/colegio-tus-hijos-previene-obesidad-infantil_2012082300118.html	4	3459	32236	2.- Nutrición/Alimentación y salud
http://www.seedo.es/	5	1318348	2083999	3.- TCA
http://www.nlm.nih.gov/medlineplus/spanish/ency/article/003101.htm	6	370	19	3.- TCA
http://5cursosnm-obesidad.pacifico-meetings.com/	3	1727403	7134152	3.- TCA
http://sintomas.com.es/anorexia	1	301918	708518	4.- ARBITRARIO
http://www.educaplay.com/es/recursoseducativos/602716/anorexia_y_bulimia_.htm	0	228025	592843	4.- ARBITRARIO
http://www.netdoctor.es/area-de-salud/endocrinologia-nutricion	3	269261	996320	3.- TCA
http://es.wikihow.com/hacerle-frente-a-la-bulimia	1	424	92	4.- ARBITRARIO

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Original/Otros

Predictors of adherence to the Mediterranean diet from the first to the second trimester of pregnancy

Sandra Abreu¹, Paula Clara Santos^{1,2}, Pedro Moreira^{1,3}, Rute Santos^{1,4}, Carla Moreira¹, Nuno Montenegro⁵ and Jorge Mota¹

¹Research Centre in Physical Activity, Health and Leisure, Faculty of Sport, University of Porto, Portugal. ²Department of Physical Therapy, School of Health Technology of Porto, Polytechnic Institute of Porto, Vila Nova de Gaia, Portugal. ³Faculty of Nutrition and Food Science, University of Porto, Porto, Portugal. ⁴Maia Institute of Higher Education, Portugal. ⁵Department of Obstetrics & Gynecology, São João Hospital Center, Medicine Faculty-University of Porto, Portugal.

Abstract

Background: Although changes in eating patterns may occur during gestation, predictors of these changes have not been explored. This study aimed to identify predictors of adherence to the Mediterranean diet (MD) from the first to second trimester of pregnancy.

Methods: A prospective study was conducted with 102 pregnant women aged 18-40, from the city of Porto, Portugal. Socio-demographic and lifestyle characteristics were assessed through a questionnaire. Food consumption was assessed with a three-day food diary completed during the first and second trimesters. Participants were categorized according to their change in adherence to the MD into the *negative change* group (i.e., women who had low adherence in each trimester or had high adherence in the first trimester and then low adherence in the second) and the *positive change* group (i.e., women who had high adherence in both trimesters or had low adherence in the first trimester and then high adherence in the second). Conditional stepwise logistic regression models were performed to assess the potential predictors of negative MD change.

Results: Among the 102 women, 39.2% had negative change from the first to the second trimester. The logistic model's results show that being married (OR=0.26, 95% CI: 0.10, 0.76) and having a higher intake of vegetables in the first trimester (OR=0.17, 95% CI: 0.10, 0.43) were associated with lower odds of having a negative change in adherence to the MD from the first to second trimester.

Conclusion: Marital status and vegetable consumption seem to be associated with a lower occurrence of negative change in adherence to the MD from early to middle pregnancy.

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Key words: Pregnant women. Diet change. Mediterranean diet. Prospective study.

Correspondence: Sandra Abreu.
Research Centre in Physical Activity, Health and Leisure,
Faculty of Sport, University of Porto.
Rua Dr. Plácido Costa, 91 - 4200.450 Porto, Portugal.
E-mail: sandramrabreu@fade.up.pt

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LOS PREDICTORES DE LA LA DIETA MEDITERRÁNEA DESDE EL PRIMERO HASTA EL SEGUNDO TRIMESTRE DEL EMBARAZO

Resumen

Introducción: Aunque los cambios en los patrones pueden ocurrir durante la gestación, predictores de estos cambios no han sido explorados. Este estudio pretende identificar predictores de la adhesión a la dieta mediterránea (DM) desde el primer al segundo trimestre del embarazo.

Metodología: Se realizó un estudio prospectivo con 102 embarazadas de edad 18-40, de la ciudad de Oporto, Portugal. Se evaluaron las características socio-demográficas y de estilo de vida a través de un cuestionario. Consumo de alimentos se evaluó con un diario de alimentos de tres días concluido durante los primeras y segundo trimestres. Los participantes fueron categorizados según su cambio en la adhesión a la DM en el cambio negativo (es decir, las mujeres que tenían poca adhesión en cada trimestre o tenido alta adhesión en el primer trimestre y luego baja adhesión en el segundo) y el grupo de cambio positivo (es decir, las mujeres que tenían alta adhesión en ambos trimestres o tenía baja adhesión en el primer trimestre y luego elevada adhesión en el segundo). Modelos de regresión logística stepwise condicional se realizaron para evaluar los posibles predictores de la variación negativa de DM.

Resultados: Entre las 102 mujeres, 39,2% tenían cambio negativo del primer al segundo trimestre. Los resultados model's logística muestran que estar casada (OR = 0,26, IC95%: 0,10, 0,76) y tener una mayor ingesta de verduras en el primer trimestre (OR = 0,17, IC95%: 0,10, 0,43) se asociaron con menor probabilidad de tener un cambio negativo en la adhesión a la DM del primer al segundo trimestre.

Conclusiones: Estado civil y el consumo de vegetal parecen estar asociado con una menor ocurrencia de cambio negativo en la adhesión a la MD desde temprano a medio embarazo.

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Palabras clave: Embarazadas. Cambio de dieta. Dieta mediterránea. Estudio prospectivo.

Abbreviations

BMI: body mass index.
CI: confidence interval.
MUFA: monounsaturated fatty acids.
PPAQ: pregnancy physical activity questionnaire.
OR: odds ratio.
SFA: saturated fatty acids.

Introduction

Maternal dietary intake during pregnancy plays a critical role in the outcomes of pregnancy, fetal growth and development, birth outcomes, and childhood health. The potential benefits of the Mediterranean diet during pregnancy have been described as a lower risk of excessive weight gain^{1,2}, reduced risk of pre-term birth³, higher levels of serum and red blood cell folate and serum vitamin B12, lower plasma homocysteine⁴ and high-sensitivity C-reactive protein plasma concentrations⁵. On the other hand, low adherence to Mediterranean diet was associated with increased risk of offspring with spina bifida⁴ and decreased intra-uterine size with a lower placental and birth weight⁵. Furthermore, maternal diets with a low Mediterranean diet adherence score during the first trimester may negatively affect neonatal insulin and HOMA-IR-levels⁶. The adherence to a healthy dietary pattern, such as Mediterranean diet, during pregnancy may be affected by several factors other than the nutritional requirements that are intrinsic to gestation. Evidence suggests that pregnant women with a higher educational level, higher age, higher income, and lower parity had increased adherence to a healthy dietary pattern⁷⁻⁹. Dietary changes over the course of a pregnancy may occur after women know they are pregnant or after their first prenatal visit¹⁰ and may affect pregnancy outcomes¹¹. Furthermore, the eating pattern adopted during pregnancy may be maintained after childbirth¹² and thus may affect the mother's health. It has been widely described that the Mediterranean dietary pattern offers a protective effect against cardiovascular disease, cancer, and other degenerative diseases¹³⁻¹⁵.

However, to our knowledge, no study has explored the potential predictors of change in adherence to the Mediterranean diet during pregnancy. Thus, the objective of this study was to identify the predictors of adherence to this diet from the first to the second trimester of pregnancy.

Methods

Sampling

Data for the present prospective study came from a sample of pregnant women attending outpatient obstetrics clinics at São João Hospital in Porto, Portugal.

Women were invited to participate when they came in for their first ultrasound evaluation screening. The recruitment was made consecutively from July 2010 to May 2012. From those who agreed to participate, data were collected in the first trimester between the tenth and twelfth weeks of gestation (at the time of baseline assessment) and again in the second trimester between the twentieth and twenty-second weeks (at the time of the second ultrasound).

The inclusion criteria used in this study were a spontaneous pregnancy and a gestational age of 10-12 weeks at baseline, as confirmed by ultrasound. Women were considered ineligible if they had severe heart disease (including symptoms of angina, myocardial infarction, or arrhythmia), persistent bleeding after 12 weeks of gestation, multiple pregnancies, poorly controlled thyroid disease, pregnancy-induced hypertension or preeclampsia, diabetes or gestational diabetes, an age of less than 18 or over 40 years, and lack of competence in the Portuguese language or any type of cognitive inability that would prevent them from answering a questionnaire.

A total of 137 pregnant women were invited to participate in this study, and 134 (participation rate: 97.8%) agreed to take part. Some of the 134 participants were subsequently excluded because of miscarriage (n=1), no singleton pregnancy (n=2), and age (n=1). Furthermore, 28 (20.9%) more were excluded because they did not provide their dietary data for each trimester. Thus, the final sample, which included women who participated in both trimesters and provided a three-day food record for each trimester, consisted of 102 women. Women who were excluded from the study did not differ significantly from those who were included in terms of age, educational level, marital status (single/divorced and married/cohabitate), monthly income, pre-pregnancy body mass index (BMI) and parity ($P>0.05$, for all).

All participants in this study were informed of its objectives and provided written informed consent. The study was approved by the Ethics Committee of the Hospital de São João (Reference No. 09988), and it was conducted in accordance with the World Medical Association's Helsinki Declaration for Human Studies.

Dietary assessment

Dietary intake was assessed by a three-day food diary that included two weekdays plus one weekend day, and was completed for each trimester. Oral and written instructions on how to complete the diary were given to the women by a trained nutritionist. Food portion sizes and beverages consumed were estimated using household measures (cups, glasses, spoons, slices, food wrappers, containers, etc.) as an aid in determining serving sizes. A description of each food and beverage consumed was recorded, including the method of preparation, the time it was eaten (to the

nearest five minutes), location, and, if appropriate, the brand name of the product. The nutrient analysis was performed using the software Food Processor SQL (ESHA Research Inc., Salem, OR, US). This program relies on nutritional information from the United States that has been adapted for use with typical Portuguese foods and beverages. The nutrient means of the three days were used in the analysis.

The degree of adherence to the Mediterranean diet was calculated according to the revised scale developed by Trichopoulou et al.^{16,17}. This scale is based on nine components (vegetables, legumes, fruits and nuts, cereals, fish, meat and meat products, dairy products, alcohol and fat). The fat component was expressed as the ratio of monounsaturated (MUFA) to saturated (SFA) fatty acids. For the beneficial components (vegetables, legumes, fruits and nuts, cereals, fish, and fat), a value of 1 was given to women with a consumption intake (g/day) equal to or above the median of the total sample and a value of zero for a daily intake below the median. For the detrimental components (meat and meat products, dairy products), a value of 1 was given to women with a consumption intake (g/day) below the median of the total sample and a value of zero for a daily intake equal to or above the median. Ethanol was not included in the calculations for the total score of adherence to the Mediterranean diet due to none of the women in our sample reporting alcohol consumption¹⁸. Thus, the Mediterranean diet score was calculated by the sum of the eight components, and ranged between 0 (minimal adherence) to 8 (maximal adherence). Then, based on the total score, each woman was categorized into one of two groups for each trimester: low adherence (<4 points) or high adherence (≥4 points). Furthermore, the sample was divided into two groups according to the change in adherence to the Mediterranean diet: women who had low adherence in each trimester (n=19) or had high adherence in the first trimester and then low adherence in the second (n=21) were categorized in the *negative change* group, while women who had high adherence in both trimesters (n=46) or had low adherence in the first trimester and then high adherence in the second (n=16) were categorized in the *positive change* group.

Assessment of socio-demographic and maternal lifestyle characteristics

Data were collected at the time of the first ultrasound (baseline) by researchers who administered structured and self-reported questionnaires. The questionnaires were designed to cover personal and socio-demographic data and lifestyle variables.

Height was measured to the nearest mm in bare or stocking feet, with participants standing upright against a Holtain Portable Stadiometer (Crymych, Pembrokeshire, UK). Weight at baseline was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt) and with the use of a

portable digital beam scale (Tanita Inner Scan BC 532, Tokyo, Japan). Weight gain was computed as the difference between weight before pregnancy and weight assessed at baseline divided by weeks of gestation at the time of measurement.

Pre-pregnancy BMI was estimated by using the ratio of weight/height² (kg/m²) with a self-reported pre-pregnancy weight. Participants were classified as non-overweight, overweight, or obese according to World Health Organization criteria¹⁹. The underweight participants (1%) were combined with the normal weight participants in the non-overweight category due to the fact that the former represented such a small proportion of the overall sample.

Professional status was assessed via a self-reported questionnaire, and the participants were divided into three categories: *employed* (full- or part-time), *unemployed*, and *student*. Since only two subjects fell into the *student* category, they were pooled with the members of the *employed* category.

Each respondent was asked to estimate the total income (including pensions, allowances, and investments) received by all household members in the last month by using a single measure comprised of three narrowly-ranged income categories: < 500 Euros, [500-1250] Euros and ≥1250 Euros.

For the variable educational level, subjects were divided into three categories that reflected the organization of the Portuguese educational system: *mandatory or less* (≤9 school years), *secondary* (10 to 12 school years), and *college/university* (>12 school years).

Concerning parity, women were considered primiparous if this was their first gestation and multiparous if they had at least one previous gestation.

Information regarding physical activity was gathered with the Pregnancy Physical Activity Questionnaire (PPAQ) validated by Chasan-Taber et al.²⁰. PPAQ is a self-reported questionnaire that evaluates the type, duration, and frequency of physical activities performed by pregnant women. Respondents were asked to select the category that best approximated the amount of time they spent per day or per week on various activities during the first trimester. Possible durations ranged from 0 to 6 or more hours per day and from 0 to 3 or more hours per week. At the end of the questionnaire, an open-ended section allowed respondents to add activities not already listed. Each activity was classified according to intensity: sedentary (<1.5 METs), light (1.5-3.0 METs), moderate (3.1-6.0 METs), or vigorous (>6.0 METs). Time reportedly spent on each activity was then multiplied by the activity's intensity to achieve a measure of average weekly energy expended (MET hours.week⁻¹).

Anxiety was measured using the Zung Self-rating Anxiety Scale²¹ that was translated into Portuguese by Ponciano et al.²². This scale comprises of 20 statements with 4 answer choices per question. The total score ranges between 20 and 80. Higher values correspond to worse states of anxiety. Women were catego-

rized according to their total score into anxious (40-80 points) or non-anxious (20-39 points).

Women were considered to have nutritional counseling and current pregnancy planned if they gave a positive answer to these specific questions: *Are you attending nutritional counseling during your first trimester? Was the current pregnancy planned?* Regarding smoking habits, women were classified as smokers if they smoked at least one cigarette a day during the first trimester.

Statistical analysis

The outcome variable of interest was defined as having negative change in adherence to the Mediterranean diet from the first to the second trimester. The potential predictors were pre-pregnancy BMI, weight gain rate, baseline physical activity, age, educational level, marital status, professional status, monthly income, smoking, parity, nutritional counseling, anxiety, current pregnancy planned, baseline consumption of fruits, vegetables, meat, fish, legumes, cereals, and dairy, the MUFA/SFA ratio, and the baseline score of adherence to the Mediterranean diet.

The Kolmogorov-Smirnov test was used to verify the variables' normality. An independent-samples t-test or the Mann-Whitney test was performed to compare continuous variables between groups, while the χ^2 test was used for categorical variables. A paired t-test or Wilcoxon test was used to compare paired continuous variables. A univariate logistic regression model was fitted to verify the relationships between negative change and each potential predictor (Supplemental file 1). Variables from the univariate analysis with $P \leq 0.25$ were considered potential independent variables and were thus entered into the logistic regression model as candidate variables for inclusion^{23,24}. Then, we used a conditional stepwise logistic regression model to identify significant variables associated with negative change in adherence to the Mediterranean diet from the first to the second trimester. A cut-off value of $P < 0.05$ was used to determine which variables to include in the multivariate model.

An odds ratio (OR) lower than one expresses an optimal attainment of the Mediterranean diet from the first to the second trimester, whereas an OR greater than 1 means lower success and higher odds for negative change.

A P value of <0.05 was regarded as significant. All analyses were performed using the statistical software package IBM SPSS Statistics Version 22.

Results

Among the 102 women, 34.3% and 39.2% had low adherence to the Mediterranean diet during the first and second trimester, respectively; furthermo-

re, 39.2% had negative change from the first to the second trimester. Table I shows the baseline characteristics of the participants according to change in adherence to the Mediterranean diet from the first to second trimester. Participants in the positive group were less anxious, and a higher proportion of them were married compared to participants in the negative group ($P < 0.05$ for all). No significant differences were seen in age, weight gain, physical activity, pre-pregnancy BMI, educational level, professional status, monthly income, smoking, parity, nutritional counseling, or current pregnancy planned across groups.

As shown in Table II, the women had higher energy (1894.0 ± 462.4 kcal/day vs. 1713.7 ± 401.6 kcal/day, $P < 0.001$), MUFA intake ($23.3(18.0-28.1)$ g/day vs. $20.4(16.4-24.1)$ g/day) in the second trimester than they had in the first trimester. According to changes in adherence to the Mediterranean diet from the first to second trimester, women in the negative group had a lower intake of fruits and nuts and, vegetables and a lower Mediterranean diet score at baseline compared to the positive group ($P < 0.05$, for all).

Figure 1 displays the proportion of women by the median of total the sample for components of the Mediterranean diet and the Mediterranean diet score during the first trimester according to changes in Mediterranean diet adherence from the first to second trimester. A lower proportion of the participants in the negative group consumed above or equal to the median for fruits and nuts (32.5% vs. 64.5%, $P = 0.002$) and vegetables (30% vs. 69.4%, $P < 0.001$) compared to the participants in the positive group.

The variables that remained in the model after the conditional stepwise method are presented in Table III. Being married (OR = 0.26 95%CI: 0.10, 0.76) and having a higher intake of vegetables during the first trimester (OR = 0.17 95%CI: 0.10, 0.43) were associated with lower odds of having negative change in adherence to the Mediterranean diet from the first to second trimester.

Discussion

This prospective study explored the predictors associated with higher accomplishment adhering to the Mediterranean diet from the first to second trimester of pregnancy. Results showed that being married and having a higher vegetable intake during the first trimester predicted lower odds of not following adherence to the Mediterranean diet from the first to second trimester.

To our knowledge, this is the first study to explore factors associated with changes in adherence to the Mediterranean diet during pregnancy. Among populations that are not pregnant, determinants of dietary change have been explored by Zazpe et al.²⁵ whose study aimed to identify predictors of the higher suc-

Table I
Maternal socio-demographic and lifestyle characteristics according to change in adherence to the Mediterranean diet from the first to second trimester

	Change in adherence to the Mediterranean diet from the first to second trimester*		P
	Negative (n=40)	Positive (n=62)	
Pre-pregnancy BMI (kg/m ²) ^{c, d}	23.2(21.8-26.6)	23.3(21.3-27.2)	0.956
Weight gain (g/week) ^{a, b}	224.7±213.3	236.2±227.4	0.799
Total physical activity [†] (MET.hour.week ⁻¹) ^{c, d}	242.7(149.3-372.2)	239.8(190.7-348.1)	0.537
	n(%)	n(%)	
Age (years)			
[18, 30]	23(57.5)	24(38.7)	0.063
[31, 40]	17(42.5)	38(61.3)	
Educational level			
Mandatory or less	17(42.5)	17(27.4)	0.134
Secondary	15(37.5)	22(35.5)	
College/university	8(20.0)	23(37.1)	
Marital status [†]			
Single/Divorced	14(35.0)	9(14.5)	0.016
Married/Cohabitate	26(65.0)	53(85.5)	
Professional status [†]			
Unemployed	7(17.5)	10(16.1)	0.856
Employed/Student	33(82.5)	52(83.9)	
Monthly income (€) [†]			
<500	13(32.5)	13(21.0)	0.230
[500-1250[	21(52.5)	32(51.6)	
≥1250	6(15.0)	17(27.4)	
Smoking [†]			
Yes	8(20.0)	8(12.9)	0.336
No	32(80.0)	54(87.1)	
Parity			
Primiparous	27(67.5)	34(54.8)	0.203
Multiparous	13(32.5)	28(45.2)	
Pre-pregnancy weight status			
Non-overweight	25(62.5)	37(59.7)	0.776
Overweight/Obese	15(37.5)	25(40.3)	
Anxiety [†]			
Yes	9(22.5)	5(8.1)	0.039
No	31(77.5)	57(91.9)	
Nutritional counseling [†]			
Yes	2(5.0)	4(6.5)	0.761
No	38(95.0)	58(93.5)	
Current pregnancy planned			
Yes	16(40.0)	17(27.4)	0.185
No	24(60.0)	45(72.6)	

BMI, body mass index.

^aData are mean±standard deviation; ^banalysis by Student's *t*-test for continuous variables; ^c data are median (P25-P75); ^d analysis by Mann-Whitney test.

[†]At baseline.

cess of an intervention intended to increase adherence to a Mediterranean diet in individuals who were at high cardiovascular risk and participating in a trial for the primary prevention of cardiovascular disease. Twelve months after the intervention, the results indicated that

a low baseline consumption of fruits and vegetables in both men and women, having a family history of cardiovascular disease among men, and being married among women were predictors of successful dietary changes. In contrast with these, our study verified

Table II
Dietary and nutritional characteristics of the sample according to assessed trimesters, and change in adherence to the Mediterranean diet from the first to second trimester

	First trimester (n=102)	Second trimester (n=102)	P	Change in adherence to the Mediterranean diet from the first to second trimester*		P
				Negative (n=40)	Positive (n=62)	
Total energy intake (kcal/day) ^a	1713.7±401.6	1894.0±462.4	<0.001 ^e	1720.1±321.1	1709.6±448.2	0.898 ^b
SFA (g/day) ^c	18.1(14.7-22.7)	18.5(15.523.4)	0.294 ^f	19.6(15.0-24.6)	17.0(14.1-21.3)	0.096 ^d
MUFA (g/day) ^c	20.4(16.4-24.1)	23.3(18.0-28.1)	0.014 ^f	21.6(18.5-24.1)	19.1(15.6-24.1)	0.119 ^d
MUFA/SFA (g/day) ^c	1.12(0.95-1.30)	1.17(1.02-1.39)	0.080 ^f	1.12(0.95-1.32)	1.11(0.92-1.36)	0.768 ^d
Fruits and nuts (g/day) ^a	240.2±147.1	266.6±156.6	0.070 ^e	184.9±124.3	275.9±150.5	0.002 ^b
Vegetables (g/day) ^c	39.7(11.4-73.9)	54.5(13.1-98.9)	0.071 ^f	13.6(6.5-50.7)	50.2(33.3-82.7)	<0.001 ^d
Legumes (g/day) ^c	0(0-7.1)	0(0-7.3)	0.387 ^f	0(0-7.1)	0(0-8.7)	0.911 ^d
Cereals (g/day) ^a	252.0±75.0	261.5±80.5	0.352 ^e	250.0±61.1	253.2±83.2	0.832 ^b
Fish (g/day) ^c	37.3(0-69.8)	33.3(0-440.4)	0.572 ^f	33.3(0-65.0)	39.3(14.6-72.1)	0.228 ^d
Dairy products (g/day) ^a	347.6±150.5	336.4±148.8	0.478 ^e	339.2±160.2	353.0±145.0	0.655 ^b
Meat and meat products (g/day) ^a	127.2±62.0	137.9±58.3	0.150 ^e	123.0±58.5	130.0±64.5	0.583 ^b
Mediterranean diet score ^c	4(3-5)	4(3-5)	0.681 ^f	3.6±1.5	4.3±1.4	0.018 ^d

MUFA, monounsaturated fatty acids; SFA, saturated fatty acids. *Values are presented according to dietary intake at first trimester. ^aData are mean±standard deviation; ^banalysis by Student's *t*-test for continuous variables; ^cdata are median (P25-P75); ^danalysis by Mann-Whitney test; ^eanalysis by paired *t* test for continuous variables; ^fanalysis by Wilcoxon test.

