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Composición corporal en niños y adolescentes: en búsqueda de la técnica ideal

Body composition in children and adolescents: looking for the best technique

El sobrepeso y la obesidad se definen como un depósito anormal o excesivo de grasa corporal. El aumento de su prevalencia en las últimas décadas lo convierte en uno de los principales problemas de salud pública que afecta a 42 millones de niños menores de 5 años en el mundo (1). Su presencia durante la infancia puede ser causa de enfermedades metabólicas hasta ahora consideradas típicas del adulto y mortalidad prematura, por lo que su correcto diagnóstico y tratamiento son fundamentales.

Para el diagnóstico de la obesidad en la infancia se emplean habitualmente los puntos de corte del índice de masa corporal (IMC) (2). Sin embargo, el IMC es más un marcador de corpulencia que de adiposidad, y no permite distinguir entre masa grasa (MG) y masa libre de grasa (MLG). Además, su relación con la masa grasa (MG) varía con el sexo y la edad (3); mientras que el IMC aumenta linealmente con la edad, la MG se estabiliza o incluso disminuye entre los 8 y los 12 años (4). Teniendo en cuenta que la masa grasa (MG) es la principal responsable de las complicaciones asociadas a la obesidad, su medición ha de constituir un elemento fundamental en la valoración de todo paciente obeso.

El trabajo de Vázques y cols. (5) en este número de la revista compara modelos de dos (2C) y cuatro compartimentos (4C) para evaluar la MG en escolares chilenos obesos, utilizando dilución isotópica, pletismografía, absorciometría por rayos X de doble fotón (DEXA) y bioimpedancia. Sus autores concluyen que el modelo de 2C con dilución isotópica y DEXA es el más preciso para determinar la MG en niños y adolescentes obesos.

Existe una gran variedad de técnicas para medir la composición corporal, que van desde modelos más sencillos de 2C, los cuales dividen el cuerpo en MG y masa libre de grasa (MLG), a modelos más complejos de 3 y 4C, que resultan de dividir la MLG en sus distintos componentes (agua, proteínas y minerales). Si bien algunos métodos son más exactos que otros, no hay un *gold* estándar para el estudio de la composición corporal en la infancia y la adolescencia, dado que todos los métodos utilizan asunciones que pueden no ser válidas en todos los casos. La mayoría de los estudios en edad pediátrica utilizan modelos de 2C basados en la ecuación de Siri, asumiendo que la MLG tiene una densidad constante. Esto en muchos casos puede sobreestimar el porcentaje de MG, puesto que los niños tienen una menor proporción de proteínas y minerales, y, por tanto, una menor proporción de MLG (6).

Los modelos de 4C cuantifican la MG y MLG de forma más precisa al tener en cuenta la variabilidad de los distintos componentes, más allá de asumir una densidad constante de la MLG (7). Sin embargo, su coste y la necesidad de equipos sofisticados limitan su uso en la práctica clínica. En concordancia con los resultados de Vázques y cols., otros trabajos han demostrado que la dilución isotópica y el DEXA son los métodos más precisos para determinar la MG y MLG (8-10). No obstante, a pesar de su fiabilidad para medir la MG, nuevamente el coste y la dificultad para disponer del material y equipos necesarios, hacen que su uso se vea relegado fundamentalmente a la investigación.

Son necesarias, por tanto, técnicas más sencillas y asequibles, que, junto con los parámetros antropométricos, nos permitan el estudio de la MG. En este sentido la bioimpendancia se ha utilizado para la valoración de la CC en numerosos estudios en niños y adolescentes, y es una de las técnicas más empleadas en la edad adulta. Los resultados de los estudios, en comparación con técnicas de referencia como el DEXA, demuestran en la mayoría de los casos una infraestimación de la MG (11). Esta infraestimación de la MG es más frecuente con

editorial

los equipos monofrecuencia a 50 kHz, como el utilizado en el estudio de Vázquez y cols. Estos equipos emplean además ecuaciones predictivas específicas, con la limitación añadida de que existen pocas validadas en edad pediátrica. En la actualidad se han desarrollado equipos multifrecuencia segmentarios, que utilizan ecuaciones genéricas y permiten disminuir el error de los equipos monofrecuencia, y podrían convertirse en una alternativa sencilla y precisa para valorar los cambios de composición corporal en niños y adolescentes.

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Bibliografía

1. World Health Organization. Facts and Figures on Childhood Obesity. Available online: http://www.who. int/end-childhood-obesity/facts/en/ (accessed on 5 September 2016).
2. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000; 320:1240-3.
3. Ellis KJ, Abrams SA, Wong WW. Monitoring childhood obesity: Assessment of the weight/height index. Am J Epidemiol 1999;150:939-46.
4. Telford RD, Cunningham RB, Abhayaratna WP. Temporal divergence of percent body fat and body mass index in pre-teenage children: the LOOK longitudinal study. Pediatr Obes 2014;9(6):448-54.
5. Vásquez F, Salazar G, Diaz E, Lera L, Anziani A, Burrows R. Comparison of body fat calculations by sex and puberty status in obese schoolchildren using two and four compartment body composition models. Nutr Hosp 2016;33(5):1116-22.
6. Roemmich JN, Clark PA, Weltman A, Rogol AD. Alterations in growth and body composition during puberty. I. Comparing multicompartment body composition models. J Appl Physiol 1997;83:927-35.
7. Wells JCK, Fuller NJ, Dewit O, Fewtrell MS, Elia M, Cole TJ. Four-component model of body composition in children: density and hydration of fat-free mass and comparison with simpler models. Am J Clin Nutr 1999;69:904-12.
8. Gately PJ, Radley D, Cooke CB, Carroll S, Oldroyd B, Truscott JG, et al. Comparison of body composition methods in overweight and obese children. J Appl Physiol 2003;95:2039-46.
9. Fields DA, Goran MI. Body composition techniques and the four compartment model in children. J Appl Physiol 2000;89:613-20.
10. Vergara FV, Bustos ED, Marques LL, Flores LV, Gonzalez AA, Argote RB. The four-compartment model of body composition in obese Chilean schoolchildren, by pubertal stage: comparison with simpler models. Nutrition 2014; 0(3):305-12.
11. Kyle UG, Earthman CP, Pichard C, Coss-Bu JA. Body composition during growth in children: limitations and perspectives of bioelectrical impedance analysis. Eur J Clin Nutr 2015;69(12):1298-305.

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Nutrición Hospitalaria

Trabajo Original

Nutrición artificial

Enteral feeding through endoscopic gastrostomy in amyotrophic lateral sclerosis patients

Nutrición enteral por gastrostomía endoscópica en pacientes con esclerosis lateral amiotrófica

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Abstract

Background: Dysphagia is common in amyotrophic lateral sclerosis (ALS) and may result in malnutrition. Endoscopic gastrostomy (PEG) is recommended when oral feeding is unsafe. This work aims to assess the effectiveness and safety of PEG feeding on improving nutritional and prognostic parameters in ALS patients.

Methods: Observational and retrospective study using records from ALS patients referred for gastrostomy. Age, gender and mortality data were collected. NRS 2002, body mass index (BMI), serum albumin, transferrin and total cholesterol were recorded at the time of PEG (T0) and repeated after 3 months (T3). The evolution of these parameters was analysed and compared to survival.

Results: Data from 37 ALS patients (18 men/19 women) aged 43-88 years (mean: 69 years). All patients presented NRS 2002 ≥ 3 points. On average, patients underwent gastrostomy 11 months after diagnosis. No major procedural complications occurred. Mean survival after diagnosis was 22.2 months. Mortality rate at 3 months was 21.6% with a mean survival after PEG of 11.2 months. Albumin, transferrin and cholesterol levels increased from T0 to T3 without reaching statistical significance. Higher albumin ($R = 0.3$) and transferrin ($R = 0.4$) at admission tend to be positively correlated with survival. Mean BMI was similar at the two moments but higher initial values were associated with better outcome ($R2 = 0.39$, $p < 0.05$).

Conclusions: PEG is a safe and effective technique for enteral feeding and should be considered early in ALS patients with dysphagia. Higher BMI predicts longer survival. The association between higher serum proteins and survival must be confirmed in further studies.

Key words:

Amyotrophic lateral sclerosis. Nutrition. Gastrostomy. PEG.

Resumen

Introducción: la disfagia es común en pacientes con esclerosis lateral amiotrófica (ELA) y pude resultar en desnutrición. Se recomienda la gastrostomía endoscópica (PEG) cuando la alimentación oral no es más segura. Este trabajo tiene como objetivo evaluar la eficacia y seguridad de la alimentación por PEG en la mejora de los parámetros nutricionales y de pronóstico en pacientes con ELA.

Métodos: estudio observacional y retrospectivo que utilizó los registros clínicos de pacientes con ELA referidos para gastrostomía. Se recogieron datos sobre la edad, el género y la mortalidad. Se registró el NRS 2002, el índice de masa corporal (IMC), la albúmina sérica, la transferrina y el colesterol total en el momento de PEG (T0) y después de 3 meses (T3).

Resultados: fueron recolectados los datos de 37 pacientes con ELA (18 hombres/19 mujeres), con edades comprendidas entre 43-88 años (media: 69 años). Todos los pacientes presentaron NRS 2002 ≥ 3 puntos. En promedio, los pacientes fueron sometidos a gastrostomía 11 meses después del diagnóstico. No hubo complicaciones mayores del procedimiento. La media de supervivencia después del diagnóstico de ELA fue de 22,2 meses. La tasa de mortalidad a los 3 meses fue de 21,6%, con una supervivencia media de 1,.2 meses después de PEG. Los niveles de albúmina, transferrina y colesterol aumentaron de T0 a T3, sin embargo sin alcanzar significación estadística. Mayores niveles de albúmina ($R = 0,3$) y de transferrina séricas ($R = 0,4$) en el momento de PEG tienden a estar correlacionados positivamente con una supervivencia más larga. El IMC medio fue similar en los dos momentos, pero valores iniciales más altos están asociados con un mejor pronóstico ($R2 = 0,39$, $p < 0,05$).

Conclusiones: PEG es una técnica segura y eficaz para la nutrición enteral y se debe considerar temprano en pacientes con ELA y disfagia. Un mayor IMC predice una mayor supervivencia. La asociación entre proteínas séricas más altas y la supervivencia debe ser confirmada en estudios posteriores.

Palabras clave:

Esclerosis lateral amiotrófica. Nutrición. Gastrostomía. PEG.

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INTRODUCTION

Amyotrophic lateral sclerosis (ALS) is a severe and relentlessly progressive neurodegenerative disease of unknown aetiology, characterized by the degeneration of both upper and lower motor neurones, leading to progressive muscle paralysis (1). ALS affects 1.7-2.1 per 100,000 person/years worldwide, most cases are sporadic (90-95%), there is a slight male gender predilection, and the mean age at diagnosis is 60 years (2).

The classical limb-onset form of the disease is mainly characterized by focal muscle weakness and wasting in the limbs (due to spinal cord involvement), while the bulbar-onset form usually presents with dysarthria, dysphagia and dyspnoea, with limb features developing later in the course of the disease (1). Additional clinical features include cognitive impairment (frontotemporal dysfunction), constipation, anxiety, depression, fatigue and insomnia (3). Since disease-modifying treatment is limited to riluzole (extends survival of patients by 3-6 months), symptomatic treatments, namely nutritional support, remain the keystone of ALS management. Notwithstanding, death due to respiratory failure ultimately occurs within 2-5 years after diagnosis (1).

During the course of ALS, a decline in nutritional status is common. Weight loss may be explained by several factors, including reduced food intake associated with decrease strength for food manipulation and chewing, impaired salivary secretion, swallowing difficulties, constipation and fear of pulmonary aspiration. On the other hand, most of these patients present a state of hypermetabolism that increases resting energy expenditure and caloric requirements (4-6). Malnutrition is an independent, negative, prognostic indicator for survival as it may exacerbate catabolism, atrophy of respiratory muscles and weakness the immune system, thus contributing for a higher risk of infection (6,7).

Interventions to maintain adequate nutritional intake include altering food consistency, increasing the number of daily meals and the use of feeding assistance devices and high calorie supplements. However, as dysphagia gradually progresses, enteral feeding is often required in the nutritional management of these patients (7). Percutaneous endoscopic gastrostomy (PEG) is used to improve nutrition in patients with ALS who develop severe dysphagia, so that food and liquid can bypass normal oral entry and be delivered directly through the PEG tube, therefore avoiding malnutrition and dehydration. PEG feeding also prevents food aspiration episodes, which can contribute to respiratory function decline and death, although microaspiration of oropharyngeal secretion remains possible in PEG-fed patients. Nevertheless, the timing of gastrostomy is not consensual, the optimal parameters of enteral feeding are not known and its potential disease-modifying effects remain uncertain (8,9).

According with different guidelines and recommendations (9-12) endoscopic gastrostomy is a safe procedure. It should be considered early when dietary counselling for food modification is not sufficient and nutrition status is compromised by severe dysphagia and weight loss (5-10% of usual body weight). Forced vital capacity (FVC) should stay above 50% at the time of the PEG procedure to prevent aspiration and minimize the respiratory risks associated with the technique. However, some trials showed that, even in patients with severe ventilatory compromise, PEG can be placed safely (9-12).

Recent systematic reviews showed no randomised controlled trials assessing the outcome of tube fed patients with ALS and indicating whether enteral nutrition is beneficial compared to the maintenance of oral feeding. The benefits of PEG on improving nutritional status have been shown in observational studies but have not been carefully tested. Some researchers describe an increase in survival time but strong results were not uniformly reported (7-8,11,13-15).

The present work aims to assess the effectiveness of PEG feeding for nutritional support in ALS patients through a retrospective review of the experience of our enteral feeding team. We intend to:

- Characterize the nutritional status of ALS patients referred for gastrostomy using anthropometric and laboratory data.
- Assess the survival of those patients and to identify factors that are associated with shorter or longer survival after the gastrostomy procedure.
- Ascertain the effectiveness of PEG in improving parameters usually associated with nutritional status and prognosis, including Body Mass Index (BMI), serum proteins and serum total cholesterol.
- Demonstrate the safety of PEG and its low complication rate.

MATERIALS AND METHODS

STUDY DESIGN

A single centre, observational, longitudinal and retrospective study was performed in a large hospital setting. This project was approved by the Ethic Committee of our hospital.

PATIENTS

We studied consecutive patients with ALS that were referred to the Enteral Feeding Team (GENE) of the Gastroenterology Department of Hospital Garcia de Orta from 2003 until 2015, underwent endoscopic gastrostomy to improve nutritional support and were followed at the Artificial Nutrition Outpatient Clinic.

The diagnosis of ALS was made according to the revised *El Escorial criteria* published by the World Federation of Neurology (16) and all patients were previously assessed by a neurologist. Only patients who fulfilled the revised *El Escorial criteria* for a definite ALS diagnosis were enrolled. The indications for gastrostomy were the presence of malnutrition defined by clinical, anthropometric and laboratory data, persistent moderate-severe dysphagia with chewing and swallowing compromise or at least one previous episode of aspiration pneumonia. Study exclusion criteria included diagnosis of other neurodegenerative diseases with motor impairment as well as patients with terminal ALS and an admission-estimated life expectancy less than one month. Patients under non-invasive ventilation were also not eligible for endoscopic gastrostomy.

Furthermore, all patients included had normal lung auscultation and peripheral oxygen saturation (> 90%). No severe respiratory compromise was evident despite pulmonary function tests were not routinely performed.

CLINICAL OUTCOME

According to the clinical outcome, patients were divided into three categories: *alive and still PEG fed*, *deceased,* and *lost to follow-up*. All the patients with unknown survival status were considered lost for follow-up. Time span from ALS diagnosis until the gastrostomy procedure and death (or until June 30th 2015) was rounded up to the nearest month. Reports of major complications were evaluated.

NUTRITIONAL RISK SCREENING 2002

NRS 2002 was performed in every patient as part of a systematic hospital routine.

ANTHROPOMETRIC EVALUATION

Anthropometric evaluation was performed, according with the ISAK manual of International Society for the Advancement of Kinanthropometry, just before the gastrostomy procedure (T0), between 8:00 and 10:00 AM. The average of three consecutive measurements was then recorded on the patients´ file. The anthropometric evaluation was repeated three months later (T3) for surviving patients not lost to follow-up:

1. Body Mass Index (BMI) was obtained in most patients using the equation Weight/Height^2. If patients were unable to easily stand up for weight and height evaluation, BMI was estimated using the Mid Upper Arm Circumference (MUAC) and regression equations described by Powell-Tuck and Hennessy (17) which were previously been used and proved to provide a reliable BMI estimation in PEG feeding patients (20). Each patient was classified according to age: having low weight if BMI < 18.5 kg/m^2 for patients under 65 years or BMI < 22 kg/m^2 for patients 65 years old or older (19).
2. MUAC was measured in centimeters, using a flexible measuring tape wrapped around the mid upper arm, halfway between the olecranon and the acromion process.

LABORATORY EVALUATION

A blood sample for serum albumin, transferrin and total cholesterol was obtained minutes before endoscopic gastrostomy (T0), between 8:00 and 10:00 AM following at least 12 hours of fasting. The whole laboratory evaluation was repeated three months later (T3) for surviving patients not lost to follow-up. Values of albumin < 3.5 g/dL, transferrin < 200 mg/dL and total cholesterol < 160 mg/dL were considered low values, suggestive of malnutrition and/or poor prognosis.

STATISTICAL ANALYSIS

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS® Inc., Chicago, IL), version 21, and Microsoft Office Excel Professional 2013®. The demographic variables analyzed in every patient were age, gender, time span from diagnosis until PEG, survival after diagnosis until death (or until June 30th 2015), *and* survival after PEG until death (or June 30th 2015).

The anthropometric and laboratory variables considered at T0 and T3 were: BMI, serum albumin, transferrin and total cholesterol levels.

After a descriptive analysis of all the variables, we applied a *Student T Test with paired samples* to compare the evolution of BMI, albumin, transferrin and cholesterol at the two moments, a *Pearson Test* to assess the correlation between those markers and patient survival, and a multivariate analysis using the ordinary least squares (OLS) regression model. Inferential tests were performed at the 5% level of statistical significance.

RESULTS

PATIENTS

This study involved 37 ALS patients (18 men and 19 women) ranging from 43 to 88 years old (mean: 69 years; median: 71 years) that underwent PEG for nutritional support. Only 12 individuals were younger than 65 years. The demographic data of our sample are displayed in table I.

All patients had a definite ALS diagnosis according with the revised El Escorial criteria. The major indication for gastrostomy was established malnutrition or evidence of high nutritional risk associated with persistent moderate-severe dysphagia. All patients were previously assessed by a speech therapist with a large experience in swallowing evaluation who confirmed the aspiration risk. Nevertheless, none of the patients developed aspiration pneumonia.

Twenty-two patients presented with bulbar-onset symptoms and 15 with the spinal form of the disease. Time span from ALS diagnosis to gastrostomy ranged from zero to 49 months (mean: 11 months; median: 6.5 months) and did not differ between ALS bulbar and spinal form. Nine patients (24%) underwent PEG within the first month after diagnosis.

NUTRITIONAL RISK SCREENING 2002

NRS 2002 was performed in every patient as part of the hospital routine. NRS 2002 was ≥ 3 points in all patients, signalling high nutritional risk.

Table I. Baseline patients' characteristics according with age

	< 65 years	66-75 years	> 75 years	Total
Male	6 (16%)	6 (16%)	6 (16%)	18 (48%)
Female	6 (16%)	8 (22%)	5 (14%)	19 (52%)
NRS 2002 (≥ 3 points)	12 (32%)	14 (38%)	11 (30%)	37 (100%)
Low BMI	3 (8%)	7 (19%)	5 (14%)	15 (41%)
Normal BMI	8 (22%)	6 (16%)	13 (35%)	17 (73%)
Low albumin < 3.5 g/dL	3 (8%)	5 (14%)	4 (11%)	12 (33%)
Normal albumin	8 (22%)	9 (24%)	5 (14%)	22 (60%)
Low transferrin < 200 mg/dL	3 (8%)	4 (11%)	3 (8%)	10 (27%)
Normal transferrin	6 (16%)	9 (24%)	5 (14%)	20 (54%)
Low total cholesterol < 160 mg/dl	3 (8%)	2 (5%)	3 (8%)	8 (22%)
Normal total cholesterol	8 (22%)	12 (32%)	6 (16%)	26 (70%)

CLINICAL OUTCOME

By the end of June 2015, from the 37 included patients, 32 have died, two were alive and still PEG fed and three were lost to follow-up. It was possible to perform PEG in all referred patients with no major procedural complications.

Survival after PEG ranged from less than one month (two patients) to a maximum of 58 months. Mean survival after PEG insertion was 11.2 months (median: eight months). Mortality rate at three months was 21.6%. Mean survival after ALS diagnosis was 22.2 months (minimum two; maximum 64; median 18 months). Patient age was poor correlated with survival after ALS diagnosis until death ($R = - 0.1$, $p = 0.46$) and survival after PEG ($R = - 0.1$, $p = 0.63$). There were no differences in survival after diagnosis and survival after PEG between genders and the two presentation forms. A survival analysis after endoscopic gastrostomy using *Kaplan Meier method* is shown in figure 1.

No episodes of aspiration were documented after the gastrostomy procedure.

ANTHROPOMETRY

Regarding the 37 patients included in this study, we obtained BMI from 32 patients at admission (T0). In 26 patients, BMI was assessed using the equation weight/height^2, and in the remaining six patients it was estimated using Powell-Tuck and Hennessy regression equations. At admission, BMI ranged from 16 to 33 (mean: 21.5; median: 21) and, adjusting to age, 15 patients displayed low BMI.

In the clinical assessment performed after three months of PEG feeding (T3) we recorded BMI data from 23 patients out of the initial 32. BMI values ranged from 14 to 31.5 (mean: 21.4; median: 21.3). Eleven patients displayed low BMI. However, eight patients died before the three months anthropometric evaluation and one was lost for follow-up.

Among the patients for whom BMI evolution was known, the number of low BMI patients at T0 and T3 was similar. Using a Student T test with paired samples to compare means, BMI did not increase after three months of PEG feeding (IC95%: 21.6-21.5, $p = 0.83$) (Table II).

There was a positive correlation between BMI and survival ($R = 0.3$) that almost reached statistical significance ($p = 0.06$) (Fig. 2).

LABORATORY ASSESSMENT

At admission, serum albumin, transferrin and total cholesterol levels were recorded in 34, 30 and 34 patients, respectively: 12 displayed low albumin, 10 low transferrin and eight low total cholesterol.

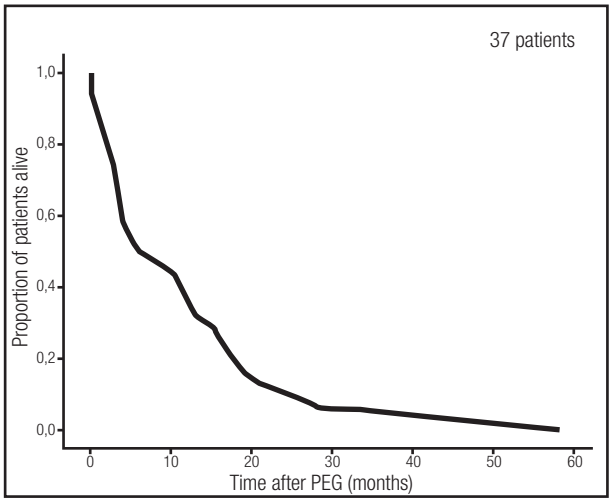

Figure 1.

Kaplan Meier curve of Patient Survival after Percutaneous Endoscopic Gastrostomy (survival analysis).

Table II. Body mass index (BMI) and laboratory parameters evolution during patient follow-up (paired samples)

	n = 23 BMI - weight/height²		n = 22 Albumin		n = 21 Transferrin		n = 20 Total cholesterol	
	Malnourished	*Well nourished*	*Low < 3.5 g/dL*	*Normal*	*Low < 200 mg/dL*	*Normal*	*Low < 160 mg/dL*	*Normal*
Patients T0	11 (47,8%)	12 (52,2%)	6 (27,3%)	16 (72,7%)	7 (33,3%)	14 (66,7%)	3 (15%)	17 (85%)
Patients T3	11 (47,8%)	12 (52,2%)	4 (18,2%)	19 (86,4%)	9 (42,9%)	12 (57,1%)	2 (10%)	18 (90%)
Mean + Std T0	21,6 ± 3,6		3,8 ± 0,5		206 ± 33		204 ± 44	
Mean + Std T3	21,5 ± 3,8		3,9 ± 0,6		213 ± 42		205 ± 34	
T test	- 0,1 (p = 0.83)		0,1 (p = 0.30)		7 (p = 0.46)		1 (p = 0.97)	

At T3, serum albumin, transferrin and total cholesterol levels were obtained in 22, 21 and 20 patients, respectively. From these patients, three displayed low albumin, nine low transferrin and two low total cholesterol.

Analysing these data using a Student T test with paired samples to compare means we found that serum albumin (IC95%: 3.8-3.9, p = 0.30), transferrin (IC95%: 206-213, p = 0.46) and total cholesterol levels (IC95%: 204-205, p = 0.97) were slightly improved after 3 months of PEG feeding, but not reaching statistical significance (Table II).

Data from Pearson correlation test showed that high albumin (R = 0.3, p = 0.35) and transferrin (R = 0.4, p = 0.26) were positively correlated with longer survival in the group of patients who had low levels of these markers at admission, although not reaching statistical significance (Fig. 2).

There was no linear correlation between total cholesterol levels and survival after PEG (R = - 0.06; p = 0.89).

A multivariate analysis, using the ordinary least squares regression model (OLS), was also performed to assess the relationship between BMI, biochemical markers and patient survival. This approach revealed a positive impact of high initial BMI on survival ($R^2 = 0.39$; p = 0.004). Data regarding albumin, transferrin and total cholesterol (p > 0.05) failed to achieve statistical significance.

DISCUSSION

Neurological dysphagia, the most important cause of malnutrition in ALS, is a classical indication for endoscopic gastrostomy in this setting. Besides its potential negative impact on nutritional status, dysphagia raises other important concerns, such as predisposition to aspiration pneumonia and pneumonitis, frequent hospital admissions, accelerated functional decline, and overall poor prognosis (8,9).

ALS is a chronic, incurable, and inexorably progressive neurodegenerative disease (1). Because of the scarcity of disease modifying treatments, supportive measures, including nutritional status improvement, remain the mainstay of care in ALS. When these patients become malnourished and oral feeding is deemed unsafe, PEG can be placed in order to maintain hydration and muscle mass, avoid micronutrient deficiency, as well as prevent further complications associated with dysphagia (6,7).

For over a decade, a considerable number of ALS patients at high nutritional risk were referred to our centre. PEG placement for nutritional support was decided, according to the existing guidelines, taking into account the severity of dysphagia, and the patient's comorbidities and performance status. With the present study, we intended to assess the effectiveness and safety of PEG feeding, an efficient method of prolonged enteral nutrition in ALS patients.

Considering the small prevalence of the disease, its rapidly progressive nature and the fact that not all patients present with dysphagia or have indication for gastrostomy, we were still able to study an appreciable number of ALS patients for a single centre. Most of our patients were older adults with a slight female predominance. Survival after diagnosis ranged from two months to approximately five years, with a mean of almost two years. This high short-term mortality rate has been previously reported in literature. During the course of the disease our patients were gastrostomized, on average, 12 months after diagnosis, and survived around a year after the procedure. Mortality after gastrostomy was not negligible, with 21.6% of the patients dying within the first three months. Specific causes of death were not examined because most patients died outside the hospital and we could not access their death certificates. However, we admit probable development of respiratory failure caused by disease progression in most cases.

Several patients were referred to our department with established malnutrition, as defined by both anthropometric and laboratory parameters. We evaluated BMI on admission in most patients, since it is the anthropometric parameter most frequently used to assess nutritional status. However, between the two evaluations, mean BMI did not increase and the number of malnourished patients according with this parameter remained the same. We believe that, for ALS patients, three months may be a too short

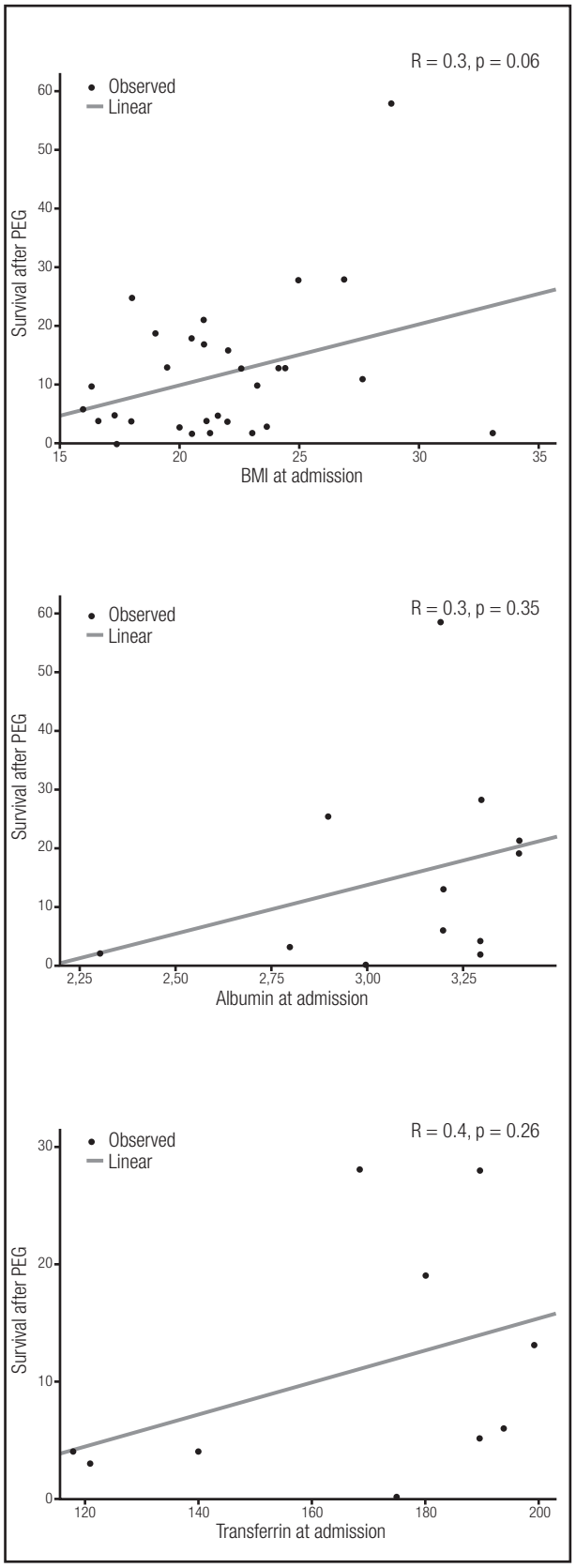

Figure 2.

T0 body mass index and serum proteins correlation with patient survival (months).

time period to achieve significant changes in weight, which requires protein synthesis and increased cell turnover in order to replenish metabolic reserves and improve muscle and fat mass. BMI changes may need a period longer than three months to become noticeable, which can be infeasible in this clinical setting.

Compared to the initial evaluation, fewer laboratory data were available at 3 months, chiefly because some patients did not survive or did not return for further assessment. Our results show that mean serum albumin, transferrin and total cholesterol increased slightly after 3 months of adequate PEG feeding. However, this difference was not statistically significant. This was probably due to the small number of patients that participated in both T0 and T3 laboratory evaluations. We conceive that PEG feeding may have a favourable biochemical effect and that a longer period using this approach can also have a positive anthropometric repercussion.

In addition, patients with higher serum proteins and/or higher BMI prior to gastrostomy appear to survive longer, though not significantly. The low Pearson correlation coefficients and high p-values obtained may again be attributed to the small sample size. However, when we performed a multivariate analysis we were able to verify that higher BMI significantly correlates with lower mortality, which supports the importance of maintaining good nutritional and physical status to improve prognosis.

No major procedural complications were observed in this study, confirming that, despite its (minimally) invasive nature, PEG is a safe procedure. Fear regarding patients' intolerance to the PEG procedure due to respiratory failure is common in ALS. Yet, it was possible to perform the technique without significant risks to our patients, as they did not have significant ventilatory compromise at admission. However, of note, pulmonary function was not routinely studied in all of our patients as most of them had severe malnutrition and considering that the alternative to feed this patients was a surgical gastrostomy (radiological guided gastrostomy is not performed in our institution) with much more risks in this disease we did not consider this tests essential. Furthermore, there are some studies showing that even with impaired respiratory function PEG could be made safely (14).

This study has some limitations. First, it is a retrospective study and the collected data is dependent on the accuracy of the clinical files. Second, we used a convenience sample, individuals were not randomized, and there was no control group to compare survival between patients that underwent PEG and those who did not. Randomization and blinding are virtually impossible in this clinical setting, as the PEG procedure must be individually debated with the patient and the caregivers. Third, despite the small number of patients lost to follow-up, several anthropometric and laboratory markers were not available at the 3 months evaluation, limiting the T0-T3 comparison. The sample is homogeneous in terms of indication for gastrostomy and dysphagia severity but its small size may be an important obstacle when trying to establish stronger conclusions. Lastly, serum albumin, transferrin and total cholesterol may also be influenced by multiple factors besides nutrition, as they are negative acute phase reactants.

Our results clearly show that established malnutrition prior to gastrostomy is associated with poor survival. PEG can successfully

deal with the problem of dysphagia by maintaining the nutritional status and reducing the aspiration risk. The use of PEG in correcting malnutrition seems to be effective but needs to be confirmed in a larger and more representative sample. Nevertheless, our results suggest that early optimized nutritional support, while being associated with a decreased risk of aspiration and malnutrition, can possibly explain some cases of prolonged survival in our sample.

CONCLUSIONS

Dysphagia plays an important role in the development of malnutrition among ALS patients. From our experience in this study, PEG is a safe procedure in this clinical setting and that short-term survival after endoscopic gastrostomy is substantial, particularly when considering the poor overall survival after diagnosis. Higher BMI at admission clearly predicts a better outcome. PEG-feeding may avoid deterioration of nutritional status, but its effectiveness to correct established malnutrition, and improve BMI and other biochemical parameters needs to be confirmed in larger studies. Based on our results we recommend early enteral feeding through PEG in ALS patients with dysphagia considering that an early optimized nutritional status may contribute to longer survival.

ETHICAL APPROVAL

All procedures performed were in accordance with the ethical standards of the institutional and/or national committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

REFERENCES

1. Kiernan MC, Vucic S, Cheah BC, Turner MR, Eisen A, Hardiman O, et al. Amyotrophic lateral sclerosis. Lancet 2011;377(9769):942-55. DOI: 10.1016/S0140-6736(10)61156-7.
2. Logroscino G, Traynor BJ, Hardiman O, Chiò A, Mitchell D, Swingler RJ, et al. Incidence of amyotrophic lateral sclerosis in Europe. J Neurol Neurosurg Psychiatry 2010;81:385-90.
3. Tiryaki E, Horak HÁ. ALS and other motor neuron diseases. Continuum (Minneap Minn) 2014;20(5):1185-207. DOI: 10.1212/01.CON.0000455886.14298.a4. Review.
4. Shoesmith CL, Strong MJ. Amyotrophic lateral sclerosis. Update for family physicians. Can Fam Physician 2006;52:1562-69.
5. Desport JC, Preux PM, Magy L, Boirie Yves, Vallat JM, Beaufrère B, et al. Factors correlated with hypermetabolism in patients with amyotrophic lateral sclerosis. Am J Clin Nutr 2001;74:328-34.
6. Rosenfeld J, Ellis A. Nutrition and Dietary Supplements in Motor Neuron Disease. Phys Med Rehabil Clin N Am 2008;19(3):573-x. Doi:10.1016/j.pmr.2008.03.001.
7. Limousin N, Blasco H, Corcia P, Gordon PH, De Toffol B, Andres C, et al. Malnutrition at the time of diagnosis is associated with a shorter disease duration in ALS. J Neurol Sci 2010;297(1-2):36-9. DOI: 10.1016/j.jns.2010.06.028.
8. Oliveira ASB, Pereira RDB. Amyotrophic Lateral Sclerosis (ALS) Three letters that change the people´s life for ever. Arq Neuropsiquiatr 2009;67:750-82.
9. Dorst J, Dupuis L, Petri S, Kollewe K, Abdulla S, Wolf J, et al. Percutaneous endoscopic gastrostomy in amyotrophic lateral sclerosis: a prospective observational study. J Neul 2015;4:849-58. DOI: 10.1007/s00415-015-7646-2.
10. Katzberg HD, Benatar M. Enteral tube feeding for amyotrophic lateral sclerosis/motor neuron disease. Cochrane Database Syst Rev 2011;1:CD004030. DOI: 10.1002/14651858.
11. Loser Chr, Aschl G, Hébuterne X, Mathus-Vliegen EMH, Muscaritoli M, Niv Y, et al. ESPEN guidelines on artificial enteral nutrition – Percutaneous endoscopic gastrostomy (PEG). Clinical nutrition 2005;24:848-61.
12. Czell D, Bauer M, Binek J, Schoch OD, Weber M. Outcomes of percutaneous endoscopic gastrostomy tube insertion in respiratory impaired amyothophic lateral sclerosis patients under noninvasive ventilation. Respir Care 2013;58(5):838-44. DOI: 10.4187/respcare.02024.
13. Pena MJ, Ravasco P, Machado M, Pinto A, Pinto S, Rocha L, et al. What is the relevance of percutaneous endoscopic gastrostomy on the survival of patients with amyotrophic lateral sclerosis. Amyotroph Lateral Scler 2012;13(6):550-54. DOI: 10.3109/17482968.2012.684215.
14. Spataro R, Ficano L, Piccoli F, La Bella V. Percutaneous endoscopic gastrostomy in amyotrophic lateral sclerosis: effect on survival. J Neurol Sci 2011;304(1-2):44-8. DOI: 10.1016/j.jns.2011.02.016.
15. Miller RG, Rosenberg JA, Gelinas DF, Mitsumoto H, Newman D, Sufit R, et al. Practice Parametter: the care of the patient with amyotrophic lateral sclerosis (an evidence-based review): report of the quality standards subcommittee of the American Academy of Neurology: ALS Practice Parameters Task Force. Neurology 1999; 52(7):1311-23.
16. World Federation of Neurology Research Group on Motor Neuron Diseases. El Escorial revisited: revisited criteria for the diagnosis of amyotrophic lateral sclerosis. Amyotroph Lateral Scler Olther Motor Neuron Disord 2000;1(5):293-99.
17. Powell-Tuck J, Hennessy EMA. Comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalized patients. Clin Nutr 2003;22(3):307-12.
18. Pereira M, Santos C, Fonseca J. Body Mass Index Estimation on Gastrostomy Patients Using the Mid Upper Arm Circunference. J Aging Res Clin Pract 2012;1:252-55.
19. American Academy of Family Physicians, American Dietetic Association, National Council on the aging. Nutrition Intervention Manual for Professionals Caring for Older Americans. Washington DC: Nutritional Screening Initiative: s.n.; 1992.

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Nutrición Hospitalaria

Trabajo Original

Nutrición artificial

Nutrición enteral domiciliaria en la Región de Murcia. Perfil de la muestra, evolución del coste y perspectiva. Años 2007-2010

Home enteral nutrition in Region of Murcia. Sample profile, trends and outlook cost. From 2007 to 2010

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Resumen

Introducción: en Murcia, y hasta 2010, la administración de la nutrición enteral domiciliaria (NED) dictaba cumplir la regulación marcada en cuanto a los facultativos con competencias para su prescripción.

Objetivos: examinar aspectos esenciales de este recurso en el periodo 2007-2010, características de la muestra y evolución del coste, así como perspectivas de futuro.

Métodos: estudio del perfil de la población NED en un área de salud específica. Selección de recetas facturadas de productos NED en el conjunto de la Región, clasificación por tipos y análisis de la evolución en importe y en envases para el periodo 2007-2010.

Resultados: respecto al perfil de la muestra del Área I de Salud de la Región, la patología, vía de administración y tipo de nutrición más frecuentes resultaron, respectivamente, la enfermedad neurológica, la vía oral y la nutrición no específica. Por otro lado, el gasto sanitario en productos dietoterápicos, en el Servicio Murciano de Salud, aumentó alrededor del 50% entre los años 2007 y 2010. Tanto en envases como en importe, Murcia se sitúa por encima de la media nacional.

Conclusiones: el perfil de la muestra no coincide con trabajos publicados en otras regiones. Este dato, junto a la posición de Murcia en gasto dietoterápico, y su evidente tendencia al alza en los años analizados, hace evidente la necesidad de medidas que mejoren la calidad de la NED en la Región de Murcia y, en caso de ser posible, conseguir alcanzar valores nacionales en relación con el consumo medio y el gasto.

Palabras clave:

Nutrición enteral. Soporte nutricional. Cuidados domiciliarios. Gasto en medicación.

Abstract

Introduction: It was 2010 when the prescription of home enteral nutrition (HEN) in Murcia changed restricting this task to those physicians with skills for it.

Objectives: To evaluate key aspects of this registry data over 2007-2010; sample characteristics, cost trends and future prospects.

Methods: Retrospective study of the HEN population profile in one specific health area and HEN products billed in the whole region; analysis of the chosen formula and changes concerning prescriptions and its value during 2007-2010.

Results: Regarding the profile of the specific area (Area I de Salud de la Región de Murcia), indication, route of administration and type of formula most frequent were, respectively, neurological disease, oral, and non-specific nutrition. On the other hand, health expenditure in these products concerning the Murcia Health Service increased about 50% in both aspects, number of prescriptions and amount between 2007 and 2010. Compared with the rest of the country, Murcia is above the national average.

Conclusions: The profile of this specific area does not match with other published works, moreover, the expense in nutrition and the clear upward trend during this period clarify the need for steps to improve the quality of the HEN in the Region of Murcia and try to reach national values related to average consumption and spending.

Key words:

Enteral nutrition. Nutrition support. Home care services. Drug costs.

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INTRODUCCIÓN

El crecimiento de la utilización de la nutrición enteral domiciliaria (NED) ha sido exponencial en las últimas décadas, como resultado de su validación por los estudios basados en la evidencia científica. Así, el gasto que ello acarrea ha de ser evaluado y controlado de forma eficiente. La aplicación de la Ciencia Económica al campo de la salud ha dado lugar a técnicas y formas de medición y análisis propias del ámbito sanitario, tan conocidas como el análisis coste-efectividad (1).

La nutrición enteral se define como la administración de una solución de nutrientes directamente al tracto digestivo, generalmente mediante una sonda implantada por vía nasal o percutánea, también por vía oral, ya sea como dieta total o como suplementación (2). Por otro lado, y según la Guía NED del Sistema Nacional de Salud (SNS) (3), esta consiste en la administración de fórmulas enterales por vía digestiva, para evitar la desnutrición de los pacientes atendidos en su domicilio cuyas necesidades no pueden ser cubiertas con alimentos de consumo ordinario. El objetivo es contribuir al aprovisionamiento de los requerimientos totales o parciales del paciente. Por otro lado, la NED permite al paciente permanecer en su entorno sociofamiliar, con similares garantías de seguridad y eficacia a las hospitalarias, siempre que se programe adecuadamente el tratamiento y seguimiento del paciente.

En España, la práctica de la NED está regulada por el Real Decreto 1030/2006 por el que se establece la Cartera de Servicios Comunes del Sistema Nacional de Salud y el procedimiento para su actualización (4). Así, la *Guía de Práctica Clínica de Nutrición Enteral Domiciliaria* del Ministerio de Sanidad y Consumo de 2008 (3) recoge, entre otros, los requisitos que debe cumplir el paciente, los criterios para la selección del tipo de fórmula y vía de administración, normas de seguimiento, revisión y actualización. En Murcia, y hasta 2010, la prescripción de la NED no estaba regulada por los facultativos nominados por las leyes vigentes.

El objetivo de este trabajo es comunicar aspectos esenciales de la NED en el periodo 2007-2010 y la perspectiva de futuro, la evolución del coste en el Servicio Murciano de Salud (SMS) en general (total de áreas sanitarias de la Región de Murcia), y el perfil de la muestra del Área de Salud I Murcia Oeste en particular (1 área sanitaria), cuyo hospital de referencia es el Hospital Clínico Universitario Virgen de la Arrixaca (HCUVA).

MATERIAL Y MÉTODOS

Diseño observacional y retrospectivo en el que se han analizado las peticiones de NED (fórmulas no específicas, específicas y módulos) de adultos, del Área de Salud I Murcia Oeste, en el año 2010, recogiendo variables relativas a la patología del paciente, vía de administración y tipo de nutrición, y variables sociodemográficas como la edad y el sexo. Estas peticiones provenían de la puesta en marcha de un protocolo piloto para la centralización, en las unidades de nutrición de los hospitales, de la prescripción de la NED en la Región de Murcia; conformando la muestra todas las peticiones de los centros de atención primaria del Área de Salud I Murcia Oeste y del resto de especialidades del HCUVA; quedando excluidas las prescripciones realizadas por nuestro Servicio de Endocrinología y Nutrición. Por otro lado, se analizó la evolución del gasto regional en NED, cifras totales en importe y número de envases, así como el gasto por habitante, y se realizó un análisis pormenorizado de los diferentes tipos de fórmulas entre los años 2007 y 2010.

Para describir los diversos parámetros, criterios clínicos y evolución de la NED se utilizó el programa IBM SPSS Statistics 22.0. Así, se utilizan técnicas descriptivas para el cálculo de las frecuencias absolutas y relativas en las variables cualitativas, y en su caso medias centrales y de dispersión para las cuantitativas. Para los análisis entre variables se usaron técnicas de significación como la t de Student y Chi-cuadrado.

En el caso de las medidas de gasto y de prevalencia del consumo de NED, en el conjunto de áreas de salud de la Región de Murcia, se utilizó el sistema de información de facturación de recetas del SMS (5), en combinación con el Nomenclator oficial de dietas del Ministerio de Sanidad, Servicios Sociales e Igualdad del Gobierno de España (6). La evolución de los diversos índices, de gasto y prevalencia, se expondrán de forma clara mediante figuras. Las medidas utilizadas fueron tres: número de envases (unidad de venta) por cada 100 habitantes, número de envases (unidad de venta) por cada 1.000 habitantes e importe en euros por habitante. La unidad de venta hace referencia a la colección de envases individuales que se venden como un *pack* indivisible.

La utilización de la información y datos sobre consumo de productos dietoterápicos cuenta con la autorización de la Dirección General de Asistencia Sanitaria de la Región de Murcia. Además, este estudio cuenta con el informe favorable del Comité Ético de Investigación Clínica del HCUVA, conforme a los aspectos éticos de la Declaración de Helsinki, considerando que se respetan los principios éticos básicos y su realización es pertinente, cumple los requisitos de idoneidad del protocolo en relación con los objetivos del estudio y quedan justificados los riesgos y molestias previsibles para el sujeto.

Finalmente, no existe conflicto de interés.

RESULTADOS

PERFIL DE LA MUESTRA

En este trabajo fueron registrados un total de 345 peticiones de NED de pacientes adultos, de las que el 51,9% (n = 179) eran mujeres. La edad media fue de 78,28 ± 15,96 años y la mediana de 83 años (rango: 14-105 años). No se encontraron diferencias significativas entre hombres y mujeres en relación con la edad (p = 0,13. La duración media fue de 18,15 ± 20,9 meses (rango = 0-180).

En relación con la patología de diagnóstico, la más frecuente fue la enfermedad neurológica, que supone un 61,7% de los casos, situándose la enfermedad oncológica y la digestiva a

una gran distancia: 8,4% y 5,8%, respectivamente. Se presenta un 19,7% de enfermedades encuadrables en otros diagnósticos y un 4,3% de pacientes sin diagnóstico definido. Por otro lado, respecto a la vía de administración, predomina la vía oral, que asciende al 85,8% (de estas, menos del 4% era nutrición enteral exclusiva), seguida de la utilización de sonda nasogástrica y gastrostomía con un 12,2% y 2,0%, respectivamente. El tipo de nutrición más frecuente fue la denominada no específica (48,4%), seguida de la específica (26,7%) y finalmente de los módulos (24,9%). Por último, el 24,1% de las nutriciones fueron espesantes.

EVOLUCIÓN DEL COSTE

En las figuras 1 y 2 puede apreciarse la evolución de las medidas de consumo del Sistema Murciano de Salud (SMS). Además, se pueden observar las mismas medidas en relación con el Sistema Nacional de Salud (SNS).

En la medida relacionada con el número de envases por centenar de habitantes se observa un incremento entre los años 2007 y 2010, tanto en el SMS como en el SNS. En el caso de Murcia, el índice aumenta de los 10,83 envases/100 habitantes a los 13,19; mientras que en el SNS este aumento va desde los 7,74 envases/100 habitantes a los 9,00.

En la medida relacionada con el importe (euros) por habitante, igualmente se aprecia un incremento entre los años 2007 y 2010, tanto en el SMS como en el SNS. En el caso de Murcia, el índice aumenta de los 7,45 euros/habitante a los 11,56; mientras que en el SNS este aumento va desde los 5,99 euros/habitante a los 8,12.

Así, en 2010, el consumo de estos productos dietéticos mediante receta fue de 192.838 envases, por un importe de casi 17 millones de euros, lo que supuso un incremento en 3 años de casi el 30% en envases y 63% en importe (Fig. 3). En ese periodo de tiempo el incremento de población fue del 5,02% (7).

Si analizamos la situación por tipo de dieta, dejando al margen las pediátricas, encontramos importantes diferencias entre los consumos medios regionales y nacionales, especialmente en fórmulas no específicas y específicas en el año 2010 (Fig. 4).

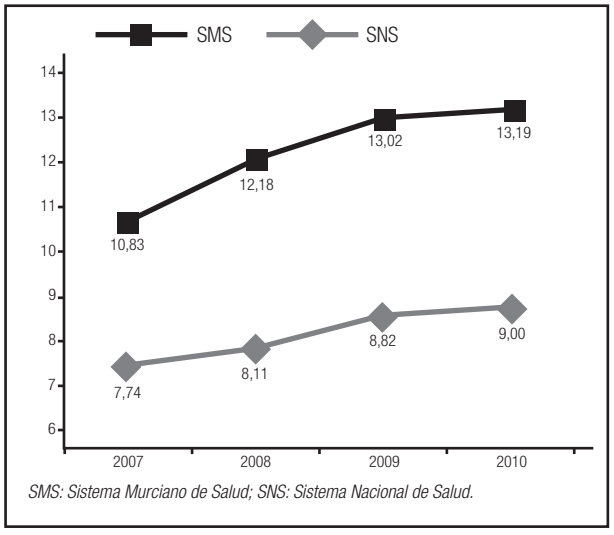

Figura 1.

Envases por 100 habitantes en el Sistema Murciano de Salud (5) y en el Sistema Nacional de Salud (6) (con excepción de Cataluña y Galicia).

DISCUSIÓN

Respecto al perfil de la muestra, observamos que no existen diferencias significativas en edad y sexo. El porcentaje de ambos

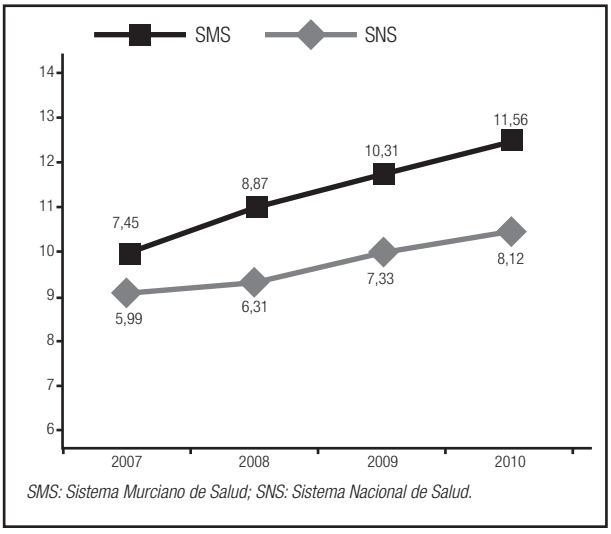

Figura 2.

Importe por habitante en el Sistema Murciano de Salud (5) y en el Sistema Nacional de Salud (6) (con excepción de Cataluña y Galicia).

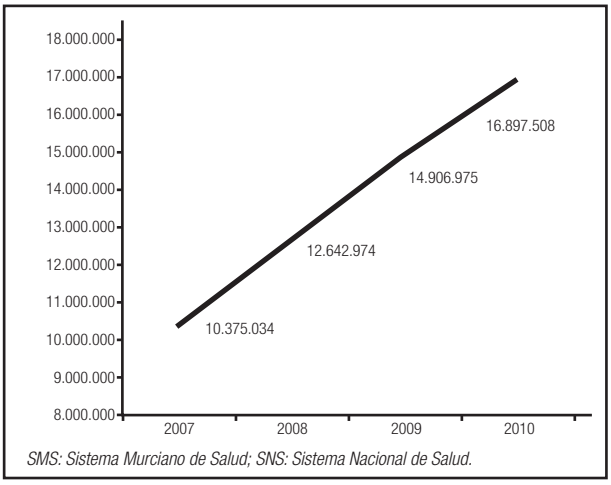

Figura 3.

Gasto sanitario (euros) en productos dietoterápicos en el Sistema Murciano de Salud (5).

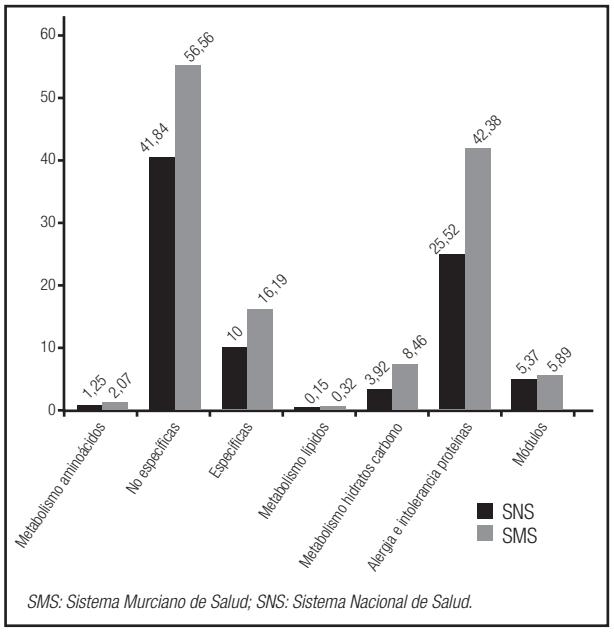

Figura 4.

Tipos de dietas. Envases por 1.000 habitantes en el Sistema Murciano de Salud (5) y en el Sistema Nacional de Salud (6).

sexos se sitúa en torno al 50% y la edad media por encima de los 75 años, este dato es superior al de la mayoría de los registros de NED publicados, tanto del Grupo de Trabajo en Nutrición Domiciliaria y Ambulatoria (NADyA) de la Sociedad Española de Nutrición Parenteral y Enteral (SENPE) (8-12) como en los internacionales, en los que suele situarse entre los 65-70 años (13).