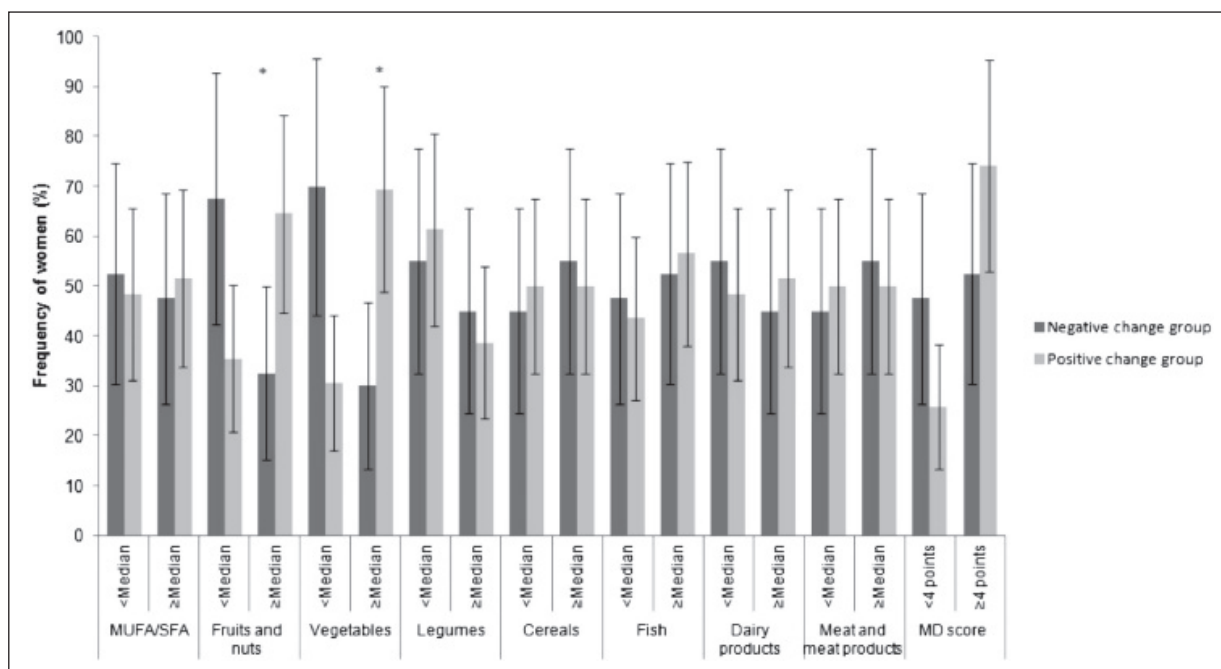


Fig. 1.—Proportion by the median of total the sample for components of the Mediterranean diet and the Mediterranean diet score during the first trimester according to changes in Mediterranean diet adherence from the first to second trimester.

MD, Mediterranean diet; MUFA, monounsaturated fatty acids; SFA, saturated fatty acids. * $P < 0.05$. MUFA/SFA median: 1.12 g/day; Fruits and nuts median: 240.7 g/day; Vegetables median: 39.7 g/day; Legumes median: 0 g/day; Cereals median: 257.7 g/day; Fish median: 37.3 g/day; Dairy products median: 356.0 g/day; Meat and meat products: 130.0 g/day.

Table III
Logistic regression model^a for factors related to negative change in adherence to the Mediterranean diet from the first to second trimester according to baseline characteristics among pregnant women

	Adjusted OR (95% CI)	P
<i>Marital status</i>		
Single/ Divorced	1 (Ref.)	0.014
Married/Cohabitate	0.26 (0.10, 0.76)	
<i>Vegetables (g/day)^b</i>		
<Median	1 (Ref.)	<0.001
≥Median	0.17(0.10, 0.43)	

CI, confidence intervals; OR, odds ratio.

^aConditional stepwise elimination was used for selecting the variables included in the model.

^bMedian= 39.7 g/day.

lower odds of having a negative change in adherence to the Mediterranean diet with a higher baseline vegetable intake. A reason that may explain this discrepancy is that pregnant women are usually more motivated to change their dietary pattern to respond to gestation requirements and child health and that these changes may occur after they know about their pregnancy¹⁰. In line with this explanation, Gardner et al²⁶ reported that perceived benefits for mother and offspring enhanced intentions to increase consumption of fruits and vegetables and to decrease consumption of high-fat foods during pregnancy. Likewise, findings from a study of Belgian women found that pregnant women reported higher intakes of fruits, beef, dairy products, and fat, and a lower intake of alcohol and food products with heightened safety-related risks compared to non-pregnant women²⁷.

Moreover, in our sample, married women were more likely to follow adherence to the Mediterranean diet from the first to second trimester. It has been described that individuals who live alone may be less motivated to cook for themselves and had an increasing likelihood to skip meals and to eat unhealthy foods². On the other hand, married women are generally responsible for food purchasing and preparing meals²⁵ and ultimately for controlling the health of other family members^{28,29}.

In contrast to our results, evidence has been suggested that age, educational level, and income were positively associated with adherence to the Mediterranean diet or to a healthy dietary pattern during pregnancy⁷⁻⁹. Discrepancies between these previous studies and ours may be due to differences in the study design, the methods of assessing diet, and the fact that the between-subject variability in age, educational level, and income were too small in the present study to find significant associations.

No significant association was observed between pre-pregnancy BMI and adherence to the Mediterranean diet during pregnancy. Although studies exami-

ning this relationship are limited, it seems that there is an association between pre-pregnancy BMI weight status and diet quality^{30,31}. However, our results and those of other studies suggest no association^{12,32}.

A highlight of the present study is that the proportion of women who had low adherence in both trimesters or had high adherence in the first trimester and then low adherence in the second is almost 40%. Revealingly, it has been suggested that the diet adopted during pregnancy may be maintained after pregnancy. A study among overweight and obese women reported a decreasing dietary quality for the duration of the pregnancy, which was maintained in early post-partum (4 months after delivery)¹². Furthermore, the authors of that study demonstrated that the decrease occurred from early pregnancy to 28 weeks of pregnancy, highlighting early pregnancy as a critical stage for targeting dietary interventions. Indeed, as previously described, pregnancy represents a “teachable moment” where the perceived value of healthy eating and exercise is enhanced³³ and where the opportunity to instill positive dietary change is improved.

The present study has limitations that should be acknowledged. First, our relatively low number of participants may have prevented us from identifying small effects²⁶. Second, although a wide range of potential predictors were evaluated we acknowledge that other predictors may be associated with our outcome. However, according to evidence, we believe we have accounted for many of them. Third, similarly to other indexes, the Mediterranean diet score has some limitations, such as the variability in defining cut-off points for the scoring components and the lack of agreement over the definition of the Mediterranean diet. Moreover, the population in this study may differ from the population for which the index was originally designed^{34,35}. Nevertheless, the worth of the Mediterranean diet indexes has been demonstrated³⁵, and the benefits’ relation with maternal and baby health outcomes has been established¹⁻⁶. Finally, the completion of a food diary may influence or change habitual eating patterns, and the omission of less socially acceptable dietary habits may have occurred³⁶. However, women were given oral and written instructions not to change their dietary habits during the recording process and to complete adequate descriptions of their diet regarding the specification of foods, amounts, and cooking methods, which may have improved the quality of information.

In summary, our results suggest that marital status and vegetable intake are associated with a successful adherence to the Mediterranean diet from the first to second trimester. Knowing the factors associated with changes in dietary pattern may help health professionals to identify who is more vulnerable and to persuade them against poor eating choices. Thus, further research is needed to identify other possible factors associated with healthy eating patterns during pregnancy.

Supplemental table
Univariate logistic regression models for factors related to negative change in adherence to the Mediterranean diet from the first to second trimester according to baseline characteristics among pregnant women

	<i>Unadjusted OR (95% CI)</i>	<i>P</i>
<i>Weight gain (g/week)</i>	0.79(0.13, 4.82)	0.796
<i>Total physical activity (MET.h.wk⁻¹)</i>	1.00(0.99, 1.00)	0.549
<i>Age (years)</i>		
[18, 30]	1 (Ref.)	0.065
[31, 40]	0.47(0.21, 1.05)	
<i>Educational level</i>		
Mandatory or less	1 (Ref.)	0.141
Secondary	0.68(0.27, 1.75)	
College/university	0.35(0.12, 0.99)	
<i>Marital status</i>		
Single/ Divorced	1 (Ref.)	0.018
Married/Cohabitate	0.32 (0.12, 0.82)	
<i>Professional status</i>		
Unemployed	1 (Ref.)	0.856
Employed /Student	0.91 (0.31, 2.62)	
<i>Monthly income (€)</i>		
<500	1 (Ref.)	0.239
[500 -1250[	0.66(0.26, 1.69)	
≥1250	0.35(0.11, 1.18)	
<i>Smoking (at baseline)</i>		
Yes	1 (Ref.)	0.339
No	0.59(0.20, 1.73)	
<i>Parity</i>		
Primiparous	1 (Ref.)	0.205
Multiparous	0.59(0.26, 1.34)	
<i>Pre-pregnancy weight status</i>		
Non-overweight	1 (Ref.)	0.776
Overweight/Obese	0.89(0.39, 2.01)	
<i>Anxiety (at baseline)</i>		
Yes	1 (Ref.)	0.046
No	0.30(0.09, 0.98)	
<i>Nutritional counseling (at baseline)</i>		
Yes	1 (Ref.)	0.762
No	1.31(0.23, 7.51)	
<i>Current pregnancy planned</i>		
Yes	1 (Ref.)	0.187
No	1.77(0.76, 4.10)	
<i>MUFA/PUFA (g/day)</i>		
<Median	1 (Ref.)	0.685
≥Median	0.85(0.38, 1.88)	
<i>Fruits and nuts (g/day)</i>		
<Median	1 (Ref.)	0.002
≥Median	0.27(0.11, 0.61)	
<i>Vegetables (g/day)</i>		
<Median	1 (Ref.)	<0.001
≥Median	0.19(0.08, 0.45)	
<i>Legumes (g/day)</i>		
<Median	1 (Ref.)	0.529
≥Median	1.30(0.58, 2.90)	

Supplemental table (cont.)
Univariate logistic regression models for factors related to negative change in adherence to the Mediterranean diet from the first to second trimester according to baseline characteristics among pregnant women

	Unadjusted OR (95% CI)	P
Cereals (g/day)		
<Median	1 (Ref.)	
≥Median	1.22(0.55, 2.71)	0.622
Fish (g/day)		
<Median	1 (Ref.)	
≥Median	0.85(0.38, 1.89)	0.695
Dairy products (g/day)		
<Median	1 (Ref.)	
≥Median	1.30(0.59, 2.89)	0.515
Meat and meat products (g/day)		
<Median	1 (Ref.)	
≥Median	0.82(0.37, 1.82)	0.622
Mediterranean diet score		
<4 points	1 (Ref.)	
≥4 points	0.38(0.17, 0.89)	0.026

CI, confidence intervals; MUFA, monounsaturated fatty acids; OR, odds ratio; SFA, saturated fatty acids.
 MUFA/SFA median: 1.12 g/day; Fruits and nuts median: 240.7 g/day; Vegetables median: 39.7 g/day; Legumes median: 0 g/day; Cereals median: 257.7 g/day; Fish median: 37.3 g/day; Dairy products median: 356.0 g/day; Meat and meat products: 130.0 g/day.

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Conflict of interest statement

The authors declare that they have no conflict of interests.

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Original/Otros

Heightened sensitivity to somatosensory stimuli in anorexia nervosa: an exploratory study with the SASTCA scale

Rosa Calvo Sagardoy¹, Luis T. Gallego Morales², Soledad Kassem García³, Rosana Codesal Julián⁴, Ascensión Blanco Fernández⁵, Gloria Solórzano Ostolaza⁶ and Carmen Morales Martínez⁷

¹PhD in Psychology. Chairman Eating Disorders Unit. Hospital La Paz. Madrid, Spain. ²PhD in Psychology. Clinical Psychologist. Hospital La Paz. Madrid, Spain. ³Clinical Psychologist. Hospital La Paz. Madrid, Spain. ⁴Psychiatrist. Hospital of Valdemoro. Madrid, Spain. ⁵PhD in Psychology. Teacher at the European University of Madrid, Spain. ⁶Nutrition Degree. Inyda Centre. Madrid, Spain. ⁷Nutritionist Degree. Inyda Centre. Madrid, Spain.

Abstract

Objectives: To analyse the presence of heightened sensory sensitivity in patients with anorexia nervosa, which seems similar but not identical to that described in patients with unexplained somatic symptoms or body dysmorphic disorder.

Methods: We developed a sensory sensitivity scale in eating disorders (SASTCA), which measures the intensity of the response to specific somatosensory stimuli. The scale was completed by 48 patients with anorexia and a control group of 31 participants matched in age, sex and social and educational level. The results were compared with those obtained with the Barsky Somatosensory Amplification Scale (SSAS).

Results: The reliability (Cronbach's/alpha, 0.946; Guttman/split-half, 0.936) and validity (ROC, 0.933) of the SASTCA scale are indicative of its high sensitivity and specificity. The anorexia group had a significantly higher mean score on the SASTCA scale than the control group ($p<.001$). Similarly, the patients with anorexia had a significantly higher mean value on the SSAS than the participants in the control group ($p<.01$), although the difference was less extreme. The 2 scales correlated positively ($r=.634$).

Discussion: These preliminary results suggest the presence in Anorexia of heightened sensory sensitivity which differs from the sensitivity of the control group. This sensitivity has a significant relationship with that described in patients with somatic complaints about health (SSD) or appearance (BDD). Could this heightened sensory sensitivity help us to explain the process of forming the distorted body self-concept (I'm fat, sick, ugly) in all these patients? Once its presence has been confirmed in other patients with anorexia, their relatives and other patients with somatic disorders this heightened sensitivity could constitute the somatic endophenotype of anorexia?

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Key words: Anorexia. Body Image. Heightened Sensory Sensitivity. Somatic Disorders. Dysmorphic Disorder.

Correspondence: Rosa Calvo Sagardoy.
Hospital Universitario La Paz. Servicio de Psiquiatría.
Paseo de la Castellana, 261. 28046 Madrid.
E-mail: rosa.calvo@salud.madrid.org

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ELEVADA SENSIBILIDAD A ESTÍMULOS SOMATOSENSORIALES EN ANOREXIA NERVOSA: UN ESTUDIO PRELIMINAR CON LA ESCALA SASTCA

Resumen

Objetivo: destacar la presencia de una sensibilidad extrema hacia estímulos externos e internos (Amplificación Somatosensorial) en pacientes con Anorexia, similar pero no idéntica, a la descrita en pacientes con unexple somatic symptoms.

Método: Se ha elaborado una escala de Amplificación Somatosensorial para Trastornos de la Conducta Alimentaria, (SASTCA), que mide la intensidad de la respuesta hacia estímulos somatosensoriales específicos. La escala ha sido cumplimentada por un grupo de 48 pacientes anoréxicas y un grupo control de 31 sujetos emparejados en edad, sexo y nivel socioeducativo. Los resultados se han comparado con los obtenidos en la escala SSAS de Barsky.

Resultados: La Fiabilidad (Alfa de Cronbach 0,946; dos mitades de Guttman 0,936) y la Validez (ROC, 0,933), son indicativas de elevada sensibilidad y especificidad de la escala SASTCA. El grupo de pacientes presenta una media 58,73 12,38, significativamente superior al grupo control 37,81 7,47, ($\alpha=.001$). Las pacientes presentan en la escala SSAS una media 31,21 6,68 significativamente superior al grupo control 26,58 5,49 ($\alpha=.01$), aunque la diferencia es menos extremada. Ambas escalas correlacionan positivamente. 0,634

Conclusiones: Los resultados sugieren la presencia en AN. de una sensibilidad extrema hacia estímulos somatosensoriales. ¿Podría esta elevada sensibilidad sensorial ayudarnos a explicar el proceso de formación del auto-concepto distorsionado ("gordo, enfermo, feo") de estos pacientes? De confirmar su presencia en otras muestras de pacientes con anorexia, en sus familiares y en diferentes pacientes somatomorfos o TCA, esta elevada sensibilidad podría considerarse el endofenotipo somatomorfo del trastorno anoréxico.

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Palabras clave: Anorexia. Imagen Corporal. Elevada Sensibilidad Somatosensorial. Trastorno Somatomorfo. Trastorno Dismórfico.

Introduction

Current studies into anorexia nervosa are attempting to determine which endophenotypes and biomarkers can cause vulnerability to the development of anorexia nervosa (AN). The cognitive, emotional and behavioural symptoms are considered to be the result of interactions among biologically determined factors, as well as neurocognitive and emotional dysfunctions expressed as abnormalities in the operation of brain neural circuits, societal and familial factors, and precipitating stressors. The importance of this understanding lies in the fact that these endophenotypes precede the onset of the disease, which helps with designing earlier treatments that are more effective and better adjusted to each patient¹.

The most important contribution has emerged from the study of neurocognitive functioning. Cognitive rigidity (difficulty in set shifting) in patients meets the requirements of an endophenotype: it is present in the acute stage, it remains after eating recovery and it appears in relatives without the disorder. The executive dysfunction can be found in other mental diseases (obsessive-compulsive disorder, bipolar disorder and schizophrenia)² and has been associated with a specific cerebral dysfunction. Neuroimaging studies of patients with cognitive inflexibility (obsessive-compulsive disorder, anorexia, and autism spectrum disorder) show a low activation of the ventral cortico-striato-thalamo-cortical pathway during the execution of set-shifting tasks. The other neurocognitive deficiency observed in anorexia, the difficulty in overall visuospatial processing (weak central coherence) and an exceptional processing of details is also a characteristic of patients with autism spectrum disorder and is therefore also considered a nonspecific endophenotype for the development of anorexia nervosa^{3,4}. The nonspecificity of the two endophenotypes has not prevented the development of new therapeutic interventions such as cognitive remediation therapy, which supplement current treatments and boost their positive result, reducing the risk of chronicity in this disease⁵.

Another important therapeutic contribution resulted from the study of the difficulty in recognising emotions (alexithymia) and self-regulating them, as observed in patients with eating disorders⁶. Pathological eating behaviours appear to act as an avoidance of negative emotions or as method of regulating them. The course of the disorder (recovery vs. chronicity) has been associated with the severity of the emotional difficulties^{7,8}. These results have encouraged new causality models for this disease, with their subsequent therapeutic implications, and the search for the potential underlying emotional endophenotype^{9,10}. In the clinical area, therapists are urged to incorporate emotional treatment techniques for their patients to increase the perception of emotions and to teach how to properly regulate them. Current research attempts to define the emotional endophenotype of ED based on the study of

heightened sensitivity to punishment and the response to reinforcement^{11,12}.

Our research seeks to contribute to the search for potential endophenotypes in anorexia and focuses on body image distortion^{13,14}. Our hypothesis is that patients with anorexia (and possibly patients with other ED) have a heightened sensory sensitivity that could be involved in the formation of the patients' distorted body self-concept ("I'm fat"), which precedes the onset of pathological eating behaviours. The decision to focus the study on this possible heightened body sensitivity is supported by several results from clinical observation and research on anxiety, perceptual bias and distortion in patients who experience SSD or BDD^{15,16,17,18}. Thus, clinical observation has allowed us to observe certain similarities between the somatic, cognitive and emotional function of patients with SSD and BDD and that of patients with anorexia, which might shed some light on the understanding of the formation of body image distortion^{19,20}. At the start of the disease, it is not uncommon to observe some adolescent patients visiting the doctor with gastrointestinal complaints, which result in numerous medical tests before being diagnosed with an eating disorder. Too often, these complaints are interpreted as a manipulation by the patient to justify rejecting food, without pausing to consider that perhaps the majority of these patients really were experiencing discomfort that we were unable to explain. Similarly, during the process of recovery, many patients go through a period of health concerns which can occasionally lead to agoraphobia. Moreover, the perceptive and cognitive function described in patients with unexplained somatic complaints about health or body shape (amplifying somatic style)²¹, appears to be present in patients with anorexia nervosa. This function is characterised by considerable concern and anxiety about the body, heightened sensitivity to somato/sensory stimuli, cognitive bias (focusing of attention) towards subtle physical perceptions, catastrophic interpretations of physical perception as a possible sign of disease (SSD) or deformity (BDD), avoidance behaviour, memory biases and increased expectations of symptom onset^{22,23}. Authors have studied these characteristics and have associated them with individuals who have undergone stressful body experiences and who have a limited awareness of their emotional states²⁴.

The similarity to patients with anorexia nervosa is somewhat surprising. These patients report undergoing stressful experiences with their body image before developing the disorder. The most common experiences are those involving teasing by school-mates and the most traumatic are related to sexual abuse. These patients demonstrate a limited awareness of their emotional states. They manifest continuous anxiety concerning the possibility of becoming fat. They interpret certain physical sensations in an alarmist manner, mistaking them for sign of fatness. One of the most

common misinterpretations is when patients attribute fatness to the feeling of discomfort produced by perstinacious constipation experienced during the peak of anorexia and during its relapse. Patients present a cognitive bias towards stimuli associated with fatness and caloric food, which is processed as a matter of priority^{25,26,27}. This bias is present in their emotional memory^{28,29}. Their pathological behaviour is considered fatness avoidance behaviour.

With so many similarities, it seems plausible that they would also have heightened sensory sensitivity towards internal and external body stimuli. If heightened sensitivity is confirmed to be present in patients with anorexia, could this help us explain the process of forming the distorted body image in all these patients?

Methodology

Objectives

The aim of this study was to highlight the presence of heightened sensory sensitivity in patients with anorexia, which seems similar but not identical to that described in patients with other unexplained somatic disorders. This heightened sensory sensitivity is a potential vulnerability factor for the development of anorexia?

Hypothesis

Patients diagnosed with Anorexia Nervosa have significantly greater heightened sensory sensitivity than control participants without eating disorders.

Design

Analytical, cross-sectional, case-control study.

Participants

We selected 48 patients diagnosed with anorexia nervosa (restrictive and purging) or eating disorder not otherwise specified (EDNOS) with anorexic profile. The patients met the criteria according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR) (42) and were referred to the Unit for Eating Disorders (UED) of Hospital La Paz of Madrid. We excluded patients with other ED diagnoses (bulimia nervosa, EDNOS with bulimic profile and binge eating disorder) and patients with physical or mental disease (diabetes, drug and alcohol consumption) associated with ED. To obtain a control group of similar age, sex and social and educational level, we asked each patient to ask someone

in their community (classmate, workmate or neighbour) to participate in the study. This control group was composed of 31 participants who met the same inclusion and exclusion criteria as the selected cases but who did not present any diagnostic criterion for ED according to the DSM-IV. The control group had no family relationship to the patients.

All participants were informed about the study, and the team invited them to participate in the study to contribute to the understanding of the disorder and to obtain some type of positive conclusion for improving treatment. Once they were informed about the study and gave their consent, the participants signed the informed consent approved by the hospital ethics committee. The data were recorded starting the third week of admission to the UED within the general assessment.

Instruments

SASTCA Scale: To assess the presence of heightened sensory sensitivity in anorexia, we developed a somatosensory scale for patients with eating disorders, the SASTCA scale. The 3 first letters (SAS) refer to the Barsky SSAS scale and attempt to recognise the author's pioneering work in the description of heightened sensitivity of patients with hypochondria. The remaining 3 letters (TCA) stand for eating disorders. The scale was constructed based on the observations collected in the clinical setting. The first version of the questionnaire was designed with 26 questions, which was reduced to 18 after eliminating redundant questions. The items included bodily sensations and reactions to stimuli from the various body senses (smell, pressure, texture, sound, vision). These items were estimated on a 5-point scale. The possible scores ranged from 18 to 90. (Appendix A).

SSAS Scale: In order to compare the specificity of the heightened sensory sensitivity of patients with anorexia, we used the Barsky somatosensory amplification scale (SSAS) used in patients with hypochondria³⁰. We used the Spanish version³¹. This scale consists of 10 items that include questions about benign bodily sensations that are bothersome but do not constitute typical symptoms of disease. These items were estimated on a 5-point scale. The possible scores ranged from 10 to 55.

Data analysis

The data analysis was performed using the SPSS 12.0 program. All hypothesis tests were considered bilateral, and values were considered statistically significant when $p < .05$. Before assessing the potential differences in somatosensory sensitivity between the patient group and the control group, we studied the psychometric characteristics of the SASTCA scale: reliability

ty, validity, sensitivity, specificity and positive and negative predictive value. After determining the scale's psychometric characteristics, we compared the results of the 2 groups (patients and controls) in both tests. The scale's reliability was studied using the statistical Cronbach's alpha and the Guttman split-half test. The scale's validity was studied using the calculation of the area under the receiver operating characteristic (ROC) curve, along with its 95% confidence interval. Based on the ROC curve, we tested various cut-off points, selecting the one with the greatest performance for the measures of sensitivity, specificity and predictive values. The chosen cut-off point was 49. These values were compared with the predictive performance of the SSAS (sensitivity, specificity and positive and negative predictive value) for anorexia. The chosen cut-off point (27) was that recommended for Spanish samples. The quantitative correlation between the 2 questionnaires was analysed using the Pearson correlation coefficient.

Results

The sample consisted of 79 participants, of whom 48 (60. 75%) were patients and 31 (39. 25%) were controls; 88. 6% were women and 11. 4% were men. The ED group consisted of 89. 59% women and 10. 41% men. The control group was composed of 86. 097% women and 12. 903% men. The proportion of men to women in the patient and control groups was not significantly different ($p > .05$). The mean ages of the patient and control groups were mean 29. 26, (SD 7. 8) years and mean 27. 88 (SD 8. 12) years, respectively. The difference in age between the groups was not significant ($p > .05$). Body mass index (BMI): At the time of the study, the patient group diagnosed with Anorexia Nervosa or EDNOS of type AN had a mean BMI of 17. 2 (range 11. 2–20. 4), although they had much lower values over the course of their disorder. Duration of the disorder: the patient group has a mean

duration of 7. 19 (SD 5. 73) years for the disorder. Previous treatments: A total of 62. 66% of the patients had undergone prior treatment at other healthcare centres. Of these, 27. 08% had undergone 3 or more treatments. Comorbidity: A total of 56. 25% of the patients were diagnosed with other associated psychiatric diseases (e. g. , obsessive compulsive disorder, anxiety and personality disorder). Attempted suicide: Some 22. 91% of the patients had attempted suicide over the course of their disorder. Self-harm: A total of 45. 83% has inflicted self-harm at some point during the course of their disorder.

1) Psychometric Characteristics of the SASTCA and SSAS scales

A) SASTCA Scale

Reliability: The scale's Cronbach alpha value was 0. 946, which indicated that the scale's reliability was very high and within the recommended criteria for clinical research ($>0. 8$). Guttman split-half test: The reliability between the two halves of the scale was very high (0. 936). This result indicates considerable consistency between the items of the scale, which according to the results measure the same trait. The correlation between forms was 0. 880. Only 0. 12 was due to possible measurement error (table I). Validity: Diagnostic performance (ROC curve): The scale's overall diagnostic performance was 0. 915 (ROC), with a 95% confidence interval in a range from 0. 837 to 0. 994 (table I) (Fig. 1). These values indicate that the scale's predictive capacity is very high in terms of the diagnosis of AN. Predictive performance of the SASTCA scale for the cut-off of 49: With this cut-off, the SASTCA scale achieved a sensitivity index of 81. 25%. A specificity of 93. 5%. A positive predictive value of 95. 1%. A negative predictive value of 76. 3% (table II).

Table I
Reliability and Validity (SASTCA Scale)

Reliability (SASTCA Scale)				
Alfa Cronbach		,946		
Guttman split-half test		,936		
Correlation between forms		,880		
Validity: Area under the Curve ROC (SASTCA Scale).				
Test Result Variable(s)				
Area	SD Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
,915	,040	,000	,837	,994

^aUnder the nonparametric assumption. ^bNull hypothesis: true area = 0. 5.

Table II
Predictive Performance for the cut-off of 49 (SASTCA scale)

SASTCA	AN Group		Control Group		Total Group
	N	%	N	%	N
Value Positive (≥ 49 p)	39	—	2	—	41
^a Sensitivity index	39/48	81,25	—	—	—
^c Positive predictive value	39/41	95,12	—	—	—
Value Negative (< 49 p)	9	—	29	—	38
^b Specificity	—	—	29/31	93,54	—
^d Negative predictive value	—	—	29/38	76,31	—
Total Group	48		31		79
Mean (SD)	58.72 (12.4)		37.80 (7.5)		F 47,248
					p <.001

^aSensitivity index (AN Group Positive/AN Group). ^bSpecificity (Control Group Negative/Control Group Total). ^cPositive predictive value (AN Group Positive/ Positive Total Group). ^dNegative predictive value (Negative Control Group/Negative Total Group).

Table III
Validity: Area Under the Curve ROC (SSAS Scale)

Test Result Variable				
Area	SD Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
,712	,068	,008	,578	,845

^aUnder the nonparametric assumption. ^bNull hypothesis: true area = 0.5.

B) SSAS Scale

Diagnostic Performance of the SSAS scale. The ROC curve of SSAS scale achieved an area of 0. 712 with a 95% confidence interval in a range from 0. 578 to 0.

845, (table III), (Fig. 2). Predictive performance of the SSAS scale for a cut-off point of 27. With this cut-off, the scale achieved a sensitivity index of 79. 2%, a specificity of 48. 4%, a positive predictive value of 70. 4% and a negative predictive value of 60. 0% (table IV).

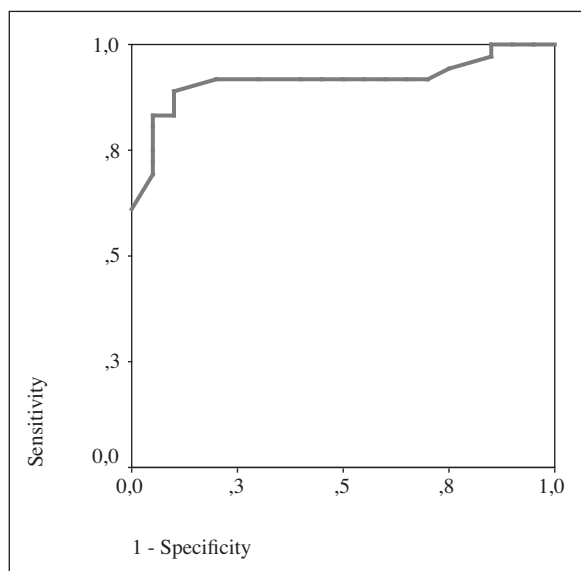


Fig. 1.—Validity: Area under the Curve *ROC (SASTCA Scale).
*Receiver Operating Characteristic (ROC).

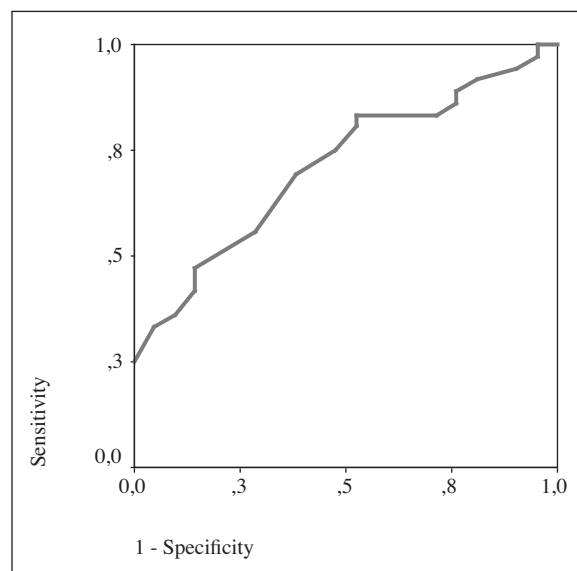


Fig. 2.—Validity: Area under the Curve *ROC (SSAS Scale).
*Receiver Operating Characteristic (ROC).

Table IV
Predictive Performance for the cut-off of 27 (SSAS scale)

SASTCA	AN Group		Control Group		Total Group
	N	%	N	%	N
Value Positive (≥ 49 p)	38	–	16	–	54
^a Sensitivity index	38/48	79,2	–	–	–
^c Positive predictive value	38/54	70,4	–	–	–
Value Negative (< 49 p)	10	–	15	–	25
^b Specificity	–	–	15/31	48,4	–
^d Negative predictive value	–	–	15/25	60,0	–
Total Group	48		31		79
Mean (SD)	31.19 (6.7)		26.57 (5.5)		F 7,202 p .010

^aSensitivity index (AN Group Positive/AN Group). ^bSpecificity (Control Group Negative/Control Group Total). ^cPositive predictive value (AN Group Positive/ Positive Total Group). ^dNegative predictive value (Negative Control Group/Negative Total Group).

C) Relationship between the two scales.

The 2 scales correlated with each other with a correlation coefficient of $r = .634$, which was statistically significant ($p < .001$)

2) Differences between the groups in the 2 scales.

The patients with Anorexia Nervosa and EDNOS achieved a mean on SASTCA scale of 58.72 (SD 12.4), which was much higher than the mean of 37.80 (SD 7.5) achieved by the control group. The difference was statistically significant ($p < .001$) and occurs to a lesser extent in the case of the SSAS scale. The patient group achieved a mean of 31.19 (SD 6.7), higher than the mean of 26.57 (SD 5.5) from the control group ($p < .001$), (table II, table IV).

Discussion

The preliminary results from this study support the possible presence of heightened sensory sensitivity in patients with anorexia, which differs from the sensitivity of the control group. This heightened sensitivity has been related to the individual's susceptibility to developing unexplained somatic complaints about health (SSD) or appearance (BDD)^{32,33,34}. This sensitivity has been related to the individual's susceptibility to developing the somatic symptoms disorder¹⁹. To measure this construct, we developed the SASTCA scale. Both the reliability and the validity of the SASTCA scale indicate that it can be a useful instrument for assessing the amplified somatosensory sensitivity of patients with anorexia. The scale's reliability measured by the statistical value Cronbach's alpha indicates that the scale is highly reliable and is within the recommended criteria for clinical research. The Guttman split-halves

revealed considerable consistency between the items on the scale, which according to the results measure the same trait. In terms of the scale's validity. The ROC values showed that the overall diagnostic performance of this scale (i. e. , its predictive capacity) is extraordinarily high for the diagnosis of AN.

After several attempted cut-off points, we selected the cut-off of 49 because it offered the scale's best predictive value. With this cut-off, the SASTCA scale had excellent diagnostic performance, which was particularly reflected in the extremely high specificity. The scale not only correctly identified patients with anorexia but also detected the absence of disease in the healthy participants. This fact makes the scale a good tool for confirming the diagnosis, given its high positive predictive value. After comparing the performance of the patient group and the control group on the SASTCA scale, the data indicate that the patients with Anorexia Nervosa or EDNOS have a much higher sensitivity than the control group. The difference was statistically significant.

When comparing the results from the SASTCA scale with those from the SSAS scale, we can see that the 2 scales are related despite their significant differences. The SSAS scale has a high sensitivity index and correctly identified patients with anorexia. However, its specificity is notably lower. The SSAS scale detects numerous false positives because it cannot properly discriminate the absence of disease in healthy patients. These values reveal that the 2 scales are related and share or describe aspects of the same "dimension" but are not identical.

The notable predictive capacity and precision of the SASTCA, reflected in the ROC curve, suggest that its sensitivity could be maximised if other cut-off points are chosen and provide the SASTCA with the capacity to screen for anorexia. Given that the heightened sensory sensitivity measured by the SASTCA detects the patient group with anorexia and discriminates those

from the participants in the control group, and given that the scale does not include any pathological eating behaviour, it is feasible to think that this heightened sensitivity could precede the onset of pathological eating behaviours. In this case, the highly sensory sensitivity would constitute a vulnerability factor for the formation of a distorted body image for patients with anorexia.

Is it possible that heightened sensory sensitivity, common to other somatic disorders, is part of a somatic vulnerability (Sensory-Processing Sensitivity)³⁵ which would explain the formation of body self-concept distortion in all these patients? This possibility is supported by several arguments. Firstly, the limited awareness of emotional states is also present in patients with anorexia³⁶. Studies of the emotional characteristics of patients with ED indicate that these patients have greater difficulty identifying and describing emotions^{37,38} and less appropriate methods (avoidance, escape, denial) for regulating the emotion than the control groups of women without ED³⁹. Difficulties recognizing emotional states are also associated with the level of severity. Secondly, there appears to be a parallel in the process of development of various perceptive distortions (disease, fatness, ugliness) in the above-mentioned patients groups^{40,41}. Given that the most detailed description in the scientific literature is that reported for patients with unexplained health complaints, we focused the comparison of the development of the self-concept "I am sick" with the development of the self-concept "I'm fat" in patients with anorexia. The correlation between the 2 processes is somewhat striking.

The start of the process is related to stressful experiences associated with the body. Patients with health concerns report having undergone negative experiences prior to the disorder, related or not to the disease itself and they exhibit considerable anxiety about their health due to the uncertainty of medical interventions. In addition, heightened sensitivity to certain external and internal body stimuli has been demonstrated in these patients^{42,43}. The interaction between a lower perceptive threshold and this fearful uncertainty would produce a heightened perception of potential sources of danger^{44,45}. As a result of this interaction, these patients react with considerable concern and alarm when faced with any bodily sensation. Their anxiety leads to focusing their attention on these sensations, which they monitor excessively and continuously, assessing the sensations as abnormal regardless of how subtle they are. The alarmist interpretation of these sensations leads them to believe that they are sick. The distorted beliefs remain relatively silent until a critical event, internal or external, mobilises them. In supposedly threatening situations, the dysfunctional beliefs activate launching alarmist thoughts about the bodily sensations ("I have cancer"), triggering strong anxiety about their health and leading to relief behaviours (visiting the emergency department^{46,47}. These relief

behaviours (negative reinforcement) contribute to the maintenance of the distorted self-concept.

If we change the concept of ill to fat, the process fits almost entirely with what we observe in anorexia nervosa. The patients with anorexia reported having undergone stressful experiences with the body during childhood and adolescence (premature or late maturity, negative verbal comments and mocking of their body, sexual abuse), which lead them to reject their body. They were exposed to other iatrogenic factors such as a gaining reinforcements (admiration for their thin appearance) at the start of weight loss, which they fear losing. In addition to these personal experiences, there is the unattainable body ideal promoted by society, which for these patients is another highly stressful element. The combination of several or all of these elements causes them considerable anxiety when faced with the possibility of being fat. Extreme anxiety, together with the heightened sensory sensitivity would produce an increased perception of potential sources of danger⁴⁵. Once the sensation is distorted, the all-or-nothing cognitive processing leads to alarmist interpretations of these sensations⁴⁸. As a result of the interaction between fearful uncertainty, heightened sensitivity, and cognitive distortion, these patients react with considerable concern and alarm when faced with certain bodily sensations. From that moment on, the belief that one is fat transforms into the defining cognitive schema of their body self-concept⁴⁹. Their entire behaviour is directed towards avoid fatness⁵⁰. The possibility of not achieving this goal creates so much anxiety that their attention is focused on monitoring these sensations in an exaggerated and continuous manner. Unfortunately for the patient, the threat is constant because the external stimuli (e. g. , news or information on thinness, fatness and related issues) are constantly present in the environment. The bothersome internal sensations that they erroneously interpret as hunger or fatness (e. g. , anxiety, tension, constipation) are hard to escape, and the possibility of gaining control over their body weight is impossible.

There are numerous research studies that have demonstrated the relationship between fatness anxiety and bias in ED. Patients process the threatening words and images of fatness and high-calorie food and actively ignore the words and images that connote a thin physique⁵¹. They also better remember the issues related to food and weight than other nonthreatening issues⁵². The bias is kept in their mind, which also stores the memory of bodily sensations that warn them of danger. In supposedly threatening situations (e. g. , greater than planned food intake, comparison of their body with other actual or photographed thin bodies), the dysfunctional beliefs activate triggering alarmist thoughts and body images that lead to relief behaviours (e. g. , restricting food intake, exercising excessively, vomiting, performing stomach crunches). These relief behaviours, as with those performed by patients with SSD who go to multiple medical consultations, act as

negative reinforcement, which contributes to the maintenance of the distorted self-concept.

The similarities between the 2 processes do not end here. The mistaken body perceptions of the 2 patient groups are not reduced by the verbal feedback provided by their close friends and practitioners who treat them⁵³. The difficulties in changing their distorted view are similar and correspond to that of patients with cerebral disconnections, such as anosognosia and split brains⁵⁴. Just as patients with anosognosia deny their paralysis and patients with SSD are not convinced by either the medical tests or the information provided by their doctors, the information received by patients with anorexia on their thinness and risks (e. g. , confronted with the child-sized clothing they wear, data on their malnutrition and osteoporosis) does not change their “perceptive judgment. ” On the contrary, they create reasons and justifications that support their opinion and continue with their self-deception. Through attentional bias towards the stimuli that supposedly indicate danger, patients ignore reality thereby ratifying their mental integrity while validating their distorted self-concept (“I’m fat”), which allows them to justify their negative eating behaviours.

Finally, there appears to be a similarity in their neurocognitive processing⁵⁵, and the participation of structures involved in the brain circuits that govern body image, both in terms of multisensory integration and the experience of personification or belonging⁵⁶. A recent review of the cognitive–affective neuroscience of somatisation disorder suggested that the dysfunctional brain regions are the dorsolateral prefrontal, insular, rostral anterior cingulate, premotor and parietal cortices, which are similar to the structures affected in AN^{57,58,59,60}. Elaborating further on the similarities between patients with anorexia and patients with somatic disorders, if we change the concepts of ill and fat for misshapen and ugly, the processes of forming distorted self-concepts in patients with BDD are dramatically similar.

Once we have proposed the parallelism of the processes of forming distorted self-concept (disease, deformity, fatness) and observed the presence of heightened sensory sensitivity in patients who exhibit them, numerous still unanswered questions arise. The first of course refers to the replication of data from this study in other groups with anorexia. If the results were positive, we should ask ourselves whether this construct proposed in the SASTCA also occurs in other eating patients at various points in their development of the disorders and in their first-degree relatives.

If the results were positive, could the heightened sensory sensitivity constitute a broad-spectrum trait (sensory processing sensitivity?) that includes patients with anorexia, patients with somatic symptom disorder, patients with body dysmorphic disorder? Such a trait would be associated with greater sensitivity and responsiveness to the environment and social stimuli⁶¹. In the setting of anorexia nervosa, it would be reflected

in an avoidant attitude that resembles the “Highly Sensitive Person”, with more inhibited behaviour in the face of novel, highly stimulating situations⁶².

We also must ask about the specificity of the distortion. Why does body image distortion focus on disease, deformity and fatness? Our study does not provide data supporting any type of accurate explanation for this question. However, we have once again returned to the hypothesis associated with the rest of the patients who show heightened body sensitivity to understand what explanation they give to this dilemma⁶³. It has been suggested that the heightened sensitivity of patients with SSD could be the result of cerebral sensitisation caused by chronic exposure to stressful experiences concerning their body. In other words, it is the result of a learning process that, through repeated exposure to stimuli, produces progressive heightened sensitivity of the response (physiological, cognitive, emotional and behavioural) to the prominence of somatosensory stimuli⁶⁴. The specificity of the stressors in each patient group would indicate the specificity of the disorders. However, considering the items on the SASTCA, our hypothesis is that a number of aspects of the construct (e. g. , “I feel choked when clothing rubs or pinches me”, “I notice right away if my stomach growls”) could be the result of a process of cerebral sensitisation. Other aspects (e. g. , tendency to bruising, skin redness and scratches), however, seem to belong to genetically determined factors (sensory processing sensitivity?), that affect the perceptive threshold of body stimuli.

Lastly, the importance of this study lies in the value it provides in understanding another neurobiological characteristic of AN that can facilitate the early detection of vulnerable individuals and, as a result, establish pre-emptive intervention. Although a large number of studies and investigations are needed to reach a similar conclusion, the results seem sufficiently suggestive to interest other research groups in the topic and for them to provide their ideas and conclusions.

Conclusions

The preliminary results from this study indicate the presence of heightened sensitivity to internal and external body stimuli in patients with anorexia, which differs from the sensitivity of the control group. The presence of a lower perceptive threshold when faced with specific body stimuli, when interacting with the extreme body anxiety resulting from social pressure to be thin, makes individuals who have this lower threshold more vulnerable to experiencing the eating disorder than individuals who, under the same social pressure, do not present somatosensory amplification.

This heightened sensitivity has a significant relationship with heightened sensitivity described in patients with SSD and BDD and could contribute to the formation of a distorted body self-concept in these pa-

tient groups. This sensitivity, which precedes the onset of pathological eating behaviours, could be the expression of a somatic endophenotype, whose understanding could provide information on an underlying biomarker in this patient group?

The importance of this study lies in the value it provides in understanding another neurobiological characteristic of AN. As has occurred with the knowledge provided by other endophenotypes (difficulties in set shifting, weak central coherence and heightened sensitivity to punishment), this vulnerability trait can facilitate the early detection of the disorder and, as a result, establish pre-emptive intervention.

The SASTCA scale, which was developed to highlight this heightened sensitivity, presents sufficient internal consistency and optimal validity, which enables it to discriminate between patients with Anorexia Nervosa and healthy control participants. Further work is needed to establish validity and reliability in a wider population, and particularly in those at risk of eating disorders in the general population.

Limitations of the study

The majority of the content of this article is suggestions based on a small group of patients, and, as such, it does not attempt to draw conclusions but rather suggest a complementary viewpoint on the genesis of anorexia. All patients included in this study are adults with numerous severity criteria, which could constitute a bias in the interpretation of the results. Given that the vulnerability of first-degree relatives is being studied and that the similarities and differences with other somatic disorders were not compared, the proposition that this vulnerability could constitute a somatic endophenotype is more a desideratum than a certainty. Similarly, our data do not allow us to determine whether this vulnerability is genetically determined or whether brain sensitisation occurred at some point in the patients' life.