En nuestra muestra predomina la patología de base neurológica, que alcanza las dos terceras partes del total. La enfermedad oncológica parece infraestimada (8,4%), con relación a cifras de otros registros. La British Association for Parenteral and Enteral Nutrition (BAPEN) publica un porcentaje creciente del 25% en el año 2000, que llega al 39% en 2010 (13), momento en que la neurológica alcanza el 45,7%. El grupo NADyA, sin embargo, informa de una caída de la neoplasia como enfermedad de base del 41% en 1994 al 28% en 2013 (8,12), con una prevalencia de los desórdenes neurológicos que asciende hasta el 60,6%. Esta modificación podría estar motivada por la exclusión desde el año 2010 de los pacientes con soporte oral en sus bases de datos, debido a la tendencia de los grupos a no incluir a los pacientes con este tipo de soporte (10). Las cifras de la República Checa de 2011 presentan el cáncer como enfermedad más prevalente entre sus pacientes con NED, alcanzando un 45%, frente a un 34% de problemas neurológicos (14). La posible explicación a nuestro perfil es que el seguimiento de pacientes oncológicos se realiza en una consulta monográfica de nuestra unidad y no entran a formar parte del circuito normalizado de la NED. En 2003, el Grupo de Trabajo de la European Society of Parenteral and Enteral Nutritión (ESPEN) publicó los resultados de un estudio sobre la práctica de la NED en Europa, donde participaron 23 centros de 8 países con un total de 1.397 pacientes en 1998. La patología de base más prevalente fue la neurológica (49,1%) y el cáncer de cabeza y cuello (26,5%) (15). En el estudio realizado en 2001 por Pérez Méndez y cols. en la población gallega (16), las enfermedades de base más frecuentes que justificaron el soporte nutricional fueron las neurológicas (43,6%), neoplasias (30,7%) y enfermedad inflamatoria intestinal (10,5%). Estos datos se asemejan a los encontrados en nuestra muestra. El orden de frecuencia coincide con nuestros resultados, pero los índices difieren. Esto podría ser explicado por el más del 20% de nuestros casos que se encuadran dentro de las categorías de "otros diagnósticos" o "sin diagnóstico". Finalmente, De Luis y cols. comunicaron en 2013 los resultados de un estudio prospectivo de seguimiento de pacientes con NED en Valladolid durante 12 años (1999-2010). La patología de base más frecuente fue la oncológica (43,8%), seguida de la infección por VIH (26,8%) y de las causas neurológicas (9,6%) (17,18).

En lo referente al tipo de vía utilizada, es la oral la que encabeza el grupo, con un 85,8% de los casos. La baja tasa de nutrición oral exclusiva puede deberse a la peculiaridad de la muestra analizada, y que posteriormente aparece como limitación del trabajo. En la República Checa esta cifra (vía oral) asciende al 59%, seguido de la gastrostomía con un 29% y de la sonda nasogástrica (SNG) con el 12% (14). El registro NADyA hablaba de administración oral en un 64% en 2007, mientras que posteriormente solo recogen administración enteral (9). En el estudio multicéntrico en 8 países de la ESPEN, la vía de administración elegida fue la gastrostomía endoscópica en el 58,2% de los casos y la sonda nasogástrica (SNG) en el 29,3% (15). En el estudio gallego (16) la vía de administración de la NED más utilizada fue la oral (58,3%), seguida de sonda nasogástrica (28,46%), la PEG (9,87%), gastrostomía (6,5%) y yeyunostomía (0,65%). Por último, en el trabajo en Valladolid (1999-2010), la vía de administración predominante fue la oral, que representa el 68,28%, la SNG un 24,3%, la gastrostomía un 6,8% y la yeyunostomía 0,6%; siendo los cambios a lo largo del tiempo escasos (17,18). Si bien la distribución difiere entre los diferentes registros y estudios, suele prevalecer un orden similar.

En relación con el gasto es necesario destacar el crecimiento mantenido que se experimentó entre los años 2007 a 2010 en el SMS. El incremento medio del importe durante estos años fue de 2.174.158 euros anuales, pasando de 10.375.034 euros en 2010 a 16.897.508 euros en 2010. Si nos referimos a los indicadores envases/100 habitantes e importe/habitante, las cifras ascendieron de 10,83 a 13,19 y de 7,45 a 11,56, respectivamente. Este perfil ascendente de consumo aparecía también a escala nacional, pasando de 7,74 a 9 envases/100 habitantes y de 5,99 a 8,12 euros/habitante en el mismo periodo de tiempo, pero, como puede apreciarse, con valores por población muy inferiores, en ambos marcadores, a los del SMS. Existen algunos trabajos que nos dan una idea de la situación en otras comunidades. En este sentido, se advierte el análisis realizado en 2009 por Olveira y cols. (19) de la situación en Andalucía en 2000-2007. Ellos describen un incremento de la facturación en NED de 1,3 millones de euros en 2000 a 37 millones en 2007 (un 2.800%). En un trabajo similar en la Comunidad de Madrid, Castaño y cols. (20) comunican las variaciones de consumo de

NED en los años 2002-2007, aumentando 2,5 veces en número de envases y alrededor de 3 veces en importe.

La primera limitación del análisis del perfil de la muestra la encontramos en su propia composición. Los datos han sido obtenidos únicamente de las peticiones realizadas desde los centros de atención primaria y del resto de especialidades del hospital a nuestra Unidad de Nutrición. De este modo, las prescripciones realizadas desde las consultas específicas de nuestro servicio no forman parte de la muestra analizada. Esto puede conllevar distorsiones en el perfil de la muestra. De este modo, podría explicar las diferencias encontradas con otros trabajos, y resultar por ejemplo en la baja tasa de enfermedad oncológica; así como la escasa utilización de la gastrostomía en la enfermedad neurológica que podría estar compuesta principalmente por pacientes con disfagia a líquidos.

La siguiente limitación con la que nos encontramos se deriva de la falta de identificación en cada petición de la especialidad del facultativo solicitante. Esta situación impide comprobar la procedencia del exceso de gasto, si bien los especialistas de la Unidad de Nutrición del HCUVA quedan excluidos.

La Instrucción n.º 2/2007 de 5 de julio (21), del Director Gerente del Servicio Murciano de Salud, establece que son los pediatras y especialistas adscritos a las unidades de nutrición hospitalaria, especialistas en endocrinología y nutrición, medicina interna, oncología, neurología, digestivo y nefrología los responsables de la indicación de esta prestación, con la excepción de cuidados paliativos donde se abre la prescripción a la Atención Primaria. Se crea, por tanto una considerable dispersión que conduce a que no se empleen criterios unificados a la hora de la asistencia, el diagnóstico, indicación y seguimiento. Así, el escenario de la NED en la Región de Murcia y, por ende, del Área Sanitaria I, entre los años 2007-2010 estaba caracterizado por dos hechos relevantes: la gran variabilidad existente en la asistencia al paciente subsidiario de esta prestación y que puede desvirtuar la calidad de esta, y el elevado consumo de productos dietoterápicos y, por consiguiente, del gasto. Por todo esto se hizo evidente la puesta en marcha de medidas que mejoraran la calidad de la NED en la Región de Murcia y, en caso de ser posible, conseguir alcanzar valores nacionales con relación al consumo medio y el gasto.

BIBLIOGRAFÍA

1. Gelonchi I. Economía y Salud. Economía, gestión económica y evaluación económica en el ámbito sanitario. Barcelona: Masson; 2002.
2. Nisim AA, Allins AD. Enteral nutrition support. Nutr 2005;21:109-12.
3. Sistema Nacional de Salud. Guía de Nutrición Enteral Domiciliaria en el Sistema Nacional de Salud. Ministerio de Sanidad; 2008.
4. Real Decreto 1030/2006, de 15 de septiembre, por el que se establece la cartera de servicios comunes del Sistema Nacional de Salud y el procedimiento para su actualización. BOE n.° 222, de 16 de septiembre de 2006. p. 32650-79.
5. Sistema Murciano de Salud. Sistema de información de facturación de recetas del SMS. BORM n.° 103, de 7 de mayo de 2015, p. 18908-87.
6. Sistema Nacional de Salud. Sistema de información de facturación de recetas del SNS. Ministerio de Sanidad; 2015.
7. Sistema Murciano de Salud. Población y mapa sanitario. Murcia; 2015.
8. Gómez Candela C, De Cos Al. Domiciliary artificial nutrition. Annual Report 1994. NADYA Group. Nutr Hosp 1997;12:20-7.
9. Cuerda C, Planas M, Gómez Candela C, Luengo LM; Group N-S. Trends in home enteral nutrition in Spain: analysis of the NADYA registry 1992-2007. Nutr Hosp 2009;24:347-53.
10. Frías L, Puiggròs C, Calañas A, Cuerda C, García-Luna PP, Camarero E, et al. Home enteral nutrition in Spain: NADYA registry in 2010. Nutr Hosp 2012;27:266-9.
11. Wanden-Berghe C, Matía Martín P, Luengo Pérez LM, Cuerda Compes C, Burgos Peláez R, Álvarez Hernández J, et al. Home enteral nutrition in Spain; NADYA registry 2011-2012. Nutr Hosp 2014;29:1339-44.
12. Wanden-Berghe C, Álvarez Hernández J, Burgos Peláez R, Cuerda Compes C, Matía Martín P, Luengo Pérez LM, et al. A home enteral nutrition (HEN); spanish registry of NADYA-SENPE group; for the year 2013. Nutr Hosp 2015;31:2518-22.
13. Nutrition BANS-BAPEN. Annual BANS Report, 2011 Artificial Nutrition Support in the UK 2000 - 2010. United Kingdom: The British Association for Parenteral and Enteral Nutrition; 2011.
14. Jirka A, Svanda J, Tesinsky P, Smejkalova V. National registry of home parenteral and enteral nutrition in czech republic: the 2010 data. Clin Nutr Suppl 2011;87.
15. Hebuterne X, Bozzetti F, Moreno Villares JM, Pertkiewicz M, Shaffer J, Staun M, et al. Home enteral nutrition in adults: a European multicentre survey. Clin Nutr 2003;22:261-6.
16. Pérez Méndez LF, García-Mayor RV, Dietética GdTdISGdNy. Current situation of domiciliary enteral nutrition in Galicia. A multicenter study. Nutr Hosp 2001;16:257-61.
17. De Luis DA, Aller R, Izaola O, Terroba MC, Cabezas G, Cuellar LA. Experience of 6 years with home enteral nutrition in an area of Spain. Eur J Clin Nutr 2006;60:553-7.
18. De Luis DA, Izaola O, Cuellar LA, Terroba MC, Cabezas G, De La Fuente B. Experience over 12 years with home enteral nutrition in a healthcare area of Spain. J Hum Nutr Diet 2013;(Suppl 1):39-44.
19. Olveira G, Tapia MJ, Colomo N, Muñoz A, Gonzalo M, C-Soriguer F. Usefulness of the daily defined dose method to estimate trends in the consumption, costs and prevalence of the use of home enteral nutrition. Clin Nutr 2009;28:285-90.
20. Castaño Escudero A, Pérez Gabarda ME. Evolution of home-based enteral nutrition in Madrid 2002-2007. Nutr Hosp 2009;24:218-25.
21. Instrucción n.o 2/2007 de 5 de julio, del Director Gerente del Servicio Murciano de Salud, por la que se establece el procedimiento a seguir para facilitar la prestación con productos dietéticos. BORM de 5 de julio de 2007.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Paciente crítico

Quality indicators for enteral and parenteral nutrition therapy: application in critically ill patients "at nutritional risk"

Indicadores de calidad para terapia nutricional enteral y parenteral: aplicación en pacientes críticamente enfermos "con riesgo nutricional"

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Abstract

Introduction: Quality Indicators for Nutritional Therapy (QINT) allow a practical assessment of nutritional therapy (NT) quality.

Objective: To apply and monitor QINT for critically ill patients at nutritional risk.

Methods: Cross sectional study including critically ill patients > 18 years old, at nutritional risk, on exclusive enteral (ENT) or parenteral nutritional therapy (PNT) for > 72 hours. After three consecutive years, 9 QINT were applied and monitored. Statistical analysis was performed with SPSS version 17.0.

Results: A total of 145 patients were included, 93 patients were receiving ENT, among then 65% were male and the mean age was 55.7 years (± 17.4); 52 patients were receiving PNT, 67% were male and the mean age was 58.1 years (± 17.4). All patients (ENT and PNT) were nutritionally screened at admission and their energy and protein needs were individually estimated. Only ENT was early initiated, more than 70% of the prescribed ENT volume was infused and there was a reduced withdrawal of enteral feeding tube. The frequency of diarrhea episodes and digestive fasting were not adequate in ENT patients. The proper supply of energy was contemplated only for PNT patients and there was an expressive rate of oral intake recovery in ENT patients.

Conclusion: After three years of research, the percentage of QINT adequacy varied between 55%-77% for ENT and 60%-80% for PNT. The results were only made possible by the efforts of a multidisciplinary team and the continuous re-evaluation of the procedures in order to maintain the nutritional assistance for patients at nutritional risk.

Key words:

Quality indicators. Enteral nutrition. Parenteral nutrition. Critically ill patient. Malnutrition.

Resumen

Introducción: los indicadores de calidad en terapia nutricional (ICTN) permiten evaluar la calidad de la terapia nutricional (TN) de forma práctica.

Objetivo: implementar y monitorizar los ICTN en pacientes críticos con riesgo nutricional.

Métodos: estudio transversal con pacientes críticos > 18 años en riesgo nutricional, en terapia nutricional enteral (TNE) o parenteral (TNP) exclusiva a > 72 horas. Después de 3 años consecutivos, 9 ICTN fueron implementados y monitorizados. El análisis estadístico fue realizado con el *software* SPSS, versión 17.0.

Resultados: fueron incluidos 145 pacientes, siendo 93 en TNE, 65% eran de sexo masculino, con edad promedio de 55,7 años (± 17,4); 52 pacientes que estaban en TNP, 67% eran de sexo masculino, con edad promedio de 58,1 años (± 17,4). Todos los pacientes (TNE y TNP) fueron cribados en la admisión, los cálculos de las necesidades calóricas y proteínicas fueron individualizados. Apenas la TNE fue precoz, > 70% del volumen prescrito fue administrado y fue visto una reducida pérdida de la sonda nasoenteral. Las frecuencias de diarrea y ayuno digestivo no fueron adecuadas en TNE. La administración adecuada de energía fue contemplada apenas en TNP y hubo una significativa tendencia de recuperación en la vía oral en TNE.

Conclusión: después de 3 años de estudio, el porcentaje de adecuación de los ICTN varió entre 55%-77% para TNE y 60%-80% para TNP. Los resultados reflejan los esfuerzos del equipo multiprofesional de TN en mantener la calidad de la asistencia nutricional en los pacientes críticos con riesgo nutricional.

Palabras clave:

Indicadores de calidad. Nutrición enteral. Nutrición parenteral. Paciente crítico. Malnutrición.

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INTRODUCTION

The prevalence of nutritional risk in hospitalized patients is high. Approximately 48% of hospitalized patients in Brazil have some degree of malnutrition and among them 12% are severely malnourished (1). The prevalence of malnutrition in Intensive Care Unit (ICU) described in the literature varies between 43 and 88% (2,3).

This group of patients generally experience catabolic stress, which may be associated with Systemic Inflammatory Response Syndrome (SIRS). Under these conditions, there are increasing of Reactive Oxygen Species and Nitrogen productions, Multiple Organ Failure, Mechanical Ventilation (MV), length and hospital stay, thereby generating rising in morbidity and mortality rates (4).

In this way, Nutrition Therapy (NT) is an essential tool for the maintenance of immune function, for reducing metabolic complications and mainly in the deficit of muscle mass. Although Enteral Nutrition Therapy (ENT) is the preferred route of nourishment for critically ill patients, Parenteral Nutrition Therapy (PNT) is indicated when digestive tract cannot be safely used (5).

Gastrointestinal and/or metabolic dysfunctions such as refeeding syndrome, hyperglycemia, as well as pneumothorax and catheter infection, among other complications, are evident in patients on NT in ICU. These complications can negatively influence patient's clinical outcome (6). However, the prevention and minimization of these complications can be done by careful monitoring and the performance of Multidisciplinary Nutrition Therapy Team (MNTT). The MNTT in Brazil is defined by ordinances that regulate NT in order to provide effective and quality nutrition care (7,8).

Recently the task force of clinical nutrition of the International Life Sciences Institute - Brazil (ILSI) aiming at higher quality control in NT, proposes indicators for assessing the quality of ENT and PNT in hospitals. These Quality Indicators for Nutrition Therapy (QINT) allow the assessment of nutritional care in a healthcare service (9,10).

By this following up, the logistics of the service can be evaluated and the application of the recommendations proposed by NT guidelines in clinical practice can be verified. Despite the availability of these indicators, continuous and careful monitoring of patients in ICU on ENT or PNT is still modestly described in the literature. Regarding this background, the study had as an objective to apply and monitor QINT in critically ill patients at nutritional risk, on ENT or PNT admitted in a university hospital ICU in São Paulo - Brazil during three consecutive years.

METHODS

It was a cross-sectional study which considered the critically ill patients at nutritional risk, aged > 18 years old who entered in the ICU of a university hospital between August and December of 2010, 2011 and 2012 and also on exclusive ENT or PNT for more than 72 hours. Patients in palliative care, using ENT concomitantly with PNT and those that did not meet the criteria mentioned above were not included.

The research was approved by the Research Ethics Committee, being held prospectively in patients on ENT (CEP 603/05) and with retrospective analysis of data collected prospectively in patients on PNT (CEP 891/09). Data about sex, age, origin, destination, diagnosis, duration of NT, number of hours before starting NT, length of stay in the ICU, prescribed and infused volumes, and involuntary withdrawal of Enteral Feeding Tubes (EFT) were obtained from medical records.

The nutritional risk was assessed with the nutritional screening tool proposed by Kovacevichi et al. (11) (Fig. 1) and it was conducted by a dietitian. In order to detect nutritional risk, the reference method considered: involuntary weight loss, reduced food intake in the past weeks and the presence of gastrointestinal symptoms such as nausea, vomit, diarrhea and abdominal distension. Furthermore, other clinical data were considered for this evaluation, such as: previous diagnose of chronic diseases, malabsorption syndrome, abdominal surgery, cancer, sepsis and septic shock. This nutritional screening tool was accepted by the MNTT because of its simple implementation and compatibility with the resources available.

After identifying the nutritional risk, all patients were daily followed by the MNTT. The nutritional requirements were calculated from the body weight measured with a crane scale (Scale-Tronix brand, 2002) upon admission. The ideal body weight obtained from reference charts according to each age group (12,13) was used when patient mobilization was not possible due to limitations caused by medical condition. For obese patients (Body Mass Index - BMI $\geq$ 30 kg/m^2), the adjusted weight was calculated and used after obtaining the weight at admission. The formula used was: adjusted body weight = (current body weight - IBW) x 0.25 + IBW) (14).

The height measurement was based on those informed by patients or their relatives and in case this information was not available, the estimated height was calculated through equations using the knee height (15,16).

Estimates of energy and protein requirements, according to each clinical condition, were carried out conforming to existing protocol in the unit (17), so it was used 25-30 calories (kcal) per kilogram (kg) of weight based on recommendations of The European Society for Clinical Nutrition and Metabolism (18) (ESPEN) and 20 kcal/kg of adjusted weight for obese patients (14). For patients with acute-phase reaction it was used 1.25 to 1.5 g protein/kg of body weight (17-19).

The position of the EFT was according to the institution's protocol. Post-pyloric position was adopted and when it was not possible, the gastric position was used. All EFT placements were verified by X-ray and in all situations nasojejunal feeding tube was used. Enteral formulas were continuously administered using infusion pumps for approximately 22 hours and the remained two hours were reserved for procedures and administration of drugs (17). Five options of enteral formulas (polymeric normocaloric and normoproteic, polymeric hypercaloric and normoproteic with or without fibers, polymeric hypercaloric and hyperproteic and oligomeric) were available for ENT.

For PNT there were six types of formulations according to patient`s clinical condition (normocaloric with or without lipids, renal failure, hypercatabolic renal failure, hepatic failure, hypercaloric

A. Diagnosis:
If the patient has at least *one* of the following diagnoses, circle and proceed to section *E* to consider the patient *at nutritional risk* and stop here.
– Anorexia nervosa/bulimia nervosa.
– Malabsorption (celiac sprue, ulcerative colitis, Crohn's disease, short bowel syndrdrome).
– Multiple trauma (closed-head injury, penetrating trauma, multiple fractures).
– Decubitus ulcers.
– Major grastrointestinal surgery within the past year.
– Cachexia (temporal wasting muscle wasting, cancer, cardiac).
– Coma.
– Diabetes.
– End-stage liver disease.
– End-stage renal disease.
– Nonhealing wounds.

B. Nutrition intake history:
If the patient has at least *one* of the following symptoms, circle and proceed to section *E* to consider the patient *at nutritional risk* and stop here.
– Diarrhea (> 500 mL x 2 days).
– Vomiting (> 5 days).
– Reduced intake (< ½ normal intake for > 5 days).

C. Ideal body weight standars:
Compare the patient's weight for heigtht to the ideal body weigth chart on the back of this form.
– If at < 80% of ideal body weight, proceed to section *E* to considerer the patient *at nutritional risk* and stop here.

D. Weight history:
– Any recent unplanned weight loss? No ____ Yes ___ Amount (lbs or kg) ___
– If yes, within the past ___ weeks or ___ months.
– Current weight (lbs or kg)___
– Usual weight (lbs or kg) ___
– Height (ft, in or cm) ___
– Find percentage of weight lost: usual wt - current wt x 100 = ____% wt loss
usual wt
– Compare the % wt loss with the chart values and circle appropriate value:

Length of time	Significant (%)	Severe (%)
1 week	1-2	> 2
2-3 weeks	2-3	> 3
1 month	4-5	> 5
3 months	7-8	> 8
5 + months	10	> 10

If the patient has experienced a significant or severe weight loss, proceed to section *E* and considerer the patient *at nutritional risk.*

E. Nurse assessment:
Using the above criteria, what is this patient's nutritional risk? (circle one)
___ *Low nutritional risk.*
___ *At nutritional risk.*

Figure 1.
The nutritional screening tool proposed by Kovacevichi et al.

with lipids), with the option of supplementing with amino acids to achieve the previously estimated needs. All venous access were central with continuous administration for 24 hours. SAPS III Index (Simplified Acute Physiology Score) was used to assess the severity of patients' medical condition.

A total of 9 QINTs were selected, of which 4 were specific for patients on ENT. All indicators with formulas and goals were described in table I (9,8,20,21).

Statistical analyzes were carried out using SPSS version 17.0. Kolmogorov-Smirnov test ($p > 0.05$) was used to verify normal distribution of the sample. Mean and standard deviation were used when the variable was parametric and median values and interquartile range (p25-p75) for nonparametric variables. Chi-square test (χ^2) was used to compare qualitative variables and quantitative variables were compared using ANOVA and Student t tests for parametric variables and Kruskal-Wallis and Mann-Whit-

ney test for nonparametric variables. Statistical significant difference, $p < 0.05$ was considered for all tests.

RESULTS

Overall, the sample was composed of 145 patients, 93 on exclusive ENT, which 65% were male and the mean age was 55.7 years (± 17.4). Fifty-two patients on exclusive PNT were included in the sample, 67% were male and the mean age was 58.1 years (± 17.4). All patients presented nutritional risk, detected on ICU admission. On average, the patients remained 12.1 (± 9.4) days on ENT and 12.5 (± 8.8) days in PNT. Tables II and III show the demographic and clinical profile of patients respectively on ENT and PNT, and stratified according to the year of monitoring.

In total, 9 QINT were applied. In ENT, the indicators that met the goals proposed in all years were the following: the screening of nutritional risk (QINT I); the estimation of energy and protein needs (QINT II); the patients with ENT infused volume above 70% of prescribed volume (QINT IV); involuntary withdrawal of feeding tubes (QINT VIII); the rate of oral intake recovery (QINT IX). Meanwhile, the indicator which verified the inappropriate fasting time before the starting of ENT (QINT III) met the goal in the years of 2011 (12.9%) and 2012 (19.4%) and the indicator which evaluated the frequency of diarrhea episodes in patients receiving ENT (QINT VII) reached the goal established only in 2011 (9.2%). In the other hand, indicators that evaluated the frequency of days with adequate supply of energy (QINT V) and digestive fasting > 24 hours (QINT VI) in patients under ENT did not contemplate the goal proposed by the literature during the years of study (Table IV).

In PNT, the indicator that verified the screening of nutritional risk (QINT I), the estimation of energy and protein needs (QINT II) and the frequency of days with adequate supply of energy (QINT IV) met the goal in all years evaluated. However, the indicator that evaluated the rate of oral intake recovery (QINT V) met the goal only in 2010 (42.8%) and 2012 (35.2%), and the indicator that evaluated the inappropriate fasting time before the starting of PNT (QINT III) never met the goal in all years evaluated (Table IV).

Therefore, in all of the indicators for ENT, the goal was achieved by 55% in 2010 (5 QINT), 77% in 2011 (7 QINT) and 66% in 2012 (6 QINT). For PNT, target was reached by 80% (4 QINT), 60% (3 QINT) and 80% (4 QINT), respectively in 2010, 2011 and 2012. All percentages of suitability for applied/contemplated QINT according to the years of study are showed in Table V.

DISCUSSION

Nutritional risk assessment is one of the most important aspects that integrate the procedure for the care of all hospitalized patients and it is essential for those who demand intensive care. Recently, the American guideline for NT in critically ill patients highlighted the importance of a careful monitoring on ENT and PNT for those who were diagnosed at high nutritional

Table I. Applied quality indicators in nutrition therapy. University Hospital of the University of São Paulo 2010-2012

Indicator	Formula	Goal
Frequency of caring out nutrition screening	No. of nutritional screening x 100 / No. of ICU admissions	≥ 80%
Frequency of estimated energy and protein needs in patients on NT	No. of patients with measurement of energy expenditure/protein x 100 / Nº of patients on NT	≥ 80%
Frequency of patients with inadequate fasting time before starting NT (> 48 h)	No. of patients on fasting > 48 h candidate to NT x 100 / total number of patients candidate to NT	< 20%
Frequency of patients with ENT infused volume above 70% of prescribed volume	No. of patients with NT infused volume > 70% x 100 / Total number of patients on NT	> 80%
Frequency of days of adequate supply of energy to patients on NT	No. of days with caloric offer between 25 a 35 kcal/kg x 100 / total number of days in the period evaluated	≥ 80%
Frequency of digestive fasting > 24 hours in patients on ENT	No. of patients in fasting > 24 h x 100 / No. of patients on ENT	≥ 10%
Frequency of diarrhea episodes in patients on ENT	No. of days with diarrhea x 100 / Total number of days on ENT	≥ 10%
Frequency of involuntary withdrawal of enteral feeding tubes in patients on ENT	No. of involuntary withdrawal of enteral feeding tube x 100 / Total number of patients on ENT x no. of days with enteral feeding tube	< 5%
Frequency of patients with oral intake recovery on NT	No. of patients which oral intake recovery x 100 / Total number of patients on NT	> 30%

ICU: Intensive Care Unit; NT: nutrition therapy; ENT: enteral nutrition therapy.

Table II. Demographic and clinical characteristics patients under enteral nutrition therapy in the period from 2010 to 2012. University Hospital of the University of São Paulo

Characteristics	2010 (n = 31)	2011 (n = 31)	2012 (n = 31)	*p*	Total (n = 93)
Genre, n (%)					
Female	10 (32.3)	10 (32.3)	12 (38.7)	0.791	32 (34.4)
Male	21 (67.7)	21 (67.7)	19 (61.3)		61 (65.6)
Age, years oucome (%)	60.6 (± 16.9)*	49.9 (±15.5)	56.5 (± 18.4)	0.05	55.7 (± 17.4)
Discharge from ICU	19 (61.3)	25 (80.7)	22 (74.2)	0.161	66 (72.0)
Death	12 (38.7)	6 (19.4)	9 (25.8)		27 (28.0)
Admitting diagnosis (%)					
Respiratory	9 (29.1)	11 (35.4)	8 (25.8)	0.779	28 (30.1)
SIRS	4 (12.9)	7 (22.6)	3 (9.7)	0.395	14 (15.1)
Neurological	5 (16.1)	7 (22.6)	5 (16.1)	0.790	17 (18.3)
Cardiovascular	7 (22.6)*	1 (3.2)	2 (6.5)	0.045	10 (10.7)
Hepatic	1 (3.2)	1 (3.2)	3 (9.7)	0.449	5 (5.4)
Surgery	1 (3.2)	2 (6.5)	8 (25.8)**	0.020	11 (11.8)
Others	4 (12.9)	2 (6.5)	2 (6.4)	0.607	8 (8.6)
SAPS III	60,9 (± 13.8)	59.2 (± 16.9)	60.7 (± 14)	0.888	60.3 (± 14.9)
CRP, mg/L	126.9 (+ 94.8)*	201.5 (± 123.9)	189.4 (± 130.7)	0.031	172.6 (± 120.5)

*Qualitative variables were analyzed by χ^2 test, and the results were expressed in absolute values followed by frequency. Quantitative variable were analyzed by t-Student test, and the results expressed in mean and standard deviation. Significance level $p < 0.05$. *2010 vs. 2011; **2012 vs. 2011. ICU:Intensive Care Unit; SIRS: Systemic Inflammatory Response Syndrome; SAPS: Simplified Acute Physiology Score; CRP: C-reactive protein.*

Table III. Demographic and clinical characteristics patients under parenteral nutrition therapy in the period from 2010 to 2012. University Hospital of the University of São Paulo

Characteristics	2010 (n = 14)	2011 (n = 21)	2012 (n = 17)	*p*	Total (n = 52)
Genre n (%)					
Female	5 (35.7)	5 (23.8)	7 (41.2)	0.307	17 (32.7)
Male	9 (64.3)	16 (76.2)	10 (58.8)		35 (67.3)
Age, years oucome (%)	54.7 (± 21.1)	55.9 (± 17)	63.8 (± 10.7)	0.259	58.1 (± 16.7)
Discharge from ICU	9 (64.3)	5 (23.8)*	6 (35.3)	0.033	20 (38.5)
Death	5 (35.7)	16 (76.2)	11 (64.7)		32 (61.5)
Adimitting diagnosis (%)					
Surgery	12 (85.8)	17 (81.0)	15 (88.2)	0.649	44 (84.6)
Hepatic	1 (7.1)	0 (0.0)	1 (5.9)	1.00	2 (3.9)
Others	1 (7.1)	4 (19.0)	1 (5.9)	0.223	6 (11.5)
SAPS III	57.4 (± 22.6)	57.5 (± 17.5)	62.6 (± 11.0)	0.683	59.0 (± 17.3)
CRP, mg/dL	203.4 (± 92.3)	215.3 (± 94.2)	243.7 (± 98.9)	0.443	221.4 (± 94.8)

*Qualitative variables were analyzed by χ^2 test, and the results were expressed in absolute values followed by frequency. Quantitative variable were analyzed by t-Student test, and the results expressed in mean and standard deviation. Significance level $p < 0.05$ *2010 vs. 2011; ICU: Intensive Care Unit; SIRS: Systemic Inflammatory Response Syndrome; SAPS: Simplified Acute Physiology Score; CRP: C-reactive protein.*

Table IV. Quality Indicators in Nutrition Therapy at Intensive Care Unit, according to the year studied. University Hospital of the University of São Paulo 2010-2012

Indicators applied on ENT	2010 (%)	2011 (%)	2012 (%)	Goal
I Frequency of caring out nutrition screening	100	100	100	≥ 80%
II Frequency of estimated of energy and protein needs in patients on ENT	100	100	100	≥ 80%
III Frequency of patients with inadequate fasting time before starting ENT (> 48 h)	22.6	12.9	19.4	< 20%
IV Frequency of patients with ENT infused volume above 70% of prescribed volume	83.8	87.1	87.1	> 80%
V Frequency of days of adequate supply of energy to patients on NT	75.6	73.6	72.3	≥ 80%
VI Frequency of digestive fasting > 24 hours	16.1	19.3	16.1	≤ 10%
VII Frequency of diarrhea episodes in patients on ENT	10.5	9.2	10.7	≤ 10%
VIII Frequency of involuntary withdrawal of enteral feeding tubes in patients on ENT	0.2	0.2	0.2	< 5%
IX Frequency of patients with oral intake recovery on enteral nutrition therapy	48.3	77.4	61.2	> 30%
Indicators applied on PNT	**2010 (%)**	**2011 (%)**	**2012 (%)**	**Goal**
I Frequency of caring out nutrition screening	100	100	100	≥ 80%
II Frequency of estimated of energy and protein needs in patients on PNT	100	100	100	≥ 80%
III Frequency of patients with inadequate fasting time before starting PNT (> 48 h)	71.4	61.9	82.3	< 20%
IV Frequency of days of adequate supply of energy to patients on NT	87.3	83.8	85.1	≥ 80%
V Frequency of patients with oral intake recovery on parenteral nutrition therapy	42.8	23.8	35.2	> 30%

NT: nutrition therapy; ENT: enteral nutrition therapy; PNT: parenteral nutrition therapy.

Table V. Quality Indicators in Nutrition Therapy at Intensive Care Unit, percentage of suitability according to the year studied. University Hospital of the University of São Paulo 2010-2012

Year / ENT	No. of applied indicators	No. of contemplated indicators	Percentage of suitability
2010	9	5	55%
2011	9	7	77%
2012	9	6	66%
Year / PNT	**No. of applied indicators**	**No. of contemplated indicators**	**Percentage of suitability**
2010	5	4	80%
2011	5	3	60%
2012	5	4	80%

ENT: enteral nutrition therapy; PNT: parenteral nutrition therapy.

risk (22). However, it appears that this specific group of patients is prone to the adverse effects of NT such as re-feeding syndrome, underfeeding/overfeeding, hypoglycemia/hyperglycemia, abdominal distension, nausea, vomiting, constipation, diarrhea and prolonged fasting; all which could result in a negative clinical outcome (5,6,18,19,22,23). These aforementioned complications that occur while applying NT could be gradually reduced or even avoided if specific protocols were implemented in NT as such as systematic application of QINT (9,10,19-22,24,25).

In our study, the QINT I that evaluated the frequency of nutritional screening for patients receiving ENT or PNT resulted in 100% of adequacy in all years considered for the study. After implementing this same QINT in 72 ICU patients, Bezerra et al. (26) also got similar results, reinforcing the importance of nutritional risk assessment in critically ill patients. A careful monitoring of the nutritional risk in critically ill patients conducted the MNTT to establish daily reviews of NT procedures in order to prevent eventual side effects of ENT and PNT during hospitalization. Therefore, the

nutritional screening guides the nutritional care, considering the presence of risk or not in the patient (22,23).

Recently the Nutrition Risk in Critically ill (NUTRIC) was considered the best tool for assessing nutritional risk in critically ill patients (22). However, before the completion of the protocols adopted by this research, the "modified NUTRIC" version without considering the IL-6 value was not available yet (23).

Besides nutritional screening, to estimate the energy and protein needs becomes the starting point for directing NT in the severely ill patient. Considering the obstacles that exist in nutritional assessment for those patients, such as sedation, intubation, anasarca, biochemical tests altered by the acute phase reactions, polytrauma and even the absence of close family or relatives. In this context, it is mandatory in ICU the use of formulas in order to estimate height, weight and energetic and proteic expenditure (22). Even when considering these obstacles, the QINT II that evaluated the frequency of estimated energetic and proteic expenditure for patients under NT met the goal established at $\geq$ 80% in all three years of study, which reiterates the MNTT efforts to individualize NT. Martins et al. (27), in a prospective study with 200 patients and Oliveira Filho et al. (28) in a retrospective study with 551 ward and ICU cancer patients, also found $\geq$ 80% of adequacy in the same QINT. With the intention of define the energy needs for the severely ill patients, the indirect calorimetry is the golden standard. However, in clinical practice, the predictive equations which estimate the energy expenditure still prevail due the availability of the calorimetric method (22).

The QINT III that evaluated the frequency of patients with inadequate fasting time (> 48 hours) before starting ENT presented values of 22% in 2010, 12.9% in 2011 and 19.4% in 2012. In 2010, this QINT was outside the established goal, which led the MNTT to reinforce the importance of early ENT commitment for critically ill patients and consequently achieved the established goal on the following years of the study.

Heyland et al. (29) in a multicentric and cohort study with 5497 patients found in those units with NT protocols that the average of hours to start ENT was 42.1 hours, while in units without protocols the mean time was 57.1 hours which was a significant difference between such units ($p = 0.0003$). Oliveira Filho et al. (30) evaluated the ENT quality at nutritional risk, critically ill and cancer patients (NUTRIC $\geq$ 6), which also highlighted the early start of this therapy. The early ENT (24-48 hours) is associated with least infectious complications, less intestinal permeability and proliferation of inflammatory cytokines, reduced mechanical ventilation time, better dietary tolerance, as well as a tendency for reduced mortality and ICU length of stay (19,22,29).

On the other hand, after conducting the same QINT III for patients receiving PNT, all values found in the present study differed from the goal of 20%. It is worth noting that in three years of the study, more than 80% were surgery patients and 90% of those had previous abdominal surgeries. The EPaNIC study found that late parenteral nutrition, was associated with fewer infections, lower incidence of cholestasis, enhanced recovery, and lower health care costs, when compared with the early parenteral (31).

The recommendations of guidelines for nutrition support in critically ill patients differ from each other. ESPEN guidelines advocated early parenteral nutrition up to 48 hours after ICU admission for patients unable to be feeding by enteral route (18). In contrast, American (5) and Canadian guidelines (32) proposed that for patients without nutrition impairment the initiation of PNT can wait until 8 days (192 hours). However, the American guideline has recently complemented its recommendations in order to emphasize the care for malnourished patients in ICU. Therefore, PNT must be initiated as soon as possible for patients at high nutritional risk (22).

After applying the QINT VI that analyzed patients who received > 70% of prescribed ENT volume, the present study met the goal during all three years monitored. Oliveira Filho et al. (30), encountered an average of > 80% of adequacy in infused ENT volume in oncological patients with NUTRIC $\geq$ 6 and under MV, while Couto et al. (33) showed values < 80% in politrauma patients and also under MV. In intensive care, to manage that patients receive a proper amount of prescribed ENT is a daily struggle, considering gastrointestinal intolerance such as abdominal distension, diarrhea and vomit or even pauses for procedures such as extubation or surgeries (30,34). Discrepancies observed between prescribed and infused volume had been reported by several authors as one of the main factors for hypoalimentation (5,18,19,29). McClave et al. (5) found that those patients who received volume of EN close to 100%, progressed with lower infectious complication rates, reduced hospital length of stay and with a tendency to a lower mortality rate.

Regarding the QINT that assessed the frequency of days of adequate supply of energy in patients with ENT (QINT V), it was observed values from 72.3 to 75.6% of adequacy in the three years of study. Several studies reported the main barriers to achieve the prescribed energy in patients with ENT, such as non-compliance with protocols and logistic failure in nutritional service (5,29,35). The hemodynamic instability, hours to nutritional goal and extubation, for example, also were the main reasons that negatively impact the energy deficit in critical oncologic patients at high nutritional risk (30). Heyland et al. (36) after evaluating 3,390 critically ill patients, under MV and at high nutritional risk, found 61.2% of adequacy in supply of energy in ENT patients and 74% of them did not receive at least 80% of their nutritional needs. In this study, the majority of critically ill patients, including high nutritional risk patients, fail to receive adequate nutritional intake.

However, for patients receiving PNT (QINT IV), it was verified a range between 83.8 to 87.3% of adequacy in the years analyzed. Shiroma et al. (37) showed that the infusion of more than 80% of the caloric needs from PNT led to hospital discharge in ward and ICU patients. The great advantage in PNT, even without gastrointestinal use, is to optimize the supply of energy in the early days of ICU stay, while there is a good metabolic and organic tolerance which can be monitored through routine biochemical tests (38). Besides, PNT is independent of the digestive tract and therefore is not negative influenced by long fasting periods for tests or procedures (e.g. endoscopy, computed tomography and extubation) in comparison to ENT and so the caloric target can be fully achieved daily.

The QINT VI analyzed the frequency of digestive fasting for more than 24 hours in patients receiving ENT and, during all three

years, our results were outside the goal. Brandão and Rosa (39) have also not met the goal in this QINT after evaluating critically ill patients during 31 days. Many factors might contribute to the prolonged fasting in severely ill patients in ENT, such as subsequent attempts of extubation, especially in patients with worse respiratory function. Furthermore, gastrointestinal complications such as elevated gastric residue and uncontrollable diarrhea, fluids, electrolytes and acid-base imbalance (38), as well as hemodynamic instability (22) contribute to an increase in fasting time and consequently, can also increase the caloric and protein deficit, length of hospital stay and mortality in ICU (40).

It is still necessary to even consider logistic issues that might interfere, such as surgery centers being unavailable for tracheostomy, as well as full schedule when scheduling exams (*e.g.* computed tomography). This can lead to a prolonged fasting period and even might not successfully undergo the procedure or exams. These results point to the need of strategic planning and, since 2012, tracheostomy procedures were conducted inside the ICU as the computed tomography had a reserved time and date for all ICU patients as a way to ensure a better schedule for the patients.

Regarding evaluation of the frequency of diarrhea in patients on ENT (IQTN VII), in 2011 the target was achieved, as it was found frequency of 9.2% of days with diarrhea. One the other hand, the values in 2010 (10.5%) and 2012 (10.7%) were bordering the target established. Bittencourt et al. (41), in an observational study with 110 patients, applied the diarrhea indicator and found a prevalence of 13%, while Martins et al. (27) met 8%. In the literature, there are records with higher percentages of episodes of diarrhea, with values ranging from 14% to 41% of the days on ENT (41). Characteristics such as age, medical condition, hospital stay and type of EN are some factors that may compromise the bowel transit. Another important point to consider is the very frequent use of antibiotics in critically ill patients, leading to dysbiosis which can result in diarrhea. The contamination by *Clostridium difficile* should also be considered (5,6,22).

When the values related to involuntary withdrawal of enteral feeding tube in patients on ENT (IQTN VIII) were evaluated, the results of all years were according to the proposed target. In the study by Martins et al. (35), the values were 6% for patients admitted to wards and 26% for patients in ICU, while Cervo et al. (42) found 4.6% for patients in critical care. The results found in the present study reflected the efforts of the nursing crew in all procedures related to the EFT, as well as, the protocols that had been developed in order to standard professional actions.

The oral intake recovery was another important aspect in our investigation. The QINT showed an adequacy of 100% in all the years evaluated in the patients receiving ENT (QINT IX), while in PNT, only in the year of 2011 (23.8%), it was not possible to achieve the goal proposed. It is worth noting that in 2011, 72.6% of the patients who received PNT had died, and that outcome turns impossible to achieve the goal. Bezerra et al. (26) has also achieved a 100% rate of adequacy for this QINT after evaluating 72 patients under ENT and intensive care. In our study, even disregarding the patients under PNT in 2011, the results in this QINT were obtained only because of a rigorous monitoring conducted by the MNTT in partnership with the speech therapy team. In our team, the QINT of rate of oral intake recovery was considered as one of the most important aspects when evaluating the quality of NT within the ICU. Considering that the oral intake is the most physiological channel for nourishment (43), one must establish that oral intake might result in ample benefits for patients under ENT or PNT, both in psychosocial and family levels.

Marshall et al. (44) has highlighted in recent studies the importance of active family participation as a strategy to optimize nutritional support to critically ill patients. The constant presence of the family and relatives during ICU stay might contribute to an increase in oral intake, mainly for elderly patients, because those are the ones who probably display a smaller percentage of oral intake recovery when compared to adult patients (34).

Considering all the three evaluated years, the QINT percentage of adequacy varied from 55-77% for ENT and 60-80% for PNT which presented a concern about quality as well as it brought aspects that need to be managed. The assessment of nutritional assistance quality must ensure the best of what NT can provide to patients, achieving as a result the recovery/maintenance of the nutritional status at reduced costs, ensuring a long term quality of life as well (9,10).

The Joint Comission on Acreditation of Health Care Organization (JCAHCO) recognized over a decade ago the need of constantly evaluation and monitoring of patients who are subjected to NT (45). Hence, the application of QINT is considered now as an adequate tool to better evaluate the quality of nutritional assistance provided in medical services. These QINT can provide a plausible comparison between different health institutions, as well as a feasible guidance for future strategic actions and improvement of results (9,10,21).

It becomes an important detail that trained health professionals, comitted to specific NT protocols and who comply with a quality-oriented hospital management program and who keep themselves familiarized with these QINT results will provide feasible benefits to patients, to the hospital and the public health by ensuring the quality in all services (46). This is a continuous process of evaluation which tends to always apply NT guidelines to clinical practices, by constantly reviewing said processes in order to improve the assistance provided.

Currently, what poses as a challenge to professionals who are NT specialists is defining which QINT are needed and could possibly be considered as applicable at clinical nutrition services in order to improve the nutritional care for the hospitalized patient. There are no standardized rules in order to establish quality indicators as they will reveal themselves as a consequence of the needs and experiences developed at each health institution (46).

We emphasize that our study has some limitations because it was carried out in a single school hospital, which had only one adult ICU for medical and surgical patients, so that it resulted in a small study sample and presented a limited number of professionals.

CONCLUSION

After three years of research, the percentage of QINT adequacy varied between 55% and 77% for ENT and 60% and 80% for PNT. There is the establishment of individualized nutrition target, with

early introduction of ENT, but not PNT. The average volume of ENT administered is above 70% and administration of calories in PNT is more adequate. There was an expressive rate of oral intake recovery in ENT, which can contribute for a long term quality of life for those patients. The results were only made possible by the efforts of a multidisciplinary team and the continuous re-evaluation of the procedures in order to maintain the nutritional assistance for patients at nutritional risk.

REFERENCES

1. Waitzberg DL, Caiaffa WT, Correia MI. Hospital malnutrition: the Brazilian national survey (IBRANUTRI): a study of 4000 patients. Nutrition 2001;17(7-8):573-80.
2. Giner M, Laviano A, Meguid MM, Gleason JR. In 1995 a correlation between malnutrition and poor outcome in critically ill patients still exists. Nutrition 1996;12(1):23-9.
3. Barr J, Hecht M, Flavin KE, Khorana A, Gould MK. Outcomes in critically ill patients before and after the implementation of an evidence-based nutrition management protocol. Chest 2004;125(4):1446-57.
4. Manzanares W, Dhaliwal R, Jiang X, Murch L, Heyland DK. Antioxidant micronutrients in the critically ill: a systematic review and meta-analysis. Crit Care 2012;16(2):R66.
5. McClave SA, Martindale RG, Vanek VW, McCarthy M, Roberts P, Taylor B, et al. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN). JPEN J Parenter Enteral Nutr 2009;33(3):277-316.
6. National Collaborating Centre for Acute Care. Nutrition support in adults Oral nutrition support, enteral tube feeding and parenteral nutrition. London: National Collaborating Centre for Acute Care; 2006.
7. Brasil. Ministério da Saúde. Regulamento técnico a terapia de nutrição parenteral. Brasília: Agência Nacional de Vigilância Sanitária; 1998.
8. Brasil. Ministério da Saúde. Regulamento técnico para a terapia de nutrição enteral. Resolução RDC n 63, de 6 de julho de 2000. Brasília: Agência Nacional de Vigilância Sanitária; 2000.
9. Waitzberg DL. Indicadores de Qualidade em Terapia Nutricional. Sao Paulo: ILSI Brasil; 2008.
10. Waitzberg DL. Indicadores de Qualidade em Terapia Nutricional: Aplicação e Resultados. Sao Paulo: ILSI Brasil; 2010.
11. Kovacevich DS, Boney AR, Braunschweig CL, Pérez A, Stevens M. Nutrition risk classification: a reproducible and valid tool for nurses. Nutr Clin Pract 1997;12(1):20-5.
12. Burr ML, Phillips KM. Anthropometric norms in the elderly. Br J Nutr 1984;51(2):165-9.
13. Company MLI. Metropolitan height and weight tables. Metropolitan Stat Bull 1983;2-9.
14. Dickerson RN, Boschert KJ, Kudsk KA, Brown RO. Hypocaloric enteral tube feeding in critically ill obese patients. Nutrition 2002;18(3):241-6. Erratum in Nutrition 2003;19(7-8):700.
15. Chumlea WC, Roche AF, Mukherjee D. Nutrition assessment of the elderly through anthropometry. Ohio: Yellow Springs; 1987.
16. Chumlea WC, Guo SS, Steinbaugh ML. Prediction of stature from knee height for black and white adults and children with application to mobility-impaired or handicapped persons. J Am Diet Assoc 1994;94(12):1385-8, 1391; quiz 1389-90.
17. Caruso L. Nutrição enteral. In: Soriano FG, Nogueira AC, editores. UTI-adulto: manual prático. São Paulo: Sarvier; 2010.
18. Kreymann KG, Berger MM, Deutz NE, Hiesmayr M, Jolliet P, Kazandjiev G, et al; DGEM (German Society for Nutrition Medicine); ESPEN (European Society for Parenteral and Enteral Nutrition). ESPEN Guidelines on Enteral Nutrition: Intensive care. Clin Nutr 2006;25(2):210-23.
19. Miller KR, Kiraly LN, Lowen CC, Martindale RG, McClave SA. "Can we feed?" A mnemonic to merge nutrition and intensive care assessment of the critically ill patient. JPEN J Parenter Enteral Nutr 2011;35(5):643-59.
20. Verotti CC, Torrinhas RS, Cecconello I, Waitzberg DL. Selection of top 10 quality indicators for nutrition therapy. Nutr Clin Pract 2012;27(2):261-7.
21. Waitzberg DL, Enck CR, Miyahira NS, Mourão JRP, Faim MMR, Oliseski M, et al. Terapia Nutricional: Indicadores de Qualidade Projeto Diretrizes. São Paulo: Associação Médica Brasileira e Conselho Federal de Medicina; 2011.
22. McClave SA, Taylor BE, Martindale RG, Warren MM, Johnson DR, et al. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN). JPEN J Parenter Enteral Nutr 2016;40:159-211.
23. Rahman A, Hasan RM, Agarwala R, Martin C, Day AG, et al. Identifying critically-ill patients who will benefit most from nutritional therapy: Further validation of the "modified NUTRIC" nutritional risk assessment tool. Clin Nutr 2016;35(1):158-62.
24. Waitzberg DL, Correia MI. Strategies for High-Quality Nutrition Therapy in Brazil. JPEN J Parenter Enteral Nutr 2016;40(1):73-82
25. Martín FT, Álvarez HJ, Burgos PR, Celaya PS, Calvo HMV, García LA. et al. Analysis of the relevance and feasibility of quality indicators in nutrition support. Nutr Hosp 2012;27(1):198-204.
26. Bezerra RGS, Costa VL, Figueira MS, Andrade RS. Indicadores de qualidade em terapia nutricional enteral em sistema fechado em um hospital particular na cidade de Belém - PA. Rev Bras Nutr Clin 2014:29(1):20-5.
27. Martins JR, Horie LM, Shiroma GM, Ortolani MC, Lugollo L, Bittencourt AF, et al. Quality control indicators in enteral nutrition: the compliance rates in a general hospital in Brazil. Clin Nutr Suppl 2009;4(suppl. 2).
28. Oliveira Filho RS, Vianna SN, Almeida MMFA, Trevisani VS, Cardenas TC. Quality Indicators in Nutrition Therapy: Results at an Oncology Reference Hospital in São Paulo Brazil. Clin Nutr 2014;33(suppl. 1):59.
29. Heyland DK, Cahill NE, Dhaliwal R, Sun X, Day AG, McClave SA. Impact of enteral feeding protocols on enteral nutrition delivery: results of a multicenter observational study. JPEN J Parenter Enteral Nutr 2010;34(6):675-84.
30. Oliveiro Filho RS, Tamburrino AC, Trevisani VS, Rosa VM. Main Barriers in Control of Energy-Protein Deficit in Critical Oncologic Patient at Nutritional Risk. J Integr Oncol 2016;5:156.
31. Casaer MP, Mesotten D, Hermans G, Wouters PJ, Schetz M, et al. Early versus late parenteral nutrition in critically ill adults. N Engl J Med 2011;11;365(6):506-17.
32. Singer P, Berger MM, Van den Berghe G, Biolo G, Calder P, Forbes A, et al. ESPEN Guidelines on Parenteral Nutrition: intensive care. Clin Nutr 2009;28(4):387-400.
33. Couto CFL, Moreira JS, Hoher JA. Enteral nutritional therapy in mechanically-ventilated multiple-trauma patients and energy intake. Rev Nutr.2012;25(6):695-705.
34. Ribeiro LMK, Oliveira Filho RS, Caruso L, Lima PA, Damasceno NRT, Soriano FG. Adequacy of energy and protein balance of enteral nutrition in intensive care: what are the limiting factors? Rev Bras Ter Intensiva 2014;26(2):155-62.
35. Martins JR, Shiroma GM, Horie LM, Logullo L, Silva ML, Waitzberg DL. Factors leading to discrepancies between prescription and intake of enteral nutrition therapy in hospitalized patients. Nutrition 2012;28(9):864-7.
36. Heyland DK, Dhaliwal R, Wang M, Day AG. The prevalence of iatrogenic underfeeding in the nutritionally 'at-risk' critically ill patient: Results of an international, multicenter, prospective study. Clin Nutr 2015;34:659-66.
37. Shiroma GM, Horie LM, Castro MG, Martins JR, Bittencourt AF, Logullo L, Teixeira da Silva ML, Waitzberg DL. Nutrition quality control in the prescription and administration of parenteral nutrition therapy for hospitalized patients. Nutr Clin Pract 2015;30(3):406-13.
38. Ribeiro PC. [coordenador da série]. Série Medicina de Urgência e Terapia Intensiva do Hospital Sírio-Libanês: Nutrição. São Paulo: Editora Atheneu; 2015.
39. Brandão VL, Rosa LPS. Nutrição enteral em pacientes internados em unidade de terapia intensiva: análise dos indicadores de qualidade. Brasília Med 2013;50(3):200-5.
40. Siqueira-Paese MC, Dock-Nascimento DB, Aguilar-Nascimento JE. Critical energy deficit and mortality in critically ill patients. Nutr Hosp 2016;33(3):522-7.
41. Bittencourt AF, Martins JR, Logullo L, Shiroma G, Horie L, Ortolani MC, et al. Constipation is more frequent than diarrhea in patients fed exclusively by enteral nutrition: results of an observational study. Nutr Clin Pract 2012;27(4):533-9.
42. Cervo AS, Magnago TSBS, Carollo JB, Chagas BP, Oliveira AS, Urbanetto JS. Eventos adversos relacionados ao uso de terapia nutricional enteral. Rev. Gaúcha Enferm 2014;35(2):53-9.
43. Verotti CCG, Torrinhas RSM, Corona LP, Waitzberg DL. Design of quality indicators for oral nutritional therapy. Nutr Hosp 2015;1;31(6):2692-5.
44. Marshall AP, Wake E, Weisbrodt L, Dhaliwal R, Spencer A, Heyland DK. A multi-faceted, family-centred nutrition intervention to optimise nutrition intake of critically ill patients: The OPTICS feasibility study. Aust Crit Care 2015;18.
45. Joint Commission on Accreditation of Healthcare Organizations (JCIHO); 1996.
46. Isosaki M, Gandolfo AS, Jorge AL, Evazian D, Castanheira FA, Bittar OJN. Indicadores de Nutrição Hospitalar. São Paulo: Editora Atheneu; 2015.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Pediatría

Cut-off values for classifying active children and adolescents using the Physical Activity Questionnaire: PAQ-C and PAQ-A

Valores de corte para clasificar niños y adolescentes activos utilizando el Cuestionario de Actividad Física: PAQ-C y PAQ-A

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Abstract

Introduction: The Physical Activity Questionnaire for children and adolescents (PAQ-C & PAQ-A) has been widely used in research and field settings. However, there is a lack of information about its final score meaning.

Objective: To determine PAQ-C and PAQ-A score cut-off values using physical activity (PA) thresholds objectively measured as reference criteria.

Methods: 146 children (n = 83 boys, n = 63 girls) and 234 adolescents (n = 115 boys, n = 119 girls) participated in this study. Accelerometers (Actigraph GT3X) were used to assess objectively PA during one-week, afterwards PAQ was filled by the participants. As participants met or not the international PA recommendations for total, moderate-vigorous (MVPA) or light PA, three categorical variables of two levels were created. ROC curves procedure were carried out to obtain score cut-off points for identifying the positive category recommendation.

Results: ROC curves analysis estimated 2.75 and 2.73 score cut-off points to discriminate > 60 minutes of MVPA for PAQ-A and PAQ-C respectively (PAQ-A AUC = 0.68, $p < 0.001$ and PAQ-C; AUC = 0.55, $p > 0.05$). Also 60 minutes of MVPA was achieved with a total volume of 10,664 steps/day in children and 9,701 steps/day in adolescents.