The SASTCA scale contains the reference to cold sensitivity, although sensitivity to cold is a symptom of anorexia. This sensitivity to cold could be a vulnerability factor and an effect of malnutrition. Future research should be done to verify this.

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Original/Otros

Satisfacción con la propia imagen corporal en una población de estudiantes universitarios de la Comunidad de Madrid

Elena Téllez Suárez¹, Ninfa Castillo Biscari², Sara García Quesada³, Isabel Yagüe Lobo⁴,
María Requena Angulo², Yoko Lucía Olmedilla Ishishi², María Arnoriaga Rodríguez² y
Víctor Manuel Andía Melero²

¹Centro de Salud Monóvar, HU Ramón y Cajal, Madrid. ²Servicio de Endocrinología y Nutrición, HGU Gregorio Marañón, Madrid. ³Servicio de Radiodiagnóstico, CHU Insular Materno-Infantil, Gran Canaria. ⁴Servicio de Endocrinología y Nutrición, HU de Fuenlabrada, Madrid. España.

Resumen

Objetivo: Valorar las características antropométricas y la satisfacción con la propia imagen corporal en un grupo de estudiantes universitarios.

Material y métodos: Se estudiaron 64 universitarios entre 21 y 25 años, 36 mujeres y 28 hombres. Se valoró la composición corporal mediante datos antropométricos y bioimpedanciometría. La satisfacción con la propia imagen corporal se valoró con una puntuación de 0 a 10.

Resultados: El IMC medio fue de 21,95 y la masa grasa 12,15 ± 5,27 Kg, siendo esta mayor en mujeres. El grado de satisfacción con la imagen corporal fue alto, con una puntuación de 7,15 + 1,15 sobre 10 y solo 3 participantes se valoraron con menos de 5 puntos. No hubo diferencias entre ambos sexos ni se observó una correlación entre la autovaloración y los resultados antropométricos en el grupo total, aunque sí se ha observado una relación inversa entre el grado de satisfacción y el IMC ($r = -0,52$), y no tan marcada con el porcentaje de grasa corporal ($r = -0,3$) en el grupo de mujeres.

Conclusiones: Las características antropométricas de la población estudiada son adecuadas, lo que se refleja en un alto grado de satisfacción con la propia imagen corporal. Sin embargo, en las mujeres hay una cierta tendencia a infravalorarse a medida que aumenta el valor del IMC, que no es tan marcada respecto al aumento de porcentaje de masa grasa, a pesar de que este último valor debería a priori reflejar más fielmente la imagen corporal real.

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Palabras clave: Antropometría. Imagen corporal. Composición corporal. Estudiantes universitarios.

SATISFACTION WITH BODY IMAGE IN A UNIVERSITY POPULATION OF THE COMUNIDAD DE MADRID

Abstract

Objective: To evaluate anthropometric characteristics and satisfaction with self body image in a group of university students.

Material and methods: 64 university students from 21 to 25 years old, 36 females and 28 males, were studied. Body composition was evaluated by anthropometric data and bioimpedance. Satisfaction with body image was self evaluated by a score from 0 to 10.

Results: Mean BMI was 21.95 and fat mass 12.15 ± 5.27 Kg, greater in women. Satisfaction level was high, with a mean score of 7.15 + 1.15, only 3 participants rated themselves below 5 points. There were no differences between sexes and there was not correlation between self evaluation and anthropometric data in the whole group but, in women, an inverse correlation ($r = -0.52$) between self evaluation and BMI was observed. This correlation was lesser ($r = -0.30$) between self evaluation and fat mass percent.

Conclusions: Anthropometric characteristics in the study population were appropriate, as reflected by the high level of satisfaction with their body images. Nevertheless, there is a trend towards a lower self evaluation at greater BMI in women. This trend is not so strong with greater fat mass percent, despite this parameter would represent more exactly the real body image.

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Key words: Anthropometry. Body image. Body composition. University students.

Abreviaturas

CUN-BAE: Clínica Universitaria de Navarra - Body Adiposity Estimator.

DEXA: Radioabsorciometría de doble energía.

EDI-2: Eating Disorder Inventory-2.

IMC: Índice de Masa Corporal.

Correspondencia: Víctor Manuel Andía Melero.
vmandia@ono.com

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Introducción

En los últimos años se está produciendo un aumento rápidamente progresivo en la prevalencia de sobrepeso y obesidad, tanto en nuestro país¹⁻³ como en el resto del mundo⁴. Sin embargo, los ideales de belleza actuales se basan en modelos delgados. En este sentido existe una importante presión del entorno, sobre todo a nivel familiar y de medios de comunicación⁵⁻⁶, que potencia estos ideales. Aunque toda la población está sometida a esta presión⁷, resulta mucho más marcada entre los adolescentes y jóvenes, sobre todo en el sexo femenino⁸.

La población universitaria es un grupo especialmente vulnerable desde el punto de vista alimentario. Esto se debe, entre otras causas, a que los universitarios asumen por primera vez la responsabilidad de cocinar para ellos mismos e incluso para los demás, dentro de su círculo social. Este aspecto seguramente no se produzca de igual manera en los universitarios que no se independizan hasta acabar sus estudios. Por este motivo la edad comprendida entre los 21-25 años es fundamental para definir el propio estilo alimentario.

Objetivo

Valorar las características antropométricas y de composición corporal en un grupo de estudiantes universitarios y su posible relación con la satisfacción con la propia imagen.

Material y métodos

Se realizó un estudio descriptivo transversal con participación voluntaria sobre una población de estudiantes universitarios de la Comunidad de Madrid. Se informó a los participantes del objetivo y características del estudio, y dieron su consentimiento informado. Los datos recogidos se codificaron para respetar la confidencialidad de los participantes. Se excluyeron los sujetos que presentaban alguna patología o siguieran algún tratamiento que pudiera modificar la composición corporal, así como los que hubieran presentado cambios importantes de peso (> 5 kg) en los últimos 3 meses de forma voluntaria o no.

Se solicitó a los participantes que valorasen su imagen corporal de forma global en una escala de 0 a 10. Para medir la talla se utilizó un tallímetro calibrado con una precisión de 0,5 cm. Las determinaciones de peso, masa grasa, masa magra y agua se realizaron en un impedanciometro tetrapolar TANITA BC-418MA con los sujetos descalzos, en ayunas al menos durante las 2 horas previas, desprovistos de cualquier material metálico y en condiciones óptimas de temperatura. Debido a la influencia del grado de hidratación sobre la bioimpedanciometría, para realizar la medición se recomendó a los sujetos no hacer ejercicio en las horas previas y vaciar la vejiga antes de la prueba. En las mu-

jes se realizó entre los días 5-10 del ciclo para garantizar la ausencia de embarazo y minimizar las modificaciones de composición corporal que se producen a lo largo del ciclo menstrual. El porcentaje de masa grasa obtenido por bioimpedanciometría se comparó con la estimación de masa grasa obtenida mediante la ecuación CUN-BAE⁹. El perímetro abdominal se midió con una cinta métrica inextensible a nivel del ombligo.

Las variables cuantitativas se presentan como media y desviación estándar, y las cualitativas mediante su distribución de frecuencias. Para estudiar la asociación entre variables cuantitativas se ha utilizado el test de la *t* de Student.

Resultados

La muestra está formada por 64 individuos, 36 mujeres y 28 varones, entre 21 y 25 años (media $23,5 \pm 0,85$), estudiantes de los últimos cursos de distintas carreras universitarias.

La talla media fue de $169,9 \pm 9$ cm, significativamente mayor en varones ($176,6$ frente a $164,7$ en mujeres, $p < 0,001$), y el peso medio de $63,64 \pm 10,25$ kg, también mayor en varones ($70,1$ frente a $58,6$, $p < 0,001$). El índice de masa corporal (IMC) medio fue de $21,95 \pm 2,31$ (rango $17,9 - 29,4$) sin que se hallasen diferencias significativas por sexos (Figura 1). El perímetro de cintura fue de $74,2 \pm 7,5$ cm., siendo significativamente mayor en varones (79 cm. frente a $70,5$ cm. en mujeres).

La media de masa grasa de la muestra determinada por bioimpedanciometría fue $12,15 \pm 5,27$ kg, mayor en mujeres ($24,3$ frente a $12,5$ kg. en varones, $p < 0,001$) y el porcentaje de masa grasa medida $19,16 \pm 7,66$ %, menor en varones ($12,5$ frente a $24,33$; $p < 0,001$). La media de masa grasa estimada mediante la ecuación CUN-BAE fue de $22,65 \pm 6,57$ %, en varones $16,76 \pm 4,39$ y en mujeres $27,23 \pm 3,67$; significativamente mayor que la medida ($p < 0,01$) pero con buena correlación entre ambas (global $r = 0,86$, varones $r = 0,59$, mujeres $r = 0,67$).

La autoevaluación de la imagen corporal en general fue buena, con una puntuación media de $7,15 \pm 1,15$. Solamente 3 participantes se puntuaron por debajo de

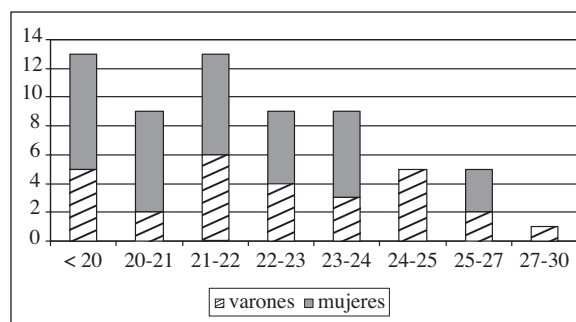


Fig. 1.—Distribución de IMC por sexo.

5, y 14 entre 5 y <7. La figura 2 muestra la correlación de esta autoevaluación con el IMC y con el porcentaje de masa grasa. No se objetivaron diferencias por sexos, aunque en las mujeres se observó cierta tendencia a valorarse más a menores valores de IMC ($r = -0,52$). Esta mejor autovaloración por parte de las mujeres no fue tan marcada a menor porcentaje de masa grasa ($r = -0,30$).

Discusión

Los datos antropométricos de la población estudiada fueron similares a los obtenidos en otros estudios sobre población universitaria tanto en España¹⁰⁻¹² como en otros países¹³⁻¹⁵, salvo en Estados Unidos donde la prevalencia de sobrepeso y obesidad es mucho mayor¹⁶.

Los valores de perímetro de cintura fueron significativamente mayores en varones que en mujeres, coincidiendo con los resultados de González Deschamps et al¹⁷. La estimación del porcentaje de masa grasa con la ecuación CUN-BAE muestra una buena correlación con el resultado obtenido mediante la bioimpedanciometría dentro de este rango prácticamente normal de IMC, al igual que se ha comprobado al compararla con el DEXA¹⁸.

En general, los universitarios de la muestra se autovaloraron positivamente respecto a su imagen corporal, encontrándose cierta tendencia entre las mujeres a una mayor puntuación cuanto menor era el valor del IMC. Estos resultados coinciden con los de Castillo y Molina-García¹⁹, que también emplearon la bioimpe-

danciometría como instrumento de medida del porcentaje de masa grasa. Sin embargo contrastan con los publicados por otros autores^{12,15,20}, en los que un elevado porcentaje de las universitarias se sentían insatisfechas con su peso corporal y deseaba pesar menos. Esta insatisfacción se aprecia ya desde edades más precoces^{8,21}.

Resulta sorprendente el hallazgo de que la satisfacción con la imagen corporal se correlacione más con el peso o IMC, que en realidad no es más que un parámetro numérico, que con el porcentaje de masa grasa que debería reflejar mejor el fenotipo real de los participantes. Este hecho podría deberse, al menos en parte, a que la valoración de la imagen se realizó de forma global y no se utilizó un cuestionario como el EDI-2²², que está más centrado en regiones anatómicas concretas. En la revisión bibliográfica realizada no se ha encontrado ningún estudio que refiera posibles diferencias en la satisfacción con la imagen corporal en función del IMC frente a mediciones de composición corporal.

La principal limitación de este estudio es que, al ser de participación voluntaria, los sujetos que aceptaron participar generalmente eran de universitarios sin problemas de sobrepeso. En el estudio realizado por Matamoros et al²³ la prevalencia de obesidad en la Comunidad de Madrid en sujetos de 20 a 29 años está entre el 15 y el 20%, siendo el IMC medio de 24 en hombres y de 21,7 en mujeres; mientras que en nuestro estudio, de 64 participantes estudiados, sólo 6 (9,4 %) tenían un IMC entre 25 y 30 (sobrepeso) y no había ningún obeso. Este resultado hace sospechar que probablemente

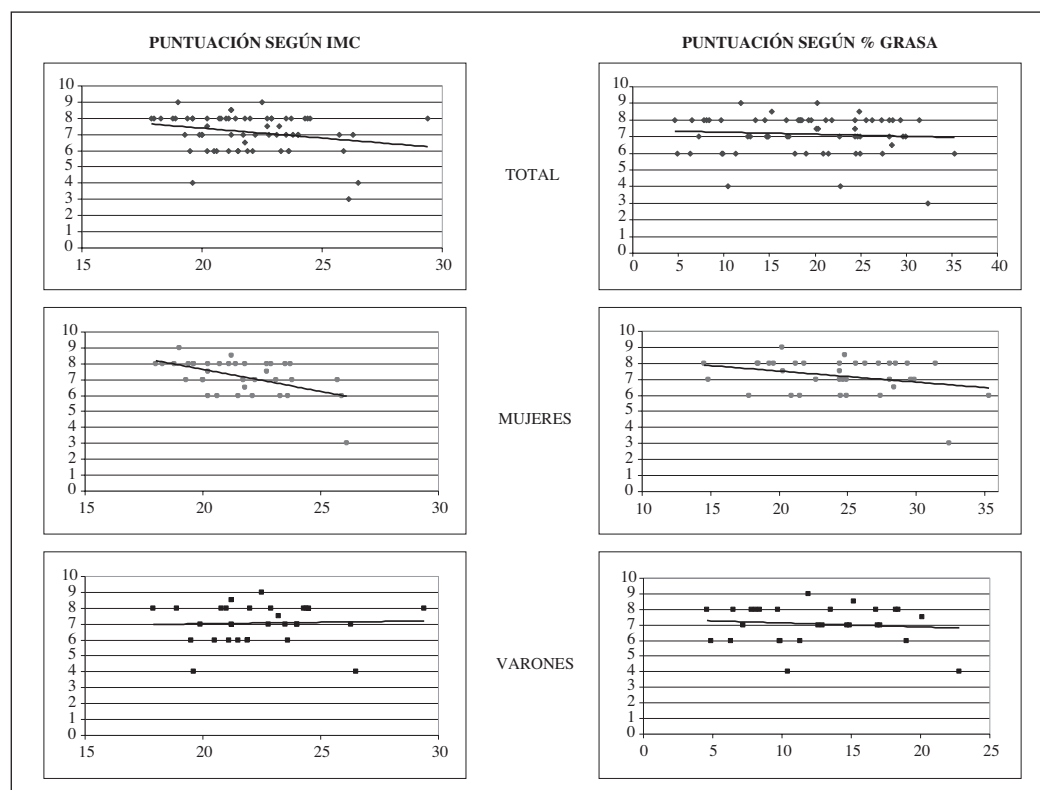


Fig. 2.

aquellos universitarios con mayor exceso de peso y/o una gran insatisfacción personal con su aspecto físico no han querido participar en el estudio, por lo que los resultados pueden no ser representativos de la población universitaria global.

Conclusiones

El grado de satisfacción con la propia imagen corporal en los sujetos estudiados ha sido elevado, pero probablemente no sea representativo de la población universitaria en general. Esta satisfacción parece más influida por el IMC que por el porcentaje de masa grasa por lo que, al menos en la población estudiada, “la báscula parece más importante que el espejo” en lo que respecta a la opinión acerca de la propia imagen.

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Original/Otros

Polyphenols benefits of olive leaf (*Olea europaea* L) to human health

Patrícia Vogel¹, Isabel Kasper Machado^{2,3}, Juliano Garavaglia^{2,3}, Valdeni Terezinha Zani²,
Daiana de Souza² and Simone Morelo Dal Bosco^{1,2}

¹Course of Nutrition, Centro Universitário UNIVATES, Lajeado/RS. ²Universidade Federal de Ciências da Saúde de Porto Alegre - UFCSPA, Department of Nutrition. ³Universidade do Vale do Rio dos Sinos - UNISINOS, Brazil.

Abstract

Introduction: The phenolic compounds present in olive leaves (*Olea europaea* L.) confer benefits to the human health.

Objectives: To review the scientific literature about the benefits of the polyphenols of olive leaves to human health.

Method: Literature review in the LILACS-BIREME, SciELO and MEDLINE databases for publications in English, Portuguese and Spanish with the descriptors “*Olea europaea*”, “olive leaves”, “olive leaf”, “olive leaves extracts”, “olive leaf extracts”, “phenolic compounds”, “polyphenols”, “oleuropein”, “chemical composition”, and “health”. There were identified 92 articles, but only 38 related to the objectives of the study and 9 articles cited in the works were included due to their relevance.

Results and discussion: The phenolic compounds present in olive leaves, especially the oleuropein, are associated to antioxidant, antihypertensive, hypoglycemic, hypocholesterolemic and cardioprotective activity. Furthermore, studies associate the oleuropein to an anti-inflammatory effect in trauma of the bone marrow and as a support in the treatment of obesity.

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Key words: *Olea europaea*. Olive leaves. Phenolic compounds. Oleuropein. Health.

BENEFICIOS POLIFENOLES HOJA DE OLIVO (OLEA EUROPAEA L) PARA LA SALUD HUMANA

Resumen

Introducción: Los compuestos fenólicos presentes en las hojas del olivo (*olea europaea* L.) conferir beneficios para la salud humana.

Objetivos: Revisar la literatura científica sobre los beneficios de los polifenoles de hojas de olivo para la salud humana.

Método: Revisión de la literatura en las bases de datos lilacs-bireme, scielo y medline para publicaciones en inglés, portugués y español con los descriptores “*olea europaea*”, “*hojas de olivo*”, “*hoja de olivo*”, “*hojas de olivo extractos*”, “*los extractos de hoja de olivo*”, “*compuestos fenólicos*”, “*polifenoles*”, “*oleuropeína*”, “*composición química*”, y “*salud*”. Se identificaron 92 artículos, pero sólo 38 en relación con los objetivos del estudio y 9 artículos citados en las obras se incluyeron debido a su relevancia.

Resultados y discusión: Los compuestos fenólicos presentes en las hojas del olivo, especialmente la oleuropeína, se asocian a antioxidante, antihipertensivo, hipoglucemiante, actividad hipocolesterolémico y cardioprotector. además, los estudios asocian la oleuropeína a un efecto anti-inflamatorio en trauma de la médula ósea y como soporte en el tratamiento de la obesidad.

(Nutr Hosp. 2015;31:1427-1433)

DOI:10.3305/nh.2015.31.3.8400

Palabras clave: *Olea europaea*. Hojas de olivo. Compuestos fenólicos. Oleuropeína. Salud.

Abbreviations

AGEs: Advanced glycation end products.
AI: Atherosclerotic index.

ALT: Alanine aminotransferase.
AMI: Acute myocardial infarction.
AST: Aspartate aminotransferase.
CAT: Catalase.
CK: Creatin kinase.
CK-MB: Creatin kinase-MB.
COX-2: Cyclooxygenase-2.
CP: Crude protein.
CPK: Creatine phosphokinase.
CPK-MB: Creatine phosphokinase-MB.
TC: Total cholesterol.
CTE: Catechin equivalent.
DBP: Diastolic blood pressure.
DM2: Type 2 diabetes mellitus.

Correspondence: Simone Morelo Dal Bosco.
Centro de Ciências Biológicas e da Saúde.
Centro Universitário Univates.
Rua Avelino Talini, 171, Universitário - Lajeado/RS.
Brasil. CEP: 95900-000.
Telephone: +55 (51) 3714 7000.
E-mail: simonebosco@gmail.com

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DXR: Doxorubicin.
 EPCs: Endothelial progenitor cells.
 GAE: Gallic acid equivalent.
 GSSG: Oxidized glutathione.
 HDL-c: High-density lipoprotein cholesterol.
 HF: Heart failure.
 HO-1: Heme oxygenase-1.
 IL-1 β : Interleukin-1 β .
 IL-6: Interleukin-6.
 iNOS: Inducible nitric oxide synthase.
 LDH: Lactate dehydrogenase.
 LDL-c: Low-density lipoprotein cholesterol.
 MDA: Erythrocyte malondialdehyde.
 NA: Nicotinamide.
 NO: Nitric oxide.
 Nrf2: Erythroid 2-related factor.
 PARP: Peroxisome proliferator-activated receptor.
 PARP γ : Peroxisome proliferator-activated receptor.
 SBP: Systolic blood pressure.
 SOD: Superoxide dismutase.
 STZ: Streptozotocin.
 TBARS: Thiobarbituric acid-reactive substance.
 TEAC: Trolox under defined conditions.
 TG: Triglycerides.
 TNF α : Tumor necrosis factor- α .

Introduction

The olive tree (*Olea europaea* L.) is cultivated in many parts of the world, but the Mediterranean region is the main area of agricultural production, it represents approximately 98% of the growing around the world¹. Apart from the Mediterranean region, the olive tree is cultivated on a large scale in the Arabian Peninsula, India and Asia².

The main product extracted from the olive tree is the olive oil, of a global production of 11 million tons per year³. The olive oil is one of the bases of the Mediterranean Diet, widely studied for its antioxidant benefit⁴, particularly given to the large number of phenolic compounds present in the olive tree⁵. However, the olive leaves also contain phenolic compounds; the oleuropein, hydroxytyrosol, verbascoside, apigenin-7-glucoside and luteolin-7-glucoside are the most abundant already identified in olive leaf extracts⁶. The term “olive leaves” refers to a mixture of leaves and branches from both the pruning of olive trees and the harvesting and cleaning of olives⁷.

The large number of phenolic compounds present in olive leaves aroused the interest of researchers around the world and the studies with animals and humans have reported beneficial health effects such as the capacity of antioxidant⁶, anti-hypertensive⁸, hypoglycemic⁹, hypocholesterolemic¹⁰, cardioprotective¹¹, anti-inflammatory¹² and as adjuvant in the treatment of obesity¹³. This study aims to review the scientific literature about the benefits of polyphenols of olive leaves to human health.

Method

This work is a literature review. There were consulted the LILACS-BIREME, SCIELO and MEDLINE databases. Scientific papers published in English, Portuguese and Spanish between the period of 2000 and 2014 about olive leaves and the benefits to human health were selected. The “*Olea europaea*”, “olive leaves”, “olive leaf”, “olive leaves extracts”, “olive leaf extracts”, “phenolic compounds”, “polyphenols”, “oleuropein”, “chemical composition” and “health” descriptors have been used to search in the database. Ninety-two articles were identified, but only 38 were related to the objectives of this study. The first analysis of the articles was conducted by the title and then by the abstract. Besides these, 9 references that have been cited in the articles were included in the articles that were found due to its relevance to the study.