Conclusions: Our results suggest that PAQ-A can be a useful tool to classify adolescents as active or inactive following international recommendations as criteria. However, we could not find a significant cut-off for PAQ-C score.

Key words:

ROC curves.
Adolescence.
Childhood. Sensitivity.
Specificity.

Resumen

Introducción: el Cuestionario de Actividad Física para Niños y Adolescentes (PAQ-C y PAQ-A) ha sido ampliamente utilizado en entornos de investigación y en el trabajo de campo. Sin embargo, existe una falta de información sobre el significado de su puntuación final.

Objetivo: determinar los valores de corte del PAQ-C y el PAQ-A y el número de pasos diarios asociados utilizando una medida objetiva de actividad física como criterio de referencia.

Metodología: 146 niños (n = 83 niños, n = 63 niñas) y 234 adolescentes (n = 115 niños, n = 119 niñas) participaron en el estudio. Se utilizó acelerometría triaxial (Actigraph GT3X) durante 7 días y los participantes completaron el PAQ-C y/o PAQ-A al entregar el acelerómetro. En base a las recomendaciones internacionales de AF se crearon tres criterios relativos a si los participantes cumplían o no con las mismas (AFMV > 60 min/día, AF vigorosa > 30 min/día, y AF total > 116 min/día; respectivamente). El análisis de las curvas ROC fue utilizado para identificar los valores de corte.

Resultados: el análisis de las curvas ROC estimó un valor de 2,75 y 2,73 para discriminar > 60 minutos de actividad física moderada-vigorosa para el PAQ-A y el PAQ-C, respectivamente (PAQ-A AUC = 0,68, $p < 0,001$ y PAQ-C; AUC = 0,55, $p > 0,05$). Dicha intensidad se logró con un volumen total de 10.664 pasos/día en niños y 9.701 pasos/día en adolescentes.

Conclusiones: nuestros resultados sugieren que el PAQ-A puede ser una herramienta útil para clasificar a los adolescentes activos siguiendo las recomendaciones internacionales de actividad física como criterio. Sin embargo, no pudimos encontrar un punto de corte significativo para el PAQ-C.

Palabras clave:

Curvas ROC.
Adolescencia.
Niñez. Sensibilidad.
Especificidad.

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INTRODUCTION

Physical activity (PA) is predictor of cardiovascular (1), skeletal (2), and mental health (3), in children and adolescents. Moreover, PA has been identified as a behavior that may contribute to the prevention of chronic diseases such as obesity, cardiovascular diseases, and metabolic syndrome (4,5). However, current youth, and especially girls, are often not enough active (6).

PA assessment by questionnaires an useful tool in field studies and continue to provide important information to assess activity patterns on large populations PA and they enable a convenient way to assess activity patterns (7). The Physical Activity Questionnaire for children and adolescents (PAQ-C & PAQ-A) are a cost-effective tools to assess PA patterns during childhood and adolescence (8) and they have been widely used in research and field settings. However, a limitation is that the outcome score is not readily interpretable (9). The PAQ asks for frequency spent in physical activities, which is a subjective rating of intensity, moreover their items are scored using ordinal scales (1-5 scale) and the outcome measure is computed as a simple mean of the individual items. As consequence, it is difficult to relate the PAQ score with the established international PA recommendations (10).

Meanwhile, objective measures are often used to validate less accurate measures, such as subjective instruments, but this does not directly improve the accuracy or precision of the self-report instrument. Equivalent estimates of PA could be generate in a more efficient and cost- effective way if we use handle self-report instruments. In this line, the utility in youth can be greatly enhanced by calibrating self-report output against objectively measured PA data. Therefore, although objective instruments are now widely used, there is a considerable need to improve the utility and accuracy of self-report measures.

Triaxial accelerometers provide an objective indicator of free-living PA that can be temporally linked to data from a self-report tool (11), so it is an appropriate method to establish cut-offs points as PA recommended. The most accurate method to measure energy expenditure of PA, such as doubly labelled water or indirect calorimetry are expensive (12) and impractical procedures to achieve this goal. Accelerometry-derived measures are usually expressed as daily min of light, moderate and vigorous physical activity to allow classification of PA according to whether health-related PA guidelines are met. Thus, it would be possible to carry out the meaningful interpretation of PA measurements into active and non-active, because this classification is linked with clinically relevant health outcomes.

In previous studies, various arbitrary PAQ-score cut-off points have been proposed to categorize youth according to their self-reported PA. Ogunleye et al. (13) divided youth as “active” or “low-active” based on an age-sex-specific median split of PAQ scores. Bailey et al. (14) grouped youth into “active,” “average” and “inactive” based on age-sex specific PAQ-score quartiles (top, middle two, and bottom quartiles, respectively). Chen et al. (15) assigned PAQ scores ≤ 2 as “low activity,” > 2 and ≤ 3 as “moderate activity,” and > 3 as “high activity”.

As shown, it is a weakness of the PAQ that there is a lack of uniformity and information about the meaning of final score which would differentiate youth active and non-active. Therefore, the aim of this study was to determine PAQ-C and PAQ-A score cut-off values using PA thresholds objectively measured as reference criteria based on international recommendations.

MATERIAL AND METHODS

SAMPLE

An invitation to participate in the study was sent to all parents who had their children and adolescents in different schools of primary and secondary education (Málaga, Jaen and Galicia, Spain). Four-hundred and forty potentially eligible subjects responded, and gave their written informed consent after receiving detailed information about the aims and procedures of the study. Subjects with incomplete PA data (n = 18) or technical errors in the instrument (n = 42) were excluded. A final sample of 146 children (n = 83 boys, n = 63 girls) and 234 adolescents (n = 115 boys, n = 119 girls) participated in this study. There were no differences on age and body mass index (BMI) between the excluded participants and the final sample.

The research protocol was reviewed and approved by the Ethics Committee of the Sports Medicine School, at the Faculty of Medicine (Málaga, Spain). The study was developed following the ethical guidelines of the Declaration of Helsinki-Seoul, last modified in 2008.

MEASURES

Body composition

Participant´s heights were measured with socks and shoes removed using a stadiometer (SECA Leicester, Birmingham, UK). A Tanita UM-050 digital weighing scale (Tanita UK Ltd, Yiewsley, Middle-sex, UK) was used to measure body mass. Body mass index (BMI; weight/height; kg/m^2) was then calculated.

Anthropometric measurements, including skinfolds, height and body mass, were performed by a level 3 certified anthropometrist according to standards for anthropometric assessment of International Society for the Advancement of Kinanthropometry. Fat mass percent (FMP) was calculated using Slaughter´s equation (16).

Physical Activity Questionnaire

PA was assessed using the PAQ-C and PAQ-A (17). The PAQ have acceptable reliability and convergent validity (18,19) and the administration and scoring are described below. In brief, the self-administered, 7-day recall questionnaire comprises nine or eight items (PAQ-C includes an additional item on recess), respectively, and collects information on participation in

different types of activities and sports (activity checklist), effort during physical education classes, and activity during lunch, after school, evening and at the weekend during the past 7 days. Each item is scored between 1 (low PA) and 5 (very high PA) and the average score denotes the PAQ score. A high score indicates higher levels of PA. The ninth (PAQ-A) and tenth (PAQ-C) item are not used in calculation of the activity score, asks children and adolescents if they were sick or otherwise prevented from engaging in regular PA. Once a value from 1 to 5 for each of the 8-9 items used in the PA composite score is obtained, the mean of these 8-9 items is taken, which results in the final PAQ activity summary score.

Cultural adaptation of the Spanish PAQ was performed following the basic steps of standardized questionnaires cultural adaptation process (20). The original Spanish translation was made by the research team members. Subsequently, two bilingual researchers outside the group performed the reverse translation. The differences between the original version and the translations were reviewed and discussed by the research group and external researchers.

Triaxial accelerometry

The Actigraph GT3X monitor device (Actigraph, Pensacola, FL, USA), was used to assess PA objectively. The accelerometer is lightweight (27 g), compact (3.8 × 3.7 × 1.8 cm) and has a rechargeable lithium polymer battery. It uses a solid-state tri-axial accelerometer to collect motion data on three axes: vertical (Y), horizontal right-left (X) and horizontal front-back axis (Z). The GT3X measures accelerations in the range of 0.05 g to 2 g, which is digitized by a 12-bit analog-to-digital converter at a rate of 30 Hz. Once digitized, the data are filtered using a band-limited frequency of 0.25 to 2.5 Hz. The Actigraph accelerometer has been shown to be a reliable and valid tool for the assessment of different types of physical activities (21).

Researchers distributed pre-initialized accelerometers face-to-face at schools. Participants wore the accelerometers on the right side of the hip, secured with an adjustable elastic belt, underneath clothing, near to the center of gravity. Participants received a demonstration from a trained researcher on how to wear the accelerometer. They were asked to only remove the device when sleeping and engaging in water-based activities. Additionally, children received a brochure about accelerometer use including the instructions. Accelerometers were set to register 1-second epoch cycles, and were programmed to start recording at 12 midnight of the day following they receive the monitor and to record activity for the following 7 days.

The version 6.11.1 of Actilife Software (Actigraph, Pensacola, FL, USA) was used to process the accelerometer data. Periods of ≥ 60 minutes of zero values, allowing for 2 minutes of non-zero interruptions, were defined as accelerometer "non-wear" time and were removed from the analyses. The first day of recording was not included in the analysis. Only participants with ≥ 4 complete days, including one weekend day, were included (22). A day was considered valid if it contained ≥ 10 hours of wear time for weekdays and ≥ 8 hours for weekend days considering different sleep patterns at weekends (23).

We selected the cut points for children from Evenson et al. (24) to determine the time spent on different intensity levels of PA for children: ≤ 100 cpm for sedentary behavior, < 2,296 cpm for light, < 4,012 cpm for moderate, and ≥ 4,012 cpm for vigorous PA. These cut-offs values were subsequently validated for adolescents (25).

A recording of more than 15,000 counts per minute was considered as a potential malfunction of the accelerometer and the value was excluded from the analyses, based on the recommendations from Esliger et al. (26).

PROCEDURE

Each participant received an information sheet and consent form for parents, and were asked to return the forms to their school. Children and adolescents with signed consent forms were subsequently assessed (initial measurements) and received an accelerometer and later eigth-days later completed PAQ-C and/or PAQ-A questionnaire. As much time as necessary time was taken to fully explain the questionnaire and examples were provided. After the trial period, the material and questionnaires were collected by the researcher, and the data was stored in a database for further analysis.

STATISTICAL ANALYSIS

The characteristics of participants were described as mean and standard deviation (SD). A descriptive statistical analysis was performed for all quantitative variables and an analysis of the normal distribution was carried out using the Kolmogorov-Smirnov test. The relationship between the PAQ and minutes of PA from accelerometers was performed using Spearman's rank correlation coefficients (rho).

Based on international recommendations (10) three factors of two levels were developed as participants met or not the PA recommendations and discriminate between "active" and "non-active" youth (MVPA > 60 min/day, vigorous PA > 30min/day, and light PA > 116 min/day; respectively). Receiver operating characteristic (ROC) curves (27) were carried out to identify PAQ-C and PAQ-A score cut-off point for each factor. Accuracy of classification for each set of cut-points was evaluated by calculating weighted statistics, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC). An area of 1 represents perfect classification, whereas an area of 0.5 represents an absence of classification accuracy. ROC-AUC values of > 0.90 are considered excellent, 0.80-0.89 good, 0.70-0.79 fair, and < 0.70 poor (28).

The analyses were performed using SPSS 22.0 (Chicago, Illinois) and MedCalc 14.12.0 (Mariakerke, Belgium) for ROC curves. The level of significance was set at $p < 0.05$.

RESULTS

Characteristics of the participants (children and adolescents) for both sex combined and separately are presented in table I. All values are reported as mean and standard deviations (SD). Significant differences between boys and girls were found in adolescents for weight, height, FMP, PAQ-A score, all PA intensities and number of steps, with higher values for boys, except for FMP. No differences between sexes were found in children. 53.4% of children met the 60 minutes of MVPA recommended; while 41.9% of adolescents met this recommendation. PAQ score was positively associated with vigorous PA, MVPA and number of steps (rho = 0.19, rho = 0.17, rho = 0.16, respectively; all $p < 0.05$) for children. In adolescents, PAQ score was positively associated with all intensities (light, moderate, vigorous and MVPA) and number of steps supplied by the accelerometer (rho = 0.33, rho = 0.21, rho = 0.39, rho = 0.36 rho = 0.41, respectively; $p < 0.001$).

PHYSICAL ACTIVITY QUESTIONNAIRE FOR CHILDREN (PAQ-C)

Details for AUC, as well as PAQ-C scores and number of steps equivalent to the coordinates with the greatest sum of sensitivity and specificity are shown in tables II and III.

AUC of PAQ-C score for MVPA > 60 min/day, vigorous PA > 30 min/day, and light PA > 116 min/day were no significant ($p > 0.05$) and only weak (AUC < 0.7) discriminators between "active" and "non-active" individuals. However, AUC of number of steps for all intensities were significant ($p < 0.001$) and good (AUC > 0.8 for 60 minutes of MVPA) discriminators. ROC analysis showed PAQ-C score cut-off points > 2.75 to discriminate active children. 60 minutes of MVPA in children appears to be achieved, on average, within a total volume of 10,664 steps/day; 30 minutes of vigorous PA within a total volume of 11,038 steps/day; and 116 minutes of light PA within a total volume of 10,190 steps/day.

Table I. Characteristics of study participants by age and sex (n = 480)

	Children			Adolescents		
	All (n = 146)	**Girls (n = 63)**	**Boys (n = 83)**	**All (n = 234)**	**Girls (n = 119)**	**Boys (n = 115)**
Age (years)	10.8 ± 1.3	10.7 ± 1.3	10.9 ± 1.2	15.3 ± 1.4	15.2 ± 1.4	15.4 ± 1.3
Weight (kg)	41.5 ± 11.7	40.0 ± 12.7	42.7 ± 10.8	59.5 ± 13.3	57.5 ± 1.7	61.5 ± 13.7*
Height (cm)	144.6 ± 10.5	143.2 ± 10.9	145.6 ± 10.1	163.9 ± 8.2	160.2 ± 6.0	167.6 ± 8.4***
BMI (kg/m^2)	19.5 ± 3.7	19.1 ± 4.0	19.9 ± 3.4	22.1 ± 4.4	22.4 ± 4.6	21.8 ± 4.2
FMP (%)	22.9 ± 9.2	22.9 ± 6.6	22.9 ± 10.9	18.9 ± 8.0	21.2 ± 7.7	16.6 ± 7.6***
PA Score (PAQ-C)	3.09 ± 0.64	3.11 ± 0.60	3.07 ± 0.66	-	-	-
PA Score (PAQ-A)	-	-	-	2.51 ± 0.72	2.29 ± 0.68	2.73 ± 0.70***
Sedentary time (min/day)	603.5 ± 60.9	609.0 ± 61.2	599.3 ± 60.7	642.9 ± 75.7	642.7 ± 83.4	643.1 ± 67.2
Light PA (min/day)	120.3 ± 33.8	121.7 ± 46.2	119.3 ± 20.3	92.7 ± 28.4	88.0 ± 27.4	97.6 ± 28.7*
Moderate PA (min/day)	33.7 ± 6.8	33.6 ± 6.2	33.8 ± 7.3	33.8 ± 12.8	31.5 ± 11.9	36.2 ± 13.4**
Vigorous PA (min/day)	29.1 ± 8.9	27.8 ± 8.3	30.1 ± 9.2	23.0 ± 14.9	16.6 ± 10.4	29.7 ± 15.8***
MVPA (min/day)	62.8 ± 13.9	61.3 ± 12.7	63.9 ± 14.7	56.9 ± 22.9	48.1 ± 18.9	65.9 ± 23.3***
Steps/day	10,668 ± 1,938	10,556 ± 1,594	10,752 ± 2,170	9,320 ± 3,561	8,434 ± 3,682	10,264 ± 3,180***

*BMI: body mass index; FMP: fat mass percent; PA: physical activity; *p < 0.05; **p < 0.01. ***p < 0.001; independent sample t test between boys and girls.*

Table II. Area under the ROC curve of PAQ-C score and steps/day, based on PA recommendations

PA recommendations	60 min MVPA		30 min vigorous PA		116 min light PA	
	Score	**Steps**	**Score**	**Steps**	**Score**	**Steps**
AUC	0.551	0.896	0.545	0.879	0.527	0.756
EE	0.0483	0.0259	0.0488	0.0278	0.0482	0.0408
95% CI	0.467 to 0.634	0.835 to 0.940	0.460 to 0.627	0.815 to 0.927	0.443 to 0.610	0.678 to 0.823
p	0.2896	< 0.0001	0.3579	< 0.0001	0.5728	< 0.0001
Youden index	0.1572	0.6497	0.1659	0.6575	0.1269	0.439

PA: physical activity; MVPA: moderate to vigorous physical activity; AUC: area under the curve; EE: standard error; CI: confidence interval; p: significance level.

Table III. PAQ-C score and steps/day cut-off points and sensitivity, specificity, likelihood ratios and predictive values, based on PA recommendations

PA recommendations		Cut point	Sens	95% CI	Spec	95% CI	+LR	95% CI	-LR	95% CI	+ PV	95% CI	-PV	95% CI
60 min MVPA	PAQ score	> 2.75	73.08	61.8-82.5	42.65	30.7-55.2	1.27	1.0-1.6	0.63	0.4-1.0	59.4	48.9-69.3	58	43.2-71.8
	Steps/day	> 10,664	78.21	67.4-86.8	86.76	76.4-93.8	5.91	3.2-11.0	0.25	0.2-0.4	87.1	77.0-93.9	77.6	66.6-86.4
30 min vigorous PA	PAQ score	> 2.75	75.41	62.7-85.5	41.18	30.6-52.4	1.28	1.0-1.6	0.6	0.4-1.0	47.9	37.6-58.4	70	55.4-82.1
	Steps/day	> 11,038	78.69	66.3-88.1	87.06	78.0-93.4	6.08	3.5-10.7	0.24	0.2-0.4	81.4	69.1-90.3	85.1	75.8-91.8
116 min light PA	PAQ score	> 2.78	68.75	57.4-78.7	43.94	31.7-56.7	1.23	0.9-1.6	0.71	0.5-1.1	59.8	49.0-69.9	53.7	39.6-67.4
	Steps/day	> 10,190	78.75	68.2-87.1	65.15	52.4-76.5	2.26	1.6-3.2	0.33	0.2-0.5	73.3	62.6-82.2	71.7	58.6-82.5

PA: physical activity; MVPA: moderate to vigorous physical activity; Sens: sensitivity; CI: confidence interval; Spec: specificity; LR: positive (+) and negative (-) likelihood ratios; PV: positive (+) and negative (-) predictive values.

The sensitivity associated with the different factors were moderate for PAQ-C score and steps/day. However, the specificity associated were low for PAQ-C score (42.7%, 41.2% and 43.9%, respectively) and high for steps/day (86.8%, 87.1% and 65.2%, respectively). This shows the low capacity of the PAQ-C to identify inactive children. An example ROC curves is illustrated in figure 1.

PHYSICAL ACTIVITY QUESTIONNAIRE FOR ADOLESCENTS (PAQ-A)

Details coordinates with the greatest sum of sensitivity and specificity are shown for AUC, as well as PAQ-A scores and number of steps equivalent to the in tables IV and V.

AUC of PAQ-A score for all factors were significant ($p < 0.01$) but only weak (AUC < 0.7) discriminators between "active" and "non-active" youth. AUC of number of steps for all intensities were significant too ($p < 0.001$) and excellent (AUC > 0.9 for 60 minutes of MVPA) discriminators. ROC analysis showed PAQ-A score cut-off points > 2.73 to discriminate active adolescents. Regarding steps analysis, 60 minutes of MVPA in adolescents appears to be achieved, on average, within a total volume of 9,701 steps/day; 30 minutes of vigorous PA within a total volume of 9,806 steps/day; and 116 minutes of light PA within a total volume of 12,511 steps/day. The sensitivity associated with the different factors were low for PAQ-A score and high for steps/day (except for 116 minutes of light PA). The capacity of the PAQ-A to identify inactive adolescent (specificity) was moderate (77.9%, 75.1% and 68.8%, respectively) and moderate-high for steps/day (93.1%, 77.1% and 68.8%, respectively). An example ROC curves is illustrated in figure 2.

The capacity of number of steps to determine "active" or "inactive" youth was greater than the capacity of the questionnaire score, as observed by the higher positive likelihood rations and lower likelihood negative ratios for all factors. The same applies to positive and negative predictive values, as well as with sensitivity and specificity values (except for sensitivity of PAQ-A for 116 minutes of light PA).

DISCUSSION AND CONCLUSIONS

The present study evaluated the capacity of PAQ-C and PAQ-A to differentiate active and non-active youth based on international PA guidelines. The main finding of this study was that PAQ-A questionnaire could be utilized to discriminate active adolescents (60 minutes of MVPA) using a cut-off point of 2.75. A value for children could not be found for PAQ-C score. Additionally, significant steps/day cut values were found both for children (10,664 steps/day) and adolescents (9,701 steps/day).

To our knowledge, this is the first study to define PAQ-C and PAQ-A cut-points values by accelerometry based on PA recommendations. Details to assess the PAQ-A score as cardiorespiratory fitness parameter have been published for English children. Our results are similar to obtained in the study of Voss et al. (29), in which a cut-off points of 2.9 for boys and 2.7 for girls were established, using cardiorespiratory fitness as the criterion-

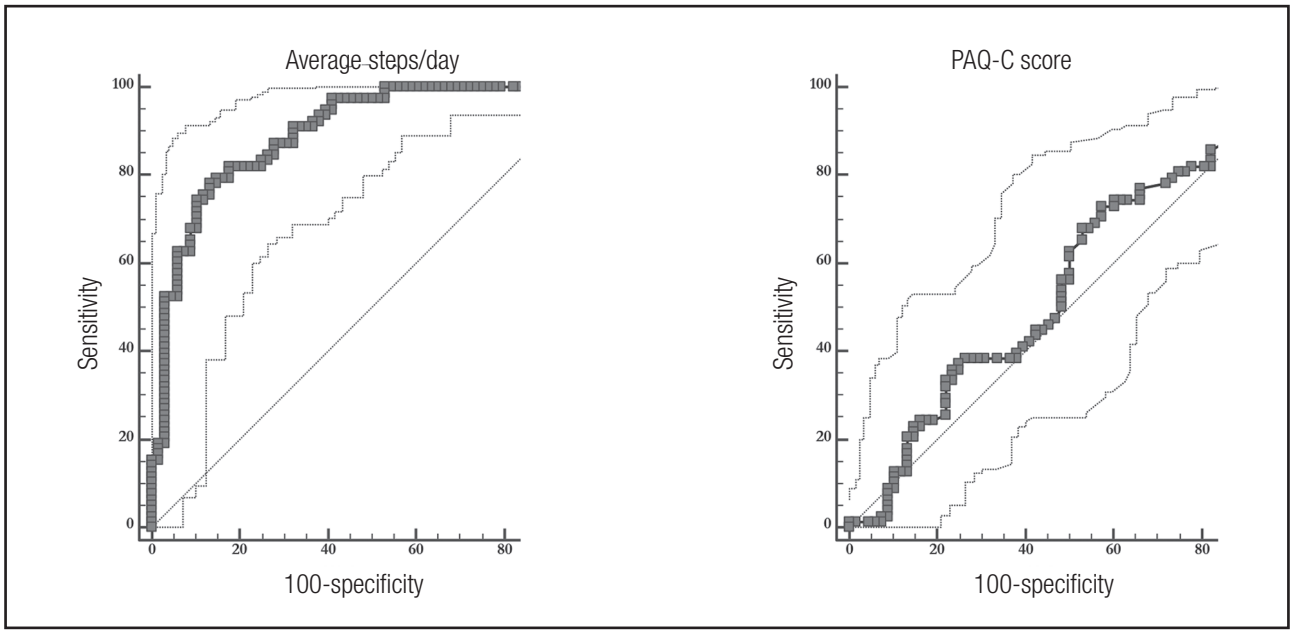

Figure 1.

Receiver-operator curves for number of steps and the Physical Activity Questionnaire for Children (PAQ-C)'s ability to identify 60 minutes of moderate to vigorous physical activity (MVPA) (n = 146).

Table IV. Area under the ROC curve of PAQ-A score and steps/day, based on PA recommendations

PA recommendations	60 min MVPA		30 min vigorous PA		116 min light PA	
	Score	Steps	Score	Steps	Score	Steps
AUC	0.677	0.957	0.658	0.879	0.631	0.724
EE	0.0356	0.0124	0.0408	0.0223	0.0476	0.0464
95% CI	0.613 to 0.736	0.921 to 0.979	0.594 to 0.719	0.829 to 0.918	0.565 to 0.693	0.661 to 0.781
p	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0061	< 0.0001
Youden index	0.2896	0.7967	0.3252	0.6399	0.2212	0.3836

PA: physical activity; MVPA: moderate to vigorous physical activity; AUC: area under the curve; EE: standard error; CI: confidence interval; P: significance level.

referenced standard. However, the ROC analysis reported differences between the two questionnaires and these results should be interpreted cautiously.

The sensitivity and the specificity analysis revealed that the PAQ-C cut-points were no able to distinguish the true negatives, but not the true positives. Furthermore, the AUC value indicates that the PAQ-C is unable to discriminate inactive children. In case of PAQ-A cut-off points, which proved sufficiently specificity to discriminate the true negatives but moderately the true positives, manifest an AUC value near to 0.7 ($p < 0.001$). A diagnostic test that yields an AUC of < 0.7, as observed here, may be deemed unacceptable for clinical use, given the potentially severe repercussions of misclassifying presence or absence of disease. However, the PAQ is not a clinical diagnostic test and comparatively low AUC are often published in a public health context. A plausible explanation for our results could be related with the construct validity of PAQ in Spanish children and adolescents. While the PAQ-A shown reasonable validity for this age range (rho = 0.39; $p < 0.001$) (30); the PAQ-C shown a questionable validity (rho = 0.28, $p < 0.05$) for assessing total PA and MVPA in Spanish children (31). Our correlation results between both instruments also concur with the line of evidence that suggests PA questionnaires for adolescents correlated better with accelerometer results than PA questionnaires for children (7).

Moreover, discrepancies and high variability in children's PA measured by accelerometers have been reported around the world, which may introduce a bias in this study (32). The output from accelerometers is a dimensionless unit commonly referred to

Table V. PAQ-A score and steps/day cut-off points and sensitivity, specificity, likelihood ratios and predictive values, based on PA recommendations

PA recommendations		Cut Point	Sens	95% CI	Spec	95% CI	+LR	95% CI	-LR	95% CI	+PV	95% CI	-PV	95% CI
60 min MVPA	PAQ score	> 2.75	51.02	40.7-61.3	77.94	70.0-84.6	2.31	1.6-3.4	0.63	0.5-0.8	62.5	51.0-73.1	68.8	60.9-76.0
	steps/day	> 9,701	86.6	78.2-92.7	93.08	87.3-96.8	12.51	6.6-23.6	0.14	0.09-0.2	90.3	82.4-95.5	90.3	84.0-94.7
30 min vigorous PA	PAQ score	> 2.77	57.38	44.1-70.0	75.14	68.0-81.4	2.31	1.6-3.2	0.57	0.4-0.8	44.9	33.6-56.6	83.3	76.5-88.8
	steps/day	> 9,806	86.89	75.8-94.2	77.11	70.0-83.3	3.8	2.8-5.1	0.17	0.09-0.3	58.2	47.4-68.5	94.1	88.7-97.4
116 min light PA	PAQ score	> 2.73	53.33	37.9-68.3	68.78	61.7-75.3	1.71	1.2-2.4	0.68	0.5-0.9	28.9	19.5-39.9	86.1	79.5-91.2
	steps/day	> 12,511	46.51	31.2-62.3	91.85	86.9-95.4	5.71	3.2-10.2	0.58	0.4-0.8	57.1	39.4-73.7	88	82.6-92.3

PA: physical activity; MVPA: moderate to vigorous physical activity; Sens: sensitivity; CI: confidence interval; Spec: specificity; LR: positives (+) and negatives (-) likelihood ratios; PV: positives (+) and negatives (-) predictive values.

Figure 2.

Receiver-operator curve for number of steps and the Physical Activity Questionnaire for Adolescents (PAQ-A)'s ability to identify 60 minutes of moderate to vigorous physical activity (MVPA) (n = 234).

as accelerometer counts. Researchers have attempted to calibrate these counts with energy expenditure in order to get a biological meaning to the output (33). This has resulted in the publication of count thresholds relating to various categories of energy expenditure, that allow researchers to summarize time spent in a given intensity of activity (34). The availability of multiple cut points or equations has led to much confusion in the accelerometer literature (35). We used the Evenson et al. (24) cut points, recommended in Trost et al. (25) comparative study to estimate time spent

in sedentary, light-, moderate-, and vigorous-intensity activity in children and adolescents. Other cut points would have yielded different results. Nonetheless, the associations and differences with total PA will continue to be same since this variable must not be highly dependent of cut-off values.

Conversely, the discriminative power of steps/day was excellent, as evidenced by the high AUC values (near of 0.9 for PAQ-C and > 0.9 for PAQ-A). The AUC provides an estimate of the "goodness" of a diagnostic test, whereby a theoretical perfect test with 100% specificity and 100% sensitivity yields an AUC of 1, and a non-discriminating test an AUC of 0.5. Sensitivity and specificity obtained were 78.2% (95% CI 67.4 to 86.8), 86.8% (95% CI 76.4 to 93.8) for 60 minutes of MVPA in children; and 86.6% (95% CI 78.2 to 92.7), 93.1% (95% CI 87.3 - 96.8) for 60 minutes of MVPA in adolescents. The cut-off points associated were 10,664 steps/day for children and 9,701 steps/day for adolescents. These values are similar to those reviewed by Tudor-Locke (36). These aspects are of interest for public health since they corroborate the insights into PA needs and recommendations for children and adolescents that may be used to evaluate scholar population and implement intervention strategies by healthcare workers and physical education teachers. In addition, quantifying PA, with a low-cost way, will be helpful in order to focus school and community interventions on youth with unhealthy lifestyles.

The specific criteria used to categorize individuals as meeting or not meeting PA recommendations were selected based on WHO guidelines (10). Recent studies indicate the need to increase the recommendation of MVPA. Thus, Jiménez-Pavón et al. (37) recommend around 60 and 85 min/day of MVPA, including 20 min/day of vigorous PA. On the other hand, data from the European Youth Heart Study with objectively measured PA suggest 90 minutes of MVPA based on metabolic health and the metabolic syndrome (4). Similarly, the criteria applied in this study (MVPA > 60 min/day, vigorous PA > 30min/day, and light PA > 116 min/day) are in agreement with the proposed guidelines, but our approach support the hypothesis that 60 min or more of MVPA could be enough, if enough vigorous PA is accumulated during such period (at least 30 minutes).

LIMITATIONS

This study has several limitations that should be considered. First, subjectivity and limited recall ability are known limitations of self-reported PA, particularly in young people (38). Limitations of self-reports items include the tendency for people to report socially desirable responses. Moreover, although objective measures of PA, such as triaxial accelerometry or heart rate monitors are ideal, even these methods have their limitations, and this practice has been criticized due to the fact that accelerometers and self-report instruments measure different things (39). Other limitations could explain our results and the capacity of discrimination. For example, our sample size was relatively small but significant for the purpose of study. However, these results should be verified in larger samples.

CONCLUSIONS

In summary, our findings provide normative PAQ scores for adolescents. According with the ROC analysis, our results suggest that PAQ-A can be a useful tool to classify adolescents as active or inactive following international recommendations as criteria. It seems, that a 2.75 score can be used to detect adolescents performing enough PA. However, this does not apply to the PAQ-C, which might not be an adequate tool to classify children as active or inactive.

These cut-off points can be useful and a cost-economic way to evaluate scholar population and implement intervention strategies. However, as far as possible, we suggest, in accordance with recent studies (40), the use of a combination of objective and subjective assessment methods.

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REFERENCES

1. Andersen LB, Riddoch C, Kriemler S, Hills A. Physical activity and cardiovascular risk factors in children. Brit J Sport Med 2011;45(11):871-6.
2. Julián-Almarcegui C, Gómez-Cabello A, Huybrechts I, González-Aguero A, Kaufman JM, Casajus JA, et al. Combined effects of interaction between physical activity and nutrition on bone health in children and adolescents: a systematic review. Nutrition reviews 2015;73(3):127-39.
3. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. Br J Sports Med 2011;45(11):886-95.
4. Andersen LB, Harro M, Sardinha LB, Froberg K, Ekelund U, Brage S, et al. Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). Lancet 2006;368(9532):299-304.
5. Cordova A, Villa G, Sureda A, Rodríguez-Marroyo JA, Sánchez-Colladoe MP. Physical Activity and Cardiovascular Risk Factors in Spanish Children Aged 11-13 Years. Rev Esp Cardiol 2012;65(7):620-6.
6. Alonso-Fernández N, Jiménez-García R, Alonso-Fernández L, Hernández-Barrera V, Palacios-Cena D. Health factors related to physical activity among children and adolescents: Results from Spanish National Health Surveys 2006 and 2011/12. Journal for specialists in pediatric nursing: JSPN 2015;20(3):193-202.
7. Chinapaw MJM, Mokkink LB, Van Poppel MNM, van Mechelen W, Terwee CB. Physical Activity Questionnaires for Youth A Systematic Review of Measurement Properties. Sports Med 2010;40(7):539-63.
8. Janz KF, Lutuchy EM, Wenthe P, Levy SM. Measuring activity in children and adolescents using self-report: PAQ-C and PAQ-A. Med Sci Sport Exer 2008;40(4):767-72.
9. Biddle SJH, Gorely T, Pearson N, Bull FC. An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. Int J Behav Nutr Phy 2011;8.
10. WHO. Global Recommendations on Physical Activity for Health. WHO Guidelines Approved by the Guidelines Review Committee. Switzerland; 2010. p. 58.
11. Vanhelst J, Hardy L, Gottrand F, Beghin L. Technical aspects and relevance of physical activity assessment in children and adolescents in free-living conditions. Arch Pediatrie 2012;19(11):1219-25.
12. Sirard JR, Pate RR. Physical activity assessment in children and adolescents. Sports Med. 2001;31(6):439-54.

13. Ogunleye AA, Voss C, Sandercock GR. Prevalence of high screen time in English youth: association with deprivation and physical activity. Journal of public health 2012;34(1):46-53.
14. Bailey DA, McKay HA, Mirwald RL, Crocker PR, Faulkner RA. A six-year longitudinal study of the relationship of physical activity to bone mineral accrual in growing children: the university of Saskatchewan bone mineral accrual study. Journal of bone and mineral research: the official journal of the American Society for Bone and Mineral Research 1999;14(10):1672-9.
15. Chen SR, Lee YJ, Chiu HW, Jeng C. Impact of physical activity on heart rate variability in children with type 1 diabetes. Child's nervous system: ChNS: official journal of the International Society for Pediatric Neurosurgery 2008;24(6):741-7.
16. Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, Vanloan MD, et al. Skinfold Equations for Estimation of Body Fatness in Children and Youth. Human Biology 1988;60(5):709-23.
17. Crocker PRE, Bailey DA, Faulkner RA, Kowalski KC, McGrath R. Measuring general levels of physical activity: Preliminary evidence for the Physical Activity Questionnaire for Older Children. Med Sci Sport Exer 1997;29(10):1344-9.
18. Kowalski KC, Crocker PRE, Faulkner RA. Validation of the physical activity questionnaire for older children. Pediatr Exerc Sci 1997;9(2):174-86.
19. Kowalski KC, Crocker PRE, Kowalski NP. Convergent validity of the physical activity questionnaire for adolescents. Pediatr Exerc Sci 1997;9(4):342-52.
20. Geisinger KF. Cross-cultural normative assessment: Translation and adaptation issues influencing the normative interpretation of assessment instruments. Psychological Assessment 1994;6(4):304-12.
21. Sasaki JE, John D, Freedson PS. Validation and comparison of ActiGraph activity monitors. J Sci Med Sport 2011;14(5):411-6.
22. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc 2008;40(1):181-8.
23. Yildirim M, Verloigne M, de Bourdeaudhuij I, Androutsos O, Manios Y, Felso R, et al. Study protocol of physical activity and sedentary behaviour measurement among schoolchildren by accelerometry-cross-sectional survey as part of the ENERGY-project. BMC public health 2011;11:182.
24. Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. J Sport Sci 2008;26(14):1557-65.
25. Trost SG, Loprinzi PD, Moore R, Pfeiffer KA. Comparison of accelerometer cut points for predicting activity intensity in youth. Med Sci Sports Exerc 2011;43(7):1360-8.
26. Esliger DW, Copeland JL, Barnes JD, Tremblay MS. Standardizing and Optimizing the Use of Accelerometer Data for Free-Living Physical Activity Monitoring. J Phys Act Health 2005;2(3):366-83.
27. Zweig MH, Campbell G. Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. Clinical chemistry 1993;39(4):561-77.
28. Metz CE. Basic principles of ROC analysis. Seminars in nuclear medicine 1978;8(4):283-98.
29. Voss C, Ogunleye AA, Sandercock GRH. Physical Activity Questionnaire for children and adolescents: English norms and cut-off points. Pediatr Int 2013;55(4):498-507.
30. Martínez-Gómez D, Martínez de Haro V, Pozo T, Welk GJ, Villagra A, Calle ME, et al. [Reliability and validity of the PAQ-A questionnaire to assess physical activity in Spanish adolescents]. Revista espanola de salud publica 2009;83(3):427-39.
31. Benítez-Porres J, López-Fernández I, Raya JF, Álvarez Carnero S, Alvero-Cruz JR, Álvarez Carnero E. Reliability and validity of the paq-c questionnaire to assess physical activity in children. J School Health 2016;86:677-85.
32. Guinhouya BC, Samouda H, de Beaufort C. Level of physical activity among children and adolescents in Europe: a review of physical activity assessed objectively by accelerometry. Public health 2013;127(4):301-11.
33. Freedson P, Pober D, Janz KF. Calibration of accelerometer output for children. Med Sci Sport Exer 2005;37(11):S523-S30.
34. Rowlands AV. Accelerometer assessment of physical activity in children: An update. Pediatr Exerc Sci 2007;19(3):252-66.
35. Welk GJ, McClain J, Ainsworth BE. Protocols for Evaluating Equivalency of Accelerometry-Based Activity Monitors. Med Sci Sport Exer 2012;44:S39-S49.
36. Tudor-Locke C, Craig CL, Beets MW, Belton S, Cardon GM, Duncan S, et al. How Many Steps/Day are Enough? for Children and Adolescents. Int J Behav Nutr Phy 2011;8.
37. Jiménez-Pavón D, Konstabel K, Bergman P, Ahrens W, Pohlabeln H, Hadjigeorgiou C, et al. Physical activity and clustered cardiovascular disease risk factors in young children: a cross-sectional study (the IDEFICS study). BMC medicine 2013;11:172.
38. Warren JM, Ekelund U, Besson H, Mezzani A, Geladas N, Vanhees L, et al. Assessment of physical activity - a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. European journal of cardiovascular prevention and rehabilitation: official journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology 2010;17(2):127-39.
39. Ham SA, Reis JP, Strath SJ, Dubose KD, Ainsworth BE. Discrepancies between methods of identifying objectively determined physical activity. Med Sci Sport Exer 2007;39(1):52-8.
40. Steene-Johannessen J, Anderssen SA, van der Ploeg HP, Hendriksen IJ, Donnelly AE, Brage S, et al. Are Self-Report Measures Able to Define Individuals as Physically Active or Inactive? Med Sci Sports Exerc 2015.

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Nutrición Hospitalaria

Trabajo Original

Pediatría

Bajos niveles de rendimiento físico, $VO2_{MAX}$ y elevada prevalencia de obesidad en escolares de 9 a 14 años de edad

Low levels of physical performance, $VO2_{MAX}$ and high prevalence of obesity among school children from 9 to 14 years of age

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Resumen

Introducción: bajos niveles de actividad física, moderada y vigorosa, son un factor de riesgo conductual importante en la obesidad en niños.

Objetivo: el objetivo del estudio fue determinar el estado nutricional y la condición física de escolares, comparando los resultados obtenidos por género, obesidad y rendimiento físico.

Material y métodos: 578 escolares: 308 hombres de 11,22 ± 1,93 años y 270 mujeres de 10,93 ± 1,92 años participaron en la investigación. Fueron evaluados: índice de masa corporal (IMC), porcentaje de masa grasa (%MG), contorno de cintura (CC), razón cintura-estatura (RCE) y rendimiento físico según los test del Estudio Nacional de Educación Física de la Agencia de Calidad de la Educación de Chile.

Resultados: el %MG fue mayor en la mujeres ($p < 0,001$). En el test de abdominales y en el de Navette el rendimiento fue mayor en los hombres, y en el test de flexo-extensiones de brazo el rendimiento fue mayor en las mujeres ($p < 0,05$). Los escolares en categoría de obeso presentaron inferiores resultados en los test de: abdominales, salto largo, flexo-extensiones de brazo y Navette ($p < 0,001$). El $VO2_{MAX}$ fue menor en los sujetos con obesidad ($p < 0,001$). Los estudiantes que necesitan mejorar 3 o 4 test presentan mayor RCE ($p < 0,001$) y %MG ($p < 0,001$). Existe una asociación negativa entre la RCE y el $VO2_{MAX}$ (-0,543, $p < 0,001$).

Conclusiones: existe una elevada prevalencia de sobrepeso y obesidad. Además, se aprecia un bajo rendimiento físico asociado a esta condición. Los escolares que necesitan mejorar 3 o 4 test de la condición física presentan mayores promedios de %MG y RCE; esta última variable es un potente indicador de riesgo cardiovascular.

Palabras clave:

Sobrepeso. Obesidad. Escolares. Rendimiento físico. $VO2_{MAX}$.

Abstract

Introduction: Low levels of moderate and vigorous physical activity are a factor of important behavioral risk in the obesity in children.

Objective: The objective of this study was to determine the nutritional status and physical condition of students, by comparing the results obtained by gender, obesity, and physical performance.

Material and methods: 578 students; 308 men of 11.22 ± 1.93 years and 270 women of 10.93 ± 1.92 years, participated in the investigation. Were evaluated; body mass index (BMI), percentage body fat (%FM), contour waist (CW), waist-to-height ratio (wtHR) and physical performance according to the test of the National Study of Physical Education of the Agency of Quality of Education of Chile.

Results: The %FM was higher in women ($p < 0.001$). In the Test of abdominal and Navette performance was higher in men and in the test of flexo-extensions of arm performance was higher in women ($p < 0.05$). Category of obese schoolchildren showed lower results in the test: abdominal, long jump, flexo-extensions of arm and Navette ($p < 0.001$). The $VO2_{MAX}$ was lower in the overweight subjects ($p < 0.001$). The students who need to improve 3 or 4 test presented more wtHR ($p < 0.001$) and %FM ($p < 0.001$). There is a negative association between the wtHR and the $VO2_{MAX}$ (-0.543, $p < 0.001$).

Conclusions: There exists a high predominance of excess weight and obesity, also it is appreciated a low physical performance associated with this condition. The students, who need to improve 3 or 4 test of physical condition, have a higher average of %FM and wtHR, this last variable is a powerful indicator of cardiovascular risk.

Key words:

Overweight. Obesity. Students. Physical Performance. $VO2_{MAX}$.

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INTRODUCCIÓN

Bajos niveles de actividad física, moderada y vigorosa, son un factor de riesgo conductual importante en la obesidad en niños (1). Esto, junto con un desequilibrio en el balance energético, conduce a un aumento inadecuado del peso corporal (2). Esta condición es una enfermedad multifactorial que plantea un riesgo importante para la salud presente y futura de las generaciones más jóvenes (3). El aumento internacional en el sobrepeso y la obesidad en niños y adolescentes en las últimas tres décadas confirman que es una epidemia global y un importante problema de salud pública que se asocia con complicaciones cardiovasculares, endocrinas y músculo-esqueléticas, además de presentar consecuencias psicosociales (4). También se ha demostrado que la malnutrición por exceso en escolares presenta una asociación negativa con el rendimiento físico (5).

De todas las cualidades que componen la condición física, la capacidad aeróbica y la fuerza muscular han sido las que han adquirido una mayor relevancia científica en el ámbito sanitario (6). En Chile, el SIMCE (sistema de medición de la calidad de la educación) aplicado en el contexto escolar arrojó que el 68% del total de estudiantes debe mejorar la potencia aeróbica máxima y solo un 8 y 5% alcanzan niveles destacados y aceptables en fuerza de brazos, respectivamente (7). La aptitud cardiorrespiratoria es una medida de las funciones del cuerpo y su evaluación debe desempeñar un papel importante en las actividades relacionadas con la promoción de la actividad física, siendo un componente fundamental de un estilo de vida saludable (8). Y la evidencia científica demuestra que, si es elevada, se asocia con menores riesgos cardiometabólicos (9).

Por lo tanto, es fundamental contar con estudios de asociación que proporcionen información acerca de las consecuencias de la malnutrición por exceso en la etapa escolar y que permitan tomar decisiones y acciones con el propósito de revertir las tendencias negativas asociadas a la obesidad infantil. Más aún, si se considera que la reducción del tiempo de actividades sedentarias puede contribuir a prevenir las consecuencias adversas para la salud (10). La práctica de actividad física de forma regular y sistemática podría contribuir a la adopción de estilos de vida más saludables durante todo el ciclo vital (11).

El objetivo del estudio fue determinar el estado nutricional y la condición física de escolares, comparando los resultados obtenidos por género, obesidad y rendimiento físico.

MATERIAL Y MÉTODOS

PARTICIPANTES

Se evaluaron entre los meses de mayo y octubre del año 2015 a 578 escolares: 308 hombres y 270 mujeres que presentaban entre 9 y 14 años de edad, pertenecientes al municipio de Temuco, región de la Araucanía, Chile. La muestra es de tipo no probabilística, elegidos de manera no aleatoria y por conveniencia. Se recolectaron datos respecto al curso de estudio, edad y género, antropométricos; IMC, porcentaje de masa grasa (%MG), contorno de cintura (CC), razón cintura-estatura (RCE) y rendimiento físico según los test del Estudio Nacional de Educación Física de la Agencia de Calidad de la Educación de Chile.

Los criterios de inclusión fueron presentar habilitación médica para la práctica de ejercicio físico, a través de un reporte escrito que acreditara que se encontraban aptos para el desarrollo de actividades física deportivas en los establecimientos educacionales, el consentimiento informado por parte de los padres o tutores, estar matriculados en los colegios de estudios y presentar entre 9 y 14 años de edad.

Los criterios de exclusión fueron presentar sobre 160 ppm en el test de Cafra, alguna lesión o enfermedad al momento de las pruebas físicas que pudieran alterar el rendimiento y la salud de los participantes o no cumplir con alguno de los criterios de inclusión mencionados.

La investigación y sus protocolos estuvieron de acuerdo con la Declaración de Helsinki 2013, y fue aprobado por la Escuela de Educación de la Universidad Santo Tomás. Cada apoderado o tutor debió firmar un consentimiento informado para que su hijo participara en el estudio.

PROCEDIMIENTOS

Para evaluar el porcentaje de masa grasa y peso se utilizó el monitor digital de mano-pie OMRON modelo HBF-514, con los pies descalzos y con la menor cantidad de ropa posible, la talla se estimó con un tallímetro de marca SECA®, graduada en mm. El IMC se utilizó para estimar el grado de obesidad (kg/m^2) determinando el estatus de peso corporal de los participantes de acuerdo con la Norma Técnica de Evaluación Nutricional del niño de 6 a 18 años, del Ministerio de Salud de Chile (12), con el siguiente criterio de calificación según su percentil; IMC < p 10: bajo peso, IMC entre p 10 y < p 85: normal, IMC entre p 85 y < p 95: sobrepeso, IMC > p 95: obesidad.

La circunferencia de cintura se midió empleando una cinta métrica, aplicando las técnicas validadas internacionalmente (13). La RCE se utilizó para estimar la acumulación de grasa en la zona central del cuerpo, se obtiene al dividir el perímetro de cintura por la estatura. Una razón mayor o igual a 0,55 indicaría un mayor riesgo cardiometabólico (RCM) (14).

El rendimiento físico fue evaluado por la batería de test físicos y sus resultados fueron categorizados en 2 condiciones: necesita mejorar y aceptable/destacado, según estándares nacionales (15); se evaluaron: el test de Cafra, test de salto largo a pies juntos, test de abdominales en 30 segundos y test de flexo-extensión de codo en 30 segundos. Para establecer el $VO2_{MAX}$ se utilizó el test de Navette y se estableció según las ecuaciones propuestas por Léger y cols, (16); donde: $VO2_{MAX} = (31{,}025 + 3{,}238\,V - 3{,}248E + 0{,}1536\,VE)$, siendo V la velocidad alcanzada en la última etapa completada y E la edad del participante.

Análisis estadístico

Se realizó un análisis descriptivo de las principales variables de estudio, posteriormente se procedió a evaluar la distribución normal

de las variables a través de la prueba Kolmogorov-Smirnov y se utilizó la prueba de Levene para medir la homogeneidad de varianzas. Para la comparación de las variables paramétricas cuantitativas entre dos grupos se utilizó el test t de Student, y cuando existían más de dos se realizó un ANOVA. En el caso de variables no paramétricas, se utilizó la prueba de la U de Mann-Whitney cuando se comparaban dos grupos, y la prueba de la H de Kruskal-Wallis para comparar más de dos. Para la asociación de variables se utilizó la prueba de correlación de Pearson o Spearman, según correspondiera. Todos los análisis se realizaron con el programa SPSS, versión 22,0. Se utilizó un margen de error del 5%, ($p < 0,05$).

RESULTADOS

La muestra del estudio presentó un promedio de 10,93 ± 1,92 años para mujeres y 11,22 ± 1,93 años para hombres. La talla y el CC fue mayor en los hombres ($p > 0,05$), EL %MG fue mayor en la mujeres ($p < 0,001$). En el test de abdominales, salto largo y Navette, el rendimiento fue mayor en los hombres y en el test de flexiones de brazo el rendimiento fue mayor en las mujeres, ambas con significancia ($p < 0,05$) (Tabla I).

En la tabla II se observa que existieron 24 estudiantes con bajo peso (4,1%), 286 con normopeso (49,4%), 164 con sobre-

Tabla I. Comparación de variables según género

	Mujer (n = 270)	Hombre (n = 308)	Valor de p
Edad (años)	10,93 ± 1,92	11,22 ± 1,93	-
Peso (kg)	46,09 ± 14,31	47,11 ± 13,99	0,230
Talla (m)	1,47 ± 0,11	1,50 ± 0,13	*0,013*
IMC (kg/m²)	20,90 ± 4,32	20,59 ± 3,60	0,759
CC (cm)	72,21 ± 11,64	73,54 ± 10,79	0,046
RCE	0,49 ± 0,06	0,49 ± 0,06	0,436
%MG	28,15 ± 6,62	25,53 ± 8,57	*< 0,001*
Test de abdominales (rep)	17,97 ± 5,64	20,83 ± 5,26	*< 0,001*
Test de salto largo	124,48 ± 23,86	142,49 ± 26,16	*< 0,001*
Test de flexiones de brazo (rep)	15,11 ± 7,10	12,89 ± 6,95	*< 0,001*
Test de Cafra (ppm)	111,39 ± 28,39	108,29 ± 24,92	0,330
Test de Navette (paliers)	5,01 ± 3,39	5,53 ± 3,32	*0,020*
$VO2_{MAX}$ (ml/kg/min)	47,46 ± 7,27	48,30 ± 6,96	0,118

Los valores mostrados como media ± DS, valores p < 0,05 son estadísticamente significativos. IMC: índice de masa corporal; CC: contorno de cintura; RCE: razón cintura-estatura; %MG: porcentaje de masa grasa.

Tabla II. Comparación de variables según estado nutricional

	Bajo peso (n = 24) 4,1%	Normopeso (n = 286) 49,4%	Sobrepeso (n = 164) 28,3%	Obesidad (n = 104) 17,9%	Valor de p
IMC (kg/m²)	14,52 ± 1,02	18,45 ± 2,12	22,21 ± 1,87	26,14 ± 3,56	*< 0,001*
CC (cm)	65,13 ± 13,21	69,98 ± 11,00	74,10 ± 9,26	80,92 ± 9,44	*< 0,001*
RCE	0,46 ± 0,07	0,47 ± 0,06	0,49 ± 0,06	0,54 ± 0,04	*< 0,001*
%MG	24,88 ± 11,43	24,85 ± 7,88	27,25 ± 6,77	31,59 ± 5,89	*< 0,001*
Test de abdominales (rep)	21,04 ± 4,28	20,21 ± 5,58	19,12 ± 5,46	17,74 ± 5,86	*< 0,001*
Test de salto largo (cm)	140,33 ± 23,80	137,18 ± 26,72	134,45 ± 26,74	122,91 ± 24,43	*< 0,001*
Test de flexiones de brazo (rep)	15,58 ± 5,69	15,07 ± 7,17	13,45 ± 7,09	11,18 ± 6,43	*< 0,001*
Test de Cafra (ppm)	102,63 ± 25,12	108,79 ± 26,64	108,66 ± 24,72	115,67 ± 29,09	0,083
Test de Navette (paliers)	4,80 ± 3,59	5,58 ± 3,35	5,54 ± 3,40	4,21 ± 3,09	*< 0,001*
$VO2_{MAX}$ (ml/kg/min)	47,98 ± 7,49	48,63 ± 7,02	48,24 ± 7,07	45,37 ± 6,89	*< 0,001*

Los valores mostrados como media ± DS, valores p < 0,05 son estadísticamente significativos. IMC: índice de masa corporal; CC: contorno cintura; RCE: razón cintura-estatura; %MG: porcentaje de masa grasa.

peso (28,3%) y 104 con obesidad (17,9%). Los escolares categorizados como obesos presentaron menores valores de rendimiento físico en los test de: abdominales, salto largo, flexiones de brazo y Navette ($p < 0,001$), en el test de Cafra no existieron diferencias estadísticamente significativas, pero los sujetos con obesidad presentaron valores superiores de frecuencia cardiaca al finalizar el test. El $VO2_{MAX}$ fue menor en los sujetos con obesidad en comparación con los otros grupos de estudio (Fig. 1).

En relación con el rendimiento físico, los estudiantes que necesitan mejorar 3 o 4 test presentan mayor RCE ($p < 0,001$) y %MG ($p < 0,001$) en comparación con los estudiantes que necesitan mejorar 1 test o ninguno (Tabla III). En los test de Navette, abdominales, salto largo y flexiones de brazo existe un número muy superior de estudiantes que necesitan mejorar su rendimiento físico en comparación a los que se encuentran aceptables (Fig. 2).

Existe una asociación negativa entre la RCE y el $VO2_{MAX}$ (-0,543), con significancia ($p < 0,001$), con el test de abdominales (-0,249), el test de flexiones de brazo (-294), el test de Navette (-0,402). Al asociar los test del rendimiento físico con el %MG existió asociación negativa con el test de abdominales, test de Navette y $VO2_{MAX}$, alcanzando significancia con baja asociación (Tabla IV).

Los estudiantes clasificados en el tramo de 13-14 años presentaron un mayor peso, IMC y CC ($p < 0,001$). El %MG fue superior en los sujetos clasificados entre 9-10 años ($p < 0,001$). Con respecto al rendimiento físico, los sujetos en el tramo de 11-12 años tuvieron un mayor $VO2_{MAX}$ y un mejor desempeño en los test de abdominales, salto largo y Navette ($p < 0,001$). Los escolares de 9-10 años obtuvieron un mayor número de repeticiones en el test de flexiones de brazo y valores menores de frecuencia cardiaca al finalizar el test de Cafra ($p < 0,001$) (Tabla V).

DISCUSIÓN

El propósito de la investigación fue determinar el estado nutricional y la condición física de escolares comparando los resultados obtenidos por género, obesidad y rendimiento físico. Dentro de los hallazgos más importantes del estudio, los escolares categorizados como obesos presentaron menores valores de rendimiento físico en los test de abdominales, salto largo, flexiones de brazo y Navette ($p < 0,001$). Además de poseer un menor valor de $VO2_{MAX}$ ($p < 0,001$). Los estudiantes que necesitan mejorar 3 o 4 test presentan mayor RCE ($p < 0,001$) y %MG ($p < 0,001$) en comparación con los estudiantes que necesitan mejorar 1 test o ninguno. Por último, existió una asociación negativa entre la RCE y el $VO2_{MAX}$ (-0,543), con significancia ($p < 0,001$). Los estudiantes clasificados en el tramo de 13-14 años presentaron un mayor

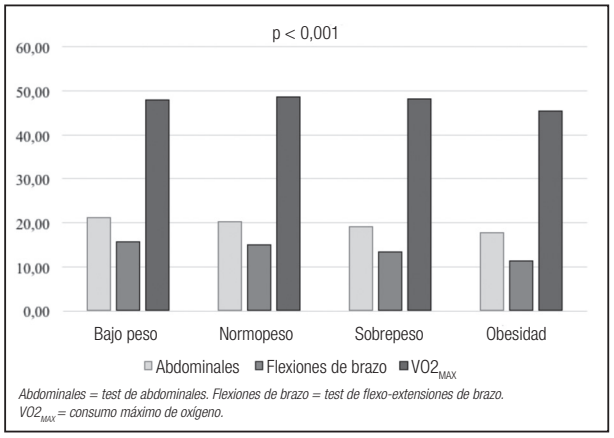

Figura 1.
Rendimiento físico, según estado nutricional.

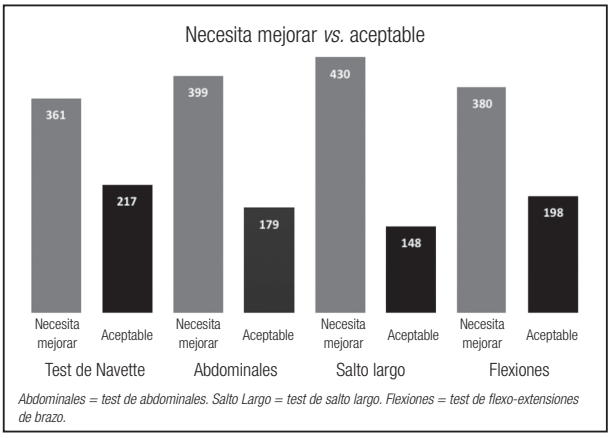

Figura 2.
Escolares que necesitan mejorar su rendimiento físico.

Tabla III. Estado nutricional *vs.* cantidad de test que necesitan mejorar (NM)

	0 (n = 15)	1 test (n = 64)	2 test (n = 160)	3 test (n = 170)	4 test (n = 169)	Valor de p
IMC (kg/m²)	19,98 ± 2,66	19,96 ± 2,84	20,65 ± 3,50	20,80 ± 4,31	21,11 ± 4,39	0,574
CC (cm)	70,93 ± 6,47	72,13 ± 8,70	73,31 ± 11,07	73,26 ± 12,29	72,67 ± 11,43	0,940
RCE	0,45 ± 0,04	0,47 ± 0,05	0,48 ± 0,06	0,49 ± 0,06	0,51 ± 0,06	*< 0,001*
%MG	25,47 ± 8,07	23,83 ± 9,94	25,95 ± 7,23	26,21 ± 7,31	29,27 ± 7,33	*< 0,001*

Los valores mostrados como media ± DS, valores p < 0,05 son estadísticamente significativos. IMC: índice de masa corporal; CC: contorno de cintura; RCE: razón cintura-estatura; %MG: porcentaje de masa grasa.

Tabla IV. Correlación de variables con test de rendimiento físico

		Abdominales	Salto largo	Flexiones de brazo	Navette	$VO2_{MAX}$
RCE	r	-0,249	-0,074	-0,294	-0,403	-0,543
	Valor de p	0,000	0,076	0,000	0,000	0,000
%MG	r	-0,209	0,110	0,048	-0,255	-0,134
	Valor p	0,000	0,008	0,254	0,000	0,001

r: rho de Spearman; valores p < 0,05 son considerados estadísticamente significativos.

Tabla V. Comparación de variables según la edad

	9-10 años (n = 231)	11-12 años (n = 176)	13-14 años (n = 169)	Valor de p
Peso (kg)	34,69 ± 7,54	53,98 ± 12,55	55,42 ± 10,64	*< 0,001*
Talla (m)	1,36 ± 0,07	1,57 ± 0,08	1,56 ± 0,07	*< 0,001*
IMC (kg/m²)	18,57 ± 3,04	21,64 ± 3,99	22,76 ± 3,58	*< 0,001*
CC (cm)	66,11 ± 7,25	77,38 ± 11,11	77,63 ± 11,11	*< 0,001*
RCE	0,49 ± 0,04	0,49 ± 0,07	0,50 ± 0,07	0,073
%MG	29,64 ± 7,37	25,59 ± 7,46	23,99 ± 7,58	*< 0,001*
Test de abdominales (rep)	16,57 ± 5,76	21,81 ± 4,36	21,18 ± 4,70	*< 0,001*
Test de salto largo (cm)	117,40 ± 16,93	148,71 ± 23,35	141,34 ± 28,76	*< 0,001*
Test de flexiones de brazo (rep)	15,36 ± 7,66	11,88 ± 6,26	14,12 ± 6,68	*< 0,001*
Test de Cafra (ppm)	89,90 ± 14,37	121,53 ± 25,69	124,83 ± 23,27	*< 0,001*
Test de Navette (paliers)	2,68 ± 1,27	7,23 ± 3,13	6,88 ± 3,23	*< 0,001*
$VO2_{MAX}$ (ml/kg/min)	45,06 ± 2,97	51,34 ± 7,91	48,28 ± 8,53	*< 0,001*

Los valores mostrados como media ± DS; valores p < 0,05 son estadísticamente significativos. IMC: índice de masa corporal; CC: contorno cintura; RCE: razón cintura-estatura; %MG: porcentaje de masa grasa.

peso, IMC y CC ($p < 0,001$). En relación con el rendimiento físico, los sujetos en el tramo de 11-12 años tuvieron un mayor $VO2_{MAX}$ y un mejor desempeño en los test de abdominales, salto largo y Navette ($p < 0,001$).

En el presente estudio, los escolares presentaron un 28,3% de sobrepeso y un 17,9 de obesidad, prevalencia de malnutrición por exceso superior a la reportada en otra muestra de estudiantes chilenos (17) (22,5 y 15,3% en sobrepeso y obesidad, respectivamente). El %MG fue significativamente mayor en las mujeres, similares a los descritos en otra investigación, en donde a partir de los 11 años las niñas tuvieron un %MG significativamente más alto que los niños (18). La CC fue superior en los varones; estos resultados concuerdan con los reportados en niños mexicanos en etapa prepuberal y adolescentes en el periodo de pubertad (19). En una muestra de adolescentes se concluyó que la obesidad abdominal está altamente asociada al síndrome metabólico (20).

En el test de abdominales y Navette el rendimiento fue mayor en los hombres; en una muestra de escolares españoles, los varones asignados al grupo de 11 años presentaron un mejor rendimiento en el test de 20 metros, carrera 4 x 10 m, dinamometría manual y salto longitudinal (21). En el presente estudio las mujeres tuvieron un rendimiento superior en la fuerza de brazos en comparación con los hombres, lo que difiere a lo reportado en otra investigación, donde los niños poseían una fuerza de prensión manual significativamente mayor (22). El $VO2_{MAX}$ fue mayor en los hombres, sin alcanzar significancia estadística ($p \geq 0,05$). Resultados diferentes se describieron en otra muestra de estudiantes de 9-13 años de edad, donde las mujeres alcanzaron valores superiores en esta variable (23).

Estudios nacionales han reportado anteriormente que los escolares con obesidad y sobrepeso presentan menores niveles de condición física (24). Los escolares categorizados como obesos presentaron valores inferiores de rendimiento físico en los test de abdominales, salto largo, flexiones de brazo y Navette ($p < 0,001$). En una muestra de escolares, los sujetos con sobrepeso u obesidad mostraron niveles significativamente más bajos de aptitud física en carrera de resistencia, velocidad y agilidad. Además, se concluyó que el aumento del IMC se asoció con una capacidad de rendimiento más baja que limita el desarrollo adecuado de las habilidades motoras (25). Inclusive, existe evidencia científica de

que la obesidad en la etapa preescolar estuvo asociada con un pobre desempeño físico (26). En el presente estudio el $VO2_{MAX}$ fue menor en los sujetos con obesidad en comparación con los otros grupos de estudio, similar a los hallazgos encontrados en niños obesos, los cuales eran más propensos a carecer de una aptitud cardiorrespiratoria adecuada medida a través de un test de carrera de 800 metros (27). Una disminución de la capacidad residual funcional fue la anormalidad más común en la función pulmonar reportada en un estudio desarrollado en niños y adolescentes obesos (28).

En relación con el rendimiento físico, los estudiantes que necesitan mejorar 3 o 4 test presentan mayor RCE ($p < 0,001$) y %MG ($p < 0,001$) en comparación con los estudiantes que necesitan mejorar 1 test o ninguno. Un estudio realizado en estudiantes españoles estableció que una baja capacidad muscular y cardiorrespiratoria estaba asociada consistente y negativamente con la grasa corporal (29). La agencia de calidad de la educación (7) reportó en escolares chilenos que el 14% debe mejorar en el test de Cafra, el 21% necesita mejorar en los abdominales cortos, el 61% debe mejorar en el salto a pie juntos, el 87% debe mejorar en la flexo-extensión de codos, y más de la mitad de la población debe mejorar su potencia aeróbica máxima. Los resultados presentes demuestran que existe un número muy superior de estudiantes que necesitan mejorar su rendimiento físico en comparación con los que se encuentran aceptables. Un estudio realizado en estudiantes colombianos concluye que se debe mejorar la condición física de este grupo como medida protectora en contra de enfermedades cardiovasculares en la etapa adulta (30).

Al asociar los test del rendimiento físico con el %MG existió asociación negativa con el test de abdominales, test de Navette y $VO2_{MAX}$, alcanzando significancia con baja asociación; se ha demostrado una correlación negativa y débil entre el $VO2_{MAX}$ medido a través del test de Rockport con el %MG (31). También se encontró una asociación negativa entre la RCE y el $VO2_{MAX}$ (-0,543). Una investigación de cohorte prospectiva realizada en Chile, con una muestra ponderada de 6.714 hombres y 6.340 mujeres, describió que el ajuste de la CC por la estatura (RCE) permite predecir con mayor precisión factores de riesgo cardiovascular y mortalidad (32).

Los sujetos clasificados en el tramo de 13-14 años presentaron un mayor peso, IMC y CC que los escolares con menor rango etario. En un estudio realizado en estudiantes de Arequipa, el grupo con mayor edad agrupado entre 11-11,9 años poseía un mayor peso, % de grasa corporal y una mayor capacidad cardiorrespiratoria en comparación con los grupos de menor edad (11). Con respecto al rendimiento físico, los sujetos en el tramo de 11-12 años tuvieron un mayor $VO2_{MAX}$ y un mejor desempeño en los test de abdominales, salto largo y Navette, distinto a los hallazgos realizados en la medición de la condición física en escolares argentinos a través de la batería ALPHA, en donde se reportó que existe una tendencia hacia el aumento en los niveles de condición física con el incremento de la edad en los participantes masculinos, en tanto, en las mujeres existió un mantenimiento o leve aumento en relación a la edad (33).

CONCLUSIÓN

Como conclusión de esta investigación desarrollada en estudiantes pertenecientes a escuelas de la ciudad de Temuco, podemos plantear que existe una elevada prevalencia de sobrepeso y obesidad en los escolares evaluados, donde los sujetos obesos obtienen un rendimiento inferior en la batería de test físicos aplicados, también, existe un porcentaje elevado de estudiantes que necesitan mejorar su rendimiento físico, por lo que se deben generar estrategias efectivas para revertir estas tendencias adversas para la salud, ya que los escolares que necesitan mejorar 3 o 4 test de la condición física, presentan mayores promedios de %MG y RCE, esta última variable es un potente indicador de riesgo cardiovascular.

BIBLIOGRAFÍA

1. Katzmarzyk PT, Barreira TV, Broyles ST, Champagne CM, Chaput JP, Fogelholm M, et al. Relationship between lifestyle behaviors and obesity in children ages 9-11: Results from a 12-country study. Obesity (Silver Spring) 2015;23(8):1696-702.
2. Ruiz E, Ávila JM, Castillo A, Valero T, del Pozo S, Rodríguez P, et al. The ANIBES Study on Energy Balance in Spain: design, protocol and methodology. Nutrients 2015;7(2):970-98.
3. Lombardo FL, Spinelli A, Lazzeri G, Lamberti A, Mazzarella G, Nardone P, et al. Severe obesity prevalence in 8- to 9-year-old Italian children: a large population-based study. Eur J Clin Nutr 2015;69(5):603-8.
4. Lazzeri G, Giacchi MV, Spinelli A, Pammolli A, Dalmasso P, Nardone P, et al. Overweight among students aged 11-15 years and its relationship with breakfast, area of residence and parents' education: results from the Italian HBSC 2010 cross-sectional study. Nutr J 2014;13(1):69.
5. Delgado P, Caamaño F, Cresp M, Osorio A, Cofré A. Estado nutricional en escolares y su asociación con los niveles de condición física y los factores de riesgo cardiovascular. Nutr Hosp 2015;32(3):1036-41.
6. Ortega FB, Ruiz JR, Castillo MJ. Physical activity, physical fit-ness, and overweight in children and adolescents: evidence from epidemiologic studies. Endocrinol Nutr 2013;60(8):458-69.
7. Agencia de Calidad de la Educación. Informe de Resultados Estudio Nacional de Educación Física 2014: Ministerio de Educación; 2014.
8. Jankowski M, Niedzielska A, Brzezinski M, Drabik J. Cardiorespiratory Fitness in Children: A Simple Screening Test for Population Studies. Pediatric cardiology 2015;36(1):27-32.
9. Díez-Fernández A, Sánchez-López M, Mora-Rodríguez R, Notario-Pacheco B, Torrijos-Niño C, Martínez-Vizcaíno V. Obesity as a mediator of the influence of cardiorespiratory fitness on cardiometabolic risk: a mediation analysis. Diabetes Care 2014;37(3):855-62.
10. Fenton SA, Duda JL, Barrett T. Inter-participant variability in daily physical activity and sedentary time among male youth sport footballers: independent associations with indicators of adiposity and cardiorespiratory fitness. J Sports Sci 2016;34(3):239-51.
11. Gómez-Campos R, Arruda M, Almonacid A, Holdbold E, Amaral E, Gamero D, et al. Capacidad cardio-respiratoria de niños escolares que viven a moderada altitud. Rev chil pediatr 2014;85(2):188-96.
12. Ministerio de Salud (MINSAL). Norma Técnica de Evaluación Nutricional del niño de 6 a 18 años. Rev. Chil Nutr 2004;31(2):128-37.
13. Marfell-Jones MJ, Olds T, Stewart AD, Carte L. International standards for anthropometric assessment. Potchefstroom University for CHE, Potchefstroom, South Africa: International Society for the Advancement of Kinanthropometry (ISAK); 2006.
14. Arnaiz P, Acevedo M, Díaz C, Bancalari R, Barja S, Aglony M, et al. Razón cintura estatura como predictor de riesgo cardiometabólico en niños. Rev Chil Cardiol 2010;29(3):281-88.
15. Agencia de Calidad de la Educación. Informe de Resultados Estudio Nacional de Educación Física 2013: Ministerio de Educación; 2013.
16. Léger LA, Lambert J, Goulet A, Rowan C, Dinelle Y. Capacité aérobie des Québécois de 6 á 17 ans -test navette de 20 métres avec paliers de 1 minute. Canadian Journal of Applied Sport Sciences 1984;9(2):64-9.

17. Barja S, Arnaís P, Villarroel L, Dominguez A, Castillo O, Farías M, et al. Dislipidemias en escolares Chilenos: prevalencia y factores. Nutr Hosp 2015;31(5):2079-87.
18. Zhang HL, Fu Q, Li WH, Liu SW, Zhong H, Duoji BM, et al. Gender differences and age-related changes in body fat mass in Tibetan children and teenagers: an analysis by the bioelectrical impedance method. J Pediatr Endocrinol Metab 2015;28(1-2):87-92.
19. Simental-Mendía LE, Castañeda-Chacón A, Rodríguez-Morán M, Aradillas-García C, Guerrero-Romero F. Relationship between elevated triglyceride levels with the increase of HOMA-IR and HOMA-β in healthy children and adolescents with normal weight. Eur J Pediatr 2015;174(5):597-605.
20. He F, Rodríguez-Colón S, Fernández-Mendoza J, Vgontzas AN, Bixler EO, Berg A, et al. Abdominal obesity and metabolic syndrome burden in adolescents-Penn State Children Cohort study. J Clin Densitom 2015;18(1):30-6.
21. Gálvez A, Rodríguez P, Rosa A, García E, Pérez J, Tárraga M, Tárraga P. Nivel de condición física y su relación con el estatus de peso corporal en escolares. Nutr Hosp 2015;31(1):393-400.
22. Ranson R, Stratton G, Taylor SR. Digit ratio (2D:4D) and physical fitness (Eurofit test battery) in school children. Early Hum Dev 2015;91(5):327-31.
23. Moselakgomo VK, Monyeki MA, Toriola AL. Relationship between physical activity and risk factors of body weight disorders among south African primary school children. Biomed Res-India 2015;26(4):730-8.
24. Delgado P, Caamaño F, Guzmán I, Jerez D, Ramírez-Campillo R, Campos C, et al. Niveles de obesidad, glicemia en ayuno y condición física en escolares chilenos. Nutr Hosp 2015;31(6):2445-50.
25. Ceschia A, Giacomini S, Santarossa S, Rugo M, Salvadego D, Da Ponte A, et al. Deleterious effects of obesity on physical fitness in pre-pubertal children. Eur J Sport Sci 2015;13:1-8.
26. Agha-Alinejad H, Farzad B, Salari M, Kamjoo S, Harbaugh BL, Peeri M. Prevalence of overweight and obesity among Iranian preschoolers: Interrelationship with physical fitness. J Res Med Sci 2015;20(4):334-41.
27. Hsieh PL, Chen ML, Huang CM, Chen WC, Li CH, Chang LC. Physical activity, body mass index, and cardiorespiratory fitness among school children in Taiwan: a cross-sectional study. Int J Environ Res Public Health 2014;11(7):7275-85.
28. Kongkiattikul L, Sritippayawan S, Chomtho S, Deerojanawong J, Prapphal N. Relationship between Obesity Indices and Pulmonary Function Parameters in Obese Thai Children and Adolescents. Indian J Pediatr 2015;82(12):1112-6.
29. Moliner-Urdiales D, Ruiz JR, Vicente-Rodríguez G, Ortega FB, Rey-López JP, España-Romero V, et al. Associations of muscular and cardiorespiratory fitness with total and central body fat in adolescents; The HELENA Study. Brit J Sports Med 2011;45(2):101-8.
30. Aguilar A, Pradilla A, Mosquera M, Gracia A, Ortega J, Leiva J, et al. Percentiles de condición física de niños y adolescentes de Santiago de Cali, Colombia. Biomédica 2011;31(2):242-9.
31. Sharma VK, Subramanian SK, Arunachalam V. Evaluation of body composition and its association with cardio respiratory fitness in south Indian adolescents. Indian J Physiol Pharmacol 2013;57(4):399-405.
32. Koch E, Romero T, Manríquez L, Taylor A, Román C, Paredes M, et al. Razón cintura-estatura: Un mejor predictor antropométrico de riesgo cardiovascular y mortalidad en adultos chilenos. Nomograma diagnóstico utilizado en el Proyecto San Francisco. Rev Chil Cardiol 2008;27:23-35.
33. Secchi J, García G, España V, Castro J. Condición física y riesgo cardiovascular futuro en niños y adolescentes argentinos: una introducción de la batería ALPHA. Arch Argent Pediatr 2014;112(2):132-40.

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Nutrición Hospitalaria

Trabajo Original

Pediatría

Ingesta de energía y nutrientes en niños de 2-4 años que asisten al programa "Buen Comienzo", Medellín (Colombia)

Energy and nutrients intake in children of 2-4 years at the "Buen Comienzo" program, Medellín (Colombia)

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Resumen

Introducción: a escala mundial y nacional se reporta una alta prevalencia de sobrepeso y obesidad en menores de 5 años. La etiología es multifactorial, pero factores ambientales como sedentarismo y el progresivo deterioro de la alimentación promueven el exceso de peso y conllevan a mayor riesgo de enfermedades crónicas no transmisibles en temprana edad.

Objetivo: describir la ingesta de alimentos, energía y nutrientes en los niños de 2-4 años con obesidad y eutróficos del programa "Buen Comienzo".

Método: estudio de corte con 111 niños con obesidad clasificada según IMC $\geq$ 3 DE, que fueron pareados por sexo, edad y tipo de atención con un niño clasificado con estado nutricional normal. Personal entrenado realizó la valoración antropométrica con equipos y métodos estandarizados y se evaluó la ingesta dietética a través de recordatorio de 24 horas. Se aplicó la prueba t-student y U de Mann Whitney en el análisis bivariado y para determinar el patrón de consumo de alimentos y se efectuó un análisis de clases latentes (ACL).

Resultados: los niños tienen un consumo de energía superior a su requerimiento, pero existe diferencia significativa según el estado nutricional; el consumo en los niños obesos es de 1.632 kcal (IQR: 1.475-1.801 kcal) y eutróficos de 1.798 kcal (IQR 1.702-1.632 kcal) ($p = 0,00$). Los niños con peso adecuado tienen mayor ingesta de macronutrientes y micronutrientes ($p < 0,05$); hay una mayor ingesta de proteínas y micronutrientes durante la semana ($p < 0,05$); el 30% de los niños no consumió ninguna verdura y el 60% ninguna fruta el día anterior a la encuesta y tuvieron, además, un alto consumo de azúcares y dulces.

Conclusiones: los niños están sometidos a una dieta obesogénica caracterizada por un bajo consumo de frutas y verduras y una alta ingesta de energía, grasas saturadas y carbohidratos concentrados, lo que promueve una ganancia de peso no deseado.

Palabras clave:

Estado nutricional. Obesidad. Energía. Nutrientes. Alimentos. Programas del Gobierno.

Abstract

Introduction: At a global and national level, high prevalence of overweight and obesity in children under five years old has been reported. The etiology is multi-factorial, but environmental factors such as sedentary lifestyle, as well as eating habits become more important, given the progressive deterioration in the food quality that promotes the overweight in childhood and leads to increased risk of chronic, noncommunicable early.

Objective: To describe the intake of food, energy and nutrients in children aged 2-4 years with obesity and healthy children, attending the "Buen Comienzo" Program in the form of institutional care setting.

Method: A Cross-sectional study of 111 children with obesity, classified according to IMC $\geq$ 3 SD, which had were matched by sex, age and type of care, with a child with normal nutritional status, Trained personnel performed the anthropometric assessment and standardized methods, and dietary intake was assessed using 24-hour recall. Student t-test and Mann Whitney test was used in the bivariate analysis and to determine the pattern of food intake in obese and eutrophic children, Latent Class Analysis (LCA) was performed.

Results: All children have a higher intake of calories to their requirements, but there are significant differences as nutritional status, consumption in obese children is 1,632 kcal (IQR: 1,475-1,801kcal) and eutrophics of 1,798 kcal (IQR 1,702-1,632 kcal) ($p = 0,00$). Children with healthy weight, have a higher intake of macro and micro-nutrients ($p < 0,05$); there is a higher intake of protein and micronutrients during the week ($p < 0,05$) and 30% of children did not consume any vegetables and 60% fruit any day prior to the survey and also had a high consumption of sugars.

Conclusions: The children subjected to a obesogenic diet, characterized by a low consumption of fruits and vegetables, as well as highly caloric diet with saturated fats and concentrated carbohydrates, that surpasses their daily requirements to gain weight in undesirable.

Key words:

Nutritional status. Obesity. Energy. Nutrients. Foods. Government programs.

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INTRODUCCIÓN

La obesidad infantil es uno de los problemas de salud pública más graves del siglo XXI; es de orden mundial y afecta a países de bajos y altos ingresos. La prevalencia de sobrepeso y obesidad ha aumentado a un ritmo alarmante. En el mundo, para el año 2012, se estimó que alrededor de 44 millones de niños menores de 5 años tendrían sobrepeso u obesidad (1). Colombia no es ajena a este problema, la Encuesta Nacional de la Situación Nutricional (ENSIN) 2010, reportó que el 20,2% de niños y niñas menores de 5 años presentaba sobrepeso y el 6,2% obesidad (2). Para el caso del municipio de Medellín, en 2010, se encontró que en la población de 2 a 5 años la prevalencia de sobrepeso fue del 20,2% y de obesidad del 7,9% (3).

La obesidad tiene una etiología multifactorial y es el resultado de la conjunción de factores biológicos, genéticos y ambientales, como el sedentarismo y los hábitos alimentarios en donde se evidencia un progresivo deterioro de la calidad alimentaria, con un incremento en el porcentaje de grasas saturadas y carbohidratos concentrados y un menor consumo de frutas y verduras (4-8), lo que conlleva a que los niños presenten alteración del crecimiento físico, la composición corporal y el desarrollo cognitivo y motor, situación que en muchas ocasiones puede ser irreversible (9-11). Los niños con exceso de peso tienen mayor probabilidad de seguir siendo obesos en la edad adulta y de padecer a edades tempranas enfermedades no transmisibles como la diabetes o alteraciones cardiovasculares (1,12,13).

En Medellín (Colombia) a través de la Resolución 12760 de 2012 (14) se reguló la prestación del Servicio de Atención Integral a la Primera Infancia en desarrollo del programa "Buen Comienzo", garantizando la atención a 24.000 niños y niñas de 2 a 4 años durante 11 meses en la modalidad entorno institucional, distribuidos en 242 sedes, la atención es de lunes a viernes por un periodo de ocho horas, durante los cuales se suministró alimentación en cuatro ocasiones: desayuno, almuerzo y refrigerio de mañana y de tarde, teniendo como parámetro una minuta que cubre el 73% de la recomendación calórica (15), y además busca fomentar el consumo de una alimentación, adecuada, moderada y variada.

Teniendo en cuenta que en el municipio de Medellín, hasta el momento, no se han realizado estudios en primera infancia que permitan identificar factores relacionados con el consumo de alimentos asociados al estado nutricional de los niños y niñas, y considerando la importancia de un adecuado estado nutricional, la alta inversión financiera y en recursos humanos destinada para programas de atención a este grupo de población, el objetivo de esta investigación fue describir la ingesta de alimentos, energía y nutrientes en los niños de 2-4 años con obesidad y eutróficos que asisten al programa "Buen Comienzo" en la modalidad de atención entorno institucional, para contar con evidencia científica qué permita realizar ajustes pertinentes al componente alimentario y nutricional del programa, que repercuta en el estado nutricional y de salud de los niños.

SUJETOS Y MÉTODOS

Se realizó un estudio de cohorte, enmarcado en la investigación *Factores asociados al estado nutricional en niños con obesidad y eutróficos de 2 a 4 años pertenecientes al programa "Buen Comienzo" en su modalidad de atención entorno institucional*, llevado a cabo por la Unidad de Seguridad alimentaria de la Secretaría de Inclusión Social y Familia de la Alcaldía de Medellín (Colombia). En la fase inicial se realizó la valoración antropométrica de 17.502 niños y niñas, donde se identificó a los menores con obesidad, clasificada según el índice de masa corporal (IMC) $\geq$ 3 desviaciones estándar (DE), de acuerdo con los parámetros establecidos por el Ministerio de la Protección Social a través de la Resolución 2121 de 2010 (Res 2121/10) (16). Los criterios de exclusión fueron diagnóstico de VIH, enfermedades neoplásicas, genéticas, metabólicas, congénitas, renales o endocrinas; algún tipo de discapacidad; tener malestar general en el momento de la evaluación, estar en tratamiento médico con corticoesteroides u hormonas tiroideas; aunque en el estudio no se encontraron niños con alguno de estos criterios, 39 niños fueron excluidos porque sus padres no aceptaron participar o por cambios en su estado nutricional. Finalmente, se realizó la evaluación de la ingesta dietética a 111 niños, que fueron pareados por sexo, edad y tipo de atención (centro infantil o jardín de calidad)[1] con un niño clasificado con estado nutricional normal (Fig. 1).

La valoración antropométrica se realizó con equipos y técnicas de uso internacional, previa capacitación y estandarización de los evaluadores (17), los indicadores antropométricos se analizaron bajo los parámetros de la Res 2121/10 para Colombia. Para el peso se utilizó una báscula SECA 813, con capacidad de 200 kg y sensibilidad de 100 g, para la estatura, un tallímetro portátil SECA 206, con capacidad de 2 m y sensibilidad de 1 mm.

EVALUACIÓN DE INGESTA DE ALIMENTOS

Se aplicó un recordatorio de 24 horas (R24h) al 100% de los participantes y un segundo R24h al 41%, seleccionado de manera aleatoria. Las encuestas se realizaron durante los 7 días de la semana y los segundos R24h se llevaron a cabo en días no consecutivos, garantizando así la independencia entre los datos. La recolección de la información fue realizada por nutricionistas dietistas, previamente entrenados y estandarizados. Para la evaluación del consumo de alimentos en el hogar, se entrevistó a la madre o al adulto responsable del cuidado del niño y de su alimentación; para precisar las cantidades ingeridas, se emplearon modelos de alimentos,

1. Jardín infantil de calidad: instalaciones construidas por la Administración municipal que cuentan con condiciones arquitectónicas de alta calidad estética, seguridad e higiene, así como con espacios amplios y organizados adaptados para la población infantil. Centro infantil: espacios debidamente adecuados y con dotación idónea para el desarrollo infantil, pero cuya infraestructura no depende de la Administración municipal, sino de espacios disponibles en el sector, tales como casas, locales y salones comunales.

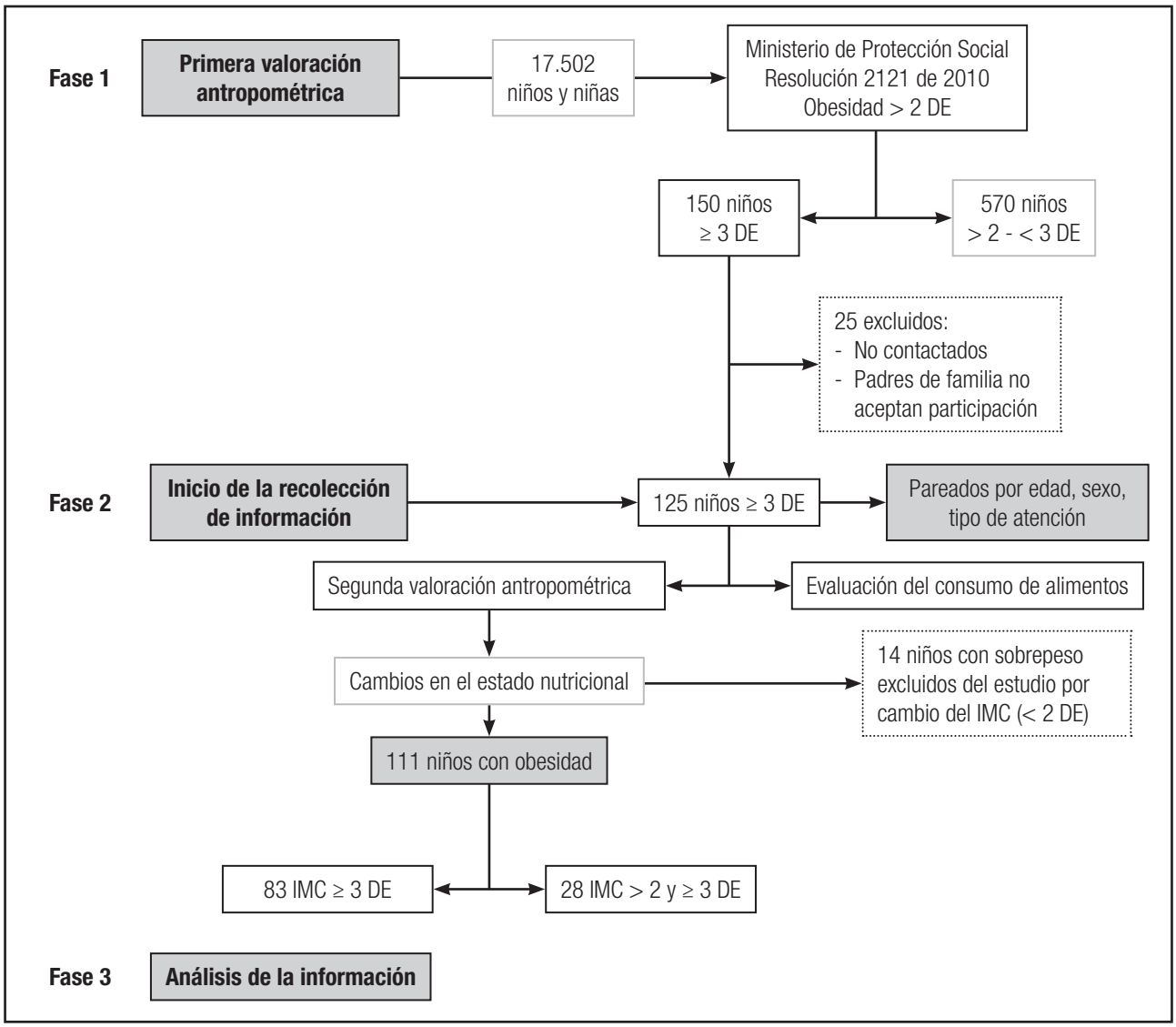

Figura 1.

Diagrama de la población de estudio.

figuras geométricas y un álbum con fotografías de utensilios en tamaño real (18). Para identificar y cuantificar el consumo de alimentos en la institución, se realizó una entrevista a la auxiliar de nutrición, persona con conocimiento del peso de los ingredientes de las preparaciones y además capacitada en las porciones de servida. Posteriormente, se entrevistó al nutricionista de cada institución, quien, de acuerdo con su observación y registro, informó sobre la cantidad realmente consumida por los niños.

La conversión de alimentos en sus respectivos nutrientes se hizo en el Programa de Evaluación de la Ingesta Dietética (EVINDI v4) de la Escuela de Nutrición y Dietética de la Universidad de Antioquia (19), que proporciona datos de los alimentos, las ocasiones de las comidas y de la ingesta bruta del consumo de energía y nutrientes; estos últimos datos se enviaron al Personal Computer Software for Intake Distribution Estimation (PC- SIDE) versión 1.0 de junio de 2004, desarrollado por el Departamento de Estadística de la Universidad del Estado de Iowa, Ames IA, EE. UU., el cual estima las distribuciones de consumos habituales en la población y el consumo habitual de un nutriente para cada individuo. El estimador del consumo habitual para cada individuo, que produce el PC-SIDE (Personal Computer Software for Intake Distribution Estimation), tiene buenas propiedades estadísticas y se conoce como el Mejor Predictor Lineal Insesgado (MPLI), el cual combina la información de la ingesta de cada individuo con la del total de la muestra. De este modo se corrigen algunos errores de medición de la ingesta habitual y se minimiza el error de predicción.

El requerimiento energético fue calculado a partir de las recomendaciones FAO/OMS/UNU de 2001 (20) y se determinó la adecuación energética (ingesta individual/valor recomendado) entre el 90 y 110%. En cuanto a los rangos aceptables de distribución de macronutrientes (AMDR), se consideró un consumo adecuado de proteínas entre el 10% y el 15% y de carbohidratos del 50% al 65%, por debajo del límite inferior se clasificó como riesgo de deficiencia y por encima del límite superior como riesgo de exceso; para las grasas saturadas y los carbohidratos simples se consideró riesgo de exceso por encima del 10% y para la grasa total por encima del 35%. Para estimar la prevalencia de riesgo de deficiencia de un micronutriente, se consideró un consumo habitual inferior al requerimiento promedio estimado (EAR, sigla en inglés) para el nutriente (21).

CONSIDERACIONES ÉTICAS

Se partió de las consideraciones y principios establecidos en la Resolución N.º 008430 de 1993, del Ministerio de Salud, de la República de Colombia (22), para lo cual clasifica el estudio en la categoría "Sin riesgo". Se contó con el consentimiento informado aprobado y firmado por el padre de familia o adulto responsable del niño. La investigación contó con la aprobación del Comité de Bioética de la Secretaria de Salud de la Alcaldía de Medellín.

ANÁLISIS ESTADÍSTICO

En el análisis univariado se calcularon las frecuencias absolutas y relativas para las variables cualitativas y medidas de tendencia central y de dispersión para las variables cuantitativas. Para evaluar el supuesto de normalidad se realizó la prueba de Kolmogorov-Smirnov, de acuerdo con el cumplimiento de este supuesto ($p > 0,05$) se aplicó la prueba t-student y U de Mann Whitney en el análisis bivariado. El análisis estadístico se realizó en el SPSS v 21.0 (Chicago: SPSS Inc.; 2012).

Para determinar el patrón de consumo de alimentos de los niños obesos y eutróficos se efectuó un análisis de clases latentes (ACL) (23), que permitió identificar el número, tamaño y características de los grupos "latentes". En el ACL se tuvieron en cuenta las variables de energía (calorías), proteínas g, carbohidratos totales g, carbohidratos simples g, grasa total g, vitamina A ER, vitamina C mg, ácido fólico mcg EFD, hierro mg, calcio mg y zinc mg categorizados en tertiles de consumo y las variables consumo (semana y fin de semana) y estado nutricional (obesos y eutróficos). Para determinar el número óptimo de clases latentes y el modelo que mejor ajustó, se usó el criterio bayesiano de clasificación (BIC) y la interpretabilidad de los parámetros de solución del modelo, con especial atención en el significado interpretativo de los perfiles de respuesta para cada una de las clases; de esta forma, el modelo que presentó el menor BIC (5015.317), modelo con tres clases, ajustó mejor, pero en términos de interpretabilidad se optó por el modelo con dos clases (BIC 5156.036), pues ofrecía un análisis más coherente. Estos criterios apoyaron una solución de un modelo con dos clases latentes. Para facilidad en la interpretación, las clases se denominaron: "Niños con ingesta alta" y "Niños con ingesta media y baja". Se utilizó el *software* R versión 2.12 con el paquete poLCA para este procedimiento (24).

RESULTADOS

Se evaluaron 111 niñas y niños obesos y 111 eutróficos de 2 a 5 años; 62,2% eran hombres, 36,5% de los participantes consumió alimentos solo en casa, lo que corresponde al consumo el fin de semana y el 63,5% ingirió alimentos tanto en la casa como en la institución, consumo realizado en la semana; ningún niño comió alimentos solo en la institución. En relación con los tiempos de comida, se observó que el 51% de los niños consumió alimentos antes de llegar al centro o jardín infantil, el 100% desayunó y almorzó, el 79% y 85% tomó refrigerio a media mañana y refrigerio a media tarde, respectivamente, en la institución; y luego de la jornada escolar en el hogar, el 92% de los niños cenó, el 39% merendó y el 54% de ellos consumió alimentos en cualquier momento del día.

Se encontraron diferencias significativas en la ingesta de energía ($p = 0,00$) entre niños obesos 1.632 kcal (IQR: 1.475-1.801 kcal) y eutróficos cuya ingesta fue mayor 1.798 kcal (IQR 1.702-1.632 kcal), pero no se encontró diferencia en el consumo en semana 1.778 kcal (IQR 1.569-2.008 kcal) y fin de semana 1.616 kcal (IQR 1.391-1.874 kcal) ($p = 0,069$).

De acuerdo con el requerimiento promedio de energía de los niños, ambos grupos excedieron su ingesta, superando la adecuación de energía con respecto a lo programado, por lo que se encontró diferencia significativa ($p < 0,05$). No hubo diferencias en la ingesta energética en la institución y en el hogar entre los niños obesos y eutróficos (Fig. 2a). Ambos grupos superaron la adecuación energética durante el fin de semana, y se encontró un porcentaje de adecuación del 131% para los eutróficos y del 123% para los niños obesos, con diferencia significativa ($p < 0,05$). (Fig. 2b)

En cuanto al aporte de macronutrientes al valor calórico total (AMDR), se observó que la mayoría de los niños tuvieron una distribución adecuada de acuerdo a los puntos de corte definidos; sin embargo, hubo una alta prevalencia de exceso en la ingesta de energía independiente del estado nutricional. Si bien no hubo diferencia significativa en el consumo de carbohidratos simples (g) y grasas saturadas (%), se encontró una alta prevalencia de exceso en la ingesta tanto en los obesos como los eutróficos, superando el 10% del AMDR, y fue mayor el fin de semana, en donde también se encontró que el 15,5% de los niños eutróficos y más de la mitad de los niños obesos (58,1%) presentó riesgo de deficiencia en la ingesta usual de proteína (Tabla I).

Se encontraron diferencias significativas entre niños obesos y eutróficos en la ingesta de carbohidratos totales g ($p = 0,00$), proteínas g ($p = 0,00$), grasa total g ($p = 0,03$), vitaminas A, B9 y minerales ($p = 0,00$), siendo mayor el consumo de nutrientes en los niños eutróficos (Tabla II). Así mismo, en el total de niños

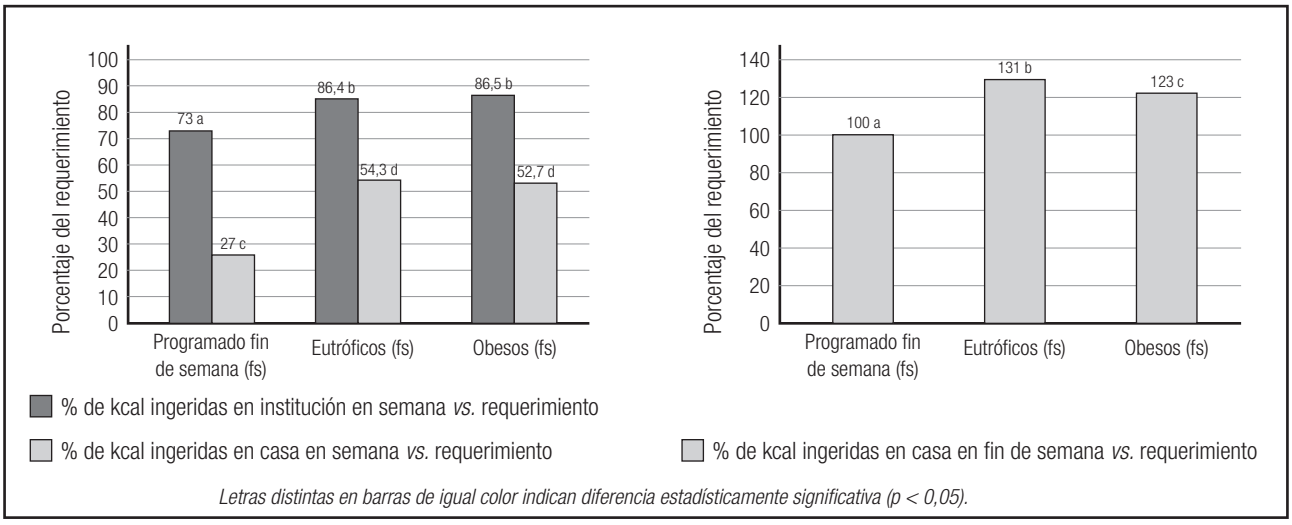

Figura 2.

Ingesta de energía durante la semana y fin de semana con respecto al requerimiento.

Tabla I. Prevalencia de deficiencia y exceso en la ingesta de energía y macronutrientes según consumo semana/fin de semana y estado nutricional

Nutriente	Puntos de corte	Obesos		Eutróficos	
		Fin de semana n = 58	Semana n = 82	Fin de semana n = 53	Semana n = 79
kcal	Déficit < 90%	17,2 (0,01)	0,2 (0,00)	1,6 (0,01)	1,6 (0,01)
	Exceso > 110%	53,2 (0,01)	94,9 (0,02)	89,8 (0,03)	88,8 (0,02)
Proteínas	Déficit < 10 %	58,1 (0,02)	3,0 (0,01)	15,5 (0,02)	0,5 (0,00)
	Exceso > 15%	5,2 (0,03)	27,3 (0,01)	12,6 (0,02)	30,4 (0,01)
Carbohidratos	Déficit < 50%	16,9 (0,02)	46,4 (0,01)	18,8 (0,04)	16,1 (0,01)
	Exceso > 65%	5,1 (0,01)	17,2 (0,01)	0,7 (0,01)	1,8 (0,00)
Carbohidratos simples	Exceso > 10%	85,3 (0,02)	66,2 (0,01)	97,8 (0,10)	84,8 (0,01)
Grasa total	Exceso > 35%	21,7 (0,03)	***	32,6 (0,04)	18,3 (0,01)
Grasas saturadas	Exceso > 10%	100,0 (0,00)	88,7 (0,01)	100,0 (0,00)	95,1 (0,01)
Grasas poliinsaturadas	Exceso > 15%	0,0 (0,00)	0,0 (0,00)	0,0 (0,00)	0,0 (0,00)
Grasas monoinsaturada	Déficit < 10%	29,3 (0,07)	44,1 (0,01)	41,0 (0,35)	48,3 (0,01)

*n: corresponde al número de recordatorios realizados en fin de semana o semana. Porcentaje de individuos (error estándar). *** No es posible obtener esta información debido a la variabilidad en los datos.*

evaluados se encontraron diferencias significativas en el consumo entre semana y durante el fin de semana en carbohidratos totales g (p = 0,02), proteína g y %AMDR (p = 0,00), vitamina A, C y ácido fólico (p = 0,00), calcio y zinc (p = 0,00), siendo mayor el consumo durante la semana, y en grasa total g y hierro (p = 0,04) con un mayor consumo durante el fin de semana.

En todos los niños la ingesta de vitaminas y minerales se encontró por encima del requerimiento, independiente de si el consumo se realizó durante la semana o en el fin de semana (Tabla II).

Por medio del análisis de clases latentes se crearon dos grupos. Una clase se denominó "Niños con ingesta alta", que incorporó al 9,1% de los niños y se caracterizó por contar con: niños con consumo en fin de semana, eutróficos, con ingestas de kilocalorías, proteínas, carbohidratos totales, carbohidratos simples, grasa total, vitamina A, vitamina C, ácido fólico, hierro, calcio y zinc en el último tertil.

En la clase "Niños con ingesta media y baja" se agrupó el 50,9%: niños con consumo en fin de semana, obesos, con ingestas en el primer tertil para kilocalorías, proteínas, carbohidratos totales, grasas totales, vitamina A, ácido fólico, hierro, calcio y

Tabla II. Consumo de nutrientes según estado nutricional y consumo durante la semana y en el fin de semana

Nutrientes	Estado nutricional			Consumo		
	Eutróficos	Obesos	p	Fin de semana	Semana	p
CHO totales g*	243 (221-266)	221 (200-244)	0,000	217 (185-253)	246 (219-275)	0,016
CHO totales %AMDR†	55 (3,62)	55 (4,25)	0,273	55 (4,71)	55 (5,65)	0,393
CHO simples g*	59 (46-74)	58 (49-69)	0,790	56 (42-74)	60 (50-72)	0,266
CHO simples %AMDR*	14 (12-17)	15 (12-17)	0,000	15 (12-18)	13 (10-17)	0,827
Proteínas g*	59 (53-67)	54 (48-61)	0,000	51 (41-61)	61 (54-69)	0,000
Proteínas %AMDR*	14 (12-15)	13,4 (13-14)	0,012	13 (11-14)	14 (13-15)	0,003
GT g*	62 (31-75)	58 (50-67)	0,031	62 (56-68)	61 (52-71)	0,044
GT% AMDR*	31,7 (31-32)	32 (29-35)	0,227	32 (30-35)	31 (27-34)	0,918
AGS% AMDR†	14 (1,75)	14 (2,44)	0,256	15 (2,08)	13 (2,44)	0,227
AGM% AMDR*	10,6 (10-11)	11 (10-12)	0,000	11 (10-12)	10 (9-12)	0,776
AGP% AMDR*	5,6 (4,4-7,0)	5,7 (5,4-6,0)	0,202	5,2 (4,7-5,6)	5,8 (5,1-6,5)	0,645
Vitamina A (ER)*	1.055 (939-1.183)	850 (732-975)	0,000	602 (452-808)	1016 (833-1.278)	0,001
Vitamina C (mg)*	140 (82-224)	146 (130-163)	0,414	96 (63-146)	198 (163-238)	0,000
Ácido fólico (mcg)*	240 (220-261)	230 (214-247)	0,000	164 (146-184)	241 (190-307)	0,000
Hierro (mg)*	13,3 (12,7-14,0)	10,5 (9,7-11,3)	0,000	12.9 (11,4-14,7)	11,8 (10,3- 13,5)	0,037
Calcio (mg)*	876 (711-1.063)	778 (655-912)	0,000	619 (431-865)	957 (877-1.042)	0,000
Zinc (mg)*	8,17 (7,26-9,17)	7,50 (6,90-8,10)	0,000	7,40 (6,40-8,50)	8,10 (7,00-9,30)	0,001

*Los valores presentados son media + DE, mediana (rango intercuartílico). *Prueba U de Mann Whitney. †Prueba t-student.*

zinc, e ingestas en el segundo tertil de carbohidratos simples y vitamina C (Tabla III).

Por otro lado, los niños obesos y eutróficos presentaron un consumo muy similar de frutas y verduras, en cuanto a la variedad y cantidad. Las verduras más consumidas fueron zanahoria, tomate, lechuga, cebolla y repollo, y las frutas como mango, tomate de árbol, moras, guayaba y banano. Aproximadamente el 30% de los niños no consumió ninguna verdura y el 60% ninguna fruta el día anterior a la encuesta. Además, la cantidad promedio ingerida de frutas es de 46 gramos, y de verduras de 11 gramos.

Los niños obesos incluyeron más alimentos del grupo de las grasas y de azúcares y dulces; sin embargo, la cantidad de grasa ingerida en promedio por porción no fue diferente entre los niños obesos y eutróficos.

En el caso de los azúcares y dulces, la panela, el azúcar y la gaseosa fueron los alimentos más consumidos; ambos grupos de niños consumieron alrededor de 60 gramos de azúcar y panela y 180 cc de gaseosa el día anterior a la entrevista.

DISCUSIÓN

Los resultados de este estudio indican que hay un exceso en la ingesta de energía independiente del estado nutricional de los niños, encontrándose un mayor consumo calórico en el grupo de los eutróficos (p = 0,00). Esta información concuerda con otros reportes realizados, en donde el menor consumo de energía en los niños más obesos parece contradictorio; sin embargo, estudios realizados en Perú, Chile y Australia describen que la ingesta media de energía en niños es más alta en aquellos con un peso normal que en los niños con obesidad (25-28). Estos resultados pueden partir de la relación entre la ingesta de energía, la práctica de actividad física y el IMC o, en su defecto, otras medidas de adiposidad, pues se ha evidenciado que probablemente aquellos niños con un IMC o porcentaje de grasa corporal (%GC) adecuado, tienen una mayor exposición a la actividad física y mayor ingesta de energía; por el contrario, aquellos individuos con IMC o %GC alto son menos activos y su ingesta energética puede ser menor (28-30). La evidencia ha mostrado que la prevalencia de obesidad no solo se debe a un balance calórico positivo, sino a la existencia de otros aspectos relacionados con el estilo de vida y con factores socioeconómicos, ambientales y culturales (31-33), entre las que se encuentra la actividad física; sin embargo, en este estudio no fue posible relacionar el estado nutricional, el consumo de alimentos y la actividad física, debido a que en el macroproyecto no se contó con la clasificación de actividad física a nivel individual.

En el presente estudio también se encontró que tanto en la institución como en el hogar se excedió el aporte de energía con respecto al requerimiento de los niños, que según lo programado corresponde al 73% y 27%, respectivamente; por tanto, la ingesta

Tabla III. Clases latentes y probabilidades condicionales

Variable	Categorías	Niños con ingesta alta 49,1%	Niños con ingesta media y baja 50,9%
Estado nutricional	Obeso	0,1004	0,8857
	Eutrófico	0,8996	0,1143
Consumo	Fin de semana	0,3112	0,4167
	Semana	0,6888	0,5833
Energía kcal	≤ 1.688	0,000	0,655
	1.689-1.789	0,3629	0,3048
	1.790+	0,6371	0,0402
Proteínas g	≤ 54,0	0,142	0,518
	54,1-59,5	0,2420	0,4215
	59,6+	0,6160	0,0605
Carbohidratos totales g	≤ 221,6	0,0601	0,5970
	221, -239,2	0,3439	0,3232
	239,3+	0,5960	0,0798
Carbohidratos simples g	≤ 54,0	0,3575	0,3101
	54,1-61,7	0,1822	0,4792
	61,8+	0,4604	0,2108
Grasa total g	≤ 55,5	0,2175	0,4451
	55,6-62,5	0,2947	0,3706
	62,6+	0,4878	0,1843
Vitamina A (ER)	≤ 873	0,0211	0,6346
	87 -1.033	0,3001	0,3654
	1.034+	0,6788	0,0000
Vitamina C (mg)	≤ 142	0,3641	0,3036
	143-152	0,0797	0,5781
	153+	0,5562	0,1183
Ácido fólico (mcg)	≤ 230	0,0787	0,5791
	231-238	0,2849	0,3801
	239+	0,6364	0,0409
Hierro (mg)	≤ 10,7	0,000	0,655
	10,8-13,2	0,3212	0,3450
	13,3+	0,6788	0,0000
Calcio (mg)	≤ 759	0,1759	0,4852
	760-875	0,2596	0,4045
	876+	0,5644	0,1103
Zinc (mg)	≤ 7,5	0,0782	0,5796
	7,6-8,0	0,2627	0,4015
	8,1+	0,6592	0,0189

de energía supera su adecuación en el 30% aproximadamente, independiente de su estado nutricional. El exceso energético es más representativo en el hogar, pues consumen el doble de lo esperado; posiblemente debido a la falta de hábitos de alimentación adecuados en la familia (34). El 13% adicional que se ofreció en la institución puede deberse a que las auxiliares de nutrición

tienen debilidades en la estandarización de porciones y en el alistamiento de los ingredientes para elaborar las preparaciones, y sirven más de lo programado en el ciclo de menú establecido. Adicionalmente, se evidencia que hubo duplicidad en algunos de los momentos de comida que los niños realizan durante el día, este hecho desmitifica la creencia de que los niños del programa, dada su vulnerabilidad socioeconómica, solo consumen alimentos en la institución.

La ingesta alta de energía en los niños es un aspecto preocupante; estudios realizados en niños alemanes han mostrado que la ganancia de peso se debe a un pequeño, pero positivo, balance de energía que se realiza constantemente (35), y que, para prevenir el sobrepeso en los niños, la brecha de energía no debe exceder de 46 a 72 kcal al día (36). En nuestro estudio, los niños obesos y eutróficos consumieron en promedio 175 y 340 kcal más de lo que requieren respectivamente, lo cual lleva a pensar que si los niños continúan con esta ingesta se promueve una ganancia de peso que supera lo deseado y además se ha evidenciado que la ganancia de peso después de los 2 años ejerce efectos predominantemente perjudiciales para la salud en términos de factores de riesgo a largo plazo (37).