Results and discussion

Chemical characteristics and bioavailability of olive leaves

The chemical composition of olive leaves varies according to origin, proportion of branches present in the extract, storage conditions, weather conditions, moisture content and degree of soil contamination^{14,15}. The nutritional composition of the extract from olive leaves is strongly influenced by processing (drying and extraction)¹⁶. One study showed that the dehydration by lyophilization, air drying and oven drying reduced the nutritional value of the extract¹⁴ and that the greatest loss of nutritive value was in the chopped samples before processing¹⁵.

An in vitro study has shown that the dehydration process has no significant influence on the bioavailability, but the composition of the extract modifies meaningfully the digestion process because the oleuropein and verbascoside are quite resistant to gastric digestion but is largely degraded in the intestinal phase. In the study, the luteolin-7-O-glucoside was the most stable phenolic compound in the in vitro simulation of the digestion process¹⁷.

The content of crude protein (CP) varies between 9.5 and 12.9%¹⁵; they are rich in amino acids such as arginine, leucine, proline, glycine, valine and alanine and poor in cysteine, methionine and lysine¹⁸. The greatest proportion of hemicellulose fibers are arabinosa type, whereas the branches have predominantly mannose¹⁹.

Polyphenols of olive leaves

The Mediterranean diet is known for its health benefits, especially given to the large amount of polyphenols present in fruits, vegetables, oilseeds and olive

oil⁶. The extra virgin olive oil is produced from the fruit of the olive tree, botanically known as *Olea europaea* L, rich in polyphenols and known for its antioxidant capacity²⁰. However, the olive leaves contain higher amount of polyphenols than olive oil. For example, the amount of oleuropein, which is the most abundant phenolic compound ranges from 0.005% and 0.12% in olive oil while in olive leaves it ranges between 1 and 14%⁴.

Phenolic compounds are secondary products to the metabolism of vegetables. In the case of the olive tree, the olive polyphenols are a consequence of the reactivity to pathogen attack and the response to insect injuries⁴.

There are five groups of identified phenolic compounds in olive tree: oleuropeosides (*oleuropein* and *verbascoside*); flavones (*luteolin-7-glucoside*, *apigenin-7-glucoside*, *diosmetin-7-glucoside*, *luteolin* and *diosmetin*); flavonols (*rutin*); flavan-3-ols (*catechin*) and substituted phenols (*tyrosol*, *hydroxytyrosol*, *vanillin*, *vanillic acid* and *caffeic acid*). The *oleuropein* is the most abundant phenolic compound in olive leaves, followed by *hydroxytyrosol*, *luteolin-7-glucosides*, *apigenin-7-glucosides* and *verbascoside*. The *hydroxytyrosol* is the precursor of the *oleuropein*, while the *verbascoside* is a conjugated glucoside of *hydroxytyrosol* and *caffeic acid*⁶.

The total content of flavonoids and polyphenols of olive leaves was determined as 2.058 mg GAE (gallic acid equivalent) per 100 g and 858 mg CTE (catechin equivalent) per 100 g, values similar to a red grape²¹.

Antioxidant activity of olive leaves

Reactive species of oxygen and nitrogen are produced constantly in the human body. They are essential for many cellular mechanisms such as energy production, chemical signaling and immune function and its production is controlled by enzymes such as superoxide dismutase (SOD), glutathione peroxidase and catalase (CAT), however, when there is an excess in the production of these reactive species there can occur an oxidative damage at cellular level. This cell damage is related to the increased risk of chronic diseases such as cardiovascular disease and cancer²². However, it is believed that the antioxidants may prevent or minimize oxidative damage and, consequently, reduce the risk of chronic diseases⁶.

Table I shows the phenolic compounds from olive leaves identified by Benavente-Garcia and collaborators in comparison to Trolox under defined conditions (TEAC). The flavonol rhamnoglucoside *rutin* (TEAC 2.75mM), flavan-3-ol *catechin* (TEAC 2.28mM) and flavone *luteolin* (TEAC 2.25mM) are the compounds with highest capacity for scavenging the ABTS•+ radical cation⁶.

The antioxidant activity of *oleuropein* is related to the *hydroxytyrosol* moiety in its structure. Compared

Table I
Antioxidant activity of phenolic compounds
from olive leaves

Phenolic compound	TEAC (mmol/L)
Olive leaf extract	1.58 ± 0.06
Rutin	2.75 ± 0.05
Catechin	2.28 ± 0.04
Luteolin	2.25 ± 0.11
Hydroxytyrosol	1.57 ± 0.12
Diosmetin	1.42 ± 0.07
Caffeic acid	1.37 ± 0.08
Verbascoside	1.02 ± 0.07
Oleuropein	0.88 ± 0.09
Luteolin-7-glucoside	0.71 ± 0.04
Vanillic acid	0.67 ± 0.09
Diosmetin-7-glucoside	0.64 ± 0.09
Apigenin-7-glucoside	0.42 ± 0.03
Tyrosol	0.35 ± 0.05
Vanillin	0.13 ± 0.01

TEAC: Trolox equivalent antioxidant capacity. Adapted Benavente-García et al. (2000).

with the *hydroxytyrosol*, the ability of scavenging the radical cation ABTS•+ is lower because of the molecular weight of the *oleuropein*. The study suggests that the olive phenolics compounds exhibit a synergistic behavior in the capacity of elimination of free radical when mixed in the form of extract, superior to the antioxidant capacity of the vitamin C and E⁶.

Benefits of polyphenols of olive leaves to human health

The polyphenols of olive leaves have numerous beneficial effects to human health, such as antioxidant capacity⁶, anti-hypertensive⁸, hypoglycemic⁹, hypocholesterolemic¹⁰, cardioprotective¹¹, anti-inflammatory¹² and as a coadjuvant in the treatment of obesity¹³.

Antihypertensive effects of polyphenols of the olive leaf

The antihypertensive action of olive leaf extract has been shown in several studies. A study with 40 monozygotic prehypertensive twins that evaluated the effects of the daily dose of 500mg and 1000mg of olive leaf extract on systolic blood pressure (SBP) and diastolic blood pressure (DBP) for 8 weeks showed

a significant reduction in SBP and DBP of the group who received a 1000 mg daily dose. The group that received 500 mg decreased its SBP and DBP, however, it was not meaningful²³. A study of Susalit and collaborators evaluated the effect of olive leaf extract on the SBP and DBP in individuals with stage 1 hypertension. The study showed that a dose of 500mg twice a day, for a total daily dose of 1000 mg, was able to reduce both systolic and diastolic pressure. The antihypertensive activity of olive leaf extracts was compared to the captopril medicament in a dose of 12.5 - 25mg, twice a day⁸. Another study that used animal models with diabetes mellitus type 2 (DM2) and renal hypertension induced by streptozotocin (STZ), nicotinamide (NA) and placement of solid plexiglass clips on left renal arteries showed a reduction in SBP due to the antioxidant activity of olive leaf extract, induced by the release of nitric oxide (NO) and sympatholytic activity²⁴. Another study corroborated the findings showing that the oleuropein confers cardiovascular protection in animal models with DM2 and renal hypertension concomitantly, particularly when the extract has been used at a dose of 60 mg/kg per day¹¹. The mechanisms responsible for the anti-hypertensive effect of the oleuropein are not well determined, however, some studies attribute this effect to the inhibition of angiotensin converting enzyme, a calcium channel-blocking activity and restoration of endothelial function²⁶, the vasodilation²⁷ and radicalscavenging activity¹⁰.

Hypocholesterolemic effects of the polyphenol of olive leaf

The phenolic compound of olive leaves and olive oil in the Mediterranean diet is associated to a reduced incidence of cardiovascular diseases, as antioxidants minimize the deleterious effects of free radicals in the body. It is believed that the process may involve phospholipase C activation and arachidonic acid metabolism, and it is thought to reduce hydrogen peroxide²⁸.

The beneficial effects of polyphenols of the olive leaf on the lipid profile such as decrease of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c) and triglycerides (TG) have been reported. In this study, the difference between the treatment group and the control group was not significant for the TG, although the serum level decreased 23.2% in the group that received 1000 mg of olive leaf extract per day⁸. This reduction was slightly lower than the fenofibrate, a potent anti-triglyceride agent²⁹. In a study mentioned previously, with 40 monozygotic prehypertensive twins, there was a significant reduction in LDL-c²³. A study with mice fed with a diet rich in cholesterol showed that oral administration of olive leaf extract, acid extract hydrolyzate and enzymatic hydrolyzate extract reduced the blood levels of TC, TG, LDL-c. In addition, the mice that received the phenolic extracts had their levels of high-den-

sity lipoprotein cholesterol (HDL-c) reestablished. ($p < 0.05$). The study suggests hypocholesterolemic effect of the phenolic compounds in the olive leaf extracts. The study also calculated the atherosclerotic index (AI), defined as the ratio of LDL-c and HDL-c, which was significantly lower in the groups that were administered phenolic compounds present in the olive leaf extracts ($p < 0.05$) and showed that there was a significant reduction in the hepatic activity of CAT and SOD in mice fed with a cholesterol-rich diet compared with the control group. However, the levels were restored in the presence of phenolic compounds present in the olive leaf extracts ($p < 0.05$)³⁰. A similar study with hypercholesterolemic rabbits showed that administration of 10 or 20 mg / kg of *oleuropein* for 6 weeks decreased the TC and the TG ($p < 0.05$)³¹. In relation to the effects of polyphenols of the olive leaf in hypocholesterolemic associated with hyperglycemia, a study that assessed the effects of the administration of extracts of oleuropein and hydroxytyrosol in diabetic mice at concentrations of 16 and 8 mg/kg of body weight showed significantly lower concentrations of TC in diabetic rats that received *oleuropein* and hydroxytyrosol compared with the control group. The administration of extracts rich in phenolic compounds was able to restore the lipid profile, especially in the groups that received oleuropein and hydroxytyrosol in a concentration of 16 mg/kg of body weight, showing that oleuropein and hydroxytyrosol olive leaf extract can correct significantly the hypercholesterolemia coupled with hyperglycemia¹⁰.

Cardioprotective effects of polyphenols of olive leaf

In addition to the antihypertensive and hypocholesterolemic effect described in the scientific literature, the polyphenols of olive leaf have other cardioprotective effects. A study that evaluated the effects of oleuropein on myocardial injury showed that the administration of 20 mg/kg of body weight prior the induction of ischemia in rats resulted in decreased release of creatine kinase (CK), which is an important marker of gravity of the cardiac injury and of oxidized glutathione (GSSG), which is a sensitive marker of heart's exposure to oxidative stress. To assess the specific molecular oxidative alterations the study also measured the concentration of thiobarbituric acid-reactive substance (TBARS), which seems to increase considerably in the cardiac muscle after the ischemia, indicating a severe oxidative change in the membrane of phospholipids. The study found no significant increase in TBARS in the mice that received oleuropein compared to the control group, suggesting cardioprotective effect³². Janahmadi and collaborators, in a study that evaluated the cardiovascular protection of oleuropein in mice, showed that pre-treatment with *oleuropein* provides protection

for acute myocardial infarction (AMI), preventing the development of heart failure (HF) secondary to AMI. The improvement of the cardiac function may be due to the reduction of the infarction size and the cardiac injury, including improvement in the serum levels of creatin kinase-MB (CK-MB), troponin I and lactate dehydrogenase (LDH)³³. Another study showed that the administration of *oleuropein* at 10 or 20mg/kg for 6 weeks or of 20 mg/kg for 3 weeks reduced the infarct size compared with the control group ($p=0.001$)³¹.

A recent study evaluated the capacity of the *oleuropein* to restore the endothelial progenitor cells (EPCs) exposed to angiotensin II. The EPCs are responsible for the neovascularization of ischaemic tissue and may participate in re-endothelization of an injured arterial wall and there is evidence that the angiotensin II impairs the function of the EPCs. EPCs are responsible for neovascularization of tissue and ischaemic may participate in re-endothelization of an arterial wall injured and there is evidence that angiotensin II impairs the function of EPCs. The study showed that the *oleuropein* has protective effect in these cells, not only for its antioxidant capacity, but also because it involves the stimulation of nuclear transcription factor erythroid 2-related factor (Nrf2) and, as a result, increase the expression of heme oxygenase enzyme-1 (HO-1)³⁴. The HO-1 enzyme has antioxidant, anti-inflammatory, anti-apoptotic properties and it has the ability to re-endothelization of injured arterial wall or neovascularization of ischemic³⁵.

The *oleuropein* has also been studied for its protective effect on the administration of certain drugs such as doxorubicin (DXR). The doxorubicin, an anthracycline antibiotic clinically known as adriamycin, is a highly effective antineoplastic drug against many malignant diseases^{36,37}, however, the clinical use of DXR is often limited because of its undesirable serious cardiotoxic side effects, probably induced by oxidative stress³⁸. An *in vivo* study that evaluated the effect of *oleuropein* in mice treated with DXR showed that the drug increases significantly the release of cardiac enzymes into the systemic circulation ($p<0.05$) and that the concomitant use of *oleuropein* in concentrations of 100 and 200mg/kg of the body weight with DXR reduced the serum levels of creatine phosphokinase (CPK), creatine phosphokinase-MB (CK-MB), LDH, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) ($p<0.05$). Furthermore, the *oleuropein* reduced lipid peroxidation induced by DXR, improving the therapeutic outcome and preventing the cardiotoxic³⁹. In another study, the *oleuropein* prevented cardiomyopathy induced by DXR, preserving the contractility of the left ventricular and alleviating the development of inflammatory and degenerative lesions in the myocardium. It also prevented the nitro-oxidative stress, the imbalance in the homeostasis of NO, the expression of pro-apoptotic mediators and the derangement of myocardial metabolism⁴⁰.

Effects of polyphenols of olive leaf in DM2

The polyphenols of olive leaves, particularly the *oleuropein*, are well known for their hypoglycemic effect; two mechanisms have been suggested to explain this effect: 1) the potential to affect glucose-induced insulin release, and 2) an effect to increase peripheral uptake of glucose⁴¹. In addition, part of the hypoglycaemic effect is attributed to the antioxidant capacity of *oleuropein*⁴². A study of Jemai and collaborators assessed the effects of the administration of extracts of *oleuropein* and hydroxytyrosol in diabetic mice at concentrations of 16 and 8 mg/kg of body weight. The study showed that the blood glucose levels were significantly lower ($p<0.05$) in diabetic rats after administration of extracts of *oleuropein* and hydroxytyrosol in all concentrations. However, the mice that received *oleuropein* and hydroxytyrosol in a concentration of 16 mg/kg of the body weight showed a hypoglycaemic effect significantly higher than those that received these compounds at a concentration of 8 mg/kg of body weight. The study showed a significant increase in liver glycogen in the groups that received *oleuropein* and hydroxytyrosol extracts compared to the two control groups (normal glucose and diabetic). The mice that received the *oleuropein* at 16mg/kg of body weight showed higher levels of hepatic glycogen concentration ($p<0.05$)¹⁰. A study with diabetic rabbits evaluated the effects of administration of the *oleuropein* extract on the levels of blood glucose. The study used a dose of 20 mg/kg of body weight for a period of 16 weeks and showed a significant effect of the *oleuropein* as hypoglycemic from the 8th week of administration of the extract. The study also revealed that the group treated with *oleuropein* showed a gradual reduction in the levels of erythrocyte malondialdehyde (MDA), which is an oxidative stress marker, significantly from the 10th week of administration compared to the control group. The study suggested the use of *oleuropein* prophylactically in the reduction of complications resulting from oxidative stress in DM2⁴¹. Another study assessed the capacity of major phenolic components of olive leaf extract (luteolin, hydroxytyrosol, luteolin-4'-O- β -D-glucopyranoside, luteolin-7-O- β -D-glucopyranoside and *oleuropein*) as inhibitors of the formation of advanced glycation end products (AGEs), showed that luteolin and luteolin-4'-O- β -D-glucopyranoside are potent inhibitors of AGEs, i.e., they delay the development of diabetic complications. The *oleuropein* inhibited the formation of AGEs, but it was not significant⁹.

Effects of polyphenols of olive leaf in chronic colitis

The effect of *oleuropein* administration in patients with chronic colitis was tested by Giner and collaborators, in a study that evaluated the effects of a diet supplemented with *oleuropein*, equivalent to 500mg/kg of body weight for 56 days in mice with chronic colitis

induced by dextran sulfate sodium. The study showed a reduction in cellular infiltration and consequently in the recruitment of inflammatory cells (macrophage, neutrophil and eosinophil) to the location of the injury. Furthermore, in the group with the diet supplemented with oleuropein decreased the release of inflammatory cytokines such as interleukin-6 (IL-6) and interleukin-1 β (IL-1 β). The IL-6 is a pro-inflammatory cytokine that plays an important role in the development of inflammatory intestinal diseases with elevated serum levels of both acute and chronic inflammation. Elevated levels of IL-1 β are also correlated with disease activity and associated with active lesions. The study suggests that the oleuropein administration is effective in alleviating symptoms of chronic colitis induced by sodium sulfate⁴³.

Effects of polyphenols of olive leaf in traumas

The anti-inflammatory effect of oleuropein in spinal cord trauma was tested in mice that were divided in 4 groups, one of them received 20 mg/kg of body weight of oleuropein soon after the spinal cord injury and the other one after 1 hour. The tests were performed 24 hours after the injury. The study showed an attenuation of the levels of tumor necrosis factor- α (TNF- α), IL-1 β , nitrotyrosine, inducible nitric oxide synthase (iNOS), cyclooxygenase-2 (COX-2) and peroxisome proliferator-activated receptor (PARP) in the mice that received oleuropein independent of the time of administration. The pro-inflammatory cytokines TNF- α and IL-1 β are synthesized immediately after the spinal cord injury worsening the posttraumatic condition by the increase of vascular permeability, recruitment of inflammatory cells and induction of iNOS and COX-2. Thus, the study suggests that oleuropein modulates the inflammatory reactions after spinal cord injury⁴⁴.

Effects of polyphenols of olive leaf in obesity

The effect of the *oleuropein* in obesity has also been studied, specifically in substantial modulation of physiological and molecular pathway involved in energy metabolism and adiposity. An *in vitro* study showed that the *oleuropein* reduced the expression of peroxisome proliferator-activated receptor γ (PPAR γ), inhibited adipogenesis and enhanced osteoblastogenesis in stem cells derived from human bone marrow¹³. Another study demonstrated that the *oleuropein* acted on 3T3-L1 cells and reduced preadipocyte differentiation and lipid accumulation and thus regulated the size of fat cells⁴⁵. A study of Svobodova and collaborators showed that the oleuropein has an anti-adipogenic effect through the inhibition and activity and PPAR γ which is essential for the formation and function of the adipocytes⁴⁶. The PPAR γ is also involved in the regulation of insulin sensitivity. De Bock and collaborators suggested dietary supplementation with polyphenols from olive leaf,

more specifically oleuropein, as a therapeutic strategy for the prevention and treatment of obesity⁴⁷.

Conclusion

Polyphenols of olive leaf, especially oleuropein, have interesting effects on the human body such as antioxidant capability, antihypertensive, hypoglycemic, hypocholesterolemic, however, many of these effects have been tested in animals and it is necessary to perform studies with human beings to confirm the benefits attributed to polyphenols from olive leaf.

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Original/Otros

Effect of zinc supplementation on superoxide dismutase activity in patients with ulcerative rectocolitis

Juliana Paz Matias¹, Danilla Michelle Costa e Silva², Kyria Jayanne Clímaco Cruz¹, Kelcylene Gomes da Silva³, Mayara Monte Feitosa⁴, Leydiane Gleici Oliveira Medeiros¹, Dilina do Nascimento Marreiro² and Nadir do Nascimento Nogueira²

¹Graduate Program in Food and Nutrition. Federal University of Piauí. Teresina. Piauí. Brazil. ²Department of Nutrition. Federal University of Piauí. Teresina. Piauí. Brazil. ³Department of Food and Experimental Nutrition, School of Pharmaceutical Sciences, University of São Paulo. São Paulo. Brazil. ⁴Graduate Program in Sciences and Health. Federal University of Piauí. Teresina. Piauí. Brazil.

Abstract

Introduction: Ulcerative rectocolitis is characterized by diffuse mucosal inflammation and oxidative stress. Thus, the organism activates the antioxidant defence system in an attempt to reduce the excessive production of reactive oxygen species or neutralize them.

Objective: This study evaluated the effect of zinc supplementation on the activity of the enzyme superoxide dismutase (SOD) in patients with ulcerative rectocolitis.

Methods: The study included 24 patients, aged between 20 and 59 years and diagnosed with ulcerative rectocolitis, in the remission stage of the disease, who were divided into two groups: experimental - deficient in zinc (n=12) and control - normal or high zinc (n=12). Only the first group underwent supplement intervention, in the form of zinc gluconate (30 mg Zn/day), taken daily in the morning, fasted for 60 days. Plasma and erythrocyte zinc concentrations were determined by flame atomic absorption spectrophotometer. The erythrocyte SOD activity was determined in vitro according to the methodology recommended by the manufacturer Randox.

Results and Discussion: Zinc supplementation caused a significant increase in the plasma concentrations of the mineral, and showed a significant reduction in erythrocyte zinc, remaining within normal limits. The SOD activity was high in patients of both the experimental and control groups, with no difference after supplementation.

Conclusion: This study demonstrates that zinc supplementation improves the homeostatic condition of the mineral, with no change in SOD activity, as a marker of oxidative stress in patients with ulcerative rectocolitis.

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Key words: Rectocolitis, Ulcerative, Zinc, Superoxide Dismutase.

Correspondence: Nadir do Nascimento Nogueira.
Rua São Pedro, 3274, Apartamento 704, Ilhotas,
CEP 64001-260, Teresina, Piauí, Brazil.
E-mail: nadirn@uol.com.br

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EFFECTO DE LA SUPLEMENTACIÓN DE ZINC SOBRE LA ACTIVIDAD DE LA ENZIMA SUPERÓXIDO DISMUTASA (SOD) EN PACIENTES CON COLITIS ULCEROSA

Resumen

Introducción: La colitis ulcerosa se caracteriza por la inflamación difusa de la mucosa y el estrés oxidativo. De esta forma, el cuerpo activa el sistema de defensa antioxidante en un intento de reducir la producción excesiva de especies reactivas de oxígeno, así como poder neutralizarlos.

Objetivo: Este estudio evaluó el efecto de la suplementación de zinc sobre la actividad de la enzima superóxido dismutasa en pacientes con colitis ulcerosa.

Métodos: El estudio incluyó 24 pacientes, con edades comprendidas entre 20 y 59 años y con diagnóstico de colitis ulcerosa en fase de remisión de la enfermedad. Los pacientes fueron divididos en dos grupos: experimental - deficiencia de zinc (n = 12) y control - normales o con altos contenido de zinc (n = 12). El grupo experimental se sometió a tratamiento con suplemento de drogas, en forma de gluconato de zinc (30 mg Zn / día), administrada diariamente por la mañana en ayunas durante 60 días. Las concentraciones en plasma y los eritrocitos de zinc se determinaron por espectrofotometría de absorción atómica de llama. La actividad de la superóxido dismutasa (SOD) se determinó por el método de eritrocitos in vitro utilizando el kit de Randox.