El consumo de carbohidratos, proteínas y grasa total fue significativamente mayor en los eutróficos; aunque en ambos grupos la distribución porcentual de macronutrientes se encontró dentro de los rangos establecidos en cuanto a lo recomendado, no se puede perder de vista que esta distribución está basada en una dieta que excede su adecuación en energía, carbohidratos concentrados y grasa saturada, comportamiento que coincide con lo reportado en otros estudios (25,26,38). Esta conducta es un factor de riesgo para la continuación de este hábito inadecuado en la edad adulta (34), pues con el tiempo conduce no solo al cambio de estado nutricional en los niños eutróficos, sino también al desarrollo de enfermedades cardiovasculares, diabetes e hipertensión. Algunos estudios han evidenciado que ingestas dietéticas altas en ácidos grasos saturados aumentan las concentraciones plasmáticas de colesterol total y LDL, e incluso, a una edad temprana, pueden aumentar el depósito de lípidos y la aparición prematura de lesiones vasculares (38).

Al comparar el consumo de alimentos entre semana y fin de semana, se evidencia claramente que la atención en el jardín o centro infantil es un factor que favorece la calidad de la alimentación en la semana, toda vez que proporciona un mejor aporte en cuanto a proteínas, vitaminas y minerales, excepto el hierro, cuyo consumo fue más alto durante el fin de semana. La prevalencia de riesgo de deficiencia en la ingesta de proteínas en el total de los niños aumentó considerablemente de semana a fin de semana, siendo más representativo en los niños obesos, cuyo aumento va de 3% a 58,1%, lo que indica que en el hogar se disminuye el aporte de alimentos fuente de este nutriente. Otro aspecto importante es que no hay diferencias en la ingesta de carbohidratos concentrados, grasa total y grasas saturadas en el consumo en semana y fin de semana, toda vez que con los alimentos suministrados durante el fin de semana se iguala e incluso se supera la ingesta de estos nutrientes durante la semana, cuyo consumo excesivo representa riesgos para la salud. Estos resultados son coherentes con lo encontrado en estudios realizados en Chile y Argentina, los cuales demostraron que la alimentación en la institución es de buena calidad y da respuesta a parámetros establecidos y que el exceso en la ingesta energética proviene del hogar, debido a una mayor oferta de alimentos de menor calidad, lo que empeora más aún durante el fin de semana (39-42).

En cuanto a la ingesta de vitaminas y minerales, es importante destacar que, aunque todos los niños consumen más de su requerimiento, la ingesta es menor en los niños obesos, lo que continúa mostrando una limitación en la calidad de la dieta de estos individuos. Asimismo, se evidencia que la ingesta de micronutrientes es mayor durante la semana, debido al aporte en la institución, que, desde sus lineamientos, espera cubrir más del 100% de la recomendación a través de los momentos de alimentación establecidos. En la revisión realizada se encontraron pocos estudios donde se evaluara el consumo de micronutrientes en niños que hubieran participado en programas de alimentación escolar por estado nutricional; sin embargo, en un estudio realizado en México en niños de 24 a 59 meses, se encontró que la ingesta de retinol, hierro y calcio fue mayor en los beneficiarios de programas de alimentación, aunque para estos no se lograba cubrir la recomendación (43).

En general, los niños y niñas presentaron un consumo insuficiente de frutas y verduras, toda vez que la Organización Mundial de la Salud recomienda un consumo diario promedio de 400 gramos entre estos dos grupos de alimentos (44); por tanto, los niños están consumiendo solo un 14% de la recomendación. Esta tendencia al bajo consumo de frutas y verduras en niños con exceso de peso se ha encontrado en otros estudios (7,30,45). Asimismo, se encontró una alta ingesta de azúcares y dulces, lo que significa un aporte diario de 340 kilocalorías provenientes solo de este grupo de alimentos. Esto indica que ni en la institución ni en la casa se están promoviendo hábitos de alimentación saludable, resultados que coinciden con otros estudios realizados en Colombia en niños y niñas del programa MANA Infantil (46).

Finalmente, al realizar el análisis de clases latentes, se formaron claramente dos perfiles que confirman los resultados hasta ahora descritos: un perfil de niños obesos con bajas ingestas de energía y nutrientes, y un perfil de niños con peso adecuado con ingesta alta de energía y nutrientes. En la búsqueda bibliográfica realizada se encontraron estudios donde se determinaron patrones de consumo de alimentos y sus grupos por medio del análisis de componente principales; sin embargo, no se hallaron estudios realizados en este grupo poblacional, ni estudios donde los perfiles se construyeran a partir de la composición nutricional de los alimentos consumidos, lo que dificultó la comparación de nuestros hallazgos en este aspecto.

El método de evaluación de ingesta empleado en el estudio es ampliamente reconocido y utilizado a escala nacional e internacional (31,46-49). El recordatorio de 24 horas permitió realizar el análisis del consumo habitual en la población, toda vez que desde la metodología se contemplaron los aspectos necesarios para estimar la variabilidad intraindividual e interindividual y para garantizar la precisión de las cantidades ingeridas (50). Sin embargo, se reconoce que existen algunas dificultades para la evaluación de la

ingesta en la población infantil, más aun cuando se trata de niños con obesidad, donde son las madres o personas responsables de la alimentación de los niños quienes proporcionan la información y probablemente se incurre en la subestimación de las porciones y se omite el reporte de alimentos entre comidas o que son considerados poco saludables. Esta posible limitación concuerda con lo reportado en otros estudios, donde se ha evidenciado que la infravaloración del consumo puede estar directamente relacionada con el IMC del niño, con la percepción que tienen los padres con respecto al peso de sus hijos o con un sentimiento de pena para reportar la comida ingerida (31,41,51).

A partir de lo encontrado en el estudio se reconoce que la alimentación proporcionada en los centros o jardines infantiles mejora el aporte de proteínas y micronutrientes; sin embargo, tanto en el hogar como en la institución, los niños están sometidos a una dieta obesogénica que con el tiempo promueve una ganancia de peso no deseado. Por este motivo estos resultados cobran importancia, pues permiten establecer medidas preventivas y correctivas en la normativa vigente, desde la implementación de intervenciones sostenibles a largo plazo a través de componentes tan importantes como lo son la educación y prácticas en alimentación y nutrición y la actividad física, partiendo de un abordaje no solo a nivel institucional, como también a nivel familiar, pues es en esta etapa del ciclo vital donde se adquieren los hábitos alimentarios que persisten en la adolescencia y en la edad adulta.

Además, es la oportunidad de afianzar las alianzas interinstitucionales e intersectoriales, para realizar una lectura del contexto y hacer un análisis de la situación alimentaria de los niños y de todos los factores condicionantes relacionados con su estado nutricional; de esta manera se puede brindar una atención integral enmarcada más desde la prevención y promoción de hábitos de estilos de vida saludable que desde la superación de la enfermedad.

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BIBLIOGRAFÍA

1. Organización Mundial de la Salud. Estadísticas Sanitarias Mundiales 2014. Ginebra: OMS; 2014.
2. ICBF. Encuesta Nacional de la Situación Nutricional en Colombia 2010. Bogotá: ICBF; 2011.
3. Álvarez LS, Mancilla LP, González LI, Isaza UA. Perfil Alimentario y Nutricional de Medellín 2010. Medellín: Alcaldía de Medellín; 2010.
4. Pedraza D. Obesidad y Pobreza: marco conceptual para su análisis en latinoamérica. Saúde Soc 2009;18(1):103-17.
5. Mosquera MA. Obesidad Infantil: una epidemia. Santiago de Cali: Carta de la Salud; 2009.
6. Saavedra JM, Dattilo AM. Factores alimentarios y dietéticos asociados a la obesidad infantil: recomendaciones para su prevención antes de los dos años de vida. Rev Peru Med Exp Salud Publica 2012;29(3):379-85.
7. Kovalskysa I, Indart P, Amigoa M, Gregoriob MJ, Rausch C, Karnera M. Ingesta alimentaria y evaluación antropométrica en niños escolares de Buenos Aires. Arch Argent Pediatr 2013;111(1):9-15.
8. Suárez N, Céspedes EM, Cabrera BK, Rodríguez KM, Agüero E, Castro E, et al. Factores determinantes de sobrepeso y obesidad en infantes de un círculo infantil. CorSalud 2012;4(3):185-90.
9. Torres M, Pérez BM, Landaeta M, Vásquez M. Consumo de alimentos y estado nutricional según estrato socioeconómico en una población infantil de caracas. Arch Venez Puer Ped 2011;74(2):2-9.
10. Portillo ZC, Solano L, Fajardo Z. Riesgo de deficiencia de macro y micronutrientes en preescolares de una zona marginal. Invest clín 2004;45(1): 17-28.
11. UNICEF. La carencia de vitaminas y minerales afecta al desarrollo de un tercio de la población mundial [Internet]. [Consultado 2013 Junio 30]. Disponible en: http://www.unicef.es/actualidad-documentacion/noticias/la-carencia-de-vitaminas-y-minerales-afecta-al-desarrollo-de-un-te
12. Organización Mundial de la Salud. Obesidad y Sobrepeso [internet]. [consultado 2013 Abril 20]. Disponible en: http://www.who.int/mediacentre/factsheets/fs311/es/
13. Freedman DS, Kahn H, Mei Z, Grummer LM, Dietz WH, Srinivasan SR, et al. Relation of body mass index and waist to height ratio to cardiovascular disease risk factors in children and adolescents: the Bogalusa Heart Study. Am J Clin Nutr 2007;86:33-40.
14. Medellín. Secretaria de Educación. Resolución 12760 de 2012, por medio de la cual se regula la prestación del servicio de Atención Integral a la Primera Infancia en desarrollo del programa Buen Comienzo. Medellín. Alcaldía de Medellín; 2012.
15. ICBF. Recomendaciones de consumo diario de calorías y nutrientes para la población Colombiana. Bogotá: ICBF; 1988.
16. Colombia. Ministerio Protección Social. Resolución 2121 de 2010, junio 9, por la cual se adoptan los Patrones de Crecimiento publicados por la Organización Mundial de la Salud, OMS, en el 2006 y 2007 para los niños, niñas y adolescentes de 0 a 18 años de edad y se dictan otras disposiciones. Bogotá: El Ministerio; 2010.
17. Lohman TG RA, Martorell R. Anthropometric standardization reference manual. Champaign: Human Kinetics Books; 1988.
18. Manjarrés LM. Métodos para precisar la recolección de la ingesta dietética en estudios poblacionales. Perspectivas en Nutrición Humana 2007;9(2): 155-63.
19. Manjarrés LM, Manjarrés S. Programa de Evaluación de Ingesta Dietética. Escuela de Nutrición y Dietética. V4 ed. Medellín: Escuela de Nutrición y Dietética. Universidad de Antioquia; 2009.
20. FAO. Food and nutricional technical report series. Human energy requirements. Report of joing FAO/WHO/UNU. Expert consultation. Roma 17-24 October 2001. p. 96.
21. Otten J, Hellwig J, Meyeres L. Dietary Reference Intakes. The Essential guide to Nutrient Requirements. Washington D.C: The National Academies Press; 2006.
22. Colombia. Ministerio de Salud. Resolución 8430 de 1993, octubre 4, por la cual se establecen las normas científicas, técnicas y administrativas para la investigación en salud. Bogotá: El Ministerio; 1993.
23. Lanza ST, Collins LM, Lemmon DR, Schafer JL. PROC LCA: a SAS procedure for latent class analysis. Struct Equ Modeling 2007;14:671-94.
24. Drew AL, Jeffrey BL. An R Package for Polytomous Variable Latent Class Analysis. J Stat Softw 2011;42:1-29.
25. Liria M, Mispireta M, Lanata C, Creed H. Perfil nutricional en escolares de Lima y Callao. Lima: Instituto de Investigación Nutricional, ILSI International Life Science Institute-Sur Andino; 2008.
26. Liberona Y, Engler V, Castillo O, Villarroel L, Rozowski J. Ingesta de macronutrientes y prevalencia de malnutrición por exceso en escolares de 5.° y 6.° básico de distinto nivel socioeconómico de la región metropolitana. Rev Chil Nutr 2008;35(3):190-9.
27. Commonwealth Department of Health and geing, et al. 2007 Australian National Children's Nutrition and Physical Activity Survey Main Findings. Canberra: Australian Data Archive, The Australian National University; 2008.

28. Telford RD, Cunningham RB, Telford RM, Riley M, Abhayaratna WP. Determinants of Childhood Adiposity: Evidence from the Australian LOOK Study. PLoS ONE 2012;7(11):1- 7.
29. Calvo N, Ochoa M, Martí A, Martínez M. Asociación entre los macronutrientes de la dieta y la obesidad en la infancia y adolescencia; un estudio de casos y controles. Nutr Hosp.2013;28(5):1515-22.
30. Nava MC, Pérez A, Herrera HA, Hernández RA. Hábitos alimentarios, actividad física y su relación con el estado nutricional antropométrico de preescolares. Rev Chil Nutr 2011;38(3):301-12.
31. Balthazar E, RM de Oliveira M. Differences in dietary pattern between obese and eutrophic children. BMC Research Notes 2011;4(567):1-7.
32. Weker H. Simple obesity in children. A study on the role of nutritional factors. Med Wieku Rozwoj 2006;10(1):3-191.
33. Mispireta ML. Determinantes del sobrepeso y la obesidad en niños en edad escolar en Perú. Rev Peru Med Exp Salud Publica 2012;29(3):361-5.
34. Missaggia G, Celestino B, Silva I, Petrucci D, Assunção M. Adequacy of energy consumption and macronutrients of children under six years of age. Rev Paul Pediatr 2012;30(4):513-9.
35. Plachta-Danielzik S, Landsberg B, Johannsen M, Lange D, James M. Determinants of the prevalence and incidence of overweight in children and adolescents. Public Health Nutr 2010;13:1870-81.
36. Plachta-Danielzik S, Landsberg B, Bosy-Westphal A, et al. Energy gain and energy gap in normal-weight children: longitudinal data of the KOPS. Obesity (Silver Spring) 2008;16:777-83.
37. Victora C. Los mil días de oportunidad para intervenciones nutricionales. De la concepción a los dos años de vida. Arch Argent Pediatr 2012;110(4):311-7.
38. Koletzko B, Dokoupil K, Reitmayr S, Weimert B, Keller E. Dietary fat intakes in infants and primary school children in Germany. Am J Clin Nutr 2000;72(suppl):1392S-8S.
39. Vásquez F, Salazar G, Andrade M, Díaz E, Rojas J. Ingesta alimentaria de preescolares obesos asistentes a los jardines infantiles de la JUNJI. Rev chil nutr 2004;31(2):100-8.
40. Rovirosa A, Britos S. Estudio sobre la alimentación de niños en edad escolar que concurren a comedores escolares en la provincia de Río Negro. CESNI; 2005. Disponible en: http://biblioteca.cesni.org.ar/references/50059b9d9e3d98078c95f24a
41. Vásquez F, Salazar G, Rodríguez M, Andrade M. Comparación entre la ingesta alimentaria de preescolares obesos y eutróficos asistentes a jardines infantiles de Junji de la zona Oriente de Santiago. Arch Latinoam Nutr 2007;57(4):343-7.
42. Vásquez F, Cardona O, Andrade M, Salazar G. Balance de energía, composición corporal y actividad física en preescolares eutróficos y obesos. Rev chil pediatr 2005;76(3):266-74.
43. Galván M, Atalah E. Variables asociadas a la calidad de la dieta en preescolares de Hidalgo, México. Rev Chil Nutr 2008;35(4):413-20.
44. Organizacion Mundial de la Salud. Estrategia mundial sobre regimen alimentario, actividad fisica y salud [internet]. [Consultado 2014 Octubre 5]. Disponible en: http://www.who.int/dietphysicalactivity/fruit/es/
45. Alba E, Gandía A, Olaso G, Vallada E, Garzón MF. Consumo de frutas, verduras y hortalizas en un grupo de niños valencianos de edad escolar. Nutr clín diet hosp 2012;32(3):64-71.
46. Cadavid MA, Chaves L, Manjarrés LM. Descripción de la ingesta de alimentos y nutrientes en niños expuestos y no expuestos al programa de complementación alimentaria MANÁ Infantil en el municipio de Envigado-Colombia, 2006-2010. Perspect Nutr Humana 2013;15:83-96.
47. Instituto Colombiano de Bienestar Familiar, Profamilia, Instituto Nacional de Salud, Universidad de Antioquia, OPS. Ingesta dietétiva. En: Borda C, editor. Encuesta nacional de la situación nutricional en Colombia, 2005. Bogotá: Panamericana Formas e Impresos SA; 2006. p. 229-315.
48. Freire W.B, Ramíres MJ, Belmont P, Mendieta MJ, Silva MK, Romero N, et al. Resumen ejecutivo. Tomo I. Encuesta Nacional de Salud y Nutición del Ecuador. ENSANUT-ECU 2011- 2013. Quito, Ecuador: Ministerio de Salud Pública/ Instituto Nacional de Estadística y Censo; 2013.
49. Baygi F, Qorbani M, Reza A, Kelishadi R, Asayesh H, Rezapour A, et al. Dietary predictors of childhood obesity in a representative sample of children in north east of Iran. Chin J Contemp Pediatr 2013;15(7):501-8.
50. Ferrari M. Estimación de la Ingesta por Recordatorio de 24 Horas. Diaeta (B Aires) 2013; 31(143):20-5.
51. Fisher JO, Johnson RK, Lindquist C, Birch LL, Goran MI. Influence of body composition on the accuracy of reported energy intake in children. Obes Res 2000;8(8):597-603.

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Nutrición Hospitalaria

Trabajo Original

Pediatría

Prevalence of overweight and obesity among adolescents in eight Arab countries: comparison between two international standards (ARABEAT-2)

La prevalencia de sobrepeso y obesidad en los adolescentes de ocho países árabes: comparación entre dos normas internacionales (ARABEAT-2)

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Abstract

Objective: The aim of this study was to highlight the prevalence of overweight and obesity among adolescents in eight Arab countries.

Methods: A school-based cross-sectional study was conducted in eight Arab countries: Iraq, Jordan, Kuwait, Libya, Palestine, Saudi Arabia, Sudan and Tunisia. The total sample included was 6,447 adolescents aged 15-18 years (3,111 males, 3,336 females). The International Obesity Task Force (IOTF) and World Health Organization (WHO) reference standards were used to determine obesity levels.

Results: The WHO standard provided lower prevalence of overweight but higher prevalence of obesity than the IOTF standard. According to the IOTF standard, overweight among males was highest in Kuwaiti adolescents (24.8%), followed by Saudi Arabian (23.2%). Among females, the highest prevalence was reported in Kuwaiti adolescents (22.1%), followed by Jordanian (20.0%). Regarding obesity, Kuwaiti adolescents showed the highest prevalence of obesity for both males (28.6%) and females (21.1%).

Conclusion: Findings revealed no progress in reducing prevalence of obesity.

Key words:

Arab countries.
Adolescents.
Overweight. Obesity.

Resumen

Objetivo: el objetivo de este estudio fue poner de relieve la prevalencia del sobrepeso y la obesidad en los adolescentes de ocho países árabes.

Métodos: estudio transversal basado en escolares, que se llevó a cabo en ocho países árabes: Irak, Jordania, Kuwait, Libia, Palestina, Arabia Saudí, Sudán y Túnez. La muestra total estuvo compuesta por 6.447 adolescentes de 15-18 años (3.111 hombres, 3.336 mujeres). Se utilizaron para determinar los niveles de obesidad de la Fuerza Internacional de Obesidad (IOTF) y los patrones de referencia de la Organización Mundial de la Salud (OMS).

Resultados: el estándar de la OMS presentó menor prevalencia de sobrepeso, pero mayor prevalencia de obesidad que el estándar de la IOTF. De acuerdo con la norma IOTF, el sobrepeso entre los varones fue más alto en los adolescentes kuwaitíes (24,8%), seguido de Arabia Saudí (23,2%). Entre las mujeres, se informó de la más alta prevalencia en adolescentes kuwaitíes (22,1%), seguido por las jordanas (20,0%). En cuanto a la obesidad, los adolescentes kuwaitíes presentaron la mayor prevalencia de obesidad tanto en hombres (28,6%) como en mujeres (21,1%).

Conclusión: los resultados revelaron que no se ha conseguido ningún progreso en la reducción de la prevalencia de la obesidad.

Palabras clave:

Países árabes.
Adolescentes.
Sobrepeso. Obesidad.

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INTRODUCTION

Obesity has become the main public health challenge in both developed and developing countries (1). A number of potential factors have contributed to explain the global high increase in obesity over the past three decades such as increase in calorie intake, change in composition of diet and decline in physical activity. Concern about co-morbidities associated with increasing obesity has become well recognized. Therefore, up-to-date information on the prevalence of and trends in overweight and obesity is important for assessing their health effects and to evaluate the progress of current prevention programmes (2).

The proportion of adolescents who are overweight or obese is markedly increasing globally (3). Indicators from Arab countries suggest an alarming prevalence of overweight and obesity in children and adolescents (4,5). Adolescence is a crucial stage in the evolution of obesity as well as for starting risk factors for some chronic diseases in adulthood (3). Therefore, this study aimed to provide up-to-date information on the prevalence of overweight and obesity among adolescents in eight Arab countries.

METHODS

The current data were extracted from the ARABEAT-2 project, which was organized by the Arab Center for Nutrition and targeted to explore the social aspects of obesity among adolescents in eight Arab countries, namely Iraq, Jordan, Kuwait, Libya, Palestine, Saudi Arabia, Sudan and Tunisia. The capital or one main city was selected from each country, which were: Mosel, Amman, Kuwait, Tripoli, Gaza, Dammam, Khartoum and Tunisia, respectively. The target group was public school students aged 15–18 years. The data were collected during the 2013–2014 school year. Each centre was responsible for obtaining the ethical approval to carry out the study from their Ministry of Education.

The aim was to include not less than 5% of total students aged 15-18 years in each city. Sample size was calculated with a 5% margin of error and with 95% confidence of interval. The students were selected using a multistage stratified sampling method. Due to the shortage of data on private schools in some countries, only public schools were included in this study. In the first stage, each city was divided into several administrative regions, ranging from two to four regions, based on governmental administration in each country. In the second stage, the public secondary schools were selected proportionally by gender from each administrative region, using a simple random method. In the third stage, the classes (levels 10-12) were selected from each country using a simple random method. The total sample of students in each country was varied depending on the number of selected schools and the number of students in each class. The total sample from the eight countries was 6,447 (3,111 males, 3,336 females). Distribution of the sample by country and gender is presented in table I. It can be seen that the proportion of male to female is almost close in all countries, except in Libya and Palestine, where the proportion of females is much higher than males. This is probably due to unsettlement (in Libya and Palestine) or poverty (in Palestine), which force the males either to become involved in the civil war, such as in Libya, or to withdraw from schools and enroll in work to earn extra income for the family, such as in Gaza, Palestine.

Weight and height were measured according to a standard procedure (6). All measurements were taken with minimum clothing and without shoes. Overweight and obesity were calculated according to both the International Obesity Taskforce (IOTF) (7) and the World Health Organization (WHO) (8) reference standards. Chi-square test was used to measure the statistically differences between the two standards.

RESULTS

Proportions of overweight and obesity among adolescents (15-18 years) in eight Arab countries according by the IOTF and WHO reference standards are presented in table II. In general the WHO standard estimated a higher prevalence of obesity, but lower prevalence of overweight than the IOTF standard. The dif-

Table I. Sample size of studied adolescents (15-18 years) by country and gender

Country	City	Male		Female		Total	
		No.	%	No.	%	No.	%
Iraq	Mosel	410	45.4	494	54.6	904	100.0
Jordan	Amman	400	50.3	395	49.7	795	100.0
Kuwait	Kuwait	343	48.6	363	51.4	706	100.0
Libya	Tripoli	307	40.4	452	59.6	759	100.0
Palestine	Gaza	227	37.2	383	62.8	610	100.0
Saudi Arabia	Dammam	518	53.8	450	46.5	968	100.0
Sudan	Khartoum	488	54.1	414	45.9	902	100.0
Tunisia	Tunisia	418	52.1	385	47.9	803	100.0
Total		3,111	48.3	3,336	51.7	6,447	100.0

Table II. Proportion of overweight and obesity among adolescents (15-18 years) in eight Arab countries by gender, according to IOTF and WHO reference standards

Country		Male			Female			Total		
	Reference	non-obese	Overweight	Obese	non-obese	Overweight	Obese	non-obese	Overweight	Obese
		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
High income										
Kuwait	IOTF	46.6	24.8	28.6	56.8	22.1	21.1	51.8	23.4	24.8
	WHO	45.5	14.0	40.5	56.7	12.1	31.2	51.3	13.0	35.7
Saudi Arabia	IOTF	52.5	23.2	24.3	73.8	15.3	10.9	62.4	19.5	18.1
	WHO	53.3	11.2	35.5	73.8	8.0	18.2	62.8	9.7	27.5
Middle income										
Iraq	IOTF	72.7	18.5	8.8	76.5	19.4	4.1	74.8	19.0	6.2
	WHO	72.2	10.5	17.3	76.5	11.9	11.6	74.6	11.3	14.1
Jordan	IOTF	78.3	14.0	7.7	77.0	20.0	3.0	77.6	17.0	5.4
	WHO	78.5	9.0	12.5	76.7	14.7	8.6	77.6	11.8	10.6
Libya	IOTF	76.2	16.6	7.2	73.9	17.9	8.2	74.8	17.4	7.8
	WHO	76.9	9.8	13.3	73.5	10.0	16.5	74.8	9.9	15.3
Tunisia	IOTF	79.4	14.8	5.8	77.4	16.9	5.7	78.5	15.8	5.7
	WHO	79.2	9.6	11.2	77.9	11.5	10.6	78.5	10.5	11.0
Low income										
Palestine	IOTF	77.5	15.9	6.6	77.5	16.5	6.0	77.6	16.2	6.2
	WHO	77.5	9.7	12.8	77.0	11.7	11.3	77.2	11.0	11.8
Sudan	IOTF	91.0	6.5	2.5	87.7	8.5	3.9	89.5	7.4	3.1
	WHO	91.0	3.1	5.9	87.9	5.8	6.3	89.6	4.3	6.1

The differences between two standards were highly statistically significant ($p < 0.001$) among all genders in all countries.

ferences between two methods were highly statistically significant ($p < 0.001$) among all genders in all countries. Using the IOTF standard, the highest proportion of overweight was observed in Kuwaiti adolescents (both males (24.8%) and females (22.1%), followed by Saudi males (23.2%) and Jordanian females (20%). The lowest proportion of overweight was noticed in Sudanese adolescents (6.5% and 8.5%, for males and females, respectively). Similarly regarding obesity prevalence, the Kuwaiti adolescents had the highest prevalence (28.6% and 21.1%, in males and females, respectively), whereas the Sudanese adolescents had the lowest prevalence (2.5% and 3.9% in males and females, respectively). There was some trend that overweight and obesity prevalence increased as per capita income of the country increased.

DISCUSSION

This study is the first attempt to compare the prevalence of overweight and obesity among adolescents in eight Arab countries using two reference standards (IOTF and WHO), as well as using similar methodology. The results suggested a high proportion of overweight and obesity among adolescents (15-18 years) in most countries studied. Even in very poor countries such as Sudan, which is experiencing severe malnutrition and shortage of food, an alarming prevalence of overweight and obesity has been observed in urban adolescents.

The high prevalence of overweight and obesity among adolescents in Kuwait and Saudi Arabia may be due to the rapid nutrition transition, which started earlier in these two countries than in other countries, mainly due to the early discovery of oil in Kuwait and Saudi Arabia. This leads to the improvement in socio-economic status and consequently to changes in dietary habits and lifestyle (3). In general, the difference in the prevalence of obesity between the eight Arab countries could be attributed to ethnic background, socio-economic status, sedentary behaviour, food habits, and timing of puberty (9,10). The higher prevalence of obesity among males than females in some Arab countries may be due to the differences in the timing of puberty, muscular tissue, and food consumption patterns between boys and girls (10,11).

Based on the findings of this study it can be concluded that no progress has been made in reducing the trends of obesity among schoolchildren in Arab countries. Practical and relevant programme to prevent and control obesity in schoolchildren is urgently needed in each Arab country.

REFERENCES

1. Ng CD. Global analyses of overweight prevalence by level of human development. J Global Health 2015;5:1-7.
2. The GBD 2013 Obesity Collaboration: Ng M, Fleming T, Robinson M, Thomson B, Graetz N, et al. Global, regional and national prevalence of overweight and obesity in children and adults 1980-2013: a systematic analysis. Lancet 2014;384:766-81.
3. Campbell KJ, Crawford DA, Salmon J, Carver A, Garnett SP, Baur LA. Associations between the home food environment and obesity-promoting eating behaviors in adolescence. Obesity 2007;15:719-30.
4. Musaiger AO, Al-Mannai M, Tayyem R, Al-lala O, Ali EY, Kalam F, et al. Prevalence of overweight and obesity in seven Arab countries: a cross-cultural study. J Obesity 2012;2012:1-5. DOI:10.1155/2012/981390.
5. Musaiger AO. Overweight and obesity in Eastern Mediterranean region: prevalence and possible causes. J Obesity 2011;2011:1-17.
6. Lee RD, Nieman DC. Nutritional Assessment. 5th edn. McGraw Hill: New York; 2010.
7. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320:1240-5.
8. De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bulletin World Health Organization 2007;85:660-7.
9. McMurry RG, Harrell JS, Deng S, Bradley CB, Cox LM, Bangdiwala SI. The influence of physical activity, socioeconomic status, and ethnicity on the weight status of adolescents. Obesity Research 2000;8:130-9.
10. Styne DM. Puberty, obesity and ethnicity. Trends Endocrin Metabol 2004;15:472-8.
11. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal, KM. Prevalence of high body mass index in US children and adolescents, 2007–2008. JAMA 2010;303:242-9.

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Nutrición Hospitalaria

Trabajo Original

Pediatría

Estado nutricional y etapas de cambio comportamental frente a la actividad física en niños y adolescentes de Bogotá, Colombia: estudio FUPRECOL

Nutritional state and stages of behaviour change regarding physical activity among children and adolescents from Bogotá, Colombia: the FUPRECOL Study

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Resumen

Objetivo: el propósito del estudio fue relacionar la etapa en el cambio en el comportamiento frente a la actividad física y el estado nutricional en escolares de Bogotá, Colombia, pertenecientes al estudio FUPRECOL.

Método: se trata de un estudio transversal, realizado en 8.000 niños y adolescentes de entre 9 y 17 años, pertenecientes a 24 instituciones educativas. Se aplicó de manera autodiligenciada el cuestionario de cambio de comportamiento en función de la intención de realizar actividad física (CCC-FUPRECOL) y se midió el peso y la estatura para determinar el estado nutricional con el índice de masa corporal (IMC).

Resultados: el porcentaje de respuesta fue del 82,5% y se consideraron válidos 6.606 registros, siendo el 58,3% (n = 3.850) niñas, con un promedio de edad de 12,7 ± 2,3 años. En la población general, el 5,3% de los escolares se encontraba en etapa de precontemplación, el 31,8% en contemplación, el 26,7% en acción y el 36,2% en etapa de mantenimiento. Al comparar la etapa de cambio con el estado nutricional por IMC, los escolares clasificados como obesos mostraron mayor frecuencia de respuesta en la etapa de precontemplación, mientras que los escolares con peso saludable acusaron mayores porcentajes en la etapa de mantenimiento.

Conclusión: en escolares de Bogotá, Colombia, se encontró una relación estadísticamente significativa entre la intención de realizar actividad con el estado nutricional medido con el IMC. Fomentar la promoción de la actividad física y monitorizar el estado nutricional deberá ser una prioridad en las agendas y políticas públicas dentro del ámbito escolar.

Palabras clave:

Conducta. Actividad motora. Estado nutricional. Niño y adolescente (DECS).

Abstract

Objective: This study was related to stages of change in behaviour regarding physical activity and nutritional state in amonq school children in Bogotá, Colombia, who were participating in the FUPRECOL study.

Methods: This was a cross-sectional study in which 8.000 9 to 17 year-old children and adolescents participated; they came from 24 educational institutions in Bogotá, Colombia. A self-completed questionnaire regarding behavioural change concerning an intension to engage in physical activity (CCC-FUPRECOL) was completed and weight and stature were measured for determining nutritional state according to body mass index (BMI).

Results: There was a 82,5% response and 6,606 replies were considered valid, 58.3% (n = 3,850) being from girls having an average age of 12.7 ± 2.3 years-old. The study population overall was placed in the following stages: 5.3% in the pre-contemplation stage, 31.8% in contemplation, 26.7% in action and 36.2% in the maintenance stage. When change stage was compared to nutritional state by BMI, those schoolchildren classified as being obese had a higher frequency of response regarding the pre-contemplation stage, whilst schoolchildren having a healthy weight had higher rates regarding the maintenance stage.

Conclusion: A statistically significant relationship was found for schoolchildren in Bogotá, Colombia, when comparing the intension to engage in physical activity and nutritional state by BMI. Encouraging the promotion of physical activity and monitoring nutritional state must become a priority on public agendas and policies regarding the scholastic setting.

Key words:

Conduct. Motor activity. Nutritional state. Children and adolescent (MesH).

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INTRODUCCIÓN

A escala mundial, la prevalencia de obesidad y el exceso de peso infantil superan el 30% (1) por lo que se considera un problema creciente en la salud pública global (2). Esta alteración nutricional ha sido descrita como un fuerte predictor de enfermedades no transmisibles, entre las que destaca la diabetes mellitus de tipo 2 (3), varios tipos de cáncer y patologías relacionadas con el sistema cardiometabólico (4,5). Frente a esta problemática, varios autores (6,7) han sugerido la implementación de intervenciones comunitarias, junto al estudio de las conductas y comportamientos relacionados con el estilo de vida desde edades tempranas. Por ello, se ha comenzado a considerar la prevención de la obesidad infantil una prioridad dentro de las políticas de salud pública en muchos países (8).

La actividad física (AF) y la dieta saludable han sido señaladas como los principales factores para prevenir las enfermedades cardiovasculares y la obesidad (9). Atendiendo a ello, se han propuesto diferentes programas, estrategias y acciones políticas, educativas y sociales con el fin de promover la salud y con el objetivo de proporcionar una orientación sobre parámetros de AF (10), consumo de frutas y verduras (11), espacios que incentiven conductas saludables (12) o que disminuyan comportamientos perjudiciales como el uso recreativo de drogas, tabaco y alcohol (13).

Así, se han descrito para este propósito varias teorías y principios del cambio conductual. Entre el más usado, el modelo transteórico (MTT), el cual aplica una serie de cinco etapas de cambio que atraviesa un individuo al modificar un comportamiento nocivo a uno saludable (14). Este modelo busca predecir la oportunidad de cambio en el comportamiento, a través de la identificación de diferentes etapas (15). En infantes y adolescentes, autores como Driskell y cols. (16) han resaltado la importancia de considerar las etapas de cambio del MTT para planificar estrategias y programas de intervención en el ámbito escolar. Asimismo, los trabajos de Madureina y cols. (17) han encontrado una fuerte asociación entre las etapas de cambio comportamental frente a la AF con el estado nutricional medido con el índice de masa corporal (IMC) en jóvenes universitarios. Estos autores han mostrado que los universitarios ubicados en la etapa el precontemplación presentaron OR 7,98 (IC 95%: 1,41 a 45,3) veces más probabilidades de tener sobrepeso que su contraparte clasificados en la etapa de mantenimiento. Así, la aplicación del MTT permitirá no solo la implementación de estrategias que consideren las etapas del cambio de conducta en las que se encuentran los distintos grupos, sino también las motivaciones y barreras que afectan su comportamiento, aspectos necesarios para mejorar la efectividad de las intervenciones en el contexto escolar (10-13).

A la fecha, varios autores (10-15) han señalado la escasez de estudios de distintos constructos del MTT en el cambio conductual en función a la AF. Sin embargo, existe evidencia coherente y explicativa del MTT en procesos de cambio en fumadores (13) y en conductas alimentarias específicas, como el consumo de frutas y verduras (11), y el consumo de grasas en algunos grupos etarios. A pesar de este interés, pocos estudios han indagado el cambio de comportamiento frente a la AF con el estado nutricional en la población escolar. El propósito del estudio fue relacionar la etapa en el cambio en el comportamiento frente a la actividad física y el estado nutricional en escolares de entre 9 y 17 años de Bogotá, Colombia, pertenecientes al estudio FUPRECOL.

MATERIALES Y MÉTODOS

El presente trabajo es un análisis secundario del proyecto FUPRECOL (Asociación de la Fuerza Prensil con Manifestaciones Tempranas de Riesgo Cardiovascular en Niños y Adolescentes Colombianos); cuya metodología ha sido publicada con anterioridad (18-20). Se trata de un estudio de corte transversal, realizado en niños y adolescentes en edad escolar de entre los 9 y 17 años, residentes en el área metropolitana del Distrito Capital de Bogotá, Colombia (2.480 msnm). Con base en la información obtenida de la Secretaria de Educación Distrital de Bogotá (SED), referente a la distribución de los escolares matriculados en los años 2012 y 2013, se decidió seleccionar escolares (n = 8.000) de 24 instituciones educativas oficiales. Se excluyeron escolares con discapacidad física, sensorial e intelectual; asimismo con enfermedades no transmisibles como diabetes mellitus de tipo 1 o 2, enfermedades cardiovasculares, autoinmunes, cáncer, estados de gestación y abuso evidente de alcohol y de sustancias psicoactivas. La exclusión efectiva se realizó a posteriori, sin conocimiento del participante, respetando así su dignidad y confidencialidad.

Antes del estudio, se explicó detalladamente su contenido y se solicitó conformidad previa por escrito por parte de cada niño y/o adolescente y de su padre/madre o tutor, además del permiso otorgado por autoridades de las escuelas participantes en el estudio. El estudio FUPRECOL se llevó a cabo siguiendo las normas deontológicas reconocidas por la Declaración de Helsinki y la Resolución 008439 de 1993 del Ministerio de Salud de Colombia que regula la investigación clínica en humanos. Además, el estudio contó con la aprobación del Comité de Investigación en Seres Humanos de la universidad encargada del estudio (UR n.º CEI-ABN026-000262). Previo a las mediciones y entrevistas, los investigadores y profesionales de la salud y del deporte realizaron diez sesiones teórico-prácticas para estandarizar el proceso de evaluación del componente morfológico descrito previamente en la batería FUPRECOL-Health and Fitness (20). Para evaluar el estado nutricional, se midió el peso con balanza de piso TANITA® modelo BF689 (Arlington Heights, IL 60005, USA), con resolución 0,100 kg. La estatura se determinó con estadiómetro portátil SECA 206® (Hamburgo, Alemania), rango 0-220 cm de 1 mm de precisión. Con el objetivo de relacionar el peso con la estatura, se utilizó el índice de masa corporal (IMC). Se utilizó la fórmula propuesta por Quetelet [IMC = peso (kg)/estatura $(m)^2$]. Posteriormente, los participantes fueron clasificados en bajo peso (Z puntuación = -2) normopeso (Z puntuación > -2 la 1), sobrepeso (Z puntuación > 1 la < 2) y obeso (Z puntuación = 2), según los criterios de crecimiento y desarrollo propuestos por Cole y cols. (21).

Para evaluar el cambio de comportamiento frente a la AF, los autores de la investigación elaboraron el cuestionario de cambio de comportamiento FUPRECOL (CCC-FUPRECOL), fundamentando en el MTT. El CCC-FUPRECOL, incluyó 5 módulos a seguir: 1) AF/ejercicio; 2) hábitos alimenticios: consumo de frutas y verduras; 3) consumo de drogas (por ejemplo bazuco, marihuana, cocaína); 4) consumo de tabaco, y 5) consumo de alcohol. Este instrumento previamente validado en escolares de Bogotá mostró a nivel global un α-cronbach de 0,72 (rango 0,69 y 0,75) para los 5 módulos del CCC-FUPRECOL (datos sin publicar). En este trabajo, se presentan los resultados preliminares de la subescala "AF/ejercicio", a partir de los criterios de Marcus y cols. (22), y Prochaska (14), previamente usado en la Encuesta Nacional de la Situación Nutricional de Salud (ENSIN-2005) (23), en cuatro etapas de cambio a seguir: (precontemplación; contemplación; preparación/acción y mantenimiento). Los cuestionarios se aplicaron a los escolares en grupos de 20 a 50 participantes, en salones para mantener la privacidad y libertad en la cumplimentación y con la presencia de, al menos, dos investigadores cualificados. Previo al diligenciamiento de los cuestionarios y mediciones nutricionales, se dieron las pautas necesarias para su correcta cumplimentación, insistiendo en la necesidad de atención en la lectura de los ítems y en la sinceridad y anonimato a la hora de responder las encuestas.

El procesamiento y análisis de la información se realizó en el programa Statistical Package for Social Science® *software,* versión 22 (SPSS; Chicago, IL, USA). Las variables continuas se expresaron como promedios ± desviación estándar y las variables categóricas se describieron en frecuencias relativas expresadas en porcentajes. Para evaluar la asociación entre el estado nutricional y la intensión de cambio de comportamiento frente a la AF en función al sexo y grupos de edad, se utilizó la prueba de Chi-cuadrado (χ^2) de Pearson con corrección de *yates*.

RESULTADOS

En el estudio participaron 6.606 escolares (tasa de respuesta 82,5%), de los cuales 58,3% eran niñas con un promedio de edad de 12,7 ± 2,3 años, peso 44,6 ± 12,3 kg, estatura 1,49 ± 0,12 m e IMC de 19,5 ± 3,2 kg/m². Con respecto al comportamiento frente a la AF, se evidencio que el 5,3% se encontraba en etapa de precontemplación; el 31,8% en contemplación, el 26,7% en preparación/acción y el 36,2% en etapa de mantenimiento. Al comparar por sexo, se identificó que los varones presentaban mayor porcentaje de respuesta en la etapa de mantenimiento; mientras que las mujeres se ubicaron en la etapa de contemplación. Adicionalmente, se encontraron diferencias estadísticamente significativas entre sexo en las etapas de contemplación y mantenimiento (Fig. 1).

Al comparar por subgrupos de edad (niños de entre 9 y 12 años *vs.* adolescentes de entre 13 y 17 años) y sexo, se observa que la mayor parte de los varones se clasificaron en la etapa de mantenimiento (46,9% *vs.* 40,5%), con diferencias significativas en las etapas de preparación/acción y mantenimiento (Fig. 2 A). En el grupo de mujeres de entre 9 y 12 años, la mayor parte de las encuestadas manifestaron estar en la etapa de mantenimiento (39,4%), a diferencia de las adolescentes (entre 13 y 17 años) que respondieron con mayor frecuencia encontrarse en la etapa de contemplación (44,0%). Además, se observan diferencias significativas entre las etapas de contemplación y mantenimiento (Fig. 2 B).

En la figura 3 se describen las etapas de cambio de comportamiento en relación con el estado nutricional estimado con el IMC. El análisis bivariado muestra que los escolares ubicados en la etapa de precontemplación tienen significativamente mayor proporción de obesidad, mientras que la mayor frecuencia de escolares clasificados en la etapa de mantenimiento, se ubicaron en la categoría de normopeso (38,8%), seguido de bajo peso (38,3%) y riesgo de bajo peso (36,0%).

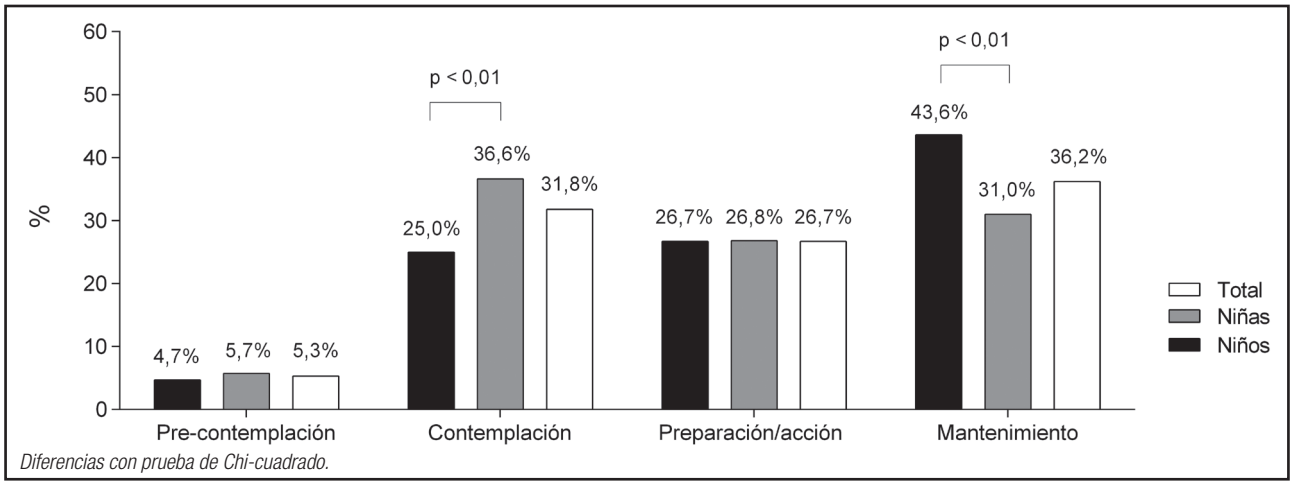
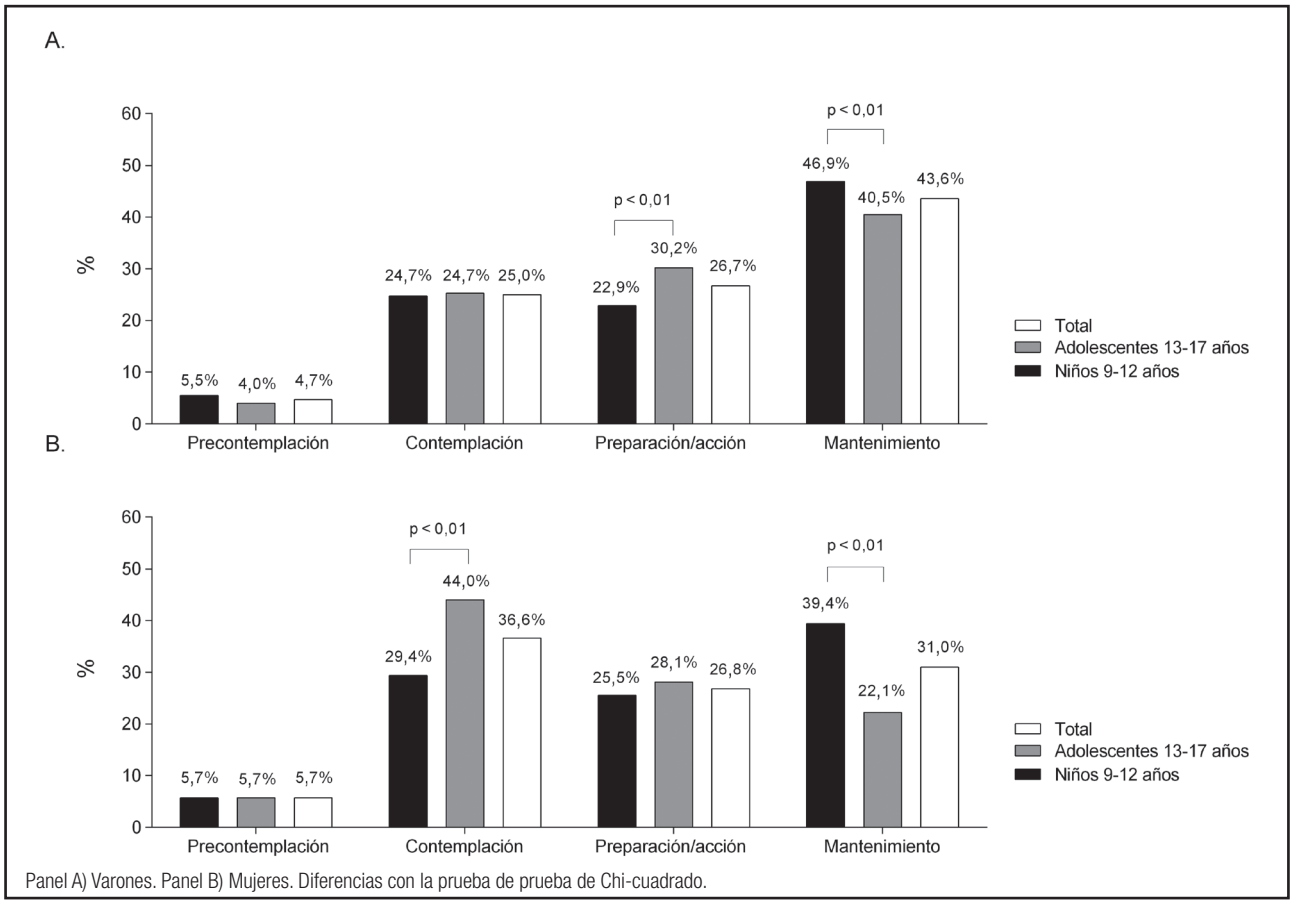


Figura 1.

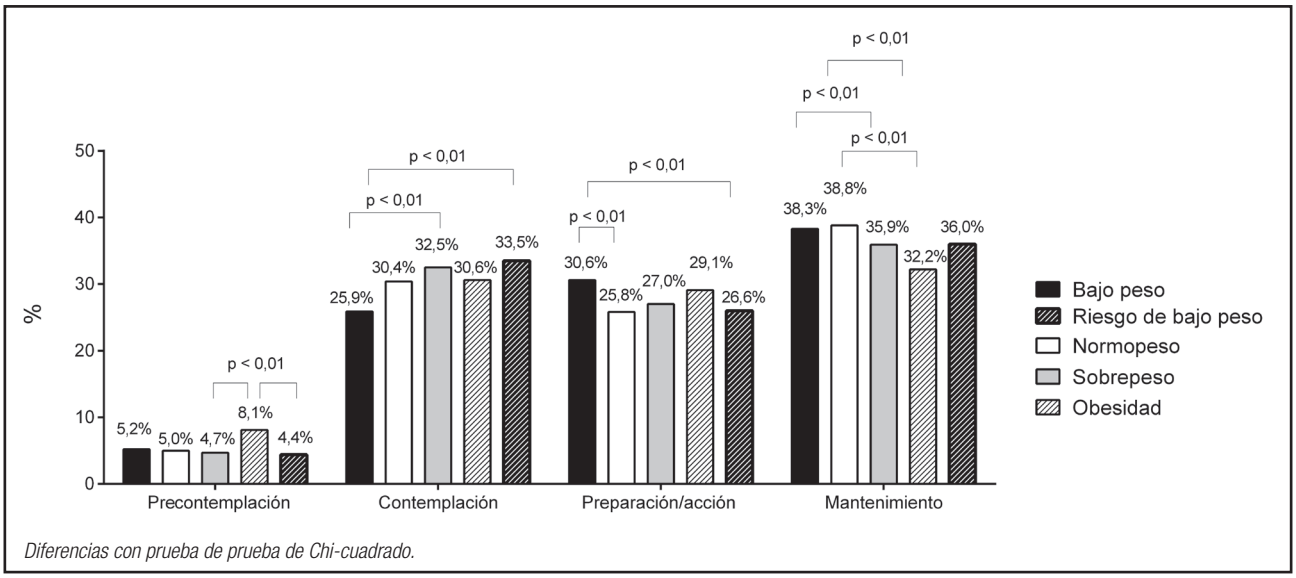
Distribución de las etapas de cambio de comportamiento en relación con la actividad física en niños y adolescentes de Bogotá, Colombia.



Panel A) Varones. Panel B) Mujeres. Diferencias con la prueba de prueba de Chi-cuadrado.

Figura 2.

Distribución de las etapas de cambio de comportamiento entre niños (9 y 12 años) y adolescentes (13 y 17 años) y en función del sexo. Estudio FUPRECOL.



Diferencias con prueba de prueba de Chi-cuadrado.

Figura 3.

Etapas de cambio de comportamiento frente a la actividad física en función del índice de masa corporal en la población general. Estudio FUPRECOL.

DISCUSIÓN

Este estudio identificó la relación entre las etapas de cambio de comportamiento frente a la AF y el estado nutricional en escolares pertenecientes a escuelas oficiales de Bogotá, Colombia (estudio FUPRECOL). Se ha observado que un 36,2% de los escolares encuestados se ubicaron en mayor frecuencia en la etapa de mantenimiento, hallazgo similar al reportado en España, por Serra Puyal y cols. (24), donde el 44,6% de los niños y adolescentes se clasificaron en esta misma etapa. En esta línea, el trabajo realizado por Herazo-Betrán y cols. (25) en universitarios colombianos describió que los participantes clasificados en la etapas de precontemplación y preparación tenían un menor gasto energético semanal relacionado con la AF estimada con la versión corta IPAQ. Al comparar estos resultados en población adulta, Cabrera y cols. (26) describieron que el 34% de los adultos se encontraron en etapa de mantenimiento, valor cercano al descrito en este informe (36,2%). Al interpretar el MTT con las directrices de autores como Marcus y cols. (22) y Nigg (15) se puede intuir, de manera hipotética, que una tercera parte de los niños y adolescentes acumulan al menos 60 minutos de AF de intensidad de moderada a vigorosa cada día y lo seguirán realizando por los próximos seis meses (27). Este resultado es cercano al reportado recientemente por Prieto-Benavides y cols. (19) quienes encontraron que el 36,9% de los escolares de tres colegios de Bogotá, Colombia, cumplían con las recomendaciones de AF en la última semana. También es similar al descrito por Oviedo y cols. (28) (31,7%) en escolares de 14,3 ± 0,8 años de la provincia de Girona, España, y menor al reportado por Martínez y cols. (29) (71,1%) en 214 adolescentes de entre 13 y 16 años de la cuidad de Madrid, España. En jóvenes de 13 a 15 años, los resultados de la Encuesta Mundial de Salud Escolar y la Encuesta de Comportamientos en Salud en la Población Escolar (en inglés: *Health Behavior in School Aged Children Survey-HBSC*) (30) muestran una prevalencia de AF de 5 ciudades de Colombia del 15% (rango 12,1% a 17,1%). Nuestros resultados son superiores a los descritos en el *Report Card* de AF (31), en donde un 26% de la población alcanzó el mínimo de AF recomendada en el grupo de edad de entre 13 y 17 años.

Al diferenciar las etapas de cambio en función del sexo, se observa que la mayoría de las mujeres se ubica en la etapa de contemplación, sugiriendo así que las participantes conocen en parte los beneficios de la AF, pero no la practican de manera regular. Estos resultados concuerdan con lo descrito recientemente en el estudio ISCOLE (en inglés: *International Study of Childhood Obesity, Lifestyle and the Environment)* (32), frente al cumplimiento de las recomendaciones de AF en una muestra representativa de 6.536 niños de entre 9 y 11 años provenientes de 12 países, incluyendo 857 escolares de Bogotá, Colombia. En este estudio las niñas escolarizadas alcanzaron 18 minutos y 68 minutos de AF vigorosa y moderada, respectivamente.

Al comparar los resultados de los escolares de Colombia con datos internacionales de países como Estados Unidos, Nueva Zelanda, España, México e Irán, encontramos en la dimensión "precontemplación" puntuaciones similares a las reportadas en escolares de Irán y, en menor medida, en Nueva Zelanda y México; mientras que en la dimensión "contemplación", los escolares de Colombia mostraron valores superiores a los acusados por los niños y adolescentes de Estados Unidos, Nueva Zelanda, España, México e Irán. En las etapas de "preparación/acción y "mantenimiento", se observaron menores valores que los escolares de Estados Unidos y España (Tabla I).

Tabla I. Comparación de las etapas de cambio comportamental frente a la actividad física entre niños y adolescentes de Bogotá, Colombia, y estudios internacionales

Referencia	País	Población	Muestra		Rango de edad	Administración	Etapa de cambio (%)			
			Varones	Mujeres			P	C	P-A	M
Nigg, 1998 (33)	Estados Unidos	Escuelas de secundaria	418	440	13-19	Autoadministrado	2,1	4,2	44,4	49,3
Prapavessis, 2004 (34)	Nueva Zelanda	Escuelas de secundaria	2.121	1.851	14-19	Autoadministrado	6,2	8,7	60,0	25,0
Serra-Puyal, 2011(24)	España	Educación secundaria obligatoria pública y privada	380	451	12-15	Autoadministrado	2,3	6,9	46,2	44,6
Escalante, 2012 (35)	México	Escuelas primarias privadas	28	20	10	Autoadministrado	12,0	15,0	71,0	2,0
Sanaeinasab, 2013 (36)	Irán	Escuelas secundarias públicas	610	941	12- 14	Autoadministrado	5,5	26,0	64,6	3,8
FUPRECOL, 2015	Colombia	Escuelas oficiales	3.850	2.756	9-17	Autoadministrado	5,3	31,8	26,7	37,2

P: precontemplación; C: contemplación; P-A: preparación/acción; M: mantenimiento.

Las diferencias observadas en las etapas de cambio comportamental frente a la AF entre niños y adolescentes de este estudio podrían deberse, en parte, a que en países de altos ingresos la práctica de la AF en niños y jóvenes es significativamente mayor entre la infancia y la adolescencia (37). De hecho, factores como el nivel socioeconómico, el ambiente físico, la educación de la madre, entre otros, han sido reconocidos como determinantes para tener un estilo de vida saludable (38) y en trabajos como los presentados por Sallis (39) se ha mostrado que intervenciones desde la escuela que incluyan activamente a la familia y a la comunidad en estos procesos garantizarían el refuerzo del comportamiento y generaría verdaderos cambios en la salud.

Frente a la relación entre el comportamiento de la AF y el estado nutricional fueron encontradas diferencias significativas, lo que refuerza la premisa de que la AF junto al peso saludable son dimensiones de la salud que inciden en la prevención de las enfermedades no transmisibles. Así, los escolares ubicados en la etapa de precontemplación presentaron significativamente proporciones importantes de obesidad y sobrepeso, mientras que una frecuencia de escolares clasificados en la etapa de mantenimiento se ubicaron en la categoría de normopeso (38,8%), seguido de bajo peso (38,3%) y riesgo de bajo peso (36,0%). Este hallazgo en congruente con la prevalencia del 30% de exceso de peso y obesidad de este trabajo. Sobre este aspecto, en varios informes (40,41) se ha descrito que la tendencia de exceso de peso infantil es similar en otros países, y posiblemente se atribuya a la disminución en los niveles saludables de AF, a los cambios en la alimentación y a la suma de otros factores ambientales y sociales que determinan que un escolar sea físicamente activo. Autores como Craggs y cols. (38) consideran cuatro niveles determinantes –fisiológico, psicológico, sociocultural y ecológico– que influyen en la AF. Por ejemplo, los determinantes fisiológicos de la AF entre los niños y jóvenes incluyen edad, sexo y grupo étnico. Específicamente se ha encontrado que las niñas son menos activas que los niños, los niños mayores y los adolescentes menos activos que los niños más pequeños y las niñas afrodescendientes menos activas que las niñas blancas. La posible disparidad de sexo y nivel sociocultural puede ayudar a explicar, en parte, la alta prevalencia de no cumplimiento de las recomendaciones de AF observada en las niñas del presente estudio, y cuyo resultado puede ser una menor salud cardiovascular futura (42). No obstante, se necesitan trabajos que incluyan las barreras percibidas de la AF, los determinantes ecológicos de la AF como el acceso a los espacios de juego, los establecimientos, la disponibilidad de equipos, la ingesta dietética, el tabaquismo y el estrato socioeconómico, para comprender la multitud de factores que pueden influir en los modelos de AF de los escolares evaluados. Asimismo, se ha descrito que menores niveles de condición física e incrementos de comportamientos sedentarios son parte de los factores determinantes del bienestar físico escolar (43). En el contexto de la pandemia de inactividad física y el exceso de peso, son factores que constituyen una prioridad en salud pública que debe ser abordada mediante la promoción de hábitos saludables, para lo cual se debe incluir en sus pilares el fomento de la AF y la reducción de los comportamientos sedentarios (43). Por ello, en 2011, en la reunión de alto nivel de enfermedades no transmisibles de las Naciones Unidas, se identificó la necesidad de incrementar la AF como una de las áreas de intervención prioritaria para reducir las enfermedades no transmisibles (44).

Como fortaleza de este trabajo cabe mencionar la utilización del instrumento (CCC-FUPRECOL) en su módulo AF/ejercicio, el cual fue validado para la población de escolares de Bogotá, Colombia (datos sin publicar). El poder contar una muestra poblacional numerosa de ambos sexos ofrece nuevas perspectivas acerca del cambio en el comportamiento hacia la AF y el estado nutricional de los escolares evaluados. Además de establecer una relación del comportamiento humano con una manifestación biológica como es el estado nutricional, se resalta la importancia de este trabajo en la planificación y evaluación de estrategias efectivas en la prevención y control de la obesidad infantil, a partir de una base sociocognitiva como la descrita en este trabajo.

Las limitaciones del presente estudio son las inherentes a su carácter transversal, adicional a la existencia del sesgo de selección, limitando la participación de escolares de otras áreas geográficas de Bogotá, Colombia. Otra limitación es la relacionada con la utilización de un instrumento por autorreporte, que puede verse afectado por los prejuicios sociales o culturales. Sin embargo, este trabajo aplicó el instrumento CCC-FUPRECOL, el cual ha mostrado ser válido y fiable en la evaluación del comportamiento frente a los seis dominios determinantes del estilo de vida relacionado con la salud –incluyendo la AF–. No obstante, este trabajo aplicó la herramienta basada en la teoría del cambio conductual y los trabajos de Cardoso-Ricardo y cols. (45) y Prochaska (14) han indicado que el MTT predice efectivamente conductas y comportamientos en salud en sujetos jóvenes. Otros marcadores de obesidad como la circunferencia abdominal, de cintura, o los niveles de adiposidad debieron ser evaluados como en estudios previos (7,18,19,42,43). Tampoco fue incluido el nivel socioeconómico, las prácticas alimentarias, el consumo de grasas y/o de comida rápida, todos ellos, descritos como factores asociados a la seguridad alimentaria y a la presencia de exceso de peso en niños y adolescentes de ambos sexos (46). Tampoco estudiamos el nivel socioeconómico o el estado de maduración sexual, ambos descritos en la percepción sobre la AF en escolares (34,39). No obstante, las limitaciones descritas en este trabajo no comprometen los resultados obtenidos en la población estudiada.

CONCLUSIÓN

Como conclusión podemos afirmar que se encontró una relación estadísticamente significativa entre la intención de realizar AF con el estado nutricional estimado con el IMC. Fomentar la promoción de la AF y monitorear el estado nutricional deberán ser prioridades en las agendas y políticas

públicas dentro del ámbito escolar. Los autores sugieren que los programas nacionales y las futuras intervenciones tengan en cuenta las etapas de comportamiento frente a la AF con el fin de incrementar su adherencia e impacto dentro de los ambientes escolares. Se requieren estudios longitudinales y prospectivos para constatar los resultados obtenidos en este trabajo.

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BIBLIOGRAFÍA

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. JAMA 2014;311(8):806-14.
2. Campbell MK. Biological, environmental, and social influences on childhood obesity. Pediatr Res 2016;79(1-2):205-11.
3. Morrison JA, Aronson Friedman L, Wang P, Glueck CJ. Metabolic syndrome in childhood predicts adult metabolic syndrome and type 2 diabetes mellitus 25 to 30 years later. J Pediatr 2008;52(2):201-6.
4. McCrindle BW. Cardiovascular consequences of childhood obesity. Can J Cardiol 2015;31(2):124-30.
5. Aguilar de Plata AC, Pradilla A, Mosquera M, Gracia de Ramírez AB, Ortega JG, Ramírez-Vélez R. Centile values for anthropometric variables in Colombian adolescents. Endocrinol Nutr 2011;58(1):16-23.
6. Valerio G, Licenziati MR, Manco M, Ambruzzi AM, Bacchini D, Baraldi E; Studio Obesità Infantile della Società Italiana di Endocrinologia e Diabetologia Pediatrica. Health consequences of obesity in children and adolescents. Minerva Pediatr 2014;66(5):381-414.
7. Ramírez-Vélez R, Suarez-Ortegón MF, Aguilar de Plata AC. Association between adiposity and cardiovascular risk factors in prepubertal children. Endocrinol Nutr 2011;58(9):457-63.
8. Sylvetsky-Meni AC, Gillepsie SE, Hardy T, Welsh JA. The impact of parents' categorization of their own weight and their child's weight on healthy lifestylepromoting beliefs and practices. J Obes 2015;2015:3073-81.
9. Cuenca-García M, Ortega FB, Ruiz JR, González-Gross M, Labayen I, Jago R, et al. Combined influence of healthy diet and active lifestyle on cardiovascular disease risk factors in adolescents. Scand J Med Sci Sports 2014;24(3): 553-62.
10. Rhodes R, Nasuti G. Review: Trends and changes in research on the psychology of physical activity across 20 years: A quantitative analysis of 10 journals. Prev Med 2011;23:5317-23.
11. Meléndez L, Olivares S, Lera L, Mediano F. Etapas del cambio, motivaciones y barreras relacionadas con el consumo de frutas y verduras y la actividad física en madres de preescolares atendidas en centros de atención primaria de salud. Rev Chil Nutr 2011;38:466-75.
12. Salazar-Torres IC, Valera-Arévalo MT, Lema-soto LF, Tamayo-Cardona JA, Duarte-Alarcon C. Evaluación de las conductas de salud en jóvenes universitarios. Rev Salud Pública 2010;12(4):599-611.
13. Flórez-Alarcón L. Classification in stages of university students of Bogota using alcohol according the transtheoretical model. Adicciones 2001;13(2):199-209.
14. Prochaska JO, Velicer WF. The Transtheoretical Model of behaviour change. Am J Health Promot 1997;12(1):38-48.
15. Nigg C. There is more to stages of exercise than just exercise. Exerc Sport Sci Rev 2005;33(1):32-5.
16. Driskell M, Dyment S, Mauriello L, Castle P, Sherman K. Relationships among multiple behaviors for childhood and adolescent obesity prevention. Prev Med 2008;46(3):209-15.
17. Madureira AS, Corseuil HX, Pelegrini A, Petroski EL. Associação entre estágios de mudança de comportamento relacionados à atividade física e estado nutricional em universitários Cad Saude Publica 2009;25(10):2139-46.
18. Rodríguez-Bautista YP, Correa-Bautista JE, González-Jimenez E, Schmidt Río Valle J, Ramírez Vélez R. Valores del índice cintura/cadera en la población escolar de Bogotá, Colombia: Estudio FUPRECOL. Nutr Hosp 2015;32(5):2054-61.
19. Prieto-Benavides DH, Correa-Bautista JE, Ramírez-Vélez R. Niveles de actividad física, condición física y tiempo en pantallas en escolares de Bogotá, Colombia: Estudio FUPRECOL. Nutr Hosp 2015;32(5):2184-92.
20. Ramírez-Vélez R, Rodrígues-Bezerra D, Correa-Bautista JE, Izquierdo M, Lobelo F. Reliability of Health-Related Physical Fitness Tests among Colombian Children and Adolescents: The FUPRECOL Study. PLoS One 2015;10(10):e0140875.
21. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320:1240-3.
22. Marcus B, Selby V, Niaura R, Rossi J. Self-efficacy and the stages of exercise behavior change. Res Q Exerc Sport 1992;63:60-6.
23. Instituto Colombiano de Bienestar Familiar. Encuesta de Situación; 2005. Disponible en: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/ED/GCFI/Ensin%202005.pdf (Consultado 15-02-2016).
24. Serra-Puyal JR, Generelo-Lanaspa E, Zaragoza-Casterad J. Estados de cambio y su relación con los niveles de actividad física en población adolescente. Rev Int Med Cienc Act Fís Deporte 2011;11(42):298-309.
25. Herazo-Beltrán Y, Hernández-Escolar J, Domínguez Anaya R. Etapas de cambio y niveles de actividad física en estudiantes universitarios de Cartagena (Colombia). Salud Uninorte. Barranquilla (Col.) 2012;28(2):298-318.
26. Cabrera G, Gómez L, Mateus J. Actividad física y etapas de cambio comportamental en Bogotá. Colombia Médica 2004;35:2:82-6.
27. OMS. Global Recommendations on Physical Activity for Health; 2010.
28. Oviedo G, Sánchez J, Castro R, Calvo M, Sevilla JC, Iglesias A, et al. Niveles de actividad física en población adolescente: estudio de caso. Retos: nuevas tendencias en educación física, deporte y recreación 2013;23:43-7.
29. Martínez-Gómez D, Welk GJ, Calle ME, Marcos A, Veiga OL; AFINOS Study Group. Preliminary evidence of physical activity levels measured by accelerometer in Spanish adolescents: the AFINOS Study. Nutr Hosp 2009;24(2):226-32.
30. Piñeros M, Pardo C. Actividad física en adolescentes de cinco ciudades colombianas: resultados de la Encuesta mundial de Salud a escolares. Rev Sal Pub 2010;12(6):903-14.
31. González S, Sarmiento O, Cohen D, Camargo D, Correa-Bautista J, Páez C, et al. Results From Colombia's 2014 Report Card on Physical Activity for Children and Youth. J Phys Act Health 2014;11(Supp 1):S33-S44.
32. Katzmarzyk P, Barreira T, Broyles S, Champagne C, Chaput J, Fogelholm M, et al. Physical Activity, Sedentary Time, and Obesity in an International Sample of Children. Med Sci Sports Exerc 2015;47(10):2062-9.
33. Nigg CR, Courneya KS. Transtheoretical model: Examining adolescent exercise behavior. J Adolesc Health 1998;22(3):214-24.
34. Prapavessis H, Maddison R, Brading F. Understanding exercise behavior among New Zealand adolescents: A test of the Transtheoretical Model. J Adolesc Health 2004;35(4):346.e17-27.
35. Escalante-Guerrero CS, De la Roca-Chiapas JM, Macías-Cervantes MH. Knowledge, attitudes, and behavior concerning nutrition and physical activity in Mexican children. Am J Health Behav 2012;36(3):424-31.
36. Sanaeinasab H, Saffari M, Nazeri M, Karimi Zarchi A, Cardinal B. Descriptive analysis of Iranian adolescents' stages of change for physical activity behavior. Nurs Health Sci 2013;15(3):280-5.
37. Corder K, Van Sluijs EM, Goodyer I, Ridgway CL, Steele RM, Bamber D, et al. Physical Activity Awareness of British Adolescents. Arch Pediatr Adolesc Med 2011;165(7):603-9.

38. Craggs C, Corder K, Van Sluijs EM, Griffin SJ. Determinants of change in physical activity in children and adolescents: a systematic review. Am J Prev Med 2011;40(6):645-58.
39. Sallis JF. Age-related decline in physical activity: a synthesis of human and animal studies. Med Sci Sports Exerc 2000;32(9)1598-600.
40. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organization Technical Report Series World Health Organ Tech Rep Ser 2000;894:1-253.
41. Avenell A, Broom J, Brown TJ, Poobalan A, Aucott L, Stearns SC, et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement. Health Technol Assess 2004;8(21):1-182.
42. Rodríguez-Valero FJ, Gualteros JA, Torres JA, Umbarila-Espinosa LM, Ramírez-Vélez R. Asociación entre el desempeño muscular y el bienestar físico en niños y adolescentes de Bogotá, Colombia. Nutr Hosp 2015;32(4):1559-66.
43. Gualteros JA, Torres JA, Umbarila-Espinosa LM, Rodríguez-Valero FJ, Ramírez-Vélez R. A lower cardiorespiratory fitness is associated to an unhealthy status among children and adolescents from Bogotá, Colombia. Endocrinol Nutr 2015;62(9):437-46.
44. UN General Assembly 66th Session. Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. A/66/L.1. Sept 16, 2011.United Nations, New York; 2011.
45. Cardoso-Ricardo LI, Rombaldi AJ, Kopp D, Wiltgen-Ferreira R, Hallal PC, Azevedo MR. Estágios de mudança de comportamento para atividade física após uma intervenção escolar: um estudo transversal. Rev Bras Ativ Fis Saúde 2015;20(6):569-70.
46. Ramírez-Vélez R, González-Ruiz K, Correa-Bautista JE, Meneses-Echávez JF, Martínez-Torres J. Demographic and socioeconomic differences in consumption of sugar-sweetened beverages among Colombian children and adolescents. Nutr Hosp 2015;31(6):2479-86.

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Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Influencia del suplemento con inulina enriquecida con fructooligosacáridos sobre el contenido y la densidad mineral ósea tras el parto y la lactación en ratas

Influence of supplementation with oligofructose-enriched inulin on bone mineral content and density after delivery and lactation in rats

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Resumen

Introducción: la gestación y lactancia están relacionadas con pérdidas temporales en la densidad mineral ósea (DMO) materna. Una suplementación con calcio podría resultar beneficiosa para evitar la pérdida de masa ósea del esqueleto materno. Otros nutrientes como los prebióticos han sido identificados como responsables de un incremento en la absorción de minerales, pudiendo condicionar la mineralización ósea.

Objetivo: estudiar el efecto de la suplementación de la dieta materna con el prebiótico inulina enriquecida con oligofructosa, durante la gestación y la lactancia sobre el contenido mineral óseo (CMO) y la DMO al final del periodo de lactancia.

Métodos: las ratas gestantes fueron alimentadas con dieta estándar (grupo CC), dieta fortificada en calcio (grupo Ca) o enriquecida con el prebiótico inulina enriquecida con oligofructosa (grupo Pre) hasta el final del periodo de lactancia. Posteriormente se evaluó el CMO y DMO por absorciometría de rayos X (DEXA) y el pH del contenido cecal.

Resultados: en términos generales, el grupo Pre presenta los mayores valores absolutos de CMO y DMO de entre los tres grupos, siendo en la tibia significativamente diferentes en los grupos CC y Pre frente al grupo Ca. El pH del contenido cecal del grupo Pre es significativamente inferior al de los grupos CC y Ca.

Conclusión: la suplementación con inulina enriquecida con oligofructosa, en condiciones nutricionales no deficientes en calcio, durante la gestación y la lactancia, ejerce una protección del esqueleto materno en las ratas y puede ser considerada como una estrategia nutricional para proteger la masa ósea materna en el periodo perinatal.

Palabras clave:

Gestación. Lactación. Prebióticos. Calcio. Densidad ósea.

Abstract

Introduction: Pregnancy and lactation are related with temporary decreases in maternal bone mineral density (BMD). Calcium supplementation could be beneficial to prevent bone loss of maternal skeleton. Other nutrients, such as prebiotics have showed to produce an increase of the mineral absorption and therefore affecting bone mineralization.

Objective: To study the effect of maternal diet supplementation with prebiotic oligofructose-enriched inulin during gestation and lactation on the maternal bone mineral content (BMC) and BMD at the end of lactation.

Methods: Pregnant rats were fed with standard diet (CC group), calcium fortified diet (Ca group) or with prebiotic oligofructose-enriched inulin supplemented diet until the end of the lactation period. At weaning, bone mineral content (BMC) and BMD were determined by dual-energy X-ray absorptiometry and the pH of the cecal content was also determined.

Results: In absolute terms, the highest BMD and BMC were found in the Pre group as compared with the other two groups being significant in the tibia when compared Pre group and CC group with Ca group. The pH of the cecal content in the Pre group was also significantly lower as compared with the other two groups.

Conclusion: Prebiotic oligofructose-enriched inulin supplementation, in calcium no-deficient conditions, during gestation and lactation exerts a protection on maternal skeleton during pregnancy and lactation in the rats and could be considered as a plausible nutritional option for protecting maternal bone mass during these periods.

Key words:

Gestation. Lactation. Prebiotic. Calcium. Bone density.

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INTRODUCCIÓN

El efecto de la nutrición sobre la salud ósea ha sido demostrado ampliamente (1). Las células óseas responsables del mantenimiento, reparación y del depósito del tejido óseo son dependientes de la nutrición como las de cualquier otro tejido. Además, el esqueleto sirve como reserva de nutrientes, en especial de minerales como el calcio y el fósforo, dependiendo en parte del equilibrio diario entre su ingesta y su excreción (2). La dependencia del hueso con la nutrición se hace más patente en situaciones donde se requiere un mayor aporte de nutrientes como son el periodo de crecimiento o en la gestación y la lactancia. En estos periodos el esqueleto materno desempeña un papel fundamental en el desarrollo del hueso de la descendencia. Durante el desarrollo fetal, el esqueleto materno provee del calcio requerido por el feto, principalmente durante el tercer trimestre, reduciéndose los depósitos maternos de calcio conforme avanza la edad gestacional, ya que el feto acumula de 25 a 30 g de calcio durante este periodo. Más tarde, en el parto y durante la lactancia, provee del calcio necesario para la producción de la leche, ya que se transfieren unos 250 mg de calcio por día para su producción (3-5) cubriendo así los requerimientos del neonato. Por este motivo durante la gestación y la lactancia se producen cambios muy significativos en el metabolismo mineral materno, principalmente del calcio, para poder satisfacer la alta demanda de este mineral que se genera durante estos periodos. Así, durante la gestación la absorción intestinal de calcio se duplica y durante la lactancia la excreción renal se reduce, permitiendo la adaptación del metabolismo materno a las necesidades de este mineral (6).

También se ve significativamente aumentado el remodelado óseo durante el embarazo, principalmente durante el tercer trimestre y coincidiendo con el incremento en la tasa de transferencia de calcio al feto (6). Así, tanto los marcadores de formación, como la fosfatasa alcalina específica de hueso, como los marcadores de resorción, como la fosfatasa ácida tartrato resistente y la deoxipiridinolina, se ven aumentados, lo que indica un incremento en el metabolismo óseo (7). Estudios en animales, en condiciones no deficientes, relacionan este incremento con una mayor densidad de masa ósea (DMO), que indica una mayor deposición de calcio en los huesos durante la gestación (8). Este incremento en la DMO de la madre podría servir para proteger al esqueleto materno de una excesiva desmineralización y fragilidad que se produce posteriormente, durante la lactancia. Sin embargo, los estudios en humanos muestran resultados contradictorios, seguramente debido a que, al evaluar la DMO antes y después del parto, los resultados pueden depender del tiempo transcurrido entre mediciones. En general los estudios así realizados indican una pérdida en las zonas trabeculares y una ganancia en las corticales, sobre todo en mujeres con ingestas no deficientes (9). Durante la lactación también se produce una adaptación del metabolismo del calcio que se traduce en un incremento del metabolismo óseo y mineral en la madre que le permite adaptarse a las necesidades de dicho mineral para la producción de la leche materna (6). En este periodo, los marcadores de resorción llegan a superar en 2-3 veces los niveles alcanzados durante el tercer trimestre de embarazo, produciendo pérdidas superiores al 35% del hueso materno.

Durante la gestación y lactación, una ingesta deficiente de calcio está asociada con un incremento en la tasa de remodelado óseo materno, lo cual produciría un efecto negativo sobre el esqueleto materno. Es en estas condiciones cuando el uso de un suplemento de calcio sería beneficioso para evitar la pérdida de masa ósea del esqueleto materno, disminuyendo los marcadores de remodelado (10) y protegiendo el hueso de la descalcificación (11).

Otra estrategia nutricional para favorecer la absorción de calcio de la dieta puede ser a través de la administración de prebióticos. Existen diferentes estudios que indican un posible efecto beneficioso de los prebióticos sobre la disponibilidad de los minerales y de algunos oligoelementos incluidos en los alimentos, influyendo tanto en su absorción, su retención como en su uso por el organismo (12,13). De entre los prebióticos, los más estudiados son los derivados de la achicoria: la inulina y los fructooligosacáridos (FOS) (14), cuyo consumo está relacionado con un incremento en la absorción del calcio y magnesio a través del aumento de la solubilización de sus sales y de su absorción (15).

OBJETIVO

Teniendo en cuenta estos antecedentes, el objetivo del presente estudio es estudiar el efecto de la suplementación de la dieta materna con inulina enriquecida con oligofructosa durante la gestación y la lactancia sobre el contenido mineral óseo (CMO) y la DMO en las ratas tras la gestación y lactancia. Además, en el estudio, como un objetivo secundario, se ha incluido un grupo de animales alimentados con una dieta fortificada en calcio, por ser la recomendación actual para madres gestantes o lactantes.

MATERIAL Y MÉTODOS

ANIMALES

El presente estudio se ha realizado con 30 ratas hembras gestantes de la raza Sprague-Dawley de 15 semanas de edad, que se encontraban en el día 11 de gestación. Las ratas fueron suministradas por los Laboratorios Charles Rives (Orleans Cedex, Francia).

Todos los procesos experimentales fueron aprobados por el Comité de Ética del Instituto en Formación de Nutrición Animal, IFNA (Estación Experimental del Zaidín, CSIC) y se llevaron a cabo siguiendo las directrices éticas y la legislación para la utilización de animales de experimentación establecidas en el Real Decreto 1201/2005.

DISEÑO DEL ESTUDIO

Tras la recepción, los animales fueron pesados y se dividieron aleatoriamente en 3 grupos de estudio ($n = 10$). Se alojaron individualmente en jaulas adecuadas para la cría en una habitación termostatizada a 22 °C, con una humedad relativa del 50% y dotada de sistemas de iluminación y ventilación automáticos. La iluminación artificial permitía generar un ciclo de 12 horas de luz/12 horas de oscuridad. Los grupos experimentales se definieron teniendo en cuenta la dieta suministrada, cuya composición cumple con las normas internacionales de composición del American Institute of Nutrition (16) (Tabla I).

- Grupo control (grupo CC), alimentado durante el experimento con dieta estándar adecuada para el periodo perinatal (AIN93G) (16).
- Grupo fortificado en calcio (grupo Ca), alimentado durante la gestación y lactancia con dieta AIN93G fortificada con 0,5% de carbonato cálcico, lo que resulta en una concentración final de ión Ca^{2+} de 1 g por 100 g de producto.
- Grupo enriquecido con prebiótico (grupo Pre) alimentado durante la gestación y lactancia con dieta AIN93G con un 7,5% de los carbohidratos totales como inulina enriquecida con fructooligosacáridos (FOS) (Synergy-1®, Orafti, Belgium). Este prebiótico es una mezcla 1:1 de fructooligosacáridos con un grado medio de polimerización de 4, e inulina de alto rendimiento, con un grado medio de polimerización de 25.

Durante la gestación y la lactancia, las ratas tuvieron libre acceso a la comida y al agua desionizada (MilliQ). En estos periodos se realizaron controles de peso y de ingesta al menos durante dos veces por semana.

Tras el parto, las camadas fueron pesadas individualmente. Para estandarizar y minimizar las variaciones en la nutrición de las crías durante el periodo de lactancia y evitar efectos de interacción madre-cría, las crías pertenecientes a un mismo grupo de alimentación se mezclaron y se asignaron aleatoriamente a las madres del grupo. Finalmente, las nuevas camadas se formaron con un total de 8 animales, 5 hembras y 3 machos. La intervención nutricional en las madres terminó con el destete de las crías que se produjo a los 23 días tras el nacimiento.

Al final del periodo de lactancia las madres fueron sacrificadas para la obtención de las muestras. Tras un periodo de ayuno de 12 horas, los animales fueron anestesiados vía intraperitoneal con pentobarbital sódico, 30 mg/kg de peso (Abbott Laboratories, North Chicago, IL, EE. UU.). Una vez anestesiados, se les realizó una incisión abdominal y se le extrajo sangre por punción cardiaca. Tras ser desangrados,

Tabla I. Composición nutricional de las dietas ensayadas

	AIN 93 G (Grupo CC)	AIN93-G+Ca (Grupo Ca)	AIN93G + Pre (Grupo Pre)
Grasa total (g/kg dieta)			
Aceite de soja	71,8	71,8	71,8
Proteína (g/kg dieta)	183,1	183,1	183,1
Hidratos de carbono (g/kg dieta)	661,6	661,6	661,6
Celulosa	49,5	49,5	0
Inulina enriquecida en FOS*	0	0	75,0
Minerales (/kg dieta)			
Ca (g)	5,25	10,5	5,25
P (g)	3,15	3,15	3,15
Mg (mg)	539,0	539,0	539,0
Mn (mg)	15,0	15,0	15,0
Zn (mg)	39,9	39,9	39,9
Vitaminas (/kg dieta)			
A (UI)	4.200	4.200	4.200
D_3 (UI)	1.200	1.200	1200
E (UI)	90	90	90
K_1 (mg)	1,08	1,08	1,08
Energía (kcal/kg dieta)	3.880	3.880	3.840

**La fuente de prebiótico, inulina enriquecida con FOS, proviene de Orafti® Synergy 1 (Beneo, Alemania) y es una mezcla 1/1 de oligofructosa e inulina de alto rendimiento.*

se aisló el ciego y se recogió su contenido que fue congelado a -80 ºC para su posterior análisis del pH cecal. También se extrajo el fémur, la tibia y las vértebras lumbares para su medida densitométrica.

ANÁLISIS DEL pH EN EL CONTENIDO DEL CIEGO

El análisis del pH del contenido del ciego se realizó en una homogenización en agua desionizada (MilliQ). Para ello, 0,5 gramos de contenido cecal se homogenizaron en 10 ml de agua y el pH de la disolución resultante se midió con un pHmetro standard de laboratorio (CRISON, Barcelona, España).

ANÁLISIS DENSITOMÉTRICO *EX VIVO*

Al final del destete, se realizó un análisis de la densidad mineral y contenido mineral óseo de las madres. Para el análisis del CMO y la DMO se utilizó el equipo de densitometría o absorciometría con rayos X de doble energía (dual energy X-ray absorptiometry, DEXA) pDEXA® (Norland corp., Fort Atkinson, WI, EE.UU.). Se midieron CMO y DMO de los huesos aislados, fémur, tibia y vértebras lumbares de las madres. El fémur fue analizado desde el cuello femoral hasta la inserción de la rodilla. El análisis de la tibia incluyó el peroné o fíbula y se realizó desde la rodilla hasta el tobillo. Por último, las vértebras se midieron desde el nivel inferior de la vértebra lumbar número 2 hasta la parte superior de la vértebra lumbar 5 (VL2-VL5). Para evitar posibles variaciones debido al uso del equipo y posterior análisis de las muestras, todas las medidas se realizaron por el mismo técnico especializado.

La medición por DEXA permite la discriminación de diferentes estructuras del organismo. Es una técnica utilizada habitualmente en la práctica clínica centrándose sobre la columna lumbar y la cadera que permite cuantificar la DMO. A partir de esos datos, se puede estimar el riesgo de fractura, tomar decisiones terapéuticas, y evaluar la respuesta al tratamiento.

ANÁLISIS ESTADÍSTICO

Los datos se presentan como valor medio ± desviación estándar (DE). Para comprobar diferencias entre grupos atribuidas a la dieta en los diferentes parámetros, se realizó un análisis de la varianza ANOVA de una vía, seguido del test *post hoc* LSD protegido *(protected least significant difference mean separation)* de Fisher. A aquellos grupos que no mostraron una distribución normal o igualdad de la varianza se les realizó el test de Kruskal-Wallis. Las diferencias son consideradas significativas para todos los tratamientos estadísticos a un nivel de $p < 0,05$, mientras que diferencias significativas con valores de p entre el 0,05 y el 0,10 son definidas como tendencias. Todos los análisis se han efectuado con el software estadístico Statgraphics Centurion XVI (Stat Point Inc., Herndon, Virginia, EE. UU.).

RESULTADOS

En términos de valores absolutos, en los tres huesos medidos, el fémur, la tibia y la vértebra, los valores de CMO y DMO son más bajos en las madres que recibieron la dieta fortificada con calcio frente a los de las madres de los grupos CC y Pre. Además, las madres alimentadas con la dieta suplementada con el prebiótico (inulina enriquecida con FOS) presentan los mayores valores absolutos en CMO y DMO de entre los tres grupos. La estadística solo muestra diferencias significativas en la tibia, donde los valores de CMO y DMO obtienen significación ($p < 0,05$) para los grupos CC y Pre al compararlos con los del grupo Ca (Tabla II).

El pH del contenido cecal procedente de las madres del grupo Pre (8,083 ± 0,656) es significativamente inferior al de los grupos CC (8,872 ± 0,252; $p < 0,01$) y Ca (8,558 ± 0,381; $p < 0,05$).

DISCUSIÓN

Durante la gestación y la lactancia se producen cambios en el metabolismo óseo y mineral materno para cubrir los requerimientos de calcio de la descendencia. Así, los recién nacidos a término acumulan la mayoría del calcio (25-30 g) durante el tercer trimestre de la gestación. Posteriormente, durante la lactancia, la demanda de calcio procedente de la madre sigue siendo alta, ya que se pierden en torno a 250 mg de calcio al día debido a la producción de leche materna (17).

En este estudio, el esqueleto de las ratas madres alimentadas con una dieta no deficiente suplementada con inulina enriquecida con fructooligosacáridos presenta una mayor protección frente a la osteopenia transitoria que se produce durante la gestación y la lactancia. Sin embargo, la fortificación con calcio de la dieta materna durante estos mismos periodos no produce ningún efecto protector en el esqueleto de las ratas madres no deficientes nutricionalmente.

El calcio es un nutriente esencial durante la gestación y la lactancia. Es interesante subrayar que se considera que la mayoría de la población, y en especial las mujeres gestantes o lactantes, no consumen la cantidad de calcio recomendada, de 1.000 a 1.200 mg/día, por lo que la suplementación con este mineral sería recomendable durante estos periodos. De hecho, la suplementación con calcio ha mostrado tener efectos beneficiosos tanto sobre el esqueleto materno como sobre el del feto (3). Además se le ha relacionado con otros efectos positivos, como la reducción del riesgo materno a tener hipertensión inducida por el embarazo, preeclampsia y otras complicaciones (18). Por otro lado hay que tener en cuenta que la mayoría de los estudios epidemiológicos han sido realizados en poblaciones que presentan una deficiencia en calcio, por lo que, como se menciona, una suplementación con este mineral puede ejercer un efecto positivo sobre la salud ósea (3). Sin embargo, no todos los estudios realizados en humanos

Tabla II. Resultados densitométricos (pDEXA) del contenido mineral óseo (CMO) y de la densidad mineral ósea (DMO) de las madres tras el sacrificio (final de la lactación)

	AIN 93 G (Grupo CC)	AIN93-G+Ca (Grupo Ca)	AIN93G + Pre (Grupo Pre)
Fémur			
CMO (g)	0,3075 ± 0,0361	0,2813 ± 0,0385	0,3127 ± 0,0439
DMO (g/cm^2)	0,1532 ± 0,0121	0,1419 ± 0,0131	0,1585 ± 0,0172
Tibia			
CMO (g)	0,2394 ± 0,0196	0,2122 ± 0,0281^{CC}	0,2407 ± 0,0289^{Ca}
DMO (g/cm^2)	0,1229 ± 0,0059	0,1161 ± 0,0056^{CC}	0,1258 ± 0,0096^{Ca}
VL 2-5			
CMO (g)	0,3064 ± 0,0336	0,2815 ± 0,0539	0,3138 ± 0,0522
DMO (g/cm^2)	0,1473 ± 0,0091	0,1373 ± 0,0143	0,1500 ± 0,0124

Los valores están expresados como la media ± DE.
Grupo CC, grupo control; grupo Ca, grupo fortificado con calcio; grupo Pre, grupo suplementado con prebiótico (inulina enriquecida con FOS). Las diferencias estadísticas se han definido como $p < 0,05$.
CC: significativamente diferente vs. el grupo control; Ca: significativamente diferente vs. *el grupo Ca.*

han mostrado un efecto positivo de la suplementación con calcio durante la gestación y la lactancia sobre la conservación y/o protección de la salud ósea. Así, en estudios recientes, se ha descrito cómo una suplementación con calcio en mujeres embarazadas con una gran deficiencia en este mineral produce una disminución en el CMO durante la lactación (19,20).

En nuestro estudio, las ratas madres pertenecientes al grupo Ca muestran los menores CMO y DMO cuando se comparan con los grupos CC y Pre. Esto indicaría que una fortificación de la dieta materna con calcio durante la gestación y la lactación no produce ninguna protección en la salud ósea de la madre en condiciones no deficientes. Al igual que en nuestro estudio, Shackelford et al. (21) en un estudio con ratas preñadas alimentadas con una dieta no deficiente, observó la interacción negativa entre la fortificación de la dieta con calcio durante la gestación y los niveles de otros minerales esenciales como el Fe, Zn, Mg y P (hierro, zinc, magnesio y fósforo) en diferentes tejidos. Estos resultados sugieren que una suplementación exclusiva con calcio durante la gestación y la lactancia puede no ser adecuada, puesto que podría generar una disfunción en el metabolismo de otros minerales esenciales que son importantes tanto para la salud materna como para el desarrollo de la cría. De hecho, algunos investigadores han sugerido que no solo debe considerarse al calcio como el único mineral que promueve la salud ósea, sino que puede deberse a un efecto sinérgico de todos los nutrientes que se encuentran en los alimentos ricos en calcio (22).

Por otro lado, en nuestro estudio, la administración de inulina enriquecida en fructooligosacáridos genera un mayor efecto protector en los huesos de las ratas madres frente a la osteopenia transitoria asociada a la gestación y la lactación. A pesar de no ser significativamente diferentes, todos los huesos analizados de las madres pertenecientes al grupo Pre tienen unos valores, en términos absolutos, mayores de CMO y DMO que los huesos de las madres control. Hay que tener en cuenta que el análisis densitométrico no diferencia entre hueso cortical y hueso trabecular, por lo que las diferencias existentes pueden encontrarse enmascaradas al estar el hueso cortical menos afectado por la desmineralización que el hueso trabecular. De hecho, en estudios en humanos con madres lactantes es el hueso trabecular el que se ve más afectado durante la lactancia, mostrando una caída en la CMO trabecular de las mujeres de entre el 3 y el 10% tras un periodo de 2 a 6 meses de lactancia (23). De igual modo, Zeni y cols. (24) encontraron que, en un modelo preclínico, la contribución del esqueleto de la rata durante el periodo de lactación era mayor en las áreas con mayor contenido trabecular. En este estudio, la tibia proximal de las ratas madres al destete era la zona y el hueso más afectado por la desmineralización producida durante la lactación, llegando a tener una disminución de la DMO del 20% al compararlas con la misma zona de ratas no preñadas usadas como control. Sin embargo, no encontraron pérdidas significativas en las áreas donde predomina el hueso cortical, como son la zona distal y media de la tibia.

Uno de los posibles mecanismos de acción a través de los cuales los prebióticos pueden ejercer un efecto protector sobre el esqueleto materno es a través de la producción de los ácidos grasos de cadena corta (AGCC). Los AGCC son generados por la fermentación bacteriana en el lumen intestinal y los principales son el ácido butírico, el propiónico y el acético. Estos AGCC han demostrado tener influencia sobre la salud ósea a través de diferentes mecanismos. Uno de estos mecanismos es generar una disminución en el pH del ciego, lo que favorece la disolución de las sales insolubles de calcio y magnesio, acelerando la difusión

pasiva y su absorción junto con la de los propios AGCC (25-27). Así, nuestros resultados muestran una disminución significativa en el pH del contenido cecal de las madres alimentadas con la dieta suplementada con el prebiótico, inulina enriquecida con fructooligosacáridos, comparado con el pH de los otros dos grupos experimentales (CC y Ca).

En resumen, según los resultados obtenidos en nuestro estudio con ratas, la suplementación de la dieta materna con inulina enriquecida con fructooligosacáridos durante los periodos de gestación y lactación consigue proteger al hueso materno contra la pérdida producida por la respuesta del esqueleto ante la demanda de calcio generada por el feto para su desarrollo. Son diversos, y con resultados contradictorios, los estudios epidemiológicos que evalúan la relación entre la pérdida ósea durante estos periodos, principalmente durante la lactación, y la osteoporosis que se produce tras la menopausia. Así, mientras que algunos estudios muestran un efecto beneficioso de la lactación sobre la DMO materna, otros muestran un impacto negativo (28-30). Además, se ha llegado a sugerir que la recuperación en la DMO materna no consigue alcanzar los niveles de DMO existentes antes del embarazo (4), por lo que es posible suponer que una prevención de la osteopenia asociada a la lactancia puede suponer un efecto positivo sobre el hueso materno, ayudando a retrasar e incluso a disminuir el riesgo de padecer osteoporosis en el futuro. Por otro lado, tenemos que tener en cuenta que cada vez se están teniendo embarazos a edades más tardías, lo que aproxima el fin de la recuperación ósea tras el periodo de lactancia al periodo perimenopáusico, dejando al esqueleto materno en una situación de debilidad, al no encontrarse totalmente recuperado para enfrentarse a la pérdida debida a la menopausia. Por lo tanto, una menor pérdida de hueso durante la gestación y la lactancia podría significar una mayor protección contra la osteoporosis asociada a la menopausia.

CONCLUSIÓN

Los resultados del estudio preclínico presentados nos permiten indicar que una suplementación con el prebiótico inulina enriquecida con FOS en condiciones no deficientes nutricionalmente durante la gestación y la lactancia, puede ser considerada como una estrategia nutricional para proteger la masa ósea materna frente a la pérdida de hueso transitoria que ocurre durante estos periodos. Los prebióticos generan ácidos grasos de cadena corta por la fermentación bacteriana en el lumen intestinal que han demostrado tener influencia sobre la salud ósea a través de la disminución en el pH del ciego, lo que favorece la disolución de las sales insolubles de calcio y magnesio, acelerando la difusión pasiva y su absorción junto con la de los propios ácidos grasos de cadena corta. Esta protección, inducida por la inulina enriquecida con FOS, ayudaría a la madre a tener una mayor densidad de masa ósea y reserva mineral para enfrentarse a la pérdida de masa ósea (osteoporosis) generada por la edad y los factores hormonales en la perimenopausia. Si bien son necesarios posteriores estudios clínicos, los resultados descritos en este manuscrito, basados en un estudio preclínico, identifican al prebiótico inulina enriquecida con FOS como un candidato a tener en cuenta a la hora de ayudar a mantener una correcta salud ósea durante la etapa materna.

CONFLICTO DE INTERÉS

Los autores Pilar Bueno-Vargas, Manuel Manzano y José M. López-Pedrosa trabajan para la empresa Abbott Laboratories, que ha subvencionado el estudio. La autora Inmaculada López-Aliaga es profesora de la Universidad de Granada.

BIBLIOGRAFÍA

1. Cashman KD. Diet, nutrition, and bone health. J Nutr 2007;137(11 Suppl):2507S-12S.
2. Zanchetta JR, Talbot JR. Osteoporosis: fisiopatología, diagnóstico, prevención y tratamiento: Ed. Médica Panamericana; 2001.
3. Prentice A. Calcium in pregnancy and lactation. Annu Rev Nutr 2000;20:249-72.
4. Thomas M, Weisman SM. Calcium supplementation during pregnancy and lactation: effects on the mother and the fetus. Am J Obstet Gynecol 2006;194(4):937-45.
5. Kovacs CS, Fuleihan Gel H. Calcium and bone disorders during pregnancy and lactation. Endocrinol Metab Clin North Am 2006;35(1):21-51, v.
6. Kovacs CS, Kronenberg HM. Maternal-fetal calcium and bone metabolism during pregnancy, puerperium, and lactation. Endocr Rev 1997;18(6):832-72.
7. Cross NA, Hillman LS, Allen SH, Krause GF, Vieira NE. Calcium homeostasis and bone metabolism during pregnancy, lactation, and postweaning: a longitudinal study. Am J Clin Nutr 1995;61(3):514-23.
8. Kovacs CS. Calcium and bone metabolism during pregnancy and lactation. J Mammary Gland Biol Neoplasia 2005;10(2):105-18.
9. Shahtaheri SM, Aaron JE, Johnson DR, Purdie DW. Changes in trabecular bone architecture in women during pregnancy. BJOG: An International Journal of Obstetrics & Gynaecology 1999;106(5):432-38.
10. Zeni SN, Soler CRO, Lazzari A, López L, Suarez M, Di Gregorio S, et al. Interrelationship between bone turnover markers and dietary calcium intake in pregnant women: a longitudinal study. Bone 2003;33(4):606-13.
11. Metabolismo mineral óseo durante la gestación y efectos sobre la masa ósea de la madre. Anales de la Facultad de Medicina; 2008. UNMSM. Facultad de Medicina.
12. Brownawell AM, Caers W, Gibson GR, Kendall CW, Lewis KD, Ringel Y, et al. Prebiotics and the health benefits of fiber: current regulatory status, future research, and goals. J Nutr 2012;142(5):962-74.
13. Roberfroid M, Gibson GR, Hoyles L, McCartney AL, Rastall R, Rowland I, et al. Prebiotic effects: metabolic and health benefits. Br J Nutr 2010;104 Suppl 2:S1-63.
14. Franck A. Oligofructose-enriched inulin stimulates calcium absorption and bone mineralisation. (Br Nutr Found) Nutr Bull 2006;31:341-45.
15. Abrams SA, Griffin IJ, Hawthorne KM, Liang L, Gunn SK, Darlington G, et al. A combination of prebiotic short-and long-chain inulin-type fructans enhances calcium absorption and bone mineralization in young adolescents. The American journal of clinical nutrition 2005;82(2):471-76.
16. Reeves PG, Nielsen FH, Fahey GC, Jr. AIN-93 purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. J Nutr 1993;123(11):1939-51.
17. Kovacs CS. Calcium and bone metabolism in pregnancy and lactation. J Clin Endocrinol Metab 2001;86(6):2344-8.
18. Imdad A, Bhutta ZA. Effects of calcium supplementation during pregnancy on maternal, fetal and birth outcomes. Paediatr Perinat Epidemiol 2012;26 (Suppl 1):138-52.
19. Davey MR, De Villiers J, Lipschitz S, Pettifor JM. Pregnancy-and lactation-associated osteoporosis. JEMDSA 2012;17(3):149-53.

20. Jarjou LM, Sawo Y, Goldberg GR, Laskey MA, Cole TJ, Prentice A. Unexpected long-term effects of calcium supplementation in pregnancy on maternal bone outcomes in women with a low calcium intake: a follow-up study. Am J Clin Nutr 2013;98(3):723-30.
21. Shackelford M, Collins T, Black T, Ames M, Dolan S, Sheikh N, et al. Mineral interactions in rats fed AIN-76A diets with excess calcium. Food and chemical toxicology 1994;32(3):255-63.
22. Liu Z, Qiu L, Chen YM, Su YX. Effect of milk and calcium supplementation on bone density and bone turnover in pregnant Chinese women: a randomized controlled trail. Arch Gynecol Obstet 2011;283(2):205-11.
23. Kovacs CS. Calcium and bone metabolism disorders during pregnancy and lactation. Endocrinol Metab Clin North Am 2011;40(4):795-826.
24. Zeni SN, Di Gregorio S, Mautalen C. Bone mass changes during pregnancy and lactation in the rat. Bone 1999;25(6):681-5.
25. Kruger MC, Brown KE, Collett G, Layton L, Schollum LM. The effect of fructooligosaccharides with various degrees of polymerization on calcium bioavailability in the growing rat. Exp Biol Med (Maywood) 2003;228(6):683-8.
26. Roberfroid MB. Inulin-type fructans: functional food ingredients. J Nutr 2007;137(11 Suppl):2493S-502S.
27. Iwami K, Moriyama T. Effects of short chain fatty acid, sodium butyrate, on osteoblastic cells and osteoclastic cells. Int J Biochem 1993;25(11):1631-5.
28. Karlsson C, Obrant KJ, Karlsson M. Pregnancy and lactation confer reversible bone loss in humans. Osteoporos Int 2001;12(10):828-34.
29. Okyay DO, Okyay E, Dogan E, Kurtulmus S, Acet F, Taner CE. Prolonged breast-feeding is an independent risk factor for postmenopausal osteoporosis. Maturitas 2013;74(3):270-75.
30. Ersoy GS, Giray B, Subas S, Simsek E, Sakin O, Turhan OT, et al. Interpregnancy interval as a risk factor for postmenopausal osteoporosis. Maturitas 2015;82(2):236-40.

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ARÁN

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Trabajo Original

Obesidad y síndrome metabólico

Acantosis nigricans is associated with risk factors related to cardiovascular disease in Mexican children with obesity

La Acantosis nigricans *se asocia con factores de riesgo para enfermedades cardiovasculares en niños mexicanos con obesidad*

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Abstract

Introduction: The prevalence of obesity in Mexican children has increased during the last decade, as has the risk of early onset metabolic disorders and cardiovascular disease.

Objective: To determine the association of *Acantosis nigricans (AN)* with dyslipidemia, high blood pressure, body mass index (BMI), and risk factors related to eating behavior in overweight and obese children.

Patients and methods: This transverse analytical study, conducted in two Mexico City primary schools, included 300 boys and girls. Information was gathered on hereditary and perinatal background. A physical examination provided data on the presence/absence of *AN*, blood pressure, weight and height. The BMI and Z-score were calculated. The serum concentration of glucose, cholesterol and triglycerides was quantified and the lipoprotein profile determined.

Results: The prevalence of AN was 41.7%. An association was found between *AN* and risk factors for cardiovascular disease, including BMI (rS 0.432; $p < 0.0001$), systolic and diastolic blood pressure above the 90th percentile (rS 0.231, $p < 0.0001$; rS 0.128, $p = 0.026$; respectively), hypertriglyceridemia (rS 0.156; $p = 0.007$), and low levels of cHDL (rS -0.160; $p = 0.006$). *AN* was also associated with risk eating behavior, including dieting to lose weight ($p = 0.004$), losing control over eating ($p = 0.023$), and body fat percentage above the 90th percentile ($\chi^2 = 35.1$; $p = 0.0001$). No association was observed between *AN* and serum glucose concentration (rS -0.018; $p = 0.759$). Logistic regression analysis demonstrated an association of *AN* with a low concentration of cHDL (RM: 1.726; $p = 0.041$) and a high percentage of body fat (> 48%) (RM: 3.591; $p = 0.001$).

Conclusion: A high prevalence of *AN* was found in overweight and obese children. There was an association between *AN* and risk factors of cardiovascular disease, including Z-score, BMI, dyslipidemia, and high blood pressure.

Key words:

Acantosis nigricans. Dyslipidemia. Body mass index. Overweight. Obesity, Mexico.

Resumen

Introducción: la mayor prevalencia de obesidad en la población infantil mexicana durante la última década incrementa el riesgo de presentar trastornos metabólicos y enfermedades cardiovasculares a edades cada vez más tempranas.

Objetivo: determinar la asociación entre *Acantosis nigricans (AN)* con dislipidemia, hipertensión arterial, índice de masa corporal (IMC) y conductas alimentarias de riesgo en niños con sobrepeso y obesidad.

Pacientes y métodos: estudio transversal analítico realizado en dos escuelas públicas de la zona metropolitana de la ciudad de México donde participaron 300 niños, de ambos sexos, obteniéndose información de los antecedentes heredofamiliares y perinatales. Con la exploración física se valoró la presencia o ausencia de *AN* y presión sanguínea. Se pesó y midió a los escolares, se calculó el IMC y se estimó su puntaje Z. Se cuantificó la concentración sérica de glucosa, colesterol, triglicéridos y perfil de lipoproteínas.

Resultados: la prevalencia de *AN* fue 41,7%, al determinar la asociación entre la *AN* y los factores de riesgo cardiovascular, se identificó una asociación con el IMC (rS 0.432; $p < 0.0001$), entre las cifras de presión arterial sistólica y diastólica por encima del percentil 90 (rS 0.231; $p < 0.0001$) y (rS 0.128; $p = 0,026$) respectivamente, la hipertrigliceridemia (rS 0.156; $p = 0.007$), las bajas concentraciones de colesterol de lipoproteínas de alta densidad (cHDL) (rS -0,160; $p = 0,006$), así como la existencia de los trastornos de la conducta alimenticia; haber realizado dietas $p = 0.004$, ha perdido el control de lo que come $p = 0,023$ y cuando el porcentaje de grasa corporal fue superior al percentil 90, $\chi^2 = 35.1$; $p = 0.0001$, no se observó asociación con la concentración sérica de glucosa (rS -0.018; $p = 0,759$). En el análisis de regresión logística se observó que la presencia de AN mostró una asociación con las menores concentraciones de cHDL (RM: 1.726; $p = 0,041$) y con el porcentaje de grasa corporal (> 48%) (RM: 3.591; $p = 0,001$).

Conclusión: se observó una alta prevalencia de *AN* en niños con sobrepeso u obesidad y su asociación con factores de riesgo cardiovascular: puntaje Z del IMC, dislipidemia y las cifras tensionales elevadas.

Palabras clave:

Acantosis nigricans. Dislipidemia. Índice de masa corporal. Sobrepeso. Obesidad. México.

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INTRODUCTION

Overweight and obesity are defined as an abnormal or excessive accumulation of fat that implies a health risk. This phenomenon affects children as well as adults and is associated with the premature onset of chronic uninfectious diseases. In fact, some diseases before found only in adults, such as diabetes mellitus type 2 (DM-2) and high blood pressure, in some cases now appear very early in life (1,2).

Childhood obesity is one of the gravest public health problems of the 21st century, having become an emerging global epidemic that implies immediate and long-term effects. It is estimated that the percentage of obese children and adolescents has increased almost 50% in the last 20-30 years. In 2010 it was calculated that there were approximately 42 million overweight children in the world, of which about 35 million lived in developing countries. The Organization for Economic Cooperation and Development (OECD) classified Mexico as having the first place worldwide in overweight children (3).

This relatively recent, substantial increase in overweight and obese children does not bode well for the future, as these children have an eight-fold greater risk of remaining overweight or obese as adults. Indeed, 50% of children who are obese at 6 years of age and 80% of obese adolescents remain obese in adulthood (4,5). These children and adolescents also have a greater probability of early onset metabolic disorders (*e.g.,* dyslipidemia, insulin resistance, glucose intolerance and DM-2), some types of cancer, degenerative cardiovascular disease, dermatological/neurological/endocrine disorders, as well as alterations in the respiratory system, gastrointestinal tract and locomotor apparatus (6,7). All of these disorders involve, to a greater or lesser extent, a shorter life expectancy and a lower quality of life, and all are for the most part preventable (8). As can be seen, the importance of overweight and obesity go far beyond problems of self-image.

In Mexico the national prevalence of overweight and/or obese children in 2012 was estimated by the World Health Organization (WHO) to be 34.4% (19.8% for overweight and 11.8% for obesity), including 32% for Mexican girls (20.2% for overweight and 14.5% for obesity) and 36.9% for Mexican boys (19.5% for overweight and 17.4% for obesity) (9). This prevalence of obesity in Mexico is very similar to that of the United States and Chile. Furthermore, the rate of increase in childhood obesity in Mexico is greater than that seen in developed countries and other developing countries.

Generally, efforts to prevent and detect risk factors for chronic degenerative diseases, such as hypertension and DM-2, are aimed at adults. Therefore, risk factors tend to be identified once the damage is already done. However, the underlying problems exist in obese children and adolescents, giving rise to a deleterious, progressive and systemic effect that begins as subtle and undetectable changes in individuals with a normal and asymptomatic appearance (10). Hence, early detection of the presence and possibly the development of this series of disorders by non-invasive markers is of utmost importance to be able to intervene at an early stage in the population at risk and thus avoid greater complications later on (11).

In 2000, the American Diabetes Association established *Acantosis nigricans* (AN) as one criteria for identifying children at risk for DM-2. The increased incidence of AN runs parallel with that of obesity. Moreover, the diagnosis of AN is clinical, being formed by symmetrical, hyperpigmented, hypertrophic and varicose plaques that are in some cases papilloma. These skin areas appear velvety in texture and brownish-black in color, and are most commonly found on the underarm, back of the neck, flexing points of the upper and lower limbs, the naval, groin, breast folds, face, as well as peribuccal and perianal regions. The most common areas to find these skin blotches is on the back or side of the neck. *AN* is reportedly heavily influenced by genetic factors, being frequently found with Hispanic, Afro-American and Indian people, and infrequently encountered with Caucasians. This dermatological condition is associated with insulin resistance and metabolic disorders, and is known to be a good predictor of hyperinsulinemia, which can lead to DM-2 (12-14).