Resultados y Discusión: La suplementación de zinc causó un aumento significativo en las concentraciones plasmáticas de mineral y mostró una reducción significativa en los eritrocitos, permaneciendo dentro de los límites normales. La actividad de SOD fue mayor en los pacientes de los grupos experimentales y de control, sin diferencias después de la suplementación.

Conclusión: El estudio evidenció que la administración de suplementos de zinc mejora la condición homeostática del mineral, sin ningún cambio en la actividad de SOD, como un marcador de estrés oxidativo en pacientes con colitis ulcerosa.

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Palabras clave: Colitis Ulcerosa, Zinc, Superóxido Dismutasa.

Abbreviations

IBD: Inflammatory Bowel Disease.
ROS: Reactive Oxygen Species.
SOD: Superoxide Dismutase.
UH: University Hospital.
UFPI: Federal University of Piauí.
EDTA: Ethylenediamine Tetraacetic Acid.

Introduction

Inflammatory bowel disease (IBD) encompasses a heterogeneous group of chronic diseases of unknown etiology and systemic nature, which cause inflammation of the digestive tract, particularly ulcerative rectocolitis in the rectum and Crohn's disease¹. Ulcerative rectocolitis is one of the most common diseases of the large intestine, and its main characteristic is a diffuse mucosal inflammation, which is located in the proximal region of the rectum, developing extensive superficial mucosal ulceration².

Evidence has shown that the intestinal injury in patients with IBD, such as ulcerative rectocolitis, results from the leukocyte infiltration caused by the rupture of the colonic barrier and bacterial invasion, favouring the release of inflammatory mediators and reactive oxygen species (ROS), which promote oxidative damage^{3,4}. To compensate for the damage caused by oxidative processes, the organism activates the antioxidant defence system, which acts through enzymes and substances capable of reducing or neutralising the excessive production of ROS.

The enzyme superoxide dismutase (SOD) acts on the first line of antioxidant defence by catalysing the conversion of the superoxide anion into hydrogen peroxide and oxygen, and hydrogen peroxide is then converted into water and oxygen by glutathione peroxidase⁵. The important antioxidant role of zinc as a structural component of SOD in this reaction must be emphasised⁶.

Considering ulcerative rectocolitis as a chronic disease, the occurrence of zinc deficiency and of oxidative stress as common events in patients, and the importance of this mineral as an antioxidant nutrient, this study aimed to evaluate the effect of zinc supplementation on the activity of the enzyme superoxide dismutase in patients with ulcerative rectocolitis.

Methods

The study included 24 patients, aged between 20 and 59 years and diagnosed with ulcerative rectocolitis, assisted at the University Hospital (UH) of the Federal University of Piauí (Universidade Federal do Piauí - UFPI). Patients in the remission stage of the disease were selected using the Mayo Score as the criterion⁷. Patients using vitamin-mineral supplements

and/or medications that could interfere with the metabolism of zinc, as well as patients with coexisting diseases such as diabetes, high cholesterol, hypertension, and kidney disease, were excluded.

The plasma zinc concentrations were used as a basis for the evaluation of the intervention with zinc, and the patients were divided into two groups: experimental (deficient in zinc) and control (normal or high zinc). Only the first group underwent supplement intervention, in the form of zinc gluconate (30 mg Zn/day), taken daily in the morning, and fasted. The intervention with the supplement lasted 60 days, and after this period, all patients were reassessed for the biochemical parameters related to the mineral. The study was conducted after approval of the experimental protocol by the Ethics in Research Committee of the UFPI.

Determination of zinc and SOD enzyme activity

A total of 20 mL of blood was collected for the biochemical analysis, of which 15 mL was transferred to demineralised test tubes containing 30% sodium citrate as anticoagulant for the analysis of zinc, and 5 mL was transferred to tubes containing EDTA to determine SOD activity. The plasma was separated from the whole blood by centrifugation at 1831 x g for 15 minutes in a refrigerated centrifuge. The preparation of erythrocytes for zinc determination was performed according to Whitehouse et al⁸. The samples were stored at -20°C and -80°C for the analysis of zinc and SOD, respectively, after separation.

Two aliquots of each plasma sample were prepared by diluting in water processed by the MILLI-Q® Water System (Continental Water Systems Corp. El Paso, Texas), at the ratio of 1:4, and the samples were read on a flame atomic absorption spectrophotometer. Titrisol® (Merck) prepared by dilution in MILLI-Q® water with 3% glycerol was used as the zinc standard. The results were calculated from the absorbance obtained and expressed in µgZn/dL, representing the mean of the concentrations of the samples prepared in triplicate.

Aliquots of 400 µL of erythrocytic cell mass, diluted 4 times in cold MILLI-Q® water to obtain lysate 1, were used to determine zinc in the erythrocytes. From this lysate, a new 400 µL aliquot was withdrawn and diluted again 10 times in cold MILLI-Q® water to obtain lysate 2. The lysate 2 samples were read under the same conditions as the plasma mineral analysis and expressed in µgZn/gHb, and the standard curve was prepared in MILLI-Q® water at 1% nitric acid. To express the zinc results in µgZn/gHb, the haemoglobin concentration in the lysate was determined by the cyanmethaemoglobin method⁹.

The erythrocyte SOD activity was determined *in vitro* according to the methodology recommended by the manufacturer Randox®. In addition to the sample, mixed substrate, xanthine oxidase buffer, and standard

Table I
Mean values and standard deviations of zinc concentrations in plasma and erythrocytes and superoxide dismutase activity in the control and experimental groups, pre- and post-intervention. Teresina, Piauí, Brazil, 2011

Parameters	Plasma Zinc ($\mu\text{gZn/dL}$)		Erythrocyte Zinc ($\mu\text{gZn/g Hb}$)		SOD (U/gHb)	
	Pre	Post	Pre	Post	Pre	Post
Control (n=12)	94,07 $\pm$ 21,88	75,89 $\pm$ 20,49	50,83 $\pm$ 11,19	48,08 $\pm$ 11,07	3109 $\pm$ 1013,30	3194 $\pm$ 962,75
Experimental (n=12)	58,64 $\pm$ 8,14*	75,05 $\pm$ 14,44**	47,82 $\pm$ 8,98	40,09 $\pm$ 7,97**	3601 $\pm$ 917,14	3126 $\pm$ 644,97

Reference values: plasma: 70-110 $\mu\text{g/dL}$ ¹⁰; erythrocyte: 40 a 44 $\mu\text{g Zn/g Hb}$ ¹¹; SOD: 1102 - 1601 U/gHb. *p<0,05 experimental *versus* control; **p<0,05 pre *versus* post.

were prepared for later calculation of the enzyme activity, the results of which were expressed as U/gHb.

Statistical analysis

The data were analysed using the Statistical Package for Social Sciences for Windows, version 15.0 (SPSS Inc., Chicago, IL, USA). The variables of different groups were compared by Student's independent t test. The paired Student's t test was used for variables in the same group at different times. p<0.05 was considered statistically significant.

Results

The results for plasma and erythrocyte zinc concentrations as well as SOD activity are shown in table I. Zinc supplementation caused a significant increase (p<0.05) in the plasma concentrations of the mineral. Regarding the erythrocyte zinc, a significant reduction (p<0.05) was observed in the concentrations, but they remained within normal limits. The SOD activity was high in patients of both the experimental and control groups, with no difference after supplementation (p>0.05).

Discussion

Zinc supplementation in patients with ulcerative rectocolitis caused a significant increase in the plasma concentrations of this mineral. This increase may be explained by the homeostatic mechanism responsible for maintaining the plasma zinc within the physiological standards¹². Plasma zinc is an important biochemical indicator that changes as a result of acute functional responses as well as nutritional interventions¹³, as observed in this study. Our results corroborate the findings reported by Van de Wal¹⁴, who demonstrated an improvement in plasma zinc levels upon supplementation with this mineral in patients with IBD, using 100 mg of zinc aspartate three times a day.

Regarding erythrocyte zinc, this study identified reduced mineral concentration in these patients after supplementation. This result may be explained in part by

the involvement of zinc in many metabolic pathways. Thus, the decrease in the concentration of the mineral in the erythrocyte may be due to the larger demand for the micronutrient by the antioxidant defence system, given that SOD, a zinc-dependent enzyme, acts on the first line of defence against the oxidative stress characteristic of the disease.

The high values found for SOD activity in the control and experimental groups suggests that antioxidant action is exerted by the enzyme in response to the oxidative stress inherent to the disease, which may be explained by the adaptive mechanism of the mucosa activated by oxidative stress. Similar results were found by Dincer et al¹⁵, who observed elevated SOD activity in plasma from patients with IBD compared to healthy controls. The absence of change in SOD activity found in these patients after intervention may have been due to the short period of supplementation, which may not have been sufficient to promote a significant change in the activity of the enzyme. This response is consistent with the decrease in the erythrocyte zinc concentration observed in this study, a result that is supported by Mulder et al¹⁶, who performed supplementation with 300 mg of zinc aspartate for four weeks.

In the mucosa and submucosa of the human colon, enzymes such as SOD are found at low concentrations; therefore, the increased expression of the antioxidant enzyme systems in this region may decrease inflammation in clinical and experimental IBD¹⁷. Cario et al¹⁸ found that zinc supplementation promoted intestinal epithelium repair in patients with IBD through the activation of zinc-dependent enzymes with antioxidant function, such as superoxide dismutase.

Zinc deficiency enhances susceptibility to oxidative damage, contributing to a continuous inflammatory process¹⁷. Thus, it is important to note that inflammatory gastrointestinal diseases are associated with changes in zinc metabolism or deficiency¹⁹. Therefore, supplementation with this mineral can be beneficial for both the correction of zinc deficiency and the reduction of oxidative stress²⁰.

In conclusion, this study demonstrates that zinc supplementation improves the homeostatic condition of the mineral, with no change in SOD activity, as a marker of oxidative stress in patients with ulcerative rectocolitis.

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Original/Otros

Availability of food stores and consumption of fruit, legumes and vegetables in a Brazilian urban area

Milene Cristine Pessoa¹, Larissa Loures Mendes², Waleska Teixeira Caiaffa³, Deborah Carvalho Malta^{4,5} and Gustavo Velásquez-Meléndez⁵

¹Departamento de Nutrição e Saúde, Universidade Federal de Viçosa, Viçosa, Minas Gerais. ²Departamento de Nutrição, Universidade Federal de Juiz de Fora, Juiz de Fora, Minas Gerais. ³Faculdade de Medicina, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais. ⁴Secretaria de Vigilância em Saúde, Ministério da Saúde, Brasília, Distrito Federal. ⁵Escola de Enfermagem, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais. Brazil.

Abstract

Background: The food environment can have an important influence on the availability of and access to food, which plays a significant role in the health of individuals. The goal of this study was to compare the consumption of fruits, legumes and vegetables (FLV) by adults and the availability of food stores in the context of socioeconomic and geographic space connected to basic health units in a Brazilian capital city.

Methods: The study was developed from information obtained through the Risk Factors Surveillance for Non-Communicable Diseases Prevention by Telephone Survey (VIGITEL), using samples from Belo Horizonte from the years 2008 to 2010. A total of 5611 records were geocoded based on the postal code. A score was created based on the weekly and daily frequency of FLV intake of individuals. The coverage area of basic health units was used as a neighborhood unit. Georeferenced data on food stores in the city and neighborhood income were used.

Results: As neighborhood income increased, there was an increase in the distribution of food establishments for all of the studied categories. The highest FLV intake scores were observed in areas with higher income levels.

Conclusion: The highest concentration of food stores, regardless of supply quality, was observed in geographic areas with higher purchasing power and in those where there was a greater concentration of other types of businesses and services, a different pattern from that found in other countries.

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Key words: Diet. Fruit Vegetables. Environment and public health. Income.

LA DISPONIBILIDAD DE LAS TIENDAS DE ALIMENTOS Y EL CONSUMO DE FRUTAS, LEGUMBRES Y VERDURAS EN UN ÁREA URBANA DE BRASIL

Resumen

Antecedentes: El ambiente alimentar puede tener una influencia importante en la disponibilidad y el acceso a ellos, éste desempeña un papel importante en la salud de las poblaciones. El objetivo de este estudio fue comparar el consumo de frutas, legumbres y hortalizas (FLV) de adultos y la disponibilidad de las tiendas de alimentos en el contexto del espacio socioeconómico y geográfico en el territorio de las unidades básicas de salud en una capital brasileña.

Métodos: El estudio se desarrolló a partir de la información obtenida a través de la Vigilancia de Factores de Riesgo para Enfermedades no Transmisibles Prevención de Encuesta Telefónica (VIGITEL), utilizando muestras de la ciudad de Belo Horizonte en los años de 2008 a 2010. Un total de 5.611 registros fueron geo-codificados usando el código postal. Una puntuación fue creada en base a la frecuencia semanal y diario del consumo de FLV. El área de las unidades básicas de salud se utilizó como unidad vecinal. Se utilizaron los datos geo-referenciados de los comercios de venta de comida en la ciudad y el barrio.

Resultados: A medida que aumentaba la renta del barrio, hubo un aumento en la distribución de los establecimientos de comida e bebidas para todas las categorías estudiadas. Se observaron las puntuaciones más altas de consumo FLV en zonas con niveles de ingresos más altos.

Conclusión: La mayor concentración de tiendas de alimentos e bebidas e mayor puntuación de consumo, independientemente da calidad de los productos ofrecidos, fue observado en las áreas geográficas con mayor poder adquisitivo.

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Palabras clave: Dieta. Frutas. Hortalizas. Medio ambiente y la salud pública. Ingresos.

Correspondence: Gustavo Velásquez-Meléndez.
Universidade Federal de Minas Gerais/Escola de Enfermagem.
Av. Alfredo Balena, 190 - Belo Horizonte, MG, Brazil - 30130-100.
+ 55 31 3409-9868
guveme@ufmg.br

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Introduction

The consumption of fruits, legumes and vegetables (FLV) is part of healthy eating patterns associated with chronic non-communicable diseases (NCDs) prevention¹.

Recent evidence supports hypotheses about a relationship between environment and health, proposing an ecological approach to explain this relationship^{2,3}. This link can also be applied to understand how environmental factors can act on issues related to the food consumption. The food environment can have an important influence on the availability and access to food^{4,5,6,7}.

In Brazil, few studies have evaluated the food environment of neighborhoods. National household surveys based on probability samples showed low consumption of FLV in the Brazilian population⁸, which was also found in other analyzes using telephone interviews^{9,10}. In addition, a separate study¹¹ in a large Brazilian city showed that there are significant differences in the availability of food stores and restaurants in the context of neighborhoods. However, there is no information on the individual level of healthy consumption.

The social environment, the built environment and the macro-environment are included in the environmental contexts related to eating behaviors¹². Considering the built environment, for example, it was observed in several American populations that evidence points to differences in the trade and food distribution in addition to racial and socioeconomic segregation in the occupation of the urban space. Studies also show that neighborhoods with greater miscegenation and socioeconomically disadvantaged occupants tend to have a higher concentration of food stores with little food variety^{13,14}, and therefore, some healthy foods, such as fruits, legumes and vegetables, are less available or have poorer quality in lower-income areas¹⁴.

The present study aimed to compare the consumption of FLV by adults and the availability of food establishments within the socioeconomic context and geographic area attached to the basic health units in a Brazilian city.

Methods

The present study was developed from the Risk Factors Surveillance for Non-Communicable Diseases Prevention by Telephone Survey (VIGITEL) using samples obtained in Belo Horizonte, Brazil, from the years 2008, 2009 and 2010¹⁵.

For the present study, 6,034 registries were considered eligible, geocoded using the postal code. The geographic coordinates (latitude and longitude) corresponding to the centroid of the postal code rather than the residential address were georeferenced for 5,826 (96.5%) points. Of the 5,826 points to be georeferenced, 215 did not have complete information, resulting in a final sample of 5,611 participants.

For the analysis of FLV consumption, a score was created based on the weekly and daily consumption frequency of these foods, as reported by the respondents. The score of FLV consumption ranged from zero (when the individual reported no consumption of fruits, legumes and vegetables on any day of the week) to 12 points (when fruits, legumes and vegetables were consumed five or more days of the week and 2-3 times a day).

Georeferenced environmental data were obtained from databases provided by the Municipal Secretariat of Health and the Information Technology Company of the municipality of Belo Horizonte, whose information was related to the coverage area of the basic health units (territorially delimited set of census tracts) comprising 148 subdivisions of the nine Sanitation Districts of the municipality of Belo Horizonte. The coverage areas were defined by administrative and health criteria. This method of organization is used by the public system for the delivery of health services and defined by basic health units (BHU). In these BHU, the local government provides health measures and policies, including basic health care services. The average coverage area was 2.5 km², with the smallest area being 0.3 km² and the largest being 14.7 km². On average, 7,000 households and 21,000 inhabitants were observed per coverage area.

To characterize the built environment factors, a database was created with information on the food establishments in Belo Horizonte, based on the National Classification of Economic Activities from 2011. This database is the national standardization instrument of the economic activity codes and the eligibility criteria used by the various tax administration organizations of Brazil.

The databases from municipal public facilities of food security and nutrition, such as fruits and vegetables subsidized by the city and restaurants with accessible prices focused on offering nutritionally balanced, ready meals, were also included. Moreover, data such as the sum of the monthly nominal income of individuals aged 10 years or older in the coverage areas, named the overall yield of the coverage area, were obtained from the databases of the Brazilian Institute of Geography and Statistics¹⁶.

A geographic information system was used for the preliminary spatial analysis to stratify the geocoded data in information layers and to develop data maps. The crossings of the spatial information layers were translated into variables for the analysis using MapInfo software, version 8.5.

Thematic grid maps, generated from the inverse distance weighted interpolation method using the MapInfo Professional 8.5 software, were used to describe the spatial distribution of the FLV-consumption scores and neighborhood income. The categories of FLV-consumption scores were defined by calculating the mean and standard deviation values corresponding to quintiles of the overall income of the coverage areas. Geo-

graphical areas without residences and green areas of 2 km² or more were also identified on the maps.

Variance analysis and Bonferroni correction for multiple comparisons were used to compare the average number of food establishments according to the quintiles of the overall income of the coverage areas. The STATA 12.0 program was used for the analysis. The significance level was set at 0.05.

The VIGITEL implementation project was approved by the National Ethics Committee on Human Research. The present study was also approved by the Ethics Committee, according to the Opinion No. 25447414.1.0000.5149.

Results

In 2008, the average FLV consumption score was 6.0 (95% CI 5.85 - 6.24); in 2009, the score was 6.1 (95% CI 5.94 - 6.25); and in 2010, the score was 6.2 (95% CI 6.11 - 6.41). The mean score among men was 5.9 (95% CI 5.73 - 6.01), and the mean score among women was 6.3 (95% CI 6.22 - 6.49).

Table I shows the descriptive measures of the environmental variables. There was a high number of restaurants, bars and eateries in the city. On average, the food establishments with the lowest presence in the coverage areas were supermarkets and hypermarkets. In Belo Horizonte, there were 17,984 registered food establishments in total. The average number of food establishments per coverage area was approximately 154. Only one neighborhood had no food establishment. There is high variability of the total average in-

come among the coverage areas, shown by a standard error value higher than the average, which emphasizes high inequity compared to income in the municipality.

Table II shows a comparison of the availability of food establishments according to quintiles of the total income of the coverage areas. As neighborhood income increased, there was also an increase in the distribution of food establishments of all categories. Based on the multiple comparison test, there were differences in the distribution of food establishments in almost all the quintiles of overall income of the coverage areas for the analyzed categories of establishments. That is, there are more establishments in higher income areas, regardless of the type of establishment.

Thematic maps were prepared to verify the spatial distribution of the FLV-consumption score and to describe the overall income quintiles of the coverage areas of the basic health unit in Belo Horizonte (Fig. 1). Based on the maps, higher FLV consumption scores were observed in areas with higher income levels.

Discussion

In the present study, the mean FLV consumption score for the adult population of the municipality of Belo Horizonte was 6, which represents the combination of fruit and vegetables, fruits and legumes, or legumes and vegetables in 5 or more days of the week, considering 1-2 daily servings of fruits and only one serving of vegetables and legumes. This level of consumption can be considered low and is lower in males, a finding consistent with what has been widely obser-

Table I
Description of environmental variables according to the coverage areas of basic health units in Belo Horizonte - MG - Brazil. 2008-2010

<i>Variables</i>	<i>Mean (SD)</i>	<i>Median</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Total number of establishments</i>
Monthly overall income of CA (in reals)	34,200.0 (42,300.0)	15,700.0	1,423.8	204,000.0	Not applicable
Population density (Inhabitants/km ²)	9,706.7 (3,719.58)	9,530.2	519.4	26,165.2	Not applicable
Supermarkets and hypermarkets	3.3 (0.05)	2	0	22	332
Mini-markets, grocery stores and warehouses	14.2 (0.15)	14	0	51	1,846
Shops and open-air markets specializing in selling produce	5.9 (0.11)	5	0	53	723
Restaurants	33.00 (0.90)	16	0	373	3,566
Bars	17.8 (0.31)	14	0	86	2,077
Eateries	30.3 (0.83)	18	0	413	3,446
Mobile food shops	4.2 (0.08)	4	0	33	534
Total number of food establishments ^a	153.6 (9.07)	122	0	1,215	17,984

Abbreviation: SD, standard deviation; CA, Coverage area of basic health unit ^aTotal number of food establishments: Included all the food establishments in the city of Belo Horizonte, in addition to those already described in the table, such as bakeries and pastry shops; dairy and cold cuts retail businesses; sellers of sweets, candies, chocolates and similar; beverage vendors; butcher shops; fish markets; pharmacies and drug stores that sell food and department stores that sell food.

Table II
Establishments that sell food according to the overall income quintiles of the coverage areas of basic health units in Belo Horizonte - MG - Brazil. 2008-2010

Food establishment	1st Mean Quintile (SD)	2nd Mean Quintile (SD)	3rd Mean Quintile (SD)	4th Mean Quintile (SD)	5th Mean Quintile (SD)	p value
Number of supermarkets and hypermarkets	0.8 (0.03)	1.7 (0.05) ^a	1.9 (0.04) ^a	3.4 (0.07)	6.7 (0.12)	<0.001
Number of mini-markets, grocery stores and warehouses	8.4 (0.11)	13.6 (0.17)	15.2 (0.14)	17.9 (0.24)	19.9 (0.31)	<0.001
Number of shops and open-air markets specialized in selling produce	2.5 (0.05)	4.8 (0.10)	5.5 (0.07) ^a	6.2 (0.11) ^a	15.2 (0.36)	<0.001
Number of restaurants	4.3 (0.14)	9.9 (0.22)	17.8 (0.37)	43.3 (0.68)	158.9 (3.65)	<0.001
Number of bars	5.3 (0.09)	11.0 (0.14)	16.8 (0.19)	24.7 (0.42)	51.9 (0.84)	<0.001
Number of eateries	4.6 (0.11)	12.9 (0.30)	21.0 (0.43)	36.1 (0.47)	133.1 (3.55)	<0.001
Number of mobile food shops	1.8 (0.06)	3.6 (0.05)	5.1 (0.09) ^a	5.2 (0.09) ^a	8.3 (0.24)	<0.001
Total number of food establishment	43.6 (0.54)	91.5 (1.02)	127.2 (1.41)	198.8 (2.16)	523.0 (10.13)	<0.001

Abbreviation: SD - standard deviation. Bonferroni ANOVA test showed significant differences in multiple comparisons between the groups.
a - p-value > 0.05 for Bonferroni test.

ved in national studies, such as household budget surveys⁸ and telephone interviews^{9,10,15}. However, the results must be assessed with caution because the intake was measured only using an indication of consumption and not the amount consumed.

A positive relation was observed between the socioeconomic level of the areas and higher FLV consumption scores. The average FLV consumption was below the desired level reinforced by the findings of other studies^{8,9,10,15}. More quantitatively equipped geographic areas were observed. The highest concentration of food establishments, regardless of supply quality, was observed in geographic areas inhabited by individuals with higher purchasing power and where there was a greater concentration of other types of businesses and services.

Studies conducted in another Brazilian city have shown that areas with lower economic deprivation have a higher density of all types of food businesses in addition to better public transport structure and a higher density of parks and public places for the practice of sports. This finding suggests that the installation of supermarkets and other retail food establishments in a given area is largely determined by the economic market. These types of establishments tend to aggregate in regions with higher purchasing power¹⁷. That is, the supply and number of food establishments increases proportionally with the income of the neighborhood, not only for establishments that sell FLV but also for all types of establishments. In the present study, the characterization of the availability of food establishments does not allow analytical approaches that discriminate the characteristics of stores with respect to the quality of the food offered within the geographic areas under study, particularly regarding the availability of

certain healthy foods, such as fresh meat, low-fat milk and nutritionally healthy drinks, as well as competitive prices. This type of information can only be obtained using other methodological approaches, such as direct on-site observation¹⁸.

In a more detailed investigation in the city of São Paulo, it was found that the access to healthy foods varied according to the type of food establishment and according to the socioeconomic status of vicinal small geographic areas. Fast-food restaurants were more often located in low socioeconomic neighborhoods, and supermarkets and restaurants that offer full meals were more often located in neighborhoods with higher socioeconomic status¹¹.

Likewise, in some developed countries, it is possible to qualitatively distinguish the distribution of types of food establishments according to the socioeconomic status of the neighborhood. In American urban areas, for example, in addition to racial and socioeconomic segregation and occupation of the urban space, there is evidence of differences in business and food distributions (food environment). Neighborhoods with greater miscegenation and more individuals with lower income tend to have a higher concentration of commercial establishments with little food variety than of supermarkets, considered by several authors, in this specific context, as places with a greater variety of food and, generally, with the lowest prices^{13,19,20,21,22,23}.

In relation to individual consumption, based on the comparison of maps, the higher FLV consumption scores occurred in more socioeconomically advantaged areas. It is known that in addition to individual factors, neighborhood socioeconomic factors may influence the choice of food. Material conditions, including the financial situation (e.g., family income), social depri-

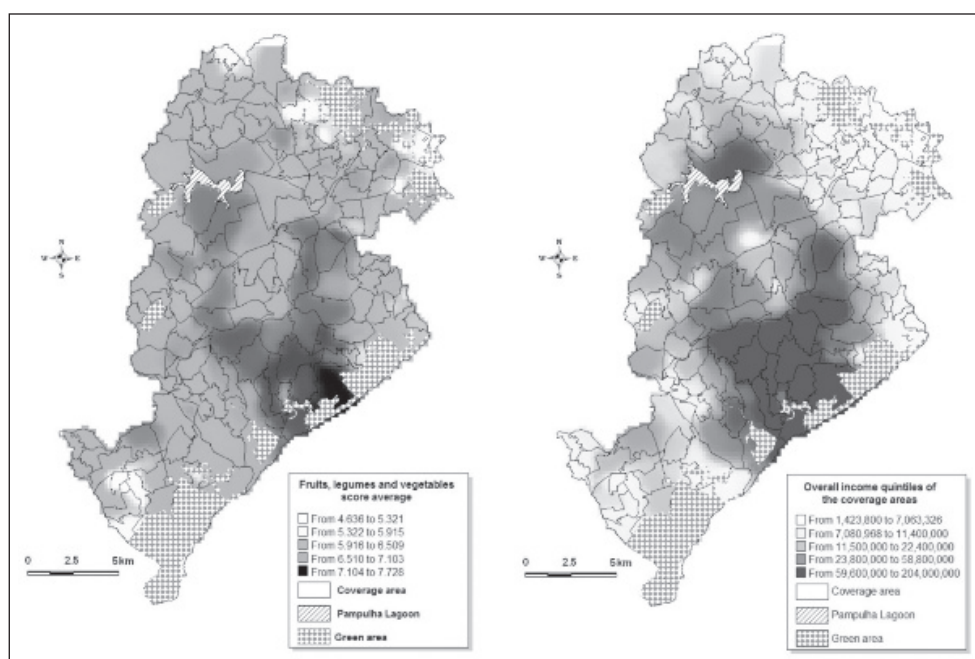


Fig. 1.—Mean score of fruits, legumes and vegetables according to the coverage area and overall income quintiles (in reais) of the coverage areas in Belo Horizonte - MG - Brazil.

vation and unfavorable working, housing and neighborhood conditions, can affect feeding behavior. The income of an individual, in part, can determine his/her access to various products and even certain food stores, hindering the purchase of healthy foods^{14, 24}.

Increased FLV consumption is an important factor in coping with NCDs and should be understood not only in the scope of individual decisions but also from the perspective of increased supply, increased production, lower prices, availability and food quality, factors that affect public policies. In 2013, the Ministry of Health launched a plan for coping with NCDs, providing increased FLV consumption in the next decade^{25,26}. The current study may support local planning to expand the availability of healthy foods and reduce health inequities based on such availability.

However, we can highlight some limitations of the present study. One of the limitations concerns the geo-referenced data used to describe the characteristics of the environment, which are secondary and derived from government and commercial sources and, therefore, may be subject to inaccuracies. An additional limitation can also be recognized regarding the impossibility of analysis of food prices, the perceived environment, the possible concomitance of the sale of fruits, legumes and unhealthy foods, and access to food establishments rather than only their availability, as analyzed in the present study. Studies including those factors would provide more consistent results regarding the analysis of the food environment in Belo Horizonte.

The present study advances the hypothesis of the correlation between healthy eating and the availability of foods and services, presented by the income in urban areas whose historical process of conformation

is diametrically opposed to developed countries. In addition, there is a need to reduce the geographical area to better discern the intra-urban differentials (although there has been great advancement in the use of the coverage areas) or to compare homogeneous geographic areas. It should also be noted that surveillance systems are important tools in this type of research and with the aid of environmental information become relevant tools for the planning of actions to promote healthy eating in urban spaces.

Acknowledgments

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Caso clínico

Mejora de los parámetros clínicos en un paciente con síndrome metabólico mediante intervención en educación nutricional y mejora del estilo de vida

María Isabel Martínez¹; Araceli Ferri², Ana María Mateos³ y Antoni Alegre⁴

¹Universidad CEU Cardenal Herrera. Moncada, Valencia Grupo Nutrición y Digestivo de SEFAC. ²Farmacia Comunitaria Montaverner Valencia. ³Farmacia Comunitaria Zaragoza. Coordinadora del grupo de Nutrición y Digestivo de SEFAC.

⁴Universidad CEU Cardenal Herrera, Moncada, Valencia. España.

Resumen

Objetivos: El objetivo general es la disminución de la morbilidad y mortalidad prematuras asociadas al síndrome metabólico (SM).

Métodos: Se realiza un recuento de ingestas de 24h para 3 días y se realiza una historia clínica y dietética. Se realiza un seguimiento de 19 consultas para seguir la evolución.

Resultados: Tras la pérdida de peso, la medición de glucemia capilar fue de 59 mg/dl retirándole el tratamiento con metformina y al cabo de 7 días sin tratamiento con metformina fue de 64 mg/dl.

Conclusiones: La intervención en educación nutricional y del estilo de vida contribuyó a la disminución de casi un 10% del peso corporal, el paciente pasó de estar en el intervalo de IMC correspondiente a obesidad al de sobrepeso además mejoró la resistencia periférica a la insulina y en consecuencia ocasionó la retirada por parte del médico de Atención Primaria de la metformina pautada.

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Palabras clave: DeCS (Descriptores en Ciencia de la Salud): Síndrome X metabólico. Terapia nutricional. Educación en salud.

Abreviaturas

SM: Síndrome metabólico.
ATP: Atención Primaria.
FID: Federación Internacional de Diabetes.
DM2: Diabetes Mellitus tipo 2.
IMC: Índice de masa corporal.
%GC: Porcentaje de grasa corporal.

IMPROVEMENT OF CLINICAL PARAMETERS IN A PATIENT WITH METABOLIC SYNDROME THROUGH INTERVENTION IN NUTRITION EDUCATION AND IMPROVEMENT OF LIFESTYLE

Abstract

Objective: The main objective is the reduction of early morbidity and mortality associated with metabolic syndrome (MS).

Methods: 24h intakes count for 3 days and clinical-nutritional history. Follow-up of 19 visits to monitor the evolution.

Results: Following weight loss, the measurement of capillary blood glucose was 59 mg/dl, discontinuing then treatment with metformin; after 7 days without metformin treatment the value was 64 mg/dl.

Conclusions: Intervention in nutritional education and lifestyle contributed to almost a 10% reduction of body weight; the patient moved from the obesity BMI range to overweight. Peripheral insulin resistance was also enhanced and the GP in charge decided to discontinue the dosing of metformin as a result.

(Nutr Hosp. 2015;31:1444-1448)

DOI:10.3305/nh.2015.31.3.7990

Key words: MeSH: Metabolic syndrome X. Nutrition therapy. Health education.

%ME: Porcentaje de músculo esquelético.
F: Indicador de grasa visceral.
TAS: Tensión arterial sistólica.
TAD: Tensión arterial diastólica.
FC: Frecuencia cardíaca.

Introducción

El síndrome metabólico (SM), también conocido como síndrome plurimetabólico, síndrome de resistencia a la insulina o síndrome X, tal como indica el nombre está constituido por una serie de problemas de salud que aparecen de forma simultánea o secuenciada así como de factores genéticos y/o ambientales¹ asociados al estilo de vida, concretamente a la sobrealimenta-

Correspondencia: María Isabel Martínez.
Universidad CEU Cardenal Herrera.
Edificio seminario, s/n. Moncada, Valencia.
E-mail: isabelmm@uch.ceu.es

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ción². El exceso de grasa abdominal junto a la ausencia de ejercicio físico favorecen la resistencia a la insulina en el individuo, considerándose el factor principal para la aparición de este síndrome³.

Existe cierta controversia respecto a los criterios aceptados para su diagnóstico. En 1999, la OMS afirmaba que el síndrome está definido por la presencia de diabetes tipo 2 coincidiendo con al menos dos de los cuatro factores siguientes: hipertensión, hiperlipidemia, obesidad, y microalbuminuria⁴. Sin embargo, contaba con algunos puntos débiles que fueron revisados en 2001 por el Panel ATP III del Programa Nacional de Educación sobre el Colesterol de los EEUU⁵, muy similares a los que establece la FID⁶.

Los criterios del ATP III exigen que al menos se den tres de los cinco factores que se citan a continuación: perímetro de cintura excesivo (102 cm o más en varones, 88 cm o más en mujeres) alto nivel de triglicéridos (150 mg/dl) o tratamiento farmacológico, bajo nivel de colesterol HDL (por debajo de los 40 mg/dl en varones; inferior a los 50 mg/dl en mujeres o tratamiento farmacológico) hipertensión (presión sistólica igual o por encima de 130 mmHg; presión diastólica igual o por encima de 85 mmHg o tratamiento farmacológico) glucosa en ayunas de 100 mg/dl o más o tratamiento farmacológico. La afectación de las patologías asociadas al SM, afectan negativamente a muchos países desarrollados o en vías de desarrollo⁷. Así pues, uno de los puntos más importantes es la determinación de los factores epidemiológicos de riesgo modificable y no modificable que en un futuro pudieran alterar el curso y pronóstico de las complicaciones asociadas al Síndrome de Resistencia a la Insulina⁸. Y la posterior implantación de medidas correctivas para su control, como es el cambio del estilo de vida aunando dieta, ejercicio y abandono del hábito tabáquico, si procede⁹. Hasta el momento no hemos encontrado ninguna descripción del impacto de una intervención nutricional realizada desde una Farmacia Comunitaria en pacientes con éste síndrome.

Objetivos

El objetivo general es la disminución de la morbilidad y mortalidad prematuras asociadas al SM y como objetivos específicos el mejorar los parámetros clínicos de un paciente con SM y mejorar su estilo de vida mediante la educación nutricional y el ejercicio.

Presentación del caso

Acude a la Farmacia Comunitaria un paciente varón, de 80 años de edad, solicitando información para pérdida de peso.

Se le entregan unas hojas de recuento de ingestas de 24h para 3 días y se le explica como completarlas indicando las horas de ingesta y los alimentos y bebidas ingeridos indicando la cantidad de los mismos.

Se concierta una cita con él a la que deberá acudir con:

- Hojas de recuento de ingestas de 24h para 3 días.
- Última analítica realizada.
- La medicación que utiliza incluyendo la pauta por el médico, la indicada por el farmacéutico y la correspondiente a automedicación, así como cualquier suplemento alimenticio o producto de herboristería.

En la primera entrevista se realiza una historia clínica y dietética en la que se recogen los siguientes datos:

- Fecha de la entrevista: 10 de Septiembre de 2012.
- Nombre y teléfono del paciente.
- Exfumador.
- Edad: 80 años.
- Valores antropométricos:
 - Talla 1.73 (m).
 - Peso 97.8 (Kg).
 - IMC (Índice de masa corporal) 32.7.
 - %GC (Porcentaje de grasa corporal) 42.1.
 - %ME (Porcentaje de músculo esquelético) 25.8.
 - F (Indicador de grasa visceral) 14.
 - TAS Tensión arterial sistólica (mmHg) 122.
 - TAD Tensión arterial diastólica (mmHg) 91.
 - FC Frecuencia cardiaca (ppm) 88.

Se utiliza para la medida de los parámetros antropométricos el medidor de bioimpedancia *BodyComposition monitor BF511* de OMRON

La bioimpedancia se realiza a las 9:30 h de la mañana, sin haber realizado ejercicio ni ingerido líquido las horas previas a la toma.

Comenzó a ganar peso hace unos 50 años asociándolo a cambio de hábitos, y que posteriormente se incrementó al dejar de fumar.

Ha realizado intentos para la pérdida de peso siguiendo el consejo de profesionales como el endocrino

- Patologías que refiere el paciente:
 - Cardiopatía isquémica obstructiva congénita.
 - Insuficiencia cardiaca.
 - Diabetes tipo 2.
 - Hipertensión arterial.
 - Dislipemia (hipertrigliceridemia).
 - Artrosis de cadera.
 - Hiperplasia benigna de próstata.
 - Pólipos intestinales.
 - Estreñimiento.
- Fármacos:
 - Nuclosina® (omeprazol) 20 mg: 1-0-0.
 - Flatoril® (cleboprida/simeticona) 0.5/200 mg 45 cápsulas: 2 ó 3 al día, a demanda.
 - Condrosan (condroitin sulfato) 400 mg 60 caps: 0-0-2.
 - Quinapril 20 mg: 1-0-0.
 - Zarator® (Atorvastatina): 10 mg: 0-0-1.

- Proscar® (finasterida) 5 mg: 1-0-0.
- Metformina 850 mg: 0-1-1.
- Píldoras Zeninas®: 0-0-1 (a demanda), (antes tomaba plantaben® (ispagula 3,5g)
- Se le pregunta sobre antecedentes familiares de patologías asociadas al síndrome metabólico, respondiendo desconocerlo.
- Refiere comer rápido realizando todas las comidas en el hogar y salir a caminar 1 hora, 3 días a la semana. Cocina su cónyuge.
Del recuerdo de 24 horas de ingesta dietética, se muestran en la tabla I.
Observandose una ingesta hídrica correcta 1-1,5 litros de agua/día.
- También se recoge en la historia dietética un listado de alimentos según gustos y aversiones para confeccionar una dieta apetecible, personalizada y de su agrado con el objetivo de conseguir adherencia a la dieta.

Análisis del caso

Intervención

Se le dan pautas nutricionales conforme a las recomendaciones generales de la dieta mediterránea y el

estudio PREDIMED, recalcando la importancia de la realización de ejercicio físico moderado:

Los requerimientos de energía y determinados nutrientes son diferentes a los de la población adulta, por lo que se presta especial atención a el aporte hídrico, proteico y de determinadas vitaminas y minerales (como vitamina, D, vitaminas B, calcio, etc..) para cubrir las necesidades del paciente. Se tiene en cuenta que los requerimientos energéticos son menores que en la población adulta, Los requerimientos proteicos en las personas mayores son superiores Se le aconseja comer despacio, masticando cada bocado y saboreando los alimentos y realizar 5-6 ingestas diarias, cumpliendo los horarios y no picando entre horas

Ingesta hídrica: No debe olvidar una ingesta hídrica de al menos 1.5 litros diarios a base de agua, caldos, infusiones edulcoradas.

Ejercicio: Adecuado a su situación particular. Se le recomienda caminar al menos una hora de 3-5 días a la semana. La sarcopenia o pérdida involuntaria de masa muscular es frecuente en la población geriátrica, por lo que se promueve la realización de ejercicio en este paciente de 80 años de edad. Además la realización de ejercicio físico en un paciente con diabetes tipo 2 en tratamiento con antidiabéticos orales va a ser fundamental para el control de la glucemia.

Tabla I
Ingesta dietética mediante el Método de Recuerdo de 24 h

DESAYUNO	9:30 h (domicilio)	– 250 ml de leche desnatada – 2 biscotes (20 g) – 25g de jamón serrano
MEDIA MAÑANA	11:00 h (fuera del domicilio)	– 1 cortado – 1 cerveza (200 ml)
COMIDA	14:00 h	DÍA 1: – Ensalada ilustrada (lechuga, tomate, cebolla, olivas verdes) – 4 sardinas fritas DÍA 2: – Judías verdes con patata – Gallo rebozado (con huevo) DÍA 3: – Borraja cocida con patata – Bistec de ternera a la plancha
MEDIA TARDE	17:00 h	– 2 piezas de fruta
CENA	21:00 h	DÍA 1: – 1 tomate a rodajas – 1 pechuga de pollo al horno – 2 piezas de fruta DÍA 2: – Ensalada de tomate, lechuga y olivas verdes – 3 piezas de fruta DÍA 3: – 1 tomate a rodajas – Tortilla francesa y 1 huevo – 2 piezas de fruta

Tabla II
Evolución y modificación de diferentes parámetros tras la intervención

<i>Fecha</i>	<i>Talla (m)</i>	<i>Peso (Kg)</i>	<i>IMC (Kg/m²)</i>	<i>%GC</i>	<i>%ME</i>	<i>F</i>	<i>TAS (mmHg)</i>	<i>TAD (mmHg)</i>	<i>FC (ppm)</i>
10-Sep-2012	1.73	97.8	32.7	42.1	25.8	22	122	91	88
19-Sep-2012	1.73	95.9	31.9	36.9	25.3	22	136	78	78
24-Sep-2012	1.73	94.9	31.7	35.5	26.1	21	121	76	80
16-Oct-2012	1.73	93.7	31.3	36.4	25.4	21	106	84	93
23-Oct-2012	1.73	92.0	30.7	35.3	25.4	20	130	73	95
2-Nov-2012	1.73	91.5	30.6	43.6	25.9	20	135	80	94
14-Nov-2012	1.73	91.1	30.4	34.8	24.5	20	149	86	100
28-Nov-2012	1.73	90.2	30.1	34.9	26.1	19	143	89	89
12-Dic-2012	1.73	91.0	30.4	34.9	26.2	20	136	80	94
26-Dic-2012	1.73	90.4	30.2	35.2	25.8	19	135	86	96
8-Ene-2013	1.73	90.0	30.1	35.3	25.8	19	136	83	88
18-Ene-2013	1.73	90.0	30.1	35.1	25.9	19	151	84	90
30-Ene-2013	1.73	89.9	30.0	34.5	26.3	19	130	77	84
11-Feb-2013	1.73	88.8	29.7	34.9	25.9	19	117	80	86
25-Feb-2013	1.73	89.4	29.9	34.3	26.4	19	140	79	85
11-Mar-2013	1.73	89.8	30.0	33.7	26.8	19	129	80	86
25-Mar-2013	1.73	90.3	30.2	32.7	27.5	19	129	78	84
16-Abr-2013	1.73	89.5	29.9	33.5	27.0	19	126	78	85

IMC: Índice de masa corporal. %GC: Porcentaje de grasa corporal. %ME: Porcentaje de músculo esquelético. F: Indicador de grasa visceral. TAS: Tensión arterial sistólica. TAD: Tensión arterial diastólica. FC: Frecuencia cardíaca.

Visitas control

Las tres primeras visitas de control se realizaron con una frecuencia semanal y quincena a partir de la cuarta. Todas las citas con el paciente se concertaron a las 9:30 con las mismas condiciones de ejercicio, ingesta de líquidos y sólidos en las horas previas a las mismas con el fin de poder comparar los resultados obtenidos en la bioimpedancia, la toma de presión arterial y frecuencia cardíaca.

En cada visita realizada a la farmacia comunitaria se anotaba el peso, así como los datos obtenidos de la bioimpedancia, valores de tensión arterial y frecuencia cardíaca. Se resolvían posibles dudas o problemas surgidos en los intervalos “entre visitas” y se le entregaba una dieta nueva.

Resultados

Tras la pérdida de peso (tabla II), el paciente acude al médico donde se le realiza una medición de glucemia capilar con resultado de 59 mg/dl retirándole el tratamiento con metformina y citándole al cabo de 7 días para repetir la glucemia capilar. El valor de glu-

cemia capilar pasados los 7 días sin tratamiento con metformina fue de 64 mg/dl.

Lo más valorado por parte del paciente con respecto a los resultados obtenidos, fue la agilidad y flexibilidad para agacharse y realizar de actividades diarias como “abrochar los cordones de los zapatos” y la mejora de la calidad del sueño.

Conclusiones

La intervención en educación nutricional y del estilo de vida del farmacéutico comunitario contribuyó a la disminución de casi un 10% del peso corporal, lo que supuso una reducción del IMC de forma que el paciente pasó de estar en el intervalo correspondiente a obesidad al correspondiente a sobrepeso. Además la realización de ejercicio y pérdida de peso mejoró la resistencia periférica a la insulina y en consecuencia ocasionó la retirada por parte del médico de Atención Primaria de la metformina pautada.

El farmacéutico comunitario es un profesional a tener en cuenta en el abordaje del SM. y ayudara al paciente a llevar una alimentación ordenada, basada en

la dieta mediterránea y acompañada de ejercicio que contribuya a la mejora de la salud.

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Caso clínico

Encefalopatía metabólica secundaria a intoxicación por vitamina D

Aura Herrera Martínez¹, Montserrat Viñals Torràs², M^a Concepción Muñoz Jiménez, Antonio Pablo Arenas de Larriva³, M^a José Molina Puerta¹, Gregorio Manzano García¹, M^a Ángeles Gálvez Moreno¹ y Alfonso Calañas-Continente¹

¹Unidad de Gestión Clínica de Endocrinología y Nutrición. ²Unidad de Gestión Clínica de Neurología. ³Unidad de Gestión Clínica de Medicina Interna. Hospital Universitario Reina Sofía. Córdoba. España.