The prevalence of *AN* varies according to ethnic origin, with an incidence of 13% in blacks, 5% in Hispanics, and less than 1% in Caucasians. Gender and age are not risk factors. In adolescents with more than 200% of normal body weight, the prevalence of *AN* is 66% (15). This skin condition is now common in young people, especially in populations with a high prevalence of DM-2. Hence, this clinical condition may constitute a simple, economical and non-invasive technique for detecting hyperinsulinemia and the propensity for DM-2 and/or metabolic syndrome, especially in children. Its simplicity and low cost make it ideal for detection of these disorders in low income or marginalized communities, advantageous in relation to the traditional test for glucose tolerance or the determination of postprandial glucose or serum insulin (15,16).

Eating habits are formed for biological, psychological and cultural reasons, and when these habits alter normal metabolism they can represent a risk factor for obesity. It has been documented that poor eating habits that lead to overweight and obesity in adolescents are related to eating while doing other activities, such as watching TV, playing computer games, doing homework and working, as well as with prolonged fasts and an obsessive preoccupation with getting fat. Although poor eating habits probably begin in childhood, they are more evident in adolescence (19,20).

In spite of the aforementioned evidence, few studies have considered the role of body weight in the development of AN, or the latter as an independent marker of insulin resistance in school-age children (5-11 years old). The increased incidence of *AN* in the pediatric age parallels the rise in obesity, endocrine pathologies, genetic syndromes, DM-2, dyslipidemia, polycystic ovary syndrome, hypertension, and insulin resistance, the latter not necessarily associated with obesity (16). Consequently, the increase in prevalence of overweight and obesity in Mexican children during the last two decades could possibly be related to the risk of a higher rates of insulin resistance and metabolic syndrome at an ever younger age. On the other hand, it should be pointed out that overweight and obesity have social and emotional implications that are immediate, affecting the quality of life of the

child or adolescent in question, independently of the effects on physical health.

The aim of the present study was to determine whether, in a group of Mexican school children that reside in Mexico City, *AN* is associated with the Z-score of the body mass index (BMI), dyslipidemia, waist circumference, blood pressure and/or risk factors related to eating behavior.

MATERIAL AND METHODS

This is a transversal analytical study carried out from October of 2012 to June of 2013, with the participation of the Regional General Hospital (Hospital General Regional #196 of the Instituto Mexicano de Seguro Social), the National Institute of Perinatology (Instituto Nacional de Perinatología de la Secretaría de Salud) and the Superior School of Medicine (Escuela Superior de Medicina del Instituto Politécnico Nacional). After receiving permission from the school authorities, all students of the fourth, fifth and sixth grades on the morning shift of two primary schools were invited to participate in the study. Exclusion criteria included any chronic disease or any child under medication.

SUBJECTS

Based on a table of random numbers, statistical sampling was carried out in order to obtain a subset of the total population with characteristics similar to those found in each school grade. For this purpose, we used a list of students enrolled in the two schools involved in the present study, with a substitution technique in case a selected student did not want to participate. The sample had the following distribution: 79 (4^{th} grade), 110 (5^{th} grade) and 111 (6^{th} grade), with 133 boys and 167 girls from 9-11 years old. Informed consent was obtained from the parents or tutor, with the informed approval of the participating child. The protocol was approved by the Ethics in Research Committee of the Instituto Mexicano del Seguro Social. A clinical history was recorded for each child, with emphasis on hereditary family background as well as prenatal and pathological information.

Medical personnel carried out a physical examination. A family doctor and a pediatrician evaluated the presence/absence of *AN* in five distinct anatomical regions: on the back of the neck, underarms, the internal flexing areas of the elbows and knees, and the naval. The children were then divided into those with and without *AN* (*AN*+ and *AN*-).

ANTHROPOMETRIC MEASUREMENTS

Evaluation of body weight (kg) was done with a portable digital scale (SECA, model 803, with precision of 100 g). Height measurements (m) were made to 0.1 cm accuracy with a stadiometer (SECA, model 0123). Anthropometric measurements included the circumference of the waist and hip (cm), made with a medical tape measure (SECA, model 200), according to the criteria proposed by the WHO (17). The BMI was calculated with the Quetelet formula (weight in kilograms divided by the height in meters squared). The Z-score for age was also calculated according to the WHO standard, classifying the school children as normal (≤ 1) overweight (> 1 and ≤ 2) or obese (> 2). Z-scores were considered valid between -5.0 and +5.0.

Body fat was determined by measuring body perimeters by using a tape measure with 1 mm accuracy (Sanny medical). Measurement of fat folds was performed with a Vernier caliper (Harpenden). These non-invasive measurements were taken in the schools, averaging 4-5 minutes for each child. The protocols for these measurements were in accordance with the requirements of the International Society for the Advancement of Kinanthropometry.

CLINICAL EVALUATION

Blood pressure was determined after at least 10 minutes of rest, using a sphygmomanometer, a cuff adequate for the children and their complexion, and a stethoscope (Riester). The method utilized was auscultatory, since the records obtained were evaluated with the tables of the National High Blood Pressure Education Program. The pressure hoses used covered 2/3 of the arm, from the olecranon to the shoulder, and the inflatable cuff covered 80% of the circumference of the arm. Measurements were made in the morning, with the child seated, leaning on the backrest of the chair, feet on the floor and the right arm extended. The systolic and diastolic blood pressure (SBP and DBP) were recorded, utilizing the Korotkoff phases I and V as a reference, respectively. The measurement was taken three times because generally the readings tend to stabilize by adaptation of the child to the method and the corresponding diminishment of his/her anxiety. The latter two readings were averaged for the final value. In case the blood pressure reading was elevated, the parents were informed and it was recommended that they visit their pediatrician or family doctor.

The tables of blood pressure of the National High Blood Pressure Education Program were used as the criterion of classification, adjusting the percentile according to height and gender. Consequently, children with blood pressure below the 90^{th} percentile of the standard were considered to have normal blood pressure, while those from the 90^{th} to 94^{th} percentile were classified as pre-hypertensive and those from the 95^{th} percentile and above as hypertensive (18).

BIOCHEMICAL PROFILE

After a fast of 12 hours, with previous asepsis, blood samples were taken by venipuncture with the system of a Vacutainer vacuum. The tubes with blood were centrifuged for 10 min at 3,500 rpm to obtain serum, which was stored in different aliquots at -70 °C to await processing. In these serum samples, the concen-

tration of glucose (mg/dL), triglycerides (mg/dL) and cholesterol (mg/dL) was quantified with colorimetric enzymatic methods. cHDL (mg/dL) was evaluated by using a kit (HDL-Cholesterin/cholesterol, Roche Diagnostics).

EVALUATION OF RISK FACTORS RELATED TO EATING BEHAVIOR

Risk factors related to eating behavior were determined with the diagnostic criteria for eating disorders proposed by the *Diagnostic Manual and Statistics of Mental Disorders IV*. The resulting values were evaluated with the scale validated by Unikel et al. in a Mexican population. The results of using this scale have shown a reliability, according to Cronback's alpha, of 0.83 for women in Mexico City and 0.72 for women in the Mexico State (19).

This scale consists of 10 questions that evaluate the preoccupation with getting fat and other risk factors related to eating behavior in the three months prior to the survey. The answers were based on four Likert-type options (never or almost never = 0, sometimes = 1, frequently but less than two times per week = 2, very frequently or more than 2 times per week = 3 points). The degree of risk was scored as follows: less than 7 was considered to be without risk, 7-10 as moderate risk and > 10 high risk (19,20).

SOCIOECONOMIC LEVEL

This factor was determined by an interview with one of the parents or the tutor of each child, according to the standards of the Mexican Association of Market Research and Public Opinion (21). The interview consisted of 10 questions to establish scoring and overall classification in one of 6 levels of the standard of living: A/B = the highest, C+ = slightly above average, C = average, D+ = slightly below average, D = low or austere, and E = the lowest.

STATISTICAL ANALYSIS

A descriptive analysis was performed, utilizing absolute and relative (percentages) frequencies as well as the mean and standard deviation of quantitative variables to determine statistical difference and to test the hypothesis. The Shapiro Wild test was used to determine normal distribution of the sample. The Spearman's rank correlation for independent samples was employed to compare the groups. To evaluate the possible association between variables, the χ^2 non-parametric test of independence was applied. For non-parametric correlations, multiple logistical regression analysis was used. For analysis of multiple regression, all variables of confusion or modifiers of effect were included. Statistical significance was considered with $p < 0.05$. The information was recorded in the Microsoft EXCEL program and analysis was carried out in the SPSS version 15 for the Windows statistical program.

ETHICAL ASPECTS

Data gathering and analysis was confidential, taking into account ethical questions related to autonomy, information and security. The findings of the present study were included in a pamphlet given to all participants. The aim of this pamphlet was to provide guidelines for good eating habits in order to help the parents to establish good nutrition for their children. The present study was carried out following the guidelines established by the Official Mexican Norm (NOM-043-SSA2-2005) of the Secretary of Health in Mexico (22).

RESULTS

Of the 300 school children that participated in the study, 55.7% (167) were girls and 44.3% (133) were boys. Regarding socioeconomic level, 18 (6%) corresponded to a low or austere standard of living, 160 (53.3%) to an average level and 122 (40.7%) to a level slightly above average. Weight classification of the children was determined with the Z-score of the BMI according to age and gender, as proposed by the WHO, finding a 39.7% prevalence of obesity (119), 18.7% (56) overweight, 40.3% (121) normal and 1.3% (4) underweight. Overweight and obesity was more common among the girls (Table I).

The perinatal background of the children, according to information gathered from the mothers, indicated that at the time of birth the average number of weeks of gestation (WOG) was 38.4 ± 2.3%, with a weight of 3.183 ± 516 g, and a height of 49 ± 4.3 cm. Exclusive breastfeeding lasted an average of 8.5 ± 6.6 months, and for 20.7% (62) it lasted less than 3 months.

The average age of the mothers at the moment of the study was 35.7 ± 5.6 years, while that of the fathers was 35.7 ± 11.4 years, with 62.7% (188/300) of the mothers and 67.5% of the fathers having finished middle school. It was observed that 64.3% (193/300) of the mothers were overweight or obese and 71.2% (200/300) of the fathers, and that 36.7% (110/300) of both parents worked. Regarding the immediate family, there was a background for 53.3% (160/300) of the children of obesity, for 59.3% (178/300) of DM-2, and for 67.3% (202/300) of systemic high blood pressure.

Table I. Weight classification according to the Z-score of the BMI, considering age and gender

Weight classification	Boys n = 133 (%)	Girls n = 167 (%)	Total n = 300 (%)
Underweight	1 (25.0)	3 (75.0)	4 (1.3)
Normal	52 (43.0)	69 (57.0)	121 (40.3)
Overweight	21 (37.5)	35 (62.5)	56 (18.7)
Obese	59 (49.6)	60 (50.4)	119 (39.7)
Total	133 (44.3)	167 (55.7)	300 (100.0)

$\chi^2 = 3.08$; $p = 0.379$.

The average values of parameters for the children was the following: age, 10.1 ± 0.7 years; weight, 42.8 ± 10.9 kg; height, 143 ± 8 cm; BMI, 20.5 ± 3.8 kg/m^2; waist circumference, 68.8 ± 10.6 cm; hip circumference, 81.1 ± 8.9 cm; serum glucose, 98.5 ± 11.8 mg/dL; and serum cholesterol, 176.4 ± 48 mg/dL. There was glucose intolerance in 6 children and DM-2 in no children.

Regarding gender, there were no significant differences in any of the anthropometric, clinical or biochemical variables. Therefore, all of the children were included in the analysis of the association between variables, without carrying out stratification by gender.

AN was found in 41.7% (125) of the children, of which 37.6% (47/125) were overweight and 54.4% (68/125) obese. With a greater BMI there was a greater frequency of *AN*, while in the children with normal weight for their height, no *AN* was found. The children with *AN* not only had a tendency to higher weight but also lower height compared to the children without *AN* (see Table II).

Blood pressure was above the 90th percentile in 10.8% of the children. This high level of blood pressure was found in 6.5% of the children with normal BMI, 9% of those overweight, and 21% of those with obesity.

Serum cholesterol concentration was similar in the children with and without *AN*, while triglyceride concentration was much higher and cHDL concentration lower in the children with *AN* (Table II).

There was an association between *AN* and the following behavior: being preoccupied with getting fat ($\chi^2 = 4.09$; p = 0.043), dieting to lose weight ($\chi^2 = 8.2$; p = 0.004), losing control over eating ($\chi^2 = 5.13$; p=0.023), and a percentage of body fat above the 90th percentile ($\chi^2 = 35.1$; p = 0.0001) (Table III). No association was observed between *AN* and the length of breastfeeding, the weight of the parents, if both parents were working, if the parents did regular exercise, or a family background of DM-2, hypertension or obesity.

Table III. Association between the presence of *Acantosis nigricans* and risk factors in relation to eating behavior, n(%)

Risk factors	*Acantosis nigricans*		p
	Yes n = 125	No n = 175	
Preoccupation with getting fat	102 (34.0%)	125 (41.7%)	0.043
Dieting to lose weight	56 (18.7%)	50 (16.7%)	0.004
Losing control over eating	42 (14.0%)	38 (12.7%)	0.023

Table II. Anthropometric, clinical and biochemical characteristics of the school children under study, both with and without *Acantosis nigricans*

Variables	Total (mean ± SD)	With *AN* n = 125	Without *AN* n = 175	p
Age	10.1 ± 0.7	10.1 ± 0.7	10.06 ± 0.8	0.199
Anthropometric evaluation				
Weight (kg)	42.8 ± 10.9	48.1 ± 11.1	39.0 ± 9.2	< 0.0001
Height (m)	1.43 ± 0.08	1.45 ± 0.08	1.41 ± 0.08	< 0.0001
BMI (kg/m^2)	20.5 ± 3.8	22.5 ± 3.7	19.2 ± 3.3	< 0.0001
Waist circumference (cm)	69.0 ± 9.8	73.7 ± 9.9	65.7 ± 8.2	< 0.0001
Hip circumference (cm)	81.1 ± 8.9	85.2 ± 8.6	78.2 ± 7.8	< 0.0001
% of body fat	47.9 ± 10.0	52.3 ± 8.5	44.8 ± 9.9	< 0.0001
% of body fat in girls	48.9 ± 9.1	52.3 ± 7.9	46.6 ± 9.3	< 0.0001
% of body fat in boys	46.7 ± 10.9	52.3 ± 9.2	42.5 ± 10.3	< 0.0001
Blood pressure				
Blood pressure (mmHg)		81 ± 28	75 ± 12	0.013
Systolic (mmHg)	97.6 ± 14.7	101.1 ± 14	95.1 ± 14	< 0.0001
Diastolic (mmHg)	66.1 ± 12.3	67.8 ± 12	64.9 ± 12	0.044
Biochemical parameters				
Glucose (mg/dL)	98.5 ± 11.8	98.1 ± 11.4	98.8 ± 12.1	0.592
Cholesterol (mg/dL)	176.4 ± 48.0	173.3 ± 46.9	178 ± 50.4	0.342
Triglycerides (mg/dL)	118.3 ± 53.2	130.4 ± 57.8	110.2 ± 47.3	0.001
cHDL (mg/dL)	58.9 ± 12.6	46.2 ± 10.6	50.9 ± 13.6	0.001
cLDL (mg/dL)	103.8 ± 42.4	101.4 ± 40.9	105.7 ± 43.4	0.350

There was an association between *AN* and the BMI (rS 0.432; p < 0.0001), systolic blood pressure (rS 0.231; p < 0.0001), diastolic blood pressure (rS 0.128; p = 0.026), hypertriglyceridemia (rS 0.156; p = 0.007), and level of cHDL (rS -0.160; p = 0.006). No association was found between *AN* and the concentration of serum glucose (rS -0.018; p = 0.759) or low-density lipoprotein cholesterol (cLDL) (rS -0.042; p = 0.472) (Table IV).

The risk of having *AN* increased with a lower concentration of cHDL (RM: 1.726; p = 0.041) and a greater percentage of body fat (RM: 3.591; p = 0.001), according to calculations based on logistical regression (Table V).

DISCUSSION

Obesity is a public health problem that has currently become a worldwide epidemic. *AN* is now frequently found in children and adolescents, especially in populations with a high prevalence of obesity, insulin resistance and DM-2. Therefore, the present study explored the possible association of *AN* with the latter medical conditions, as well as the possibility of using *AN* as a marker so that family doctors and general practitioners can identify obesity in school children in a timely manner. This would allow for preventative measures to be implemented against the development of cardiovascular disease and DM-2 in overweight and obese children (23,24).

The incidence of *AN* in children has increased together with that of obesity and insulin resistance. For this reason, the American Diabetes Association has recommended the early detection of *AN* as a criterion for identifying children at risk for developing DM-2. The prevalence of *AN* in the present study was 41.7%, greater than that reported by Stoddart et al., who found 34.2% *AN* in a Cherokee Indian population (25). Meanwhile, Mukhtar et al. documented an 18.9% prevalence of *AN* in obese adolescents in New Mexico (26), Nguyen et al. reported 25% of *AN* in overweight Afro-American children (27), and Stuart et al. found 38% of *AN* in Native Americans (28). On the other hand, Thivel D and Maisonneuve B have reported the prevalence of *AN* to be as high as 68 and 69.9%, respectively, in obese children (29,30). These differences in prevalence of *AN* have been related to the proportion of overweight and obesity in the groups under study.

With the presence of *AN* associated with obesity, there are important alterations in the metabolism of lipids. A group of children with *AN* in a previous study showed signs of greater risk for the development of atherosclerosis and cardiovascular disease (31). When comparing the children with and without *AN* in the present study, there was a lower serum concentration of cHDL (c-HDL 46 ± 10 *vs.* 50 ± 13 p = 0.001) and a higher serum concentration of triglycerides (129 ± 58 *vs.* 110 ± 47 p = 0.002). Numerous studies have demonstrated the association between the risk of developing cardiovascular disease and low serum concentrations of cHDL (32) as well as hypertriglyceridemia. The latter condition gives rise to changes in the composition of cLDL, favoring the appearance of phenotype B that is characterized by the presence of small cLDL, which is more susceptible to oxidation and therefore can lead to atherosclerosis (33,34).

One of the most relevant findings of the present study is the early age (10.1 ± 0.7 years) at which a group of children with obesity and *AN* were found to have hypertriglyceridemia as well

Table IV. Bivariate association between *Acantosis nigricans* and distinct risk factors (Spearman's rank correlation)

Variable	Spearman's rank correlation r	p
Weight	0.418	< 0.0001
Height	0.218	< 0.0001
BMI	0.432	< 0.0001
Waist circunference	0.429	< 0.0001
Systolic blood pressure	0.231	< 0.0001
Diastolic blood pressure	0.128	0.026
Glucose	-0.018	0.759
Triglycerides	0.156	0.007
cHDL	-0.160	0.006
cLDL	-0.042	0.472

Table V. Variables associated with the presence of *Acantosis nigricans*

Variable	Beta	RM	IC 95%	p
Losing control over eating	0.362	1.436	0.815-2.529	0.210
Dieting to control weight	-0.282	0.754	0.442-1.288	0.310
Low concentration of cHDL	0.546	1.726	1.024-2.911	0.041
High level of body fat (> 48%)	1.279	3.591	2.011-6.414	0.001
High systolic blood pressure (> 100 mmHg)	0.442	1.558	0.899-2.691	0.114
High concentration of triglycerides (> 100 mg/dL)	-0.140	0.607	0.510-1.482	0.607
Constant	-1.403	0.246		0.001

The other variables were not significant in the model.

as a reduced concentration of serum cHDL and a high concentration of cLDL, which probably will favor the development of cardiovascular disease at a very early age. This observation is in agreement with Fishbein in the United States (35). Additionally, the alterations found in the profile of lipoproteins is also in accordance with Skhonthachit P et al. in Thai children (36) and with Boyd GS et al. (37), who both found a high prevalence of dyslipidemia in overweight and obese children and adolescents.

The existence of dyslipidemia is often reported in the many studies that have provided evidence of the association between obesity and the risk of cardiovascular disease. Within this context, the greatest prevalence found has been hypertriglyceridemia. Almost 1 of 2 children in the present study presented concentrations of triglycerides in the range considered as high risk, while 1 of 3 children showed hypercholesterolemia and 1 of 4 mixed dyslipidemia. This fact should be alarming to the authorities in the area of public health due to the combination of obesity and an alteration in the profile of lipids in a significant percentage of children, leading to a high risk of cardiovascular and metabolic diseases at an early age (38). For this reason, children with obesity should be a target group for the implementation of measures aimed at diminishing the aforementioned metabolic alterations. Such measures should include the modification of eating habits and lifestyle (including more exercise) in order to attain a loss of weight. Additionally, there should be constant monitoring of the lipid profile in obese children and adolescents, especially if they have *AN*, as recommended by the American Heart Association (39).

On the other hand, there is a widely recognized relation between systemic high blood pressure and obesity caused by poor diet and lack of exercise. A greater percentage of obesity has been found among a population of hypertensive children and adolescents in Cuba. Furthermore, with a reduction in weight, blood pressure was normalized in this population. Nevertheless, there are few studies that take into account the relation between the degree of obesity, time of evolution, the age of appearance, and the distribution of body fat in obese and hypertensive children and adolescents.

Different studies have shown the relation of obesity in children/adolescents with systemic high blood pressure, especially in those with a greater degree of obesity and lipid anomalies. The present study demonstrates higher blood pressure in children with obesity and *AN* than in children with normal weight. The greatest difference was found in systolic blood pressure, in accordance with the study by Dong B et al. on children and adolescents in China (40), by Chiolero A. on children of the Republic of Seychelles in Africa (41), by Moser on Brazilian children (42), and by Hoog who studied the association between blood pressure and BMI in children from different ethnic groups (43).

In the present study, 10.8% of the children had systolic or diastolic blood pressure above the 90th percentile, a figure slightly less than that reported by Bojórquez Díaz et al. (44), who detected high blood pressure in 12.7% of primary school children in the State of Sonora, Mexico. However, the figure from the present study is higher than the 7.6% reported by Salvadori et al. (45) in a study on rural children in Canada and the 4.2% of children from 5 to 12 years old and 6% of adolescents from 13 to 18 years old found by Díaz (46) in a study in Argentina. Additionally, in Cuba Suárez Cobas et al. (47) reported a group of adolescents with high blood pressure above the 90th percentile, made up of 7.6% boys and 2.4% girls from 15 to 17 years old, while in the city of Merida, Venezuela, there were 6.3% of adolescents from 15 to 17 years old (48) with this condition, and in Spain 1.7% of boys and the 3.05% of girls (49). Hence, the prevalence of obesity in the present study and a previous study in Mexico is higher than that found in children of Canada, Argentina, Venezuela and Spain. Due to the foreboding presence of high blood pressure at such an early age in Mexico, especially when found in overweight and obese children, an early detection of obesity and high blood pressure is of great importance since these conditions increase the risk of health problems in adolescence and early adulthood (50).

On the other hand, the present study confirmed the positive and significant association of *AN* with obesity (percent of body fat) and dyslipidemia (low cHDL), based on the statistical analysis with the Spearman's rank correlation and multiple logistical regression (RM: 3.591; $p = 0.001$, RM: 1.726; $p = 0.041$; respectively). This suggests that *AN* reflects the increase in obesity in Mexico, which is a risk factor for cardiovascular disease and is associated with dyslipidemia, high blood pressure and a greater risk of developing DM-2 (38,39).

Regarding risk factors in relation to eating behavior, the present study evidences the greater prevalence of *AN* among those that worry about getting fat, that had dieted to lose weight, and were not able to control what they eat, confirming a study on a group of adolescents (20). However, it should be stated that poor eating habits are often accompanied by an inadequate weight, including overweight and obesity, and that this is in turn associated with the alteration of hormones like insulin that are known to provoke the development of *AN* (11). The only variables associated with *AN* in the present study were low cHDL and a high percentage of body fat.

In summary, the results of the present study highlight the high prevalence of *AN* in overweight and obese children, and its association with two risk factors for cardiovascular disease, the distribution of body fat and dyslipidemia. This suggests that it is necessary to take early preventative measures, such as carrying out a follow-up in relation to the high risk that these children will later develop DM-2, other metabolic disorders, and/or cardiovascular disease. Such measures would represent an improvement in the medical attention and quality of life for Mexican children.

One of the limitations of the present study is that the data do not come from a representative sample of all children of primary schools of Mexico. Nonetheless, the sample is made up of a homogeneous population in a certain age group. Another limitation of this study was the fact that the serum concentration of insulin was not determined, and that information was not gathered in regard to the physical activity of the children.

These limitations could in part be overcome by carrying out a follow-up prospective cohort study of this population to see if they indeed develop DM-2, atherosclerosis, and/or polycystic ovary syndrome. In spite of the limitations of the present study, one of the main contributions is the association found of *AN* with obesity, certain risk

factors for cardiovascular disease, and metabolic disorders in children, who are one of the most vulnerable groups of the world population.

CONCLUSION

A*cantosis nigricans* is easy to evaluate in a clinical setting. The present study found a high prevalence (41.7%) of AN in overweight and obese children. Certain variables were associated with the presence of *AN*, including a low concentration of cHDL, a high percentage of body fat, and high blood pressure, but not eating behavior disorders.

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CONFLICT OF INTEREST

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REFERENCES

1. Pulgaron ER and Delamater AM. Obesity and type 2 diabetes in children: epidemiology and treatment. Curr Diab Rep 2014;14(8):508. DOI:10.1007/s11892-014-0508-y.
2. Morandi A, Maffeis C. Predictors of metabolic risk in childhood obesity. Horm Res Paediatr 2014;82:3-11.
3. Organization for Economic Co-operation and Development. Key facts–Mexico. Update 2014. http://www-oecd.org/mexico/Obesity-Update-2014-MEXICO_EN.pdf
4. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang S-J, Zakeri I, Berenson GS. Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study. Eur J Clin Nutr 2006;60:48-57.
5. Magarey AM, Daniels LA, Boulton TJ, Cockington RA. Predicting obesity in early adulthood from childhood and parental obesity. Int J Obes 2003;27:505-13.
6. Morandi A, Maffeis C. Predictors of metabolic risk in childhood obesity. Horm Res Paediatr 2014;82:3-11.
7. Reinerhr T. Type 2 diabetes mellitus in children and adolescents. World J Diabetes 2013;4(6):270-81.
8. World Health Organization. Prioritizing areas for action in the field of population-based prevention of childhood obesity. WHO. February 2012.
9. Secretaría de Salud. Encuesta Nacional de Salud y Nutrición 2012. Resultados Nacionales. Cuernavaca, México: Instituto Nacional de Salud Publica, México; 2012.
10. Williams CL, Hayman LL, Daniels SR, Robinson TN, Steinberger J, Paridon S, et al. Cardiovascular Health in Childhood. A statement for health professionals from the committee on atherosclerosis, hypertension, and obesity young (AHOY) of the council on cardiovascular disease in the young, American Heart Association. Circulation 2002;106:143-60.
11. Ng HY, Young JHM, Huen KF, Chan LTW. Acanthosis nigricans in obese Chinese children. Hong Kong Med J 2014;20:290-6.
12. American Diabetes Association. Type 2 diabetes in children and adolescents. Diabetes Care 2000;23(3):381-9.
13. Brown B, Noonan C, Bentley B, Conway K, Corcoran M, FourStar K, et al. Acanthosis nigricans among northern plains American Indian children. J Sch Nurs 2010;26(6):450-60.
14. Kobaissi HA, Weigensberg MJ, Ball GD, Cruz ML, Shaibi GQ, Goran MI. Relation between Acanthosis nigricans and insulin sensitivity in overweight Hispanic children at risk for type 2 diabetes. Diabetes Care 2004;27:1412-6.
15. Urrutia-Rojas X, McConathy W, Willis B, Menchaca J, Luna-Hollen M, Marshall K, et al. Abnormal glucose metabolism in Hispanic parents of children with acanthosis nigricans. ISRN Endocrinology 2011. DOI:10.5402/2011/481371.
16. Dassanayake A, Kasturirate A, Niriella MA, Kalubovila U, Rajindrajith de Silva AP, Kato N, et al. Prevalence of Acanthosis nigricans in an urban population in Sri Lanka and its utility to detect metabolic syndrome. BMC Research Notes 2011;4:25.
17. World Health Organization. Technical report series 854. Physical status: the use and interpretation of anthropometry. Geneva;1995.
18. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004;114:555-76.
19. Unikel-Santocini C, Nuño-Gutiérrez B, Celis-de la Rosa A, Saucedo-Molina TJ, Trujillo-Chi Vacua EM. Garcia-Castro F, et al. Conductas alimentarias de riesgo: prevalencia en estudiantes mexicanas de 15 a 19 años. Rev Invest Clin 2010;62(5):424-32.
20. Sámano R, Zelonka R, Martínez-Rojano H, Sánchez-Jiménez B, Ramírez C, Ovando G. Asociación del índice de masa corporal y conductas de riesgo en el desarrollo de trastornos de la conducta alimentaria en adolescentes mexicanos. Arch Latinoam Nutr 2012;62(2):145-54.
21. Índice de Nivel Socioeconómico de la Asociación Mexicana de Agencias de Investigación de Mercados y Opinión Pública (AMAI) septiembre 2014. Regla AMAI NSE 8X7. www.amai.org/NSE/NivelSocioeconomicoAMAI.pdf
22. Norma Oficial Mexicana NOM-043-SSA2-2012. Servicios básicos de salud. Promoción y educación para la salud en materia alimentaria. Criterios para brindar orientación. Diario Oficial de la Federación; 2013.
23. Brickman WJ, Huang J, Silverman BL, Metzger BE. Acanthosis nigricans identifies youth at high risk for metabolic abnormalities. J Pediatr 2010;156:87-92.
24. Rafalson L, Pham TH, Willi SM, Marcus M, Jessup A, Baranowski T. The association between acanthosis nigricans and dysglycemia in an ethnically diverse group of eighth grade students. Obesity (Silver Spring); 2013;21(3):E328-33.
25. Stoddart M, Blevins K, Lee E, Wang W, Blackett P. Association of Acanthosis Nigricans with hyperinsulinemia compared with other selected risk factors for type 2 diabetes in Cherokee Indians. Diabetes Care 2002; 25:1009-14.
26. Mukhtar Q, Cleverley G, Voorhees R, McGrath J. Prevalence of acanthosis nigricans and its association with hyperinsulinemia in New Mexico adolescents. J Adolesc Health 2001;28:372-6.
27. Nguyen TT, Keil MF, Russell DL, Pathomvanich A, Uwaifo GI, Sebring NG, et al. Relation of acanthosis nigricans to hyperinsulinemia and insulin sensitivity in overweight African American and white children. J Pediatr 2001;138:474-80.
28. Stuart CA, Smith MM, Gilkison CR. Acanthosis nigricans among Native Americans: an indicator of high diabetes risk. Am J Public Health 1994;84:1839-42.
29. Thivel D, Malina RM, Isacco L, Aucouturier J, Meyer M, Duché P. Metabolic syndrome in obese children and adolescents: dichotomous or continuous? Metab Syndr Relat Disord 2009;7:549-55.
30. Maisonneuve B, Auclair C, Ali M, Terral D, Deméocq F, Roszyk L, et al. Metabolic abnormalities in obese French children. Arch Pediatr 2009;16:991-8.
31. Zhu WF, Liang L, Wang CL, Fu JF. Triglyceride and non-high-density lipoprotein cholesterol as predictors of cardiovascular disease risk factors in Chinese Han children. Indian Pediatr 2013;50:394-8.
32. Ayer JG, Sholler GF. Cardiovascular risk factors in Australian children: hypertension and lipid abnormalities. Aust Prescr 2012;35:51-5.
33. McGill HC, McMahan A, Zieske AW, Tracy RE, Malcom GT, Herderick EE, Strong JP. Association of coronary heart disease risk factors with microscopic qualities of coronary atherosclerosis in youth. Circulation 2000;102:374-9.
34. Harchaoui KEL, Visser ME, Kastelein JJP, Stroes ES and Dallinga-Thie GM. Triglycerides and cardiovascular risk. Curr Cardiol Rev 2009;5:216-22.
35. Fishbein MH, Mogren C, Gleason T, Stevens WR. Relationship of hepatic steatosis to adipose tissue distribution in pediatric nonalcoholic fatty liver disease. J Pediatr Gastroenterol Nutr 2006;42(1):83-8.

36. Sukhonthachit P, Aekplakorn W, Hudthagosol C, Sirikulchayanonta C. The association between obesity and blood pressure in Thai public school children. BMC Public Health 2014;14:729. DOI: 10.1186/1471-2458-14-729.
37. Boyd GS, Koeniqsberg J, Falkner B, Gidding S, Hassingk S. Effect of obesity and high blood pressure on plasma lipid levels in children and adolescents. Pediatrics 2005;116(2):442-6.
38. Srinivasan SR, Frontini MG, Xu J, Berenson GS. Utility of childhood non-high-density lipoprotein cholesterol levels in predicting adult dyslipidemia and other cardiovascular risks: The Bogalusa Heart Study. Pediatrics 2006;118(1):201-6.
39. Williams CL, Hayman LL, Daniels SR, Robinson TN, Steinberger J, Paridon S, et al. Cardiovascular Health in Childhood. A statement for health professionals from the committee on atherosclerosis, hypertension, and obesity young (AHOY) of the council on cardiovascular disease in the young, American Heart Association. Circulation 2002;106:143-60.
40. Dong B, Wang Z, Wang H-J, Ma J. Associations between adiposity indicators and elevated blood pressure among Chinese children and adolescents. J Hum Hypertens 2015;29:236-40.
41. Chiolero A, Madeleine G, Gabriel A, Burnier M, Paccaud F, Bovet P. Prevalence of elevated blood pressure and association with overweight in children of a rapidly developing country. J Hum Hypertens 2007;21:120-7.
42. Moser DC, Guiliano IC, Titski AC, Gaya AR, Coelho-e-Silva MJ, Leite N. Anthropometric measures and blood pressure in school children. J Pediatr (Rio J) 2013;89:243-9.
43. Hoog MLA, van Eijsden M, Stronks K, Gemke RJBJ, Vrijkotte TGM. Association between body size and blood pressure in children from different ethnic origins. Cardiovascular Diabetology 2012;11:136. DOI: 10.1186/1475-2840-11-36.
44. Bojórquez DCI, Angulo PCM, Reynoso EL. Factores de riesgo de hipertensión arterial en niños de primaria. Psicología y Salud 2011;21:245-52.
45. Salvadori M, Sontrop JM, Garg AX, Truong J, Suri RS, Mahmud FH, et al. Elevated blood pressure in relation to overweight and obesity among children in a rural Canadian community. Pediatrics 2008;122(4):e821-e827.
46. Díaz A, Tringler M, Molina JD, Díaz MC, Geronim V, Aguera D, et al. Control de la presión arterial y prevalencia de hipertensión arterial en niños y adolescentes de una población rural de Argentina. Datos preliminares del Proyecto Vela. Arch Argent Pediatr 2010;108(1):68-74.
47. Suárez CL, Rodríguez CA, Tamayo VJL, Rodríguez BRP. Prevalencia de hipertensión arterial en adolescentes de 15 a 17 años. MEDISAN 2009;13(6). http://bvs.sld.cu/revistas/san/vol13_6_09/san07609.htm
48. Blanco LC, Macías TC, López BM. Relación entre la maduración temprana, índice de masa corporal y el comportamiento longitudinal de la presión arterial sistólica. Acta Cient Venez 2000;51:252-6.
49. Marrodán SMD, Cabañas AMD, Carmenate MMM, González-Montero EM, López-Ejeda N, Martínez AJR, et al. Asociación entre adiposidad corporal y presión arterial entre los 6 y los 16 años. Análisis en una población escolar madrileña. Rev Esp Cardiol 2013;66(2):110-5.
50. Flynn JT, Falkner BE. Obesity hypertension in adolescents: epidemiology, evaluation, and management. J Clin Hypertens (Greenwich) 2011;13:323-31.

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Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Body mass index cutoff point estimation as obesity diagnostic criteria in Down syndrome adolescents

Estimación del punto de corte del índice de masa corporal como criterio diagnóstico de obesidad en adolescentes con síndrome de Down

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Abstract

Introduction: Adolescents with Down syndrome (DS) show high rate of overweight and tend to accumulate high amount of fat compared to the same people without the syndrome.

Objective: To estimate the cutoff point of the Body Mass Index (BMI) for the diagnosis of obesity in adolescents with DS according to different references for BMI in relation to the percentage of body fat (%BF) measured by dual-energy X-ray absorptiometry (DXA).

Methods: The sample was composed of 34 adolescents with DS (aged: 10 to 17 years old). BMI was evaluated according to the references of the International Obesity Task Force (IOTF), the World Health Organization (WHO) for the general population, and Myrelid et al. and Styles et al. for people with DS. The %BF was assessed by whole body DXA and classified according to National Health And Nutrition Examination Survey (NHANES, 2011).

Results: The boys were significantly taller than the girls and this %BF higher than boys. All references who have used BMI to assess obesity was positively associated with %BF measured by DXA in the diagnosis of obesity. Using the ROC curve in relation to %BF by DXA, all references showed high sensitivity, but the z-score of BMI by WHO showed better specificity, with the value of the accuracy of 0.82 for the cutoff point above 2.14.

Conclusions: All the references used for the diagnosis of obesity were associated with %BF measured by DXA, and the cutoff point of z-scores above 2.14 by WHO showed better specificity.

Key words:

Down syndrome. Body mass index. ROC curve. DXA. Anthropometry.

Resumen

Introducción: adolescentes con síndrome de Down (SD) muestran alta tasa de sobrepeso y tienden a acumular gran cantidad de grasa en comparación con los adolescentes sin el síndrome.

Objetivo: estimar el punto de corte del índice de masa corporal (IMC) para el diagnóstico de obesidad en adolescentes con SD de acuerdo con las diferentes referencias para el IMC en relación con el porcentaje de grasa corporal (%GC) obtenido por el absorciometría con rayos X de doble energía (DXA).

Métodos: la muestra se compone de 34 adolescentes con SD (10 a 17 años). El IMC se evaluó de acuerdo con las referencias de la International Obesity Task Force (IOTF), Organización Mundial de la Salud (OMS) para la población general, y Myrelid et al. y Estyles et al. para personas con SD. El %GC fue evaluado por DXA y clasificado según NHANES (2011).

Resultados: los niños fueron significativamente más altos que las niñas, y estas con mayor %GC que los niños. Todas las referencias que han utilizado el IMC se asociaron positivamente con el %GC medido por DXA en el diagnóstico de la obesidad. Utilizando la curva ROC en relación con %GC por DXA todas las referencias mostraron alta sensibilidad, pero el score-z del IMC por la OMS mostró mejor especificidad, con el valor de exactitud de 0,82 para el punto de corte por encima de 2,14.

Conclusiones: todas las referencias utilizadas para el diagnóstico de obesidad se asociaron con el %GC medido por DXA, y el punto de corte del score-z por encima de 2,14 por la OMS mostró mejor especificidad.

Palabras clave:

Síndrome de Down. Índice de masa corporal. Curva ROC. DXA. Antropometría.

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INTRODUCTION

The life expectancy of the population with Down syndrome (DS) has been increasing over the last 40 years (1), but studies show a high rate of overweight in children and adolescents with DS (2,3). For some authors, children and adolescents with DS tend to accumulate high amount of fat (4) compared to the same people without the syndrome due to sedentarism (5), inadequate food that worsens over the years (6) and low physical fitness (7,8). Certain comorbidities commonly found in this population may aggravate or be aggravated by obesity, such as congenital heart defects (9,10), reduction of immunological function (11), obstructive sleep apnea (12), diabetes mellitus (13), among others.

To determine excess body fat in children and adolescents with DS, researchers have used some indirect and doubly indirect methods. Among these various techniques, absorptiometry with dual energy X-ray absorptiometry (DXA) (14,15) and body mass index (BMI) (16,17) have been widely used to assess the nutritional state (2). Several graphic weight, height and BMI for specific DS were created (2,16-19), but so far there is no consensus for a standardization for both the technical procedures as for anthropometric parameters for this population (20).

The DXA is one of the most accurate and useful tools to assess body composition and determine the distribution of fat and is considered the gold standard for this purpose. It is an imaging procedure that allows the quantification of bone mass, muscle and fat, divided by body parts or the entire body (21,22).

Thus, the aim of this study was to estimate the BMI cutoff point for the diagnosis of obesity in adolescents with DS according to different references for BMI classification in relation to the percentage of body fat (%BF) measured by DXA.

MATERIALS AND METHODS

STUDY DESIGN AND PARTICIPANTS

A total sample of 34 adolescents with DS (aged 10 and 17 years), 18 males (mean: 14.8 ± 2.1 years) and 16 females (mean: 13.7 ± 2.5 years). It is a cross-sectional descriptive study, conducted in 2013, two DS treatment referral centers located in the city of Campinas (São Paulo - Brazil). This study was approved by the Ethic Committees for Human Being Research of the School of Medical Sciences (FCM); University of Campinas (UNICAMP), and was conducted in accordance with the declaration of Helsinki for human studies – under number 783/2011, and only participated in the study adolescents with written permission of their parents and/or guardians.

METHODS

Two techniques were used: to assess the nutritional status BMI and DXA for body composition.

ANTHROPOMETRY

To calculate BMI, weight and height of adolescents' measurements were made, according to standardized procedures (23). Weight was measured (kg) using portable digital scales to the nearest 0.1 kg. Height was measured (cm) using a vertical stadiometer to the nearest 0.1 cm. From those measurements, BMI was calculated using the formula (kg/m^2). BMI values was analyzed according to data from the International Obesity Task Force (IOTF) (24) and the World Health Organization (WHO) (25) and converted to standard deviation scores (z-score), according to each of these two international reference parameters. The adolescent was considered obese when he presented the z-score ≥ 2, for these two references. It was also rated the BMI according to the specific references to the DS structured by Myrelid et al. (16) and Styles et al. (17). As Myrelid et al. (16), the adolescent was considered obese when his BMI was ≥ 2 Standard Deviation (SD). While, according to Styles et al. (17), the adolescent was considered obese when his BMI was ≥ percentile 98 (P98).

BODY COMPOSITION ASSESSMENT

Body composition was analyzed using whole-body DXA equipment (Lunar iDXA - GE Healthcare - USA). With regard to the %BF obtained by DXA, the adolescents was considered obese when the %BF was ≥ P90, according to the classification of the NHANES (26). To assess the frequency of obesity according to each BMI reference in relation to %BF estimated by DXA, the adolescents were classified into two groups, eutrophic (including normal and overweight) and obese.

STATISTICAL ANALYSIS

Data was presented as mean, variance, absolute and relative frequencies. For evaluation of variables according to sex the Mann-Whitney test. For comparing the frequency of obesity according to several references was used Fisher's exact test. For the analysis of correlation between the diagnostic of obesity references the z-score of BMI by IOTF, by WHO in relation to %BF by DXA was employed by the Spearman correlation coefficient. Regarding the %BF by DXA, Receiver Operating Characteristic curves (ROC curves) were constructed to determine the cut-off weight and BMI of adolescents with DS for the diagnosis of obesity. For all statistical analysis was considered significant difference when $p \leq 0.05$.

RESULTS

A total sample of 34 adolescents were evaluated, 18 males (52,9%) and 16 females (47,0%).

Table I shows the general characteristics of the 18 boys and 16 girls with DS. There was no statistically significant difference

Table I. General characteristics of the sample of the 34 adolescents with Down syndrome

Variable	Males (n = 18)		Females (n = 16)		
	Mean ± SD	Variation	Mean±SD	Variation	p*
Age (years)	14,8 ± 2,1	10,6-17,8	13,7 ± 2,5	10,0-17,4	0,198
Height (m)	1,49 ± 0,09	1,32-1,62	1,42 ± 0,06	1,33-1,54	0,010
Weight (kg)	57,9 ± 11,7	32,4-73,7	53,6 ± 13,0	35,5-83,3	0,211
BMI (kg/m^2)	25,7 ± 4,5	18,6-32,7	26,3 ± 5,8	18,2-41,9	0,959
BMI IOTF (z-score)	1,68 ± 0,92	-0,01-2,99	1,81 ± 1,02	-0,59-3,41	0,721
BMI WHO (z-score)	1,67 ± 0,96	-0,40-3,12	1,77 ± 1,12	-0,85-3,57	0,670
BF DXA (%)	30,59 ± 9,4	13,8-48,8	41,92 ± 7,41	27,4-50,7	0,001

** Mann-Whitney test. BMI: body mass index; IOTF: International Obesity Task Force; WHO: World Health Organization; BF: Body fat; DXA: Dual energy X-ray absorptiometry; SD: standard deviation.*

between genders for age, weight, BMI, BMI z-score of the IOTF and the WHO. A significant statistical difference only at the time, with higher values in boys, and %BF estimated by DXA, with higher values in girls.

All references evaluating BMI were associated with the %BF assessed by DXA in the diagnosis of obesity in this sample (Table II).

The correlation between the %BF by DXA and BMI by several references was positive and significant, $r = 0.61$ with BMI (kg/m^2) ($p < 0.001$), $r = 0.68$ with z-score of BMI by IOTF ($p < 0.001$) and $r = 0.74$ with BMI z-score by WHO ($p < 0.001$).

Using the ROC curve, in relation to the %BF by DXA, all parameters showed high sensitivity, but the z-score of BMI by WHO

Table II. Obesity frequency of 34 adolescents with Down syndrome according to each BMI reference in relation to percentage body fat (%BF) by DXA

Variable		%BF (DXA)*		Obesity frequency (%)	p**
		Eutrophic	Obesity		
BMI IOTF	Eutrophic	18	3		0,001
	Obesity	2	11	38,2%	
BMI WHO	Eutrophic	14	0		0,001
	Obesity	6	14	58,8%	
BMI Styles et al.	Eutrophic	15	0		0,001
	Obesity	5	14	55,9%	
BMI Myrelid et al.	Eutrophic	17	5		0,005
	Obesity	3	9	35,3%	
%BF (DXA)	Eutrophic	20	-		
	Obesity	-	14	41,2%	

**NHANES, 2011; **Fisher's exact test. BMI: body mass index; IOTF: International Obesity Task Force; WHO: World Health Organization; %BF: percentage body fat; DXA: Dual energy X-ray absorptiometry.*

Table III. Parameters of the ROC curve for the diagnosis of obesity in 34 adolescents with Down syndrome

Variable	AUC ± SE	CI95%	p	Criterion	Sen (%)	Spe (%)	Accuracy (%)
Weight (kg)	0,76 ± 0,08	0,60-0,92	0,010	> 49,5	92,86	55,00	68
BMI (kg/m^2)	0,90 ± 0,05	0,80-1,00	0,000	> 26,26	92,86	80,00	79
Z-score IOTF	0,93 ± 0,04	0,84-1,00	0,000	> 2,11	100,00	75,00	85
Z-score WHO	0,93 ± 0,04	0,84-1,00	0,000	> 2,14	92,86	85,00	82

AUC: area under curve; SE: standard error; CI95%: confidence interval of 95%; Sen: sensitivity; Spe: specificity; BMI: body mass index; IOTF: International Obesity Task Force; WHO: World Health Organization; %BF: percentage body fat; DXA: dual energy X-ray absorptiometry.

showed better specificity (85%) with an accuracy of the 82% for the cut-off point above 2.14 (Table III).

DISCUSSION

In the general population, the use of BMI to assess obesity has high association with %BF by DXA (27), as well as with the risk in long-term comorbidities (28). However, in people with DS, the use of BMI, due to short stature (4,18) and the tendency to high weight (27), could lead to error, overestimating the diagnosis of obesity. In addition, one should remember that BMI does not differentiate fat mass in lean body mass (29). Therefore, this study sought to estimate the cutoff point of BMI and to verify the accuracy of these BMI references both to the general population (WHO and IOTF) and for people with DS (16,17) in diagnose obesity in relation to %BF analyzed by DXA.

The sample of adolescents with DS (18 males and 16 females) were analyzed together for not presenting significant differences between the gender, beyond that already expected as the height and %BF. Considering that only adolescents were included in this study, stage of life where sex hormones determine the difference in height and body composition between men and women.

In DS, several studies have evaluated children, adolescents, youth and adults, through the BMI, which have detected high levels of obesity (3,14,30). Considering the results of this study in relation to obesity, it was found that obesity was present among 58.8% (20 of 34 cases) of the adolescents with DS, when used references from the WHO (25) for the z-score and BMI 38.2% (13 of 34 cases) by IOTF (24). When used specific indicators of BMI for DS, 35.3% (12 of 34) were obese as references to Myrelid et al. (16) and 55.9% (19 of 34) according to the classification of Styles et al. (17).

According to the %BF by DXA, obesity was present in 41.1% (14 of 34) of adolescents with DS, showing that references the WHO (25) and Styles et al. (17) overestimated the obesity diagnosis in this group of teenagers evaluated for %BF, while references to Myrelid et al. (16) and the IOTF (24) underestimated, despite all these references used present good association with the %BF by DXA. In accordance with a New Zealand study using bioimpedance to assess %BF by means of three equations, Loveday et al. (14) compared and validated the results in relation to the %BF obtained by DXA, in 70 cases of DS aged 5 to18 years and concluded that the bioelectrical impedance showed validity to measure the %BF (14).

Regarding the correlation of %BF by DXA with different BMI references the general population (IOTF and WHO) in obesity assessment, the results of this study showed good correlation, the most significant correlation with the z-score of the BMI by WHO ($r = 0.74$). In accordance with Bandini et al. (31) who evaluated the excess body fat in 32 cases of DS, aged 13 and 21 years, through the BMI of National Center for Disease Control and Prevention (CDC) 2000, found moderate correlation between BMI and %BF ($r = 0.50$). Already Hill et al. (32), assessed the resting energy expenditure and adiposity through the z-score for BMI, skin folds and DXA in 28 children with DS and 35 in a control group without the syndrome, noted a strong correlation of the %BF obtained from measurements of skinfold thickness and DXA ($r = 0.97$) and concluded that skin folds can be used to estimate body fat instead of DXA, without leading to important errors, although there are not specific folds equations skin for people with DS.

In this study, despite the association of all references that evaluated the BMI with the %BF estimated by DXA for diagnosis of obesity in adolescents with DS, the cutoff point above 2.14 assessed by the BMI of WHO (25) showed the best specificity (85%), with an accuracy of 82%. This result was similar to Bandini et al. (31) who observed the cutting bridge above the CDC 2000 P95 with better sensitivity and specificity for the determination of excess body fat in relation to %BF obtained by the DXA. However, it is important to note that the absence of reference values for the correct analysis of the cutoff points for BMI and DXA criteria for children and adolescents with DS hinder its exact applicability.

Considering the results of this study and others cited here for evaluation of %BF in children and adolescents with DS, it was found that, regardless of the methods used is high excess fat percentage and that there is a need to establish specific criteria and reference values for this population.

Limitations of this study were the sample size and the use of %BF obtained by the DXA in relation to the general population according NHANES (26).

We believe that the criteria that use the BMI (WHO and IOTF) for estimating obesity, as well as references based on specific curves for the population with DS are associated with %BF estimated by the DXA and concluded that the cutoff point of z-score above of 2.14 of WHO presented the best specificity with an accuracy of 82%.

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REFERENCES

1. Glasson EJ, Sullivan SG, Hussain R, Petterson BA, Montgomery PD, Bittles AH. The changing survival profile of people with Down's syndrome: implications for genetic counselling. Clin Genet 2002;62(5):390-3.
2. Pinheiro AC, Urtega CR, Cañete GS, Atalah ES. Evaluación del estado nutricional en niños con síndrome de Down según diferentes referencias antropométricas. Rev Chil Pediatr 2003;74(6):585-9.
3. Van Gameren-Oosterom HBM, van Dommelen P, Schöbeck Y, Oudesluys-Murphy AM, van Wouwe JP, Buitendijk SE. Prevalence of overweight in Dutch children with Down syndrome. Pediatrics 2012;130(6):e1520-6.
4. González-Agüero A, Ara I, Moreno LA, Vicente-Rodríguez G, Casajús JA. Fat and lean masses in youths with Down syndrome: gender differences. Res Dev Disabil 2011;32(5):1685-93.
5. Esposito PE, MacDonald M, Hornyak JE, Ulrich DA. Physical activity patterns of youth with Down syndrome. Intellect Dev Disabil 2012;50(2):109-19.
6. Grammatikopoulou MG, Manai A, Tsigga M, Tsiligiroglou-Fchantidou A, Galli-Tsinopoulou A, Zakas A. Nutrient intake and anthropometry in children and adolescents with Down syndrome - a preliminary study. Dev Neurorehabil 2008;11(4):260-7.
7. Pitetti K, Baynard T, Agiovlasitis. Children and adolescents with Down syndrome, physical fitness and physical activity. J Sport Health Sci 2013;2(1):47-57
8. Izquierdo-Gómez R, Martínez-Gómez D, Tejero-González CM, Cabanas-Sánchez V, Ruiz JR, Veiga OL. Are poor physical fitness and obesity two features of the adolescent with Down syndrome? Nutr Hosp 2013;28(4):1348-51.

9. Freeman SB, Bean LH, Allen EG, Tinker SW, Locke AE, Druschel C, et al. Ethnicity, sex, and the incidence of congenital heart defects: a report from the National Down Syndrome Project. Genet Med 2008;10(3):173-80.
10. Vilas Boas LT, Albernaz EP, Costa RG. Prevalence of congenital heart defects in patients with Down syndrome in the municipality of Pelotas, Brazil. J Pediatr (Rio J) 2009;85(5):403-7.
11. Kusters MAA, Verstegen RH, Gemen EF, de Viries E. Intrinsic defect of the immune system in children with Down syndrome: a review. Clin Exp Immunol 2009;156(2):189-93.
12. Shete MM, Stocks RMS, Sebelik ME, Schoumacher RA. Effects of adeno-tonsillectomy on polysomnography patterns in Down syndrome children with obstructive sleep apnea: a comparative study with children without Down syndrome. Int J Pediatr Otorhinolaryngol 2010;74(3):241-4.
13. Van Goor JC, Massa GG, Hirasing R. Increased incidence and prevalence of diabetes mellitus in Down's syndrome. Arch Dis Child 1999;77(2):183-8.
14. Loveday SJ, Thompson J, Mitchell EA. Bioelectrical impedance for measuring percentage body fat in young persons with Down syndrome: validation with dual-energy absorptiometry. Acta Paediatr 2012;101(11):e491-5.
15. González-Agüero A, Matute-Llorente A, Gómez-Cabello A, Casajús JA, Vicente-Rodríguez G. Effects of whole body vibration training on body composition in adolescents with Down syndrome. Rev Dev Disabil 2013;34(5)1426-33.
16. Myrelid A, Gustafsson J, Ollars B, Anneren G. Growth charts for Down's syndrome from birth to 18 years of age. Arch Dis Child 2002;87(2):97-103.
17. Styles M, Cole T, Dennis J, Preece M. New cross sectional stature, weight and head circumference references for Down's syndrome in the UK and Republic of Ireland. Arch Dis Child 2002;87(2):104-8.
18. Cronk C, Crocker A, Pueschel S, Shea AM, Zackai E, Pickens G, et al. Growth chards for children with Down syndrome: 1 month to 18 years of age. Pediatrics 1988;81(2):102-10.
19. Al Husain M. Body mass index for Saudi children with Down's syndrome. Acta Paediatr 2003;92(12):1482-5.
20. Bertapelli F, Martin JE, Gonçalves EM, de Oliveira Barbeta VJ, Guerra-Júnior. Growth curves in Down syndrome: implications for clinical practice. Am J Med Genet A 2014;164A(3):844-7.
21. Knapp KM, Welsman JR, Hopkins SJ, Schallcross A, Fogelman I, Blake GM. Obesity increases precision errors in total body dual-energy x-ray absorptiometry measurements. J Clin Densitom 2015;18(2):209-16.
22. De Miguel-Etayo P, Moreno LA, Santabárbara J, Martín-Matillas M, Piqueras MJ, Rocha-Silva D, et al. Anthropometric indices to assess body-fat changes during a multidisciplinary obesity treatment in adolescents: EVAYON Study. Clin Nutr 2015;34(3):523-8.
23. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Champaign: Human Kinetics; 1988.
24. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes 2012;7(4)284-94.
25. De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ (WHO) 2007;85(9):660-7.
26. Ogden CL, Li Y, Freedman DS, Borrud LG, Flegal KM. Smoothed percentage body fat percentiles for U.S. children and adolescents, 1999-2004. Natl Health Stat Report 2011;9(43):1-7.
27. Heo M, Wylie-Rosett J, Pietrobelli A, Kabat GC, Rohan TE, Faith MS. US pediatric population-level associations of DXA-measured percentage of body fat with four BMI metrics with cutoffs. *Int J Obes* (Lond) 2014;38(1):60-8.
28. Martin L, Oepen J, Reinehr T, Wabitsch M, Claussnitzer G, Waldeck E, et al. Ethnicity and cardiovascular risk factors: evaluation of 40.921 normal-weight, overweight or obese children and adolescents living in Central Europe. Int J Obes (Lond) 2015;39(1):45-51.
29. Must A, Anderson SE. Body mass index in children and adolescents: considerations for population-based applications. Int J Obes (Lond) 2006;30(4):590-4.
30. Miyazaki Y, Okumiya A. Prediction of obesity in Down syndrome individuals using BMI and blood pressure records. J Phys Ther Sci 2004;16(1):65-71.
31. Bandini LG, Fleming RK, Scampini R, Gleason J, Must A. Is body mass index a useful measure of excess body fatness in adolescents and young adults with Down syndrome? J Intellect Disabil Res 2013;57(11):1050-7.
32. Hill DL, Parks EP, Zemel BS, Shults J, Stalling VA, Stettler N. Resting energy expenditure and adiposity accretion among children with Down syndrome: a three year prospective study. Eur J Clin Nutr 2013;67(10):1087-91.