Resumen

La asociación entre la deficiencia de vitamina D y un mayor riesgo de diversas enfermedades, entre ellas cardiovasculares y autoinmunes, ha aumentado en los últimos años el uso de suplementos para la normalización de los valores plasmáticos de esta vitamina. Desde entonces se ha descrito un mayor número de casos de intoxicación iatrogénica por vitamina D. Presentamos una enferma de 81 años con encefalopatía metabólica e insuficiencia renal secundarias a una intoxicación por vitamina D. Los suplementos orales con calcio y vitamina D se le prescribieron después de sufrir una fractura vertebral osteoporótica. La enferma mejoró clínica y analíticamente tras hidratación y diuréticos. Es importante destacar la hipercalcemia como causa de encefalopatía metabólica y considerar la intoxicación por vitamina D como etiología poco frecuente pero posible de hipercalcemia e insuficiencia renal reversibles.

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Palabras clave: Encefalopatía metabólica. Vitamina D. Intoxicación. Hipercalcemia.

METABOLIC ENCEPHALOPATHY SECONDARY TO VITAMIN D INTOXICATION

Abstract

The association between vitamin D deficiency and increased risk of, among others, cardiovascular and autoimmune diseases has lead in the last years to an enhanced interest in the usage of supplements to achieve the normalization of plasmatic values at 25(OH) D. Apparently this search for normalization is resulting in an higher incidence on vitamin D intoxication. We present the case of an 81 years old woman with metabolic encephalopathy and renal failure secondary to iatrogenic vitamin D intoxication. Calcium and vitamin D oral supplements were prescribed after an osteoporotic vertebral fracture. The patient improved clinically as well as analytically after receiving treatment with diuretics and hydration. We emphasize the importance of discarding hypercalcemia as a cause of metabolic encephalopathy; moreover we highly recommend keeping vitamin D intoxication in mind as an uncommon although always possible etiology of reversible hypercalcemia and renal failure.

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Key words: Metabolic encephalopathy. Vitamin D. Intoxication. Hypercalcemia.

La vitamina D es una hormona esencial implicada en el metabolismo mineral óseo. La descripción de la expresión de su receptor en numerosos tejidos, así como la conversión periférica de calcidiol -25(OH) D- en su forma activa, calcitriol, -1,25(OH)₂ D-, expresan su relación con otras funciones biológicas como la diferenciación celular, la inhibición del crecimiento celular y la regulación de la respuesta inmune^{1,2}.

En los últimos años ha existido un interés creciente en la vitamina D. La asociación entre sus deficiencia y el aumento en el riesgo de enfermedad cardiovascular, de esclerosis múltiple, de algunos tipos de neoplasias, de enfermedades autoinmunes y de mortalidad, ha llevado a un incremento en el uso de suplementos de vitamina D, recetados y autoadministrados, de ahí el mayor número de casos de intoxicación por vitamina D³.

Correspondencia: Dr. Alfonso Calañas-Continente.
Unidad de Gestión Clínica de Endocrinología y Nutrición.
Secretaría. Edificio de Hospitalización. 2ª planta, módulo C.
Hospital Universitario "Reina Sofía".
Avda. Menéndez Pidal s/n. 14004-Córdoba.

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La producción cutánea de vitamina D se encuentra regulada enzimáticamente y no produce intoxicación. Sin embargo, sí es posible la toxicidad secundaria a la suplementación oral o parenteral con vitamina D, que se ha descrito ante la administración de dosis excesivamente altas. El consumo de más de 50000 UI/día de vitamina D eleva los niveles de 25(OH) D a valores superiores a 150 ng/mL lo que produce hipercalcemia e hiperfosfatemia con sus síntomas correspondientes, los cuales pueden ser inespecíficos inicialmente^{3,4}.

Caso clínico

Se trata de una enferma de 81 años de edad con antecedentes de hipertensión arterial controlada, hipoacusia bilateral de larga evolución, hiperlipemia, con bloqueo de rama izquierda del haz de His, claudicación intermitente de la marcha y osteoporosis grave con fractura vertebral dorsal en octubre de 2013 (5 meses antes de su ingreso). La enferma mantenía su independencia para las actividades de la vida diaria, aunque deambulaba asistida con muletas desde la fractura vertebral y refería leve pérdida de memoria en el último año. Acudió a urgencias en enero de 2014 por caída accidental en la calle con traumatismo craneoencefálico leve. Su familia refiere que la enferma, a partir de ese momento, presentó pérdida de memoria, inapetencia y alterción de la marcha, caminando cada vez menos. Toda esta sintomatología se fue agravando progresivamente hasta llegar a una vida limitada a cama y sillón. En las últimas semanas previas a su ingreso, la enferma presentó insomnio, temblor de extremidades, tendencia a la agitación, incapacidad para reconocer a sus familiares y para mantener una conversación hasta llegar a no poder hablar, así como franca disminución de la ingesta alimentaria. Se derivó a la consulta de Neurología para estudio ingresándose de manera urgente.

A la exploración física se encontraba alerta, anártrica, incapaz de obedecer órdenes, con temblor mandibular y en extremidades, discreto aumento del tono muscular en extremidades superiores y reflejos osteotendinosos conservados con cutáneo plantares flexores. El resto de la exploración física por órganos y aparatos fue anodina.

En la TC craneal se detectaron pequeñas áreas hipodensas en sustancia blanca periventricular de etiología isquémica crónica y aumento de los espacios extraaxiales en relación con la edad, sin imágenes de sangrado ni colecciones.

El análisis de líquido cefalorraquídeo fue normal y el electroencefalograma mostró una lentificación difusa de la actividad bioeléctrica de base sin actividad paroxística focal ni generalizada.

En la analítica de rutina destacaron unos niveles séricos de urea de 68 mg/dL (valores de referencia 10-50 mg/dL), de creatinina de 2,1 mg/dL (valores de referencia 0,7-1,2 mg/dL), de calcio de 14,5 mg/dL (valores de referencia: 8,5-10,5 mg/dL), de fosfato de

2,3 mg/dL (valores de referencia 2,3-4,7 mg/dL), de 25(OH) D mayor a 100 ng/dL (valores de referencia 8-42 ng/dL), de 1,25(OH)₂ D de 14,9 pg/mL (valores normales 18-71 pg/mL) y de paratohormona de 22,7 pg/mL (valores de referencia 11-54 pg/mL). El resto de la bioquímica fue normal.

Los anticuerpos antitiroideos, marcadores tumorales (antígeno carcinoembrionario (CEA), Ca 125, Ca 15.3, antígeno de células escamosas (SCC2) y β_2 -microglobulina) y las serologías para VIH y *Treponema pallidum* fueron negativos.

En relación a otros estudios de imagen realizados a la enferma, en la radiografía de tórax no se demostraron hallazgos patológicos y en la RM cerebral se observó atrofia cerebral de predominio temporal bilateral con afectación de la sustancia blanca de probable origen hipóxico - hipertensivo.

Para completar el estudio se realizaron TC de tórax, abdomen y pelvis, con hallazgo de un angioma esplénico y ecografía cervical que no detectó aumento de tamaño en las glándulas paratiroides, ni imágenes sugestivas de adenoma.

Se inició tratamiento con hidratación parenteral (1500 mL/día durante 13 días) y por sonda nasogástrica (2000 mL/día durante 12 días), diuréticos (furosemina 20 mg IV/día), con mejoría progresiva de nivel de atención, de las funciones cognitivas y del temblor. Así mismo, se produjo una reducción progresiva de los niveles de calcio, de urea y de creatinina hasta su completa normalización.

Se comprobó que tras la fractura osteoporótica, la enferma había iniciado tratamiento con suplementos orales de calcio equivalentes a 1.000 mg/día de calcio elemento y 0,266 mg/día de calcifediol, hecho que justificaba las cifras suprafisiológicas de 25(OH) D (15.960 UI/día) y las alteraciones clínico analíticas que presentaba la enferma.

Dos meses después del alta, la enferma recuperó las funciones cognitivas superiores, su autonomía y el apetito, con normalización de los niveles de 25(OH) D (46 ng/mL), lo que confirma el diagnóstico de encefalopatía metabólica, deshidratación e hipercalcemia secundaria a hipervitaminosis D.

Discusión

Estudios previos han demostrado una ingesta inadecuada de calcio y vitamina D en mujeres españolas entre 17 y 60 años, siendo mayor durante la menopausia. Durante esta etapa de la vida, el 79,6% realiza una ingesta de calcio menor de la recomendada y el 85,2% menor de vitamina D, siendo la situación más desfavorable en mujeres con sobrepeso u obesidad⁵. Por esta razón existe una tendencia creciente a la indicación de suplementos de calcio y vitamina D con la edad, y más aún ante una fractura osteoporótica.

La hipercalcemia secundaria a intoxicación por vitamina D es infrecuente y produce una sintomatología

variada. Los síntomas de esta intoxicación dependen del depósito de cristales de fosfato cálcico en los tejidos blandos, hecho que ocurre cuando el producto calcio x fósforo es superior a 60.

Diferentes publicaciones de series de enfermos con intoxicación por vitamina D describen como manifestaciones clínicas principales la debilidad, los vómitos, la anorexia, la oliguria, alteración del nivel de conciencia / encefalopatía, arritmias y alteraciones electrocardiográficas (acortamiento del intervalo QT y elevación del segmento ST) cuando los niveles de calcemia oscilan entre 12 y 14 mg/dL, los de fosfato entre 3.9 y 8.6 mg/dl con unos niveles de creatinina sérica de 1.6 a 4.2 mg/dL⁶.

En el presente caso, es posible que la clínica haya sido ocasionada por la hipercalcemia agravada por la insuficiencia renal aguda prerrenal secundaria a los vómitos, la hiporexia y la deshidratación.

Dentro del diagnóstico diferencial de la encefalopatía metabólica con hipercalcemia se consideraron el mieloma múltiple, las enfermedades granulomatosas, las autoinmunes, las neoplasias, la enfermedad renal aguda y el hiperparatiroidismo. Las diferentes pruebas complementarias realizadas permitieron descartar estas patologías.

Si bien la dosis crónica diaria máxima tolerable de vitamina D no está bien definida, la Comisión del Comité Científico de la Comisión Europea sobre Alimentación ha establecido el límite de consumo diario en adultos de 25(OH) D en 50 mcg (2000 UI). La enferma estaba recibiendo una dosis de vitamina D 7,5 veces superior.

Es importante la monitorización plasmática de los niveles de esta vitamina así como la excreción urinaria de calcio antes de y durante la prescripción del tratamiento, con la finalidad de prevenir la intoxicación por vitamina D^{2,4}. Una monitorización ambulatoria adecuada en esta enferma probablemente hubiese permitido detectar la elevación de 25(OH) D antes del desarrollo de las manifestaciones clínicas.

La intoxicación por vitaminas calcidiol o calcitriol al tener una vida media larga, requieren tratamiento

con hidratación intravenosa, diuréticos y en algunas ocasiones con corticoides. Si la causa se relaciona con un aumento en la absorción del calcio o un incremento en la acción de 1,25(OH)₂D se recomienda el uso de bifosfonatos y la restricción en la ingesta de calcio⁶. En este caso el tratamiento basado en hidratación y diuréticos, permitió la normalización de los niveles de calcio y vitamina D, junto con la desaparición de los síntomas y la mejoría clínica de la enferma.

Conclusiones

Es de considerable importancia considerar la hipercalcemia como diagnóstico diferencial en el contexto de una encefalopatía metabólica. Este caso permite recordar que la hipercalcemia sintomática en presencia de una PTH dentro de la normalidad, debe sugerir niveles inadecuadamente altos de vitamina D⁶. La prescripción de suplementos vitamínicos debe ser vigilada con la finalidad de garantizar un adecuado ajuste de la dosis y prevenir la toxicidad.

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Caso clínico

Hydrokinesitherapy program using the Halliwick method on strength endurance and flexibility in a person with poliomyelitis sequelae

Paulina Yesica Ochoa Martínez¹, Javier Arturo Hall López¹ and Adriana Griselda Mateos Valenzuela¹

¹Faculty of Sports, Autonomous University of Baja California, México.

Abstract

This case study attempts to determine the effect of a hydrokinesitherapy program by means of the Halliwick method on physical fitness in a female aged 35 years with poliomyelitis sequelae. The intervention followed sixteen weeks of hydrokinesitherapy during 70 minutes, five times a week, where we carried out exercises from the Halliwick method. There was an assessment both before and after the application. Strength endurance and flexibility were determined according to a senior fitness test protocol. The results showed positive improvements when carrying out the exercises from the Halliwick method and the percentage change ($\Delta\%$) of strength endurance increase 361.5% in the right arm and 300% in the left arm. Flexibility increased 2 cm in the right shoulder and 10 cm in the left shoulder. In conclusion the subject was able to improve the performance of Halliwick exercises while showing an increase in strength endurance and flexibility.

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HIDROCINESITERAPIA USANDO EL MÉTODO HALLIWICK SOBRE LA RESISTENCIA A LA FUERZA Y FLEXIBILIDAD EN PERSONA CON SECUELAS DE POLIOMIELITIS

Resumen

El estudio de caso, determina el efecto de un programa de hidrocinesiterapia usando el método Halliwick sobre la resistencia a la fuerza y la flexibilidad en una mujer de 35 años con secuelas de poliomielitis. La intervención consistió en 16 semanas de hidrocinesiterapia de 70 minutos, 5 veces por semana, mediante el método Halliwick evaluándolo antes y después; La resistencia a la fuerza y la flexibilidad se determinaron por el protocolo senior fitness test. Se mejoró el desempeño en los ejercicios del método Halliwick y el porcentaje de cambio ($\Delta\%$) en la resistencia a la fuerza (361.5 % brazo derecho y 300% brazo izquierdo), la flexibilidad se incrementó 2 cm en el hombro derecho y 20 cm en el hombro izquierdo. En conclusión la paciente mejoro el desempeño en el método Halliwick, mostrando incremento en la resistencia a la fuerza y la flexibilidad.

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Palabras clave: *Poliomielitis. Hidrocinesiterapia. Capacidades Físicas.*

Introduction

According to the World Health Organization (WHO), the poliomyelitis eradication initiative began in 1988 when 350,000 poliomyelitis cases in 125 countries were reported. The application of this initiative resulted in the endemic transmission of only 223 poliomyelitis cases in 3 countries in 2012¹. However,

the prevalence of the post-polio syndrome is estimated to be present in 50% of patients suffering from poliomyelitis with a subsequently stable phase of at least 15 years². There is scientific evidence indicating that there is the presence of sarcopenia and a decrease in neuromuscular functions in post-polio individuals, thus reducing their strength and joint mobility². Moreover, sarcopenia has been identified as a disease that decreases the independence and functional autonomy when it comes to completing everyday activities³. This affects social development and decreases the quality of life in people suffering from post-polio syndrome⁴.

Evidence from cross-sectional studies shows that active lifestyles in post-polio individuals are related to a decrease in musculoskeletal symptoms⁵; also, results of controlled trials focusing on exercises in post-polio population have shown an improvement in physical fit-

Correspondence: Dr. Javier Arturo Hall López.
Address: Río Mocerito y Monclova Street S/N,
Ex ejido Coahuila Neighborhood
Zip Code 21280 Mexicali, Baja California, México.
E-mail: javierhall@uabc.edu.mx

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ness⁶. Hence, physical exercise following poliomyelitis has been proposed during rehabilitation to reduce musculoskeletal health problems related to sarcopenia⁷.

This research considered the Halliwick method⁸, carried out through hydrokinesitherapy. This form of exercise is especially recommended for people suffering from physical limitations and has become more popular and a preferred method in the last ten years, among people with physical disability. This due to the fact that we take advantage of water properties in order to provide fluidity and a wider range of movement, while decreasing the risk of injuries⁸. The Halliwick concept is a structured learning progress that aims to improve independence in the water and gain better movement control and balance. It involves ten exercises: mental adjustment, release, vertical rotation, lateral rotation, combined rotation, flotation, balance, weathering turbulence, basic movement and fundamental movements^{8,9}. In this context, there is a lack of studies showing the effects of the Halliwick method carried out through hydrokinesitherapy in people with this pathology.

Case report

A female subject aged 35 years with poliomyelitis sequelae volunteered. She was recruited to partake in this case study. The subject had sequels of poliomyelitis with the following physical characteristics: legs immobility and spasticity especially on the left side, a 50 degree scoliosis and two spinal surgeries performed and wheelchair use. She had not carried out any physical exercise in the last six months and does not have any sort of acute or chronic complication that would hinder water exercise. The present study followed the ethical principles regarding human experimentation proposed by the Helsinki declaration.

The subject completed the activities during a four-month period, five times a week, and 90 minute sessions comprised of 10 minutes of warm-up, 70

minutes performing the hydrokinesitherapy program using the ten exercises from the Halliwick method (mental adjustment, release, vertical rotation, lateral rotation, combined rotation, flotation, balance, weathering turbulence, basic movement and fundamental movements)^{8,9}. Then, a 10 minute cool down followed.

In order to determine physical fitness, we performed the senior fitness assessment to evaluate strength endurance and flexibility composed of the following tests: Arm curl test: to evaluate upper-body strength endurance. It was assessed scoring the numbered of biceps curls than were completed in 30 seconds holding a hand weight (3.63 kg). The back scratch test: to evaluate upper-body (shoulder) flexibility by scoring the number of centimeters reached with one hand over the shoulder and one up the middle of the back¹⁰.

Discussion

Qualitative statistical analysis on the Halliwick method was used to score the performance of the exercises under the categories: Not Achieved (NA), Average (A), Good (G), Very Good (VG), and Excellent (E). Descriptive statistical procedures are presented previous to the testing and post-testing as the percentage change ($\Delta\%$) was calculated $[(\text{Media post} - \text{Media pre}) / \text{Media pre}] \times 100$.

The strength endurance results assessed with the arm curl test were: 13 biceps curls in right arm that the subject completed in 30 seconds and 15 in left arm pretest at the baseline and at the end posttest of the 16-week were 60 with the right arm and 60 with the left arm; The back scratch test: to evaluate upper-body flexibility were 2 cm right shoulder and -8 cm left shoulder pre-test and 0 cm right shoulder and -18 cm left shoulder post-test. As shown in Figure I, the percentage change ($\Delta\%$) after hydrokinesitherapy showed improvements in subject values on strength endurance and flexibility.

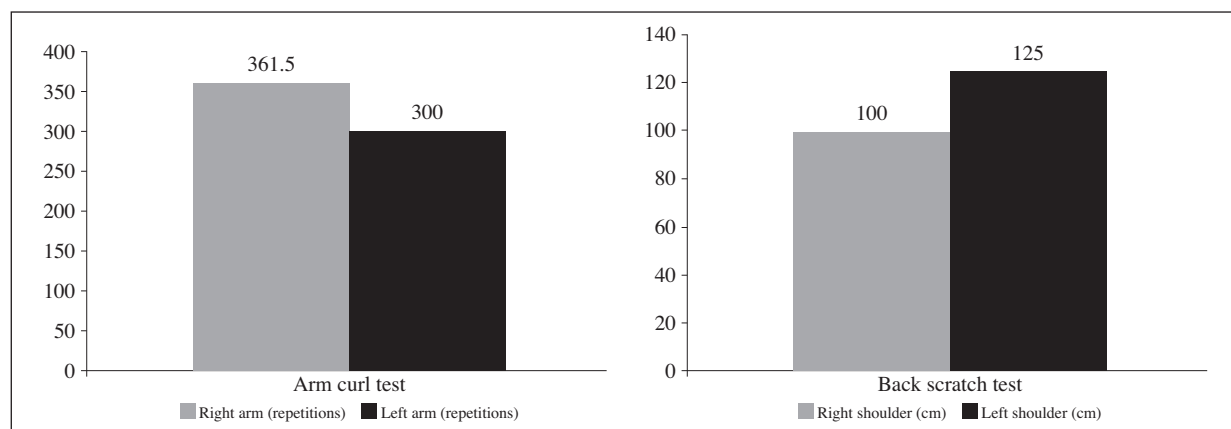
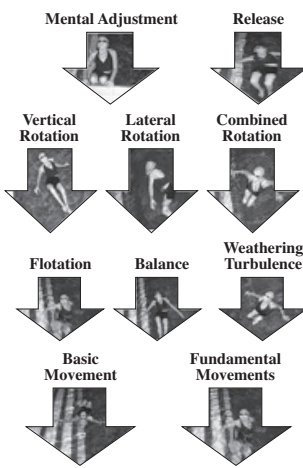


Fig. 1.—Percentage of changes ($\Delta\%$) of strength endurance assessed with arm curl test and upper-body flexibility assessed with back scratch test of senior fitness (Rikli & Jones, 2001); Assessed after 16 weeks of hydrokinesitherapy using the method of Halliwick.

Variables	Pretest	Posttest
Mental adjustment	A	G
Release	A	G
Vertical rotation	NA	VG
Lateral rotation	A	G
Combined rotation	A	G
Flotation	A	G
Balance	NA	E
Weathering turbulence	NA	G
Basic movement	NA	G
Fundamental movements	NA	G



The diagram illustrates the Halliwick method exercise categories, organized into a hierarchical structure. At the top are 'Mental Adjustment' and 'Release'. Below these are 'Vertical Rotation', 'Lateral Rotation', and 'Combined Rotation'. The next level includes 'Flotation', 'Balance', and 'Weathering Turbulence'. The bottom level consists of 'Basic Movement' and 'Fundamental Movements'. Each category is represented by a downward-pointing arrow containing a small image of a person performing the exercise.

Fig. 2.—Performance of Halliwick method exercise before and after 16 weeks of hydrokinesitherapy (Weber-Nowakowska et al., 2011). Categories assessed: not achieved (NA), average (A), good (G), very good (VG), excellent (E).

The results of the ten exercises from the Halliwick method are presented in Figure II; The 10 exercises were assessed by the instructor⁸, according to subject performance on the categories of Not Achieved (NA), Average (A), Good (G), Very Good (VG), and Excellent (E).

The main findings of this present research were that sixteen weeks of hydrokinesitherapy were able to improve the strength endurance and flexibility and the exercises performed following the Halliwick method by a female aged 35 years, with poliomyelitis sequelae. These findings are corroborated with controlled trials focusing on other exercise modalities such as conventional therapy and aerobic exercise⁶. In the physical therapy area, water exercise has been proposed during the rehabilitation of poliomyelitis sequelae⁷, due the benefits that the water environment provides in preventing neuromuscular function deterioration such as spasticity. Moreover, physical fitness should be monitored to avoid musculoskeletal problems related to poliomyelitis sequelae^{2,3}.

Regarding the assessment of physical fitness, the senior fitness test manual offers new tools to aid in the application of the senior fitness test. This includes expanded information on ways to modify test protocols for population with limiting conditions such as people with poliomyelitis sequelae. In addition to this, the senior fitness test is inexpensive, validated, easy to apply, replicable and the test provides information of certain freedom of action⁹.

Although this study had limitations, due to the fact that it was designed as a case study, there are a few re-

ferences on the Halliwick method as aquatic physical therapy¹⁰. Hopefully these results will contribute to the clarification and better understanding of the effects of hydrokinesitherapy on physical fitness in population with poliomyelitis sequelae.

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