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Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Determinación del índice glucémico y la carga glucémica de productos lácteos fermentados en sujetos adultos sanos, sedentarios y deportistas

Determination of the glycemic index and glycemic load of fermented dairy products in sedentary healthy adults and athletes

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Resumen

Introducción: el índice glucémico (IG) y la carga glucémica (CG) de productos lácteos fermentados (PLF) con lactobacilos puede ser una recomendación útil para pacientes diabéticos y para la población en general.

Objetivo: el objetivo del estudio fue medir el IG y la CG de PLF con lactobacilos en sujetos sedentarios y deportistas, y evaluar si existe diferencia entre ellos.

Métodos: el estudio se realizó en México (DF) de acuerdo con la ISO26642:210 (Organización Internacional de Normalización). Los participantes fueron: 10 sedentarios y 10 deportistas. Los PLF analizados fueron: Soful, Yakult, Gastroprotect, BeneGastro, Bonacult, Lala Bio 4 y leche descremada con sacarosa (LDS) y la cantidad de alimento que ingirieron dependió de ajustar a 25 g los HC en la porción.

Resultados: el IG de la mayoría de los PLF fue bajo para ambos grupos de sujetos; en los deportistas los PLF Yakult y Bonacult presentaron los mayores IG y solo el Yakult puede considerarse como de IG medio para este grupo; estos dos PLF presentaron la menor relación de proteína/HC. La LDS, lácteo con los HC no fermentados, presentó un IG alto para ambos grupos. La CG de los PLF se encontró entre 4 a 7,6 y solo Gastroprotect presentó estadísticamente la menor CG, lo que pudo deberse a su bajo IG, aun cuando su tamaño de ración no fue la menor, entre los PLF.

Conclusión: en general los valores de IG y CG de los PLF fueron bajos para ambos grupos. Por tanto, su consumo puede recomendarse en forma moderada. El IG y CG entre productos lácteos con azúcares fermentados y con azúcares no fermentados fueron diferentes.

Palabras clave:

Índice glucémico.
Carga glucémica.
Productos lácteos fermentados.
Sedentarios.
Deportistas.

Abstract

Introduction: Glycemic Index (GI) and glycemic load (GL) of natural dairy products fermented with lactobacilli may be useful for diabetic patients and the general population.

Objective: To measure the GI and GL in natural dairy products fermented with lactobacilli in sedentary individuals and athletes, and seeing if there is any difference between them.

Methods: The study was conducted in Mexico City (DF) according to the ISO26642:210, with a group of 10 sedentary individuals and 10 athletes. The GI was determined in the following diary drinkable products, all adjusted to contain 25 g of carbohydrates: Soful, Yakult, Gastroprotect, BeneGastro, Bonacult, Lala Bio 4 and Skimmed milk with sucrose (SMS).

Results: The GI of most dairy fermented products were low for sedentary and athletes, but in athletes Yakult and Bonacult showed the highest GI and Yakult's GI can be considered as medium for these group; these two dairy products had the lowest protein/carbohydrates ratio. SMS, which contain unfermented carbohydrates, had the highest GI in both groups. The GL of dairy fermented products was 4 to 7.6 and only Gastroprotect had statistically the lowest GL, it may be due to its low GI, even its serving size was not the least among dairy fermented products.

Conclusion: The GI and GL levels were relatively low for all the dairy products considered on each of the groups studied, therefore the moderate consumption of these can be recommended.

Key words:

Glycemic index.
Glycemic load.
Fermented milk products. Sedentary lifestyle. Athletes.

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INTRODUCCIÓN

La ingestión de alimentos con bajo IG es útil para las personas diabéticas, porque permite controlar su glucemia sanguínea (1) y en la población en general para prevenir o evitar la obesidad; también puede aplicarse al ámbito de los deportes (2), como herramienta en la nutrición deportiva, para mejorar la primera y segunda fase de recuperación del glucógeno, la carga del metabolismo durante el ejercicio e inclusive el control de la hipoglucemia.

La CG es un concepto más novedoso que no solo valora la rapidez con que los hidratos de carbono (HC) de un alimento se convierten en glucosa sanguínea, sino que también considera la cantidad de HC que tiene una ración del alimento (2), un alimento con CG alta tiene un valor de 20 o más. Si la CG va de 11 a 19 es media. Los valores de CG por debajo de 10 son bajos. Se creó para representar el efecto glucémico global de una dieta donde se toma en cuenta el tamaño habitual de la ración (3).

El consumo de alimentos con IG bajo facilita la liberación de la glucosa en la sangre de manera uniforme durante el día (4), incrementa la oxidación de los lípidos y la producción de energía, con la consiguiente preservación y disponibilidad de fuentes de glucosa durante el ejercicio; mientras que los alimentos o bebidas con un IG elevado permiten reponer el glucógeno muscular después del ejercicio (5).

Estudios realizados sobre la nutrición de deportistas, practicantes de actividad física y modelación corporal, así como de aquellos que quieren conservar su peso por regulación de la alimentación, consideran que una dieta óptima es aquella que incluye glúcidos de bajo IG, porque a corto plazo se disminuye la sensación de hambre y a largo plazo se reduce la incidencia de la obesidad y enfermedades crónicas asociadas (6), como la aparición de la diabetes tardía y la cardiopatía coronaria (7), lo que posiblemente se deba a la limitación de la demanda de insulina y a que mejoran la concentración del colesterol sanguíneo; sin embargo, no se sabe si se debe al IG o a otros aspectos del alimento (8).

Diversas investigaciones han concluido que la leche fermentada tiene efectos antihipertensivos, anticancerígenos y de regulación del sistema inmune, y algunos lácteos fermentados poseen propiedades antiinflamatorias y antioxidantes (9). Por otra parte, la inclusión de lácteos fermentados en el desayuno ha probado bajar la glicemia postpandrial (10). De los productos estudiados, solamente Yakult presenta en su etiqueta el valor de IG de 38,8; sin embargo, en la literatura especializada se informa un valor de 46,6 (11), lo que demuestra que existe variación en los valores de IG publicados para alimentos con la misma descripción. Estas diferencias podrían atribuirse a la técnica analítica utilizada en la determinación y a las características étnicas de la población participante en el estudio, entre otros. Actualmente, y con el objetivo de homogeneizar los criterios, para la obtención de valores de IG en alimentos, la FAO/WHO (12) y la Organización Internacional de Normalización (ISO) han establecido métodos analíticos para la obtención de valores de IG en alimentos; el más reciente es el descrito en la Norma ISO 26642 (13).

OBJETIVOS

El objetivo del presente trabajo fue medir el IG y calcular la CG de 6 productos lácteos fermentados, en sujetos sedentarios y deportistas sanos, así como establecer si existen diferencias en los valores de IG y CG entre los grupos de sujetos para el mismo producto lácteo; de igual manera, dentro de cada grupo se trató de determinar las diferencias entre el IG y CG de lácteos con azúcares fermentados *versus* lácteos con azúcares no fermentados.

MATERIALES Y MÉTODOS

La determinación del IG de todos los productos lácteos se realizó de acuerdo con el método ISO26642:210 (13). Adicionalmente al procedimiento descrito en la norma, se consideraron los puntos que se detallan a continuación.

CARACTERÍSTICAS DE LOS SUJETOS Y CRITERIOS DE INCLUSIÓN

Un grupo de 10 sujetos sedentarios de 19 a 35 años de edad y 10 sujetos deportistas de 22 a 53 años de edad participaron en el estudio. En ambos grupos se estableció que los participantes no fueran diabéticos o tuvieran alguna enfermedad crónica y no estuvieran consumiendo medicamentos. Los sujetos deportistas seleccionados deberían practicar regularmente algún deporte, de preferencia en un centro deportivo.

El trabajo fue aprobado por el Comité de Ética del Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán. Los participantes leyeron y firmaron un consentimiento informado.

Los participantes tuvieron una entrevista con la nutrióloga, quien registró su peso y la talla, para lo que se utilizó un equipo marca Braunker. Adicionalmente se les proporcionó una dieta, de 300 g/día en HC, indicándoles que no deberían consumir leguminosas (frijoles, habas, chícharos), ni bebidas alcohólicas durante el tiempo que dura el estudio.

Las características físicas del grupo sedentario y deportistas se detallan en la tabla I.

CARACTERÍSTICAS Y PREPARACIÓN DE LOS ALIMENTOS LÁCTEOS

Los producto lácteos fermentados estudiados adquiridos en tiendas de autoservicio fueron: Soful, Yakult, Gastroprotect, BeneGastro, Bonacult y Lala Bio 4. La Norma ISO, establece que se debe proporcionar al participante una cantidad de alimento que contenga 50 g de HC para realizar la prueba; sin embargo, permite utilizar, dependiendo del tamaño de la porción, una cantidad de alimento con 25 g, por lo que en este estudio a los participantes se les presentó esta opción. Es importante mencionar que también se incluyó una muestra de leche descremada, la cual se preparó con una concentración similar de HC, proteína y grasa

Tabla I. Características físicas del grupo de sujetos sanos sedentarios y deportistas

Parámetros	Total (n = 10)	Mujeres (n = 7)	Hombres (n = 3)
	Promedio ± DE		
Sujetos sanos sedentarios			
Edad (años)	22,6 ± 0,84	22,71 ± 0,95	22,3 ± 0,58
Peso (kg)	62,5 ± 9,47	59,29 ± 9,69	70,00 ± 1,00
Talla (m)	1,66 ± 0,06	1,63 ± 0,06	1,72 ± 0,03
IMC (kg/m^2)	22,57 ± 1,92	22,06 ± 2,09	23,76 ± 0,65
		Mujeres (n = 2)	Hombres (n = 8)
Sujetos sanos deportistas			
Edad (años)	33,10 ± 9,6	27,00 ± 7,07	34,06 ± 9,90
Peso (kg)	69,90 ± 12,7	53,00 ± 8,40	74,1 ± 9,70
Talla (m)	1,60 ± 0,08	1,59 ± 0,02	1,70 ± 0,08
IMC (kg/m^2)	25,50 ± 2,80	21,10 ± 3,96	25,60 ± 1,90

cruda, a la que contienen, de promedio, los productos lácteos fermentados; para tal efecto a 200 ml de leche se le adicionaron 70 ml de agua y 15 g de sacarosa.

En la tabla II se presenta la composición química de cada producto lácteo y la cantidad de producto lácteo (CPL) con 25 g de HC.

DETERMINACIÓN DEL ÍNDICE GLUCÉMICO

Para el estándar de glucosa

El IG se determinó en los dos grupos con previo ayuno de 12 horas. Después de tomar la muestra basal (tiempo 0) se les proporcionó el estándar de glucosa, 25 g de glucosa anhidra disuelta en 250 ml de agua. Se obtuvieron muestras de sangre capilar a los tiempos 0, 15, 30, 45, 60, 90 y 120 minutos por medio de punción en la yema del dedo con una lanceta automática. La sangre se recolectó en un capilar con heparina; posteriormente, la sangre recolectada en dos capilares se depositó en un tubo eppendorf de 0,5 ml para realizar la medición de glucosa sanguínea en un equipo Biochemistry Analyzer YSI 2700.

Se obtuvieron tres mediciones con el estándar de glucosa y se obtuvo el promedio; este valor se empleó como referencia para determinar el IG de los productos lácteos fermentados y la leche descremada.

Índice glucémico. Área bajo la curva de glucemia durante dos horas que se produce por el consumo de cierto alimento comparado con el incremento que se produce al consumir un alimento de referencia como glucosa.

$$IG = \frac{\text{Área bajo la curva de glicemia 2 horas depués de consumir el alimento}}{\text{Área bajo la curva de glicemia 2 horas después de consumir 25 g de glucosa (estándar}} \times 100$$

Para los alimentos lácteos fermentados y la leche descremada

La metodología para determinar el IG de los productos lácteos fermentados y la LDS fue igual a la que se aplicó para el estándar de glucosa. Es importante mencionar que a cada sujeto se le proporcionó un producto lácteo diferente por sesión, de forma aleatoria y de acuerdo con un diagrama de bloques.

DETERMINACIÓN DE LA CARGA GLUCÉMICA

Se basa en el concepto del índice glucémico y proporciona una medida de la respuesta glucémica total de una persona cuando ingiere un alimento o platillo.

Tabla II. Composición química de los productos lácteos fermentados en g o mg/100 g* y cantidad de producto lácteo con 25 g de HC disponibles (CPL)

Nutrimento	Soful	Yakult	Gastroprotect	BeneGastro	Bonacult	Lala Bio 4	LDS+
	(g / 100 g) o (mg / 100 g)						
Proteínas g	2,80	1,20	2,90	1,90	1,20	2,70	2,29
Grasas g	0,60	0,05	1,20	0,90	0,00	0,90	0,73
HC totales g	7,20	14,89	13,60	14,40	15,20	13,30	11,04
Sodio mg	46,00	15,20	60,00	34,60	19,90	43,00	39,18
Calcio mg	157,00	42,20	95,50	72,90		93,00	86,78
CPL g	347,00	168,00	184,00	174,00	165,00	188,00	226,43

** Cantidades que se obtuvieron con la información de la etiqueta comercial de cada producto lácteo fermentado.*

+ Composición aproximada de la leche descremada con sacarosa adicionada (LDS), que se obtuvo por cálculo, se consideró una densidad de la leche descremada de 1,034 g/ml.

Es el resultado de multiplicar el valor del IG por la cantidad en gramos de los HC en una ración de dicho alimento.

$$CG = \frac{IG * (g \text{ de HC en una ración})}{100}$$

Se consideran valores altos de CG aquellos que sobrepasan el valor de 20; mientras que los de baja carga glucémica son aquellos cuyos valores son inferiores a 10.

CONTROL DE CALIDAD DE LAS MEDICIONES

Para que la curva patrón de glucosa sea válida, el coeficiente de variación entre las mediciones debe ser ≤ del 30%; si resulta mayor es posible eliminar una curva, pero si, aun así, es mayor o igual al 30% es necesario repetir la medición.

En este estudio se obtuvo el promedio y dos desviaciones estándar (2DS) de las 10 mediciones realizadas a los productos lácteos y a la leche descremada, el resultado de cada sujeto se aceptó cuando se encontró dentro del intervalo de las 2DS; de lo contrario se repitió la determinación en dicho sujeto (13).

ANÁLISIS ESTADÍSTICO

Para determinar las diferencias en el IG y CG entre productos lácteos en el mismo grupo de sujetos, se realizó un ANOVA con una significancia de 0,05. En aquellos grupos que informaron diferencia se aplicó una prueba de comparación múltiple de Duncan. Para determinar diferencias entre grupos de sujetos para el mismo producto lácteo se utilizó una prueba t para muestras relacionadas con una significancia de 0,05.

RESULTADOS

En el grupo de los deportistas predominó el género masculino (Tabla I), lo que se atribuyó a que fue más fácil que los hombres aceptaran participar en el estudio, aunque tener un grupo con igual número de mujeres y hombres no fue prioridad en este estudio.

Los deportistas tenían en promedio 10,87 ± 9,11 años de entrenamiento con un tiempo de 8,12 ± 2,56 horas/semana. Por sesión realizaron 61,25 ± 27,13 minutos de ejercicio cardiovascular y 39,37 ± 33,17 minutos de fuerza (con pesas); es decir, en promedio los sujetos deportistas estudiados tuvieron en promedio 487 ± 153 min de entrenamiento por semana.

Los productos lácteos fermentados presentaron un IG bajo para ambos grupos (Tabla III); en el grupo sedentario no se observaron diferencias estadísticas en el IG entre los productos lácteos fermentados estudiados; el valor promedio se encontró debajo de 55 (13); sin embargo, para los deportistas, el producto lácteo Yakult, con un IG de 59,98 que no puede considerarse de IG bajo, y Bonacult presentaron IG significativamente mayores. Lo anterior pudo deberse al menor contenido proteico y de grasa de estos lácteos con respecto a los demás lácteos fermentados (Tabla II).

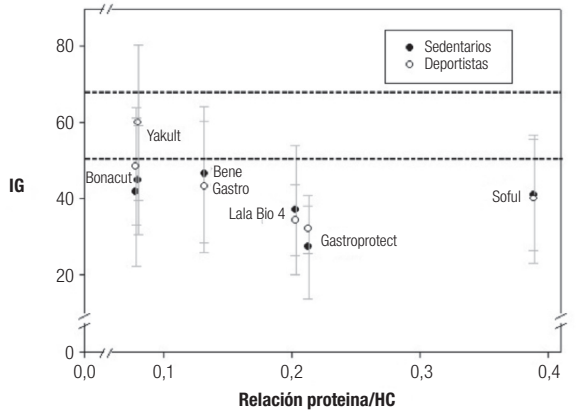
Tabla III. Índice glucémico (IG) de productos lácteos fermentados por grupo*

Producto lácteo	Sedentarios	Deportistas	p
	IG (promedio ± DS)		
Soful	41,03 ± 14,66[a]	39,98 ± 16,76[a]	0,778
Yakult	44,88 ± 14,37[a]	59,98 ± 20,42[b]	0,072
Gastroprotect	27,36 ± 13,51[a]	32,03 ± 6,28[a]	0,564
BeneGastro	46,44 ±17,97[a]	43,26 ± 17,19[a]	0,482
Bonacult	41,87 ± 19,46[a]	48,57 ± 15,39[b]	0,929
Lala Bio 4	37,09 ± 17,02[a]	34,37 ± 9,28[a]	0,365
Leche	71,07 ± 30,28[b]	77,66 ± 23,76[c]	0,267

**La misma letra por columna indica que no hay diferencia significativa.*

Los IG de los productos lácteos fermentados entre grupos de sujetos no fueron estadísticamente diferentes y se puede decir que no hubo efecto en el IG por ser sujeto deportista o sedentario.

En la figura 1 se observa que la mayoría de los productos lácteos estudiados, a excepción del Yakult para los deportistas, pueden considerarse de IG bajo para ambas poblaciones. En los productos lácteos estudiados, el IG disminuyó en los productos con una mayor relación de proteína/HC, esta resultó de dividir el contenido de proteína entre el contenido de HC en 100 g de producto lácteo, situación que se cumplió para la mayoría de los productos lácteos estudiados. La excepción fue el producto lácteo Soful, ya que el IG obtenido para este producto lácteo, a pesar de que la relación proteína/HC es la mayor, no presentó un IG menor con relación a los demás productos estudiados.



Las líneas punteadas marcan los límites para establecer un alimento como de índice glicémico bajo, medio y alto.

Figura 1.

Índice glicémico de los productos lácteos fermentados respecto a su relación de proteína/HC.

La LDS, producto lácteo que contenía los azúcares no fermentados, tuvo un IG mayor que el de las leches fermentadas. Lo anterior permite establecer que la fermentación tiene efecto positivo y reduce el IG en los productos lácteos; también se debe considerar que los HC contenidos en los productos lácteos fermentados no son libres, como en el caso de esta muestra considerada testigo. Es de interés mencionar que la LDS tuvo una relación de proteína/HC de 0,21 similar a la de Gastroprotect.

En la tabla IV se observa que la CG fue menor a 10 para todos los productos lácteos fermentados, valor que se encuentra en el intervalo de CG baja aun considerando su desviación estándar. Para el grupo sedentario BeneGastro obtuvo la CG mayor *versus* aquellos productos cuyo tamaño de ración se encontró cercana a los 100 g. En el grupo de deportistas Yakult presentó la CG mayor; lo que podría deberse al porcentaje de sólidos solubles en este lácteo o, más específicamente, al contenido de azúcares reductores; coincidentemente estos productos lácteos obtuvieron el mayor IG en sus respectivos grupos. La LDS obtuvo la mayor CG de los productos estudiados como era de esperarse, y Gastroprotect presentó estadísticamente la menor CG en ambos grupos.

La CG entre los grupos de sujetos para un mismo lácteo no fue estadísticamente diferente, por lo que ser deportista o sedentario no determinó la CG de los productos lácteos.

DISCUSIÓN

La variación en el IG de un alimento puede deberse:

- A la forma en que se toma la muestra de sangre, ya sea por medio de punción en la vena o sangre capilar. Algunos métodos de determinación de IG pueden incluir alguna de estas formas de obtención de sangre
- Al uso de diferentes tablas de composición de alimentos para calcular la porción requerida de alimento a probar, o
- Al método para calcular el área bajo la curva (11,14).

Estas fuentes de variación no se presentaron en este estudio, por lo que se deduce que la variación se puede deber al alimento, a la variación entre lotes de fabricación, o a las características de la población participante. En algunas investigaciones se hace referencia al cambio de materia prima y a diferentes condiciones de elaboración cuando se estudian productos similares de diferentes fabricantes (11).

En el presente trabajo no se encontraron diferencias estadísticas en el IG entre población sedentaria y deportista para los productos lácteos estudiados; sin embargo, Yakult se acercó a la significancia con una $p = 0,072$, lo que nos hace pensar que, si se incrementa el número de sujetos, la diferencia en el IG para este producto lácteo podría ser significativa. Al evaluar el IG de cereales para desayuno en estudios realizados por Mettler y col. (15,16) se encontró diferencia en el valor IG del alimento entre dos grupos de deportistas con diferente intensidad de entrenamiento, 163 ± 55 y 659 ± 192 minutos/semana y sedentarios. El IG del cereal fue mayor en los sujetos sedentarios que en los deportistas, lo que se atribuyó al tiempo de entrenamiento; sin embargo Trompers y cols. (17), quienes determinaron el IG de una barra energética, no encontraron estas diferencias entre población sedentaria y deportista. Estos hallazgos nos llevaron a suponer que encontrar diferencias en el IG de un producto alimenticio entre estas poblaciones depende del alimento más que de una diferencia en el metabolismo de los hidratos de carbono de cada grupo.

Originalmente el IG se utilizó para el manejo de pacientes diabéticos en nutrición clínica. Posteriormente se ha ampliado su aplicación y puede ser útil en el diseño de las raciones alimentarias del deportista. Las pruebas sugieren que el consumo de alimentos con IG elevado, previo al ejercicio puede ser perjudicial por la tendencia a producir durante el ejercicio hipoglicemia y reducir la oxidación de lípidos *versus* la de los HC. Estas desventajas se pueden eliminar si se consumen altas concentraciones de HC de elevado IG durante el esfuerzo. Cuando se realizan ejercicios prolongados de moderada intensidad, el beneficio de consumir HC de alto IG se asocia a mantener la glucemia; mientras que durante ejercicios de baja intensidad, el consumo de HC de alto IG puede reducir la oxidación de las grasas, situación no deseable en sujetos que realizan ejercicio como medio de reducir su tejido adiposo. Posterior al ejercicio, el consumo de HC de IG alto ha

Tabla IV. Carga glucémica (CG) de los productos lácteos por grupo*

Producto lácteo		Sedentarios	Deportistas	p
	Ración (g)+	CG (promedio ± DS)		
Soful	213,00	6,29 ± 2,25[b]	6,13 ± 2,57[b]	0,778
Yakult	85,13	5,69 ± 1,82[b]	7,60 ± 2,59[b]	0,829
Gastroprotect	110,00	4,09 ± 2,02[a]	4,79 ± 0,94[a]	0,561
BeneGastro	100,00	6,69 ± 2,59[b]	6,23 ± 2,48[b]	0,482
Bonacult	75,20	4,79 ± 2,22[b]	5,55 ± 1,76[b]	0,928
Lala Bio 4	120,00	5,92 ± 2,72[b]	5,49 ± 1,48[b]	0,365
Leche descremada	240,00	17,48 ± 7,45[c]	19,10 ± 5,84[c]	0,267

**Misma letra por columna indica que no hay diferencia significativa.*

+Cantidad de producto que se sugiere consumir o generalmente se consume en una ingestión, expresada en gramos.

demostrado utilidad en acelerar la reposición de los depósitos de energía y reducir el catabolismo proteico (18).

Otros investigadores han establecido su influencia en la homeostasis de la glucosa antes y durante el ejercicio y han demostrado cómo el IG puede modular la respuesta fisiológica para mejorar el rendimiento durante el ejercicio (19,20).

Los resultados obtenidos en el IG de los productos lácteos fermentados podrían atribuirse a la relación de proteína/HC, ya que esta relación tiene un mayor efecto de control glucémico que la relación grasa/HC (21). O'Connor y cols. (22) mencionan que productos lácteos fermentados se asociaron con un menor riesgo de diabetes porque el proceso de fermentación hidroliza a los HC y se forman disacáridos, polisacáridos y ácidos orgánicos, por lo que la biodisponibilidad de los HC disminuye. Mencionan también que existen otros mecanismos potenciales para explicar la relación de la disminución del riesgo de padecer diabetes de tipo 2 y el consumo de productos lácteos fermentados, como son la presencia de menaquinonas (vitamina K2) sintetizadas por el tejido animal, aunque también puede ser de origen microbiano. Unido a lo anterior, las bacterias probióticas presentes en los lácteos fermentados han demostrado mejorar el perfil lipídico y el estado antioxidante en individuos con diabetes de tipo 2 y tener efectos beneficiosos sobre las concentraciones de colesterol (22).

El resultado del IG obtenido para el producto lácteo Soful, que presentó la mayor relación de proteína/HC, se explica porque este producto fue probablemente adicionado con sacarosa, que es un HC de rápida absorción y la relación proteína/HC no influyó en el IG obtenido. Se han informado diferencias importantes en el valor del IG de los alimentos en función del tipo de azúcares, gomas, fibras o almidones que contienen (14,23,24); en el caso de las proteínas se ha comprobado que las proteínas lácteas tienen un efecto positivo en el control de peso, mejoran la sensibilidad de la insulina, el control glucémico y la dislipidemia, comportamiento que se relacionó con su significativo menor IG (25,26). Lo anterior sugiere que el Soful podría contener sólidos de leche o caseinatos, los cuales pueden modificar la relación de proteínas provenientes de la leche en el producto final y modificar su IG, situación que requiere estudiarse con más detalle. Otras investigaciones argumentan que los ácidos orgánicos en los lácteos fermentados tienen efecto glicémico e insulinémico (10); estos ácidos se forman durante la fermentación, lo que se debería a la cepa utilizada para la fermentación.

Las leches fermentadas en deportistas mejoran el metabolismo de la glucosa y disminuyen el dolor muscular después del ejercicio intenso (9); sin embargo, no hay información de cómo se manifiesta esta respuesta con el IG o CG del producto lácteo. Una hipótesis sería que a menor IG o CG se mejora esta respuesta.

El conocer del IG y CG de los alimentos ayuda a comprender su efecto en la dieta y puede evitar que grandes cargas de glucosa circulen en la sangre (2). En la actualidad no existen estudios IG y CG en productos lácteos fermentados en los que concretamente hayan experimentado en sujetos sedentarios y deportistas.

CONCLUSIÓN

Existe diferencia significativa entre el IG de la leche adicionada con sacarosa y el IG de los productos lácteos fermentados con lactobacilos, diferencia que no se observó entre el grupo de participantes sedentarios y el de deportistas. En general se obtuvo un bajo índice glucémico y carga glucémica para cada producto estudiado, en ambos grupos. Por tanto, es posible recomendar su consumo en forma moderada para personas sedentarias, deportistas y a la población en general. La relación de proteína/HC influye en el IG de la mayoría de los PLF estudiados y las excepciones tendrían que estudiarse.

BIBLIOGRAFÍA

1. Goto M, Morita A, Goto A, et al. Dietary glycemic index and glycemic load in relation to HbA1c in Japanese obese adults: a cross-sectional analysis of the Saku Control Obesity Program. Nutr Metab (Lond) 2012;9(1):79. DOI:10.1186/1743-7075-9-79.
2. Franco-Mijares AC, Cardona-Pimentel G, Villegas-Canchola KP, Vázquez-Flores AL, Jáuregui-Vega PI, Jaramillo-Barrón E. Sobre el índice glucémico y el ejercicio físico en la nutrición humana. El Resid 2013;8(3):89-96.
3. Wolever TM, Jenkins DJ, Jenkins AL, Josse RG. The glycemic index: methodology and clinical implications. Am J Clin Nutr 1991;54(5):846-54.
4. Opperman M, Venter CS, Oosthuizen W, Thompson R, Vorster H. Meta-analysis of the health effects of using the glycaemic index in meal-planning. Br J Nutr 2004;92(03):367-81. DOI:10.1079/BJN20041203.
5. Mondazzi L, Arcelli E. Glycemic Index in Sport Nutrition. J Am Coll Nutr 2009;28(sup4):455S - 463S. DOI:10.1080/07315724.2009.10718112.
6. Hernández D, Arencibia R, Bosques JJ. Índice glicémico y carga glicémica en la alimentación del deportista. efdeportes.com 2010;144(15). http://www.efdeportes.com/efd144/carga-glicemica-en-la-alimentacion-del-deportista.htm
7. Kelly S, Frost G, Whittaker V, Summerbell C. Low glycaemic index diets for coronary heart disease. Cochrane Database Syst. 2004;18(4):1-94. http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004467.pub2/pdf/standard. Accessed November 26, 2014.
8. Siu P, Wong S. Use of the glycemic index: effects on feeding patterns and exercise performance. J Physiol Anthropol Appl Human Sci 2004;23:1-6. http://jlc.jst.go.jp/JST.JSTAGE/jpa/23.1?from=Google. Accessed November 26, 2014.
9. Iwasa M, Aoi W, Mune K, et al. Fermented milk improves glucose metabolism in exercise-induced muscle damage in young healthy men. Nutr J 2013;12(1):83-90. DOI:10.1186/1475-2891-12-83.
10. Östman E, Liljeberg HG, Björck IME. Inconsistency between glycemic and insulinemic responses to regular and fermented milk products. Am J Clin Nutr 2001;(74):96-100. http://ajcn.nutrition.org/content/74/1/96.short. Accessed November 11, 2014.
11. Foster-Powell K, HA Holt S, Brand-Miller JC. International table of glycemic index and glycemic load values: 2002. Am J Clin Nutr 2002;76(2):5-56. http://ajcn.nutrition.org/content/76/1/5.full. Accessed November 11, 2014.
12. FAO, WHO. FAO/WHO Carbohydrates in human nutrition. Report of a Joint FAO/WHO Expert consultation. 1998:1-122.
13. The International Organization for Standardization. ISO 26642:2010 Food products- Determination of the glyceamic index (GI) and recommendation for food classification; 2010.
14. Aston LM, Gambell JM, Lee DM, Bryant SP, Jebb S. Determination of the glycaemic index of various staple carbohydrate-rich foods in the UK diet. Eur J Clin Nutr 2008;62(2):279-85. DOI:10.1038/sj.ejcn.1602723.
15. Mettler S, Lamprecht-Rusca F, Stoffel-Kurt N, Wenk C, Colombani PC. The influence of the subjects' training state on the glycemic index. Eur J Clin Nutr 2007;61(1):19-24. DOI:10.1038/sj.ejcn.1602480.
16. Mettler S, Wenk C, Colombani PC. Influence of training status on glycemic index. Int J Vitam Nutr Res 2006;76(1):39-44. DOI:10.1024/0300-9831.76.1.39.
17. Trompers W, Perry TL, Rose MC, Rehrer NJ. Glycemic and insulinemic response to selected snack bars in trained versus sedentary individuals. Int J Sport Nutr Exerc Metab 2010;20(1):27-33.

18. MacMillan N. Utilidad del Índice Glicémico en Nutrición Deportiva. Rev Chil Nutr. 2002;29(2):92-97. http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0717-75182002000200003. Accessed November 26, 2014.
19. Wright HH. The glycaemic index and sports nutrition. SAJCN 2005;18(3): 222-8.
20. Marcelo Fernández J, Miranda López J, Pérez Jiménez F. Índice glucémico y ejercicio físico. Rev Andaluza Med del Deport 2008;1(3):116-24.
21. Panahi S, El Khoury D, Kubant R, et al. Mechanism of action of whole milk and its components on glycemic control in healthy young men. J Nutr Biochem 2014;25(11):1124-31. DOI:10.1016/j.jnutbio.2014.07.002.
22. O'Connor LM, Lentjes MH, Luben RN, Khaw KT, Wareham NJ, Forouhi NG. Dietary dairy product intake and incident type 2 diabetes: A prospective study using dietary data from a 7-day food diary. Diabetologia 2014;57(5):909-17. DOI:10.1007/s00125-014-3176-1.
23. Marco MsA, Douglas Goff MsH, Kisch PJA, Coulson MsA, Wright PAJ. Effects of soy-soluble fiber and flaxseed gum on the glycemic and insulinemic responses to glucose solutions and dairy products in healthy adult males. J Am Coll Nutr 2013;32(2):98-110. DOI:10.1080/07315724.2013.767579.
24. Torres NT, Palacios-González B, Noriega-López L, Tovar-Palacio AR. Índice glicémico, Índice insulinémico y carga glicémica de bebidas de soya con un contenido bajo y alto en hidratos de carbono. Rev Investig Clin 2006;58:487-97.
25. Shlisky JD, Durward CM, Zack MK, Gugger CK, Campbell JK, Nickols-Richardson SM. An energy-reduced dietary pattern, including moderate protein and increased nonfat dairy intake combined with walking promotes beneficial body composition and metabolic changes in women with excess adiposity: a randomized comparative trial. Food Sci Nutr 2015;3(5):376-93. DOI:10.1002/fsn3.231.
26. Parker B, Noakes M, Luscombe N, Clifton P. Effect of a high-protein, high-monounsaturated fat weight loss diet on glycemic control and lipid levels in type 2 diabetes. Diabetes Care 2002;25(3):425-430. DOI:10.2337/diacare.25.3.425.

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Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Association of the rs9939609 gene variant in FTO with insulin resistance, cardiovascular risk factor and serum adipokine levels in obese patients

Asociación del polimorfismo rs9939609 en el gen FTO *con la resistencia a la insulina, factores de riesgo cardiovascular y niveles de adipocitoquinas en pacientes obesos*

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Abstract

Introduction: The aim of our study was to analyze the relationship of the rs9939609 FTO gene polymorphism with insulin resistance and serum adipokine levels.

Material and methods: A population of 610 patients with obesity was analyzed in a cross sectional design. Weight, blood pressure, basal glucose, c-reactive protein (CRP), insulin, insulin resistance (HOMA), lipid profile and adipocytokines (leptin, adiponectin, resistin, TNF alpha, and interleukin 6) levels were measured.

Results: Insulin (122.2 ± 101.8 pmol/L *vs.*104.5 ± 61.5 pmol/L *vs.* 112.1 ± 74.3 pmol/L: $p < 0.05$) and HOMA-IR values (4.76 ± 4.4 *vs.* 3.71 ± 2.5 *vs.* 3.76 ± 3.1; $p < 0.05$) were higher in TT group than AT and AA groups. Triglycerides values were higher in TT group than AA group (1.42 ± 0.71 mmol/L *vs.* 1.39 ± 0.69 mmol/L *vs.* 1.23 ± 0.64 mmol/L; $p < 0.05$). Adiponectin levels were lower in TT genotype group than AA genotype group (35801.2 ± 35,912.3 ng/L *vs.* 26,718.1 ± 36,323.1 ng/L *vs.* 21,112.3 ± 25,623.1 ng/L $p < 0.05$).

Conclusion: The FTO gene polymorphism, rs9939609, was found to be associated with insulin resistance, insulin, triglyceride and adiponectin levels in obese patients with TT variant.

Key words:

Adipocytokines. Cardiovascular risk factors. Insulin resistance to rs9939609 gene variant. Obesity.

Resumen

Introducción: el objetivo de nuestro estudio fue analizar la relación del polimorfismo rs9939609 del gen *FTO* con la resistencia a la insulina y los niveles de adipocitoquinas séricas.

Material y métodos: se analizó una población de 610 pacientes con obesidad en un diseño transversal. Se registraron los valores de peso, presión arterial, glucosa basal, proteína C-reactiva (PCR), insulina, resistencia a la insulina (HOMA), perfil lipídico y adipocitoquinas (leptina, adiponectina, resistina, TNF alfa y la interleucina 6).

Resultados: los niveles de insulina circulante (104,5 + /l *vs.* / L 112.1 ± 74,3 pmol 61,5 pmol 122,2 ± 101,8 pmol/l *vs.*: $p < 0,05$) y HOMA-IR (4,76 ± 4,4 *vs.* 3,71 + 2,5 *vs.* 3,76 ± 3,1; $p < 0,05$) fueron mayores en el grupo TT que en el grupo AT+ AA. Los valores de triglicéridos fueron mayores en el grupo TT que AA (1,42 ± 0,71 mmol/l *vs.* 1,39 + 0,69 mmol/l *vs.* 1,23 ± 0,64 mmol/l; $p < 0,05$). Los niveles de adiponectina fueron menores en el grupo con genotipo TT que en el grupo con genotipo AA (35.801,2 ± 35.912,3 ng/l *vs.* 26.718,1 ± 36.323,1 ng/l *vs.* 21.112,3 ± 25.623,1 ng/l $p < 0,05$).

Conclusión: el polimorfismo del gen *FTO*, rs9939609, está asociado con los niveles de resistencia a la insulina, insulina, triglicéridos y de adiponectina en pacientes obesos con variante TT.

Palabras clave:

Adipocitoquinas. Factores de riesgo cardiovascular. Resistencia a rs9939609. Obesidad.

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INTRODUCTION

Obesity, which is a risk factor for various disorders including type 2 diabetes, hypertension, cancer, and cardiovascular disease, is one of the most common disorders in clinical practice worldwide. It has been reported that the occurrence of obesity is determined by both environmental and genetic factors (1-2). Common polymorphisms of the fat mass and obesity associated gene (FTO) have been linked to obesity in some populations (3-5). The FTO gene is highly polymorphic, and several polymorphisms of the gene have been found to be associated with obesity or obesity phenotypes, such as high body mass index (BMI). One of these genetic variants (rs9939609), located within the first FTO intron, has been related to an increased risk for both obesity and type 2 diabetes mellitus (7-16). Although the association of the FTO gene with obesity is observed across many different ethnic populations (7-16), there are several controversies. Some showed an association of the FTO gene with obesity (15-16), and some failed to replicate the result (17). The reason for this discrepancy is not clear. Lack of adjustment for confounding factors, especially dietary intake, may also be the reason, since such factors seem to be important to modulate the gene susceptibility for lifestyle-related disorders such as obesity.

In the other hand, the current view of adipose tissue is that of an active secretor organ, sending out and responding to signals that modulate appetite, insulin sensitivity, energy expenditure, inflammation and immunity. Adipocytokines are proteins produced mainly by adipocytes (18). These molecules have been shown to be involved in the pathogenesis of the metabolic syndrome and cardiovascular disease (for example; adiponectin, leptin, resistin, IL6 and TNF alpha) (19-22). Association of this FTO polymorphism with adipokine levels has been evaluated in few studies (23-25). Contradictories data have been obtained with leptin, adiponectin and interleukine-6 levels (19-25) and the relationship with resistin levels has not yet been evaluated.

Our aim was to analyze the relationship of the rs9939609 FTO gene polymorphism with body weight, insulin resistance, cardiovascular risk factors and serum adipokine levels.

SUBJECTS AND METHODS

SUBJECTS

A population of 610 patients with obesity was analyzed in a cross sectional design. These patients were recruited in a Nutrition Clinic Unit and signed informed consent. Local ethical committee approved the protocol (CIENC Committee Valladolid). Exclusion criteria included history of cardiovascular disease or stroke during the previous 24 months, total cholesterol > 12.8 mmol/L, triglycerides > 3.3 mmol/L, blood pressure > 140/90 mmHg, fasting plasma glucose > 3.9 mg/dL, as well as the use of sulphonilurea, thiazolidinedions, insulin, dypeptidil type 4 inhibitors, exenatide, glucocorticoids, antineoplasic agents, agiotensin receptor blockers and angiotensin converting enzyme inhibitors. Smoking habit has been excluded, too. Inclusion criteria included body mass index > 30, age > 18 years and signed informed consent.

PROCEDURE

Weight, blood pressure, basal glucose, c-reactive protein (CRP), insulin, insulin resistance (HOMA-IR), total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides blood and adipocytokines (leptin, adiponectin, resistin, TNF alpha, and interleukin 6) levels were measured. A tetrapolar bioimpedance and a prospective serial assessment of nutritional intake with 3 days written food records were realized. Genotype of FTO gene polymorphism (rs9939609) was studied.

Genotyping of rs9939609 FTO gene polymorphism

Oligonucleotide primers and probes were designed with the Beacon Designer 5.0 (Premier Biosoft International®, LA, CA). The polymerase chain reaction (PCR) was carried out with 50 ng of genomic DNA, 0.5 uL of each oligonucleotide primer (primer forward: 5'-GGCTCTTGAATGAAATAGG-3'and reverse 5'-GACTGTTACCTATTAAAACTTTAG-3' and 0.25 uL of each probes (wild probe: 5'-Fam-ATC AAG AGC ACG GTC AAG ATT GCC-BHQ-1-3') and (mutant probe: 5'-Texas red- ATC AAG AGC ACA GTC AAG ATT GCC -BHQ-1-3') in a 25 uL final volume (Termociclador iCycler IQ (Bio-Rad®), Hercules, CA). DNA was denaturated at 95 ºC for 3 min; this was followed by 35 cycles of denaturation at 95 ºC for 15 s, and annealing at 55º for 45 s). The PCR were run in a 25 uL final volume containing 12.5 uL of IQTM Supermix (Bio-Rad®, Hercules, CA) with hot start Taq DNA polymerase.

BIOCHEMICAL ASSAYS

Plasma glucose levels were determined by using an automated glucose oxidase method (Glucose analyser 2, Beckman Instruments, Fullerton, California). Insulin was measured by RIA (RIA Diagnostic Corporation, Los Angeles, CA) with a sensitivity of 3.6 pmol/L (normal range 3.5-220 pmol/L) (26) and the homeostasis model assessment for insulin resistance (HOMA-IR) was calculated using these formula (insulin x glucose/22.5) (27). CRP was measured by immunoturbimetry (Roche Diagnostics GmbH, Mannheim, Germany), with a normal range of (0-28nm l/L) and analytical sensivity 2 nmol/L. Serum total cholesterol and triglyceride concentrations were determined by enzymatic colorimetric assay (Technicon Instruments, Ltd., New York, NY, USA), while HDL cholesterol was determined enzymatically in the supernatant after precipitation of other lipoproteins with dextran sulphate-magnesium. LDL cholesterol was calculated using Friedewald formula.

Resistin was measured by ELISA (Biovendor Laboratory, Inc., Brno, Czech Republic) with a sensitivity of 200 ng/L with a normal range of 4,000-12,000 ng/L (28). Leptin was measured by ELISA (Diagnostic Systems Laboratories, Inc., Texas, USA) with a sensitivity of 50 ng/L and a normal range of 10,000-100,000 ng/L (29). Interleukin 6 and TNF alpha were measured by ELISA (R&D systems, Inc., Mineapolis, USA) with a sensitivity of 0.7 ng/L and 0.5 ng/L, respectively. Normal values of IL6 was (1.12-12.5 ng/L) and TNF alpha (0.5-15.6 ng/L) (30-31). Adiponectin was measured by ELISA (R&D systems, Inc., Mineapolis, USA) with a sensitivity of 246 ng/L and a normal range of 8,650.0-21,430.0 ng/L (32).

ANTHROPOMETRIC MEASUREMENTS AND DIETARY INTAKES

Body weight was measured to an accuracy of 0.1 kg and body mass index computed as body weight/(height^2). Waist (narrowest diameter between xiphoid process and iliac crest) and hip (widest diameter over greater trochanters) circumferences to derive waist-to hip ratio (WHR) were measured, too. Tetrapolar body electrical bioimpedance was used to determine body composition with an accuracy of 5 g (33). An electric current of 0.8 mA and 50 kHz was produced by a calibrated signal generator (Biodynamics Model 310e, Seattle, WA, USA). Blood pressure was measured twice after a 10 minutes rest with a random zero mercury sphygmomanometer, and averaged.

Patients received prospective serial assessment of nutritional intake with 3 days written food records. All enrolled subjects received instruction to record their daily dietary intake for three days including a weekend day. Handling of the dietary data was by means of a personal computer equipped with a software (Dietosource 2.0®), incorporating use of food scales and models to enhance portion size accuracy. Records were reviewed by a registered dietician and analyzed with the software (Dietosource 2.0®). National composition food tables were used as reference (34).

STATISTICAL ANALYSIS

Sample size was calculated to detect differences over 0,5 kg in body weight with 90% power and 5% significance (n = 600). The results were expressed as average ± standard deviation. The distribution of variables was analyzed with Kolmogorov-Smirnov test. Patients were divided by genotype in 3 groups (TT, TA and AA) and ANOVA test was used where indicated with Bonferroni test as a post hoc test. Non-parametric variables were analyzed with the Mann-Whitney U test. Pearson test was used to analyze correlation. Qualitative variables were analyzed with the chi-square test, with Yates correction as necessary, and Fisher's test. A p-value under 0.05 was considered statistically significant.

RESULTS

Six hundred and ten patients gave informed consent and were enrolled in the study. No dropout during the study. The mean age was 45.3 ± 11.1 years and the mean BMI 35.7 ± 6.0.Two hundred and ninety patients (48.1%) had the genotype *TT*, 134 (21.7%) patients had the genotype *TA* and 186 patients had the genotype AA (30.2%). Age was similar in all groups (46.1 ± 16.1 years in TT group *vs.* 44.9 ± 16.2 years in TA group *vs.* 43.9 ± 15.2 years in AA group). Sex distribution was similar in different genotype groups (males vs females: 23.3% *vs.* 76.7% in TT group, 25.4% vs 74.6% in TA group, 30.1% *vs.* 69.9% in AA group).

Table I shows the anthropometric variables. No differences were detected among genotype groups.

Table II shows the classic cardiovascular risk factors. Insulin and HOMA values were higher in TT group than AT and AA groups. Triglycerides values were higher in TT group than AA group.

Table I. Anthropometric variables by genotypes

Genotypes	TT (n = 296)	AT (n = 134)	AA (n = 186)
BMI	36.4 ± 5.6	35.7 ± 6.3	36.4 ± 5.7
Weight (kg)	95.7 ± 16.7	93.9 ± 19.7	96.5 ± 17.8
Fat mass (kg)	39.8 ± 12.3	40.8 ± 13.7	42.1 ± 12.5
Waist circumference	111.4 ± 13.7	110.1 ± 15.1	110.8 ± 13.3
Waist to hip ratio	0.92 ± 0.08	0.91 ± 0.07	0.92 ± 0.1
Systolic BP (mmHg)	129.7 ± 15.0	128.9 ± 14.7	127.7 ± 14.4
Diastolic BP (mmHg)	82.5 ± 8.8	82.3 ± 9.1	82.4 ± 8.8

BMI: body mas index; WC: waist circumference. No statistical differences.

Table II. Biochemical variables by genotypes

Genotypes	TT (n = 296)	AT (n = 134)	AA (n = 186)
Glucose (mmol/L)	3.61 ± 0.42	3.51 ± 0.52	3.6 ± 0.81
Total ch. (mmol/L)	10.51 ± 2.13	10.6 ± 2.23	10.7 ± 2.31
LDL-ch. (mmol/L)	6.41 ± 1.72	6.43 ± 1.81	6.49 ± 1.76
HDL-ch. (mmol/L)	2.72 ± 0.63	2.80 ± 0.71	2.81 ± 0.70
TG (mmol/L)	1.42 ± 0.71	1.39 ± 0.69	1.23 ± 0.64*
Insulin (pmol/L)	122.2 ± 101.8	104.5 ± 61.5$^+$	112.1 ± 74.3*
HOMA	4.76 ± 4.4	3.71 ± 2.5$^+$	3.76 ± 3.1*
CRP (nmol/L)	24.04 ± 18.4	23.83 ± 21.3	24.23 ± 20.2

Ch: cholesterol; HOMA: homeostasis model assessment; TG: triglycerides. Statistical differences ($p < 0.05$) between TA and TT groups ($^+$). Statistical differences ($p < 0.05$) between AA and TT groups (*).

Table III shows nutritional intake with 3 days written food records. No statistical differences were detected in caloric, carbohydrate, fat, and protein intakes. Aerobic exercise per week was similar in both groups.

Table IV shows levels of adipocytokines. Adiponectin levels were lower in TT genotype group than AA genotype group. No differences were detected among genotype groups in other serum adipocytokine levels.

DISCUSSION

We analyzed the single nucleotide polymorphism (SNP) rs9939609 of the FTO gene in obese Caucasian subjects. No associations could be found between investigated SNP and BMI, weight and some cardiovascular risk parameters (glucose, LDL cholesterol, HDL cholesterol and blood pressure). However, an association between this SNP and insulin levels, insulin resistance, triglyceride levels and adiponectin was observed.

The relation of rs9939609 with body weight is a contradictory topic area. For example, Do et al reported that the FTO variants (rs17817449 and rs1421085) have been associated with several measures of adiposity including weight, BMI, fat mass and waist circumference (35). However, rs9939609 did not show these associations (35). Dina et al. (36) note that the gene may play a role in body weight regulation, since it is highly expressed in the hypothalamic-pituitary-adrenal axis. These contradictory results might be explained by ethnicity factors. For example, Fang et al. (24) reported a significant association of FTO and BMI in Asian adults, although the risk allele effects on weight were lower in Caucasian samples, as our data shown.

In the above-mentioned study, the obesity risk alleles of rs17817449 and rs1421085 were associated with fasting insulin and HOMA-IR, the influence of these SNPs on insulin sensitivity appears to be mediated through obesity (35). We also confirmed the finding of Freathy et al (37), that FTO genotype was associated with metabolic traits. These previous results implied that the association of FTO variant with serum triglycerides and adiponectin levels may be mediated through obesity. Nevertheless, in our study, the association of these parameters was independent of body weight. In accord with other study (38), no association between leptin levels and rs9939609 genotypes were detected. In the other hand, Zimmerman et al (23) reported an association between circulating leptin levels and FTO variant, but the effect was accounted for by BMI and that the FTO A-allele tended to lower IL-6 levels. In aother pediatric group of patients (39), the minor A allele of the FTO rs9939609 was significantly associated with higher serum leptin concentrations independently of potential confounders including adiposity.

The effect of the FTO rs9939609 on insulin resistance is an unclear area, too. Tan et al (40) reported an increase in insulin resistance and hiperinsulinemia in obese patients with polycystic ovary syndrome with the A allele, without effect on glucose levels. In other study, FTO was associated with both metabolic syndrome and glucose without finding an association to insulin resistance (41). Our findings of insulin resistance and elevated triglyceride levels in patients with TT genotype were different than previous, without a clear explanation. For example, Grunnet et al. (42) have proposed that modifications of energy efficiency in oxidative muscle fibers may contribute to the association of FTO variants (A allele) and insulin resistance, but we reported an association with T allele.

These discrepancies in the metabolic findings between studies could be partly due to differences in population characteristics, such as gender, age, ethnic composition and environmental exposures such as dietary intakes. Our results suggest that there is no association of FTO with either energy intake or macronutrient composition, as other studies (43). At present the mechanism of the FTO variant on insulin resistance, triglyceride levels and adiponectin levels is uncertain. Human adipose tissue is heter-

Table III. Dietary intake by genotypes

Genotypes	TT (n = 296)	AT (n = 134)	AA (n = 186)
Energy (kcal/day)	1,815.1 ± 625.7	1,848.2 ± 667.2	1,865.3 ± 614.1
CH (g/day)	196.3 ± 77.4	196.3 ± 77.1	195.1 ± 74.3
Fat (g/day)	78.9 ± 35.1	80.5 ± 36.9	78.6 ± 33.5
Protein (g/day)	85.7 ± 26.6	90.2 ± 28.3	88.5 ± 26.7
Exercise (hs/week)	1.7 ± 3.1	1.8 ± 2.9	1.5 ± 2.8
Dietary fiber	15.4 ± 7.0	15.2 ± 6.3	14.9 ± 6.1

CH: carbohydrate. No statistical differences.

Table IV. Levels of aipokines by genotypes

Genotypes	TT (n = 296)	AT (n = 134)	AA (n = 186)
IL 6 (ng/L)	2.0 ± 2.1	2.1 ± 3.6	1.9 ± 2.4
TNF-α (ng/L)	6.1 ± 4.7	5.9 ± 3.7	5.8 ± 3.6
Adiponectin (ng/L)	35,801.2 ± 35,912.3	26,718.1 ± 36,323.1	21,112.3 ± 25,623.1*
Resistin (ng/L)	4,012.3 ± 1,812.3	4,212.4 ± 2,034.5	4,489.4 ± 1,912.3
Leptin (ng/L)	76,734.4 ± 58,445.3	75,298.2 ± 80,112.9	79,834.5 ± 80,222.1

Statistical differences ($p < 0.05$) between AA and TT groups (*).

ogeneous in its metabolic activity, and some sites in the adipose tissue might be expanded preferentially among TT carriers, resulting in an increased insulin resistance, insulin levels and triglyceride with a decreased adiponectin levels.

CONCLUSION

In conclusion, the FTO gene polymorphism, rs9939609, was found to be associated with insulin resistance, insulin, triglyceride and adiponectin levels in obese patients with TT variant. A failure to control for the factors (caloric expenditure due to exercise, medications, smoking, age and gender is a biass in our design). However, further studies are necessary to confirm our results and to explore new metabolic relationships of this SNP and to performed metanalysis with pooled data as in children populations (44).

REFERENCES

1. De Luis DA, González M, Aller R, Izaola O, Conde R. Effects of C358A missense polymorphism of the endocannabinoid degrading enzyme fatty acida mide hydrolase on weight loss after a hypocaloric diet. Metabolism Clinical and Experimental 2011;60;730-4.
2. De Luis DA, González M, Aller R, Izaola O, Conde R. Metabolic syndrome and ALA54Thr polymorphism of fatty acid-binding protein 2 in obese patients.. Metabolism Clinical and Experimental 2011;60;664-8.
3. Hinney A, Nguyen TT, Scherag A, Friedel S, Bronner G, Muller TD, et al. Genome wide association (GWA) study for early onset extreme obesity supports the role of fat mass and obesity associated gene (FTO) variants. PLoS ONE 2007;2: e1361.
4. Villalobos-Comparan M, Teresa Flores-Dorantes M, Teresa Villarreal-Molina M, Rodríguez-Cruz M, García-Ulloa AC, Robles L, et al. The FTO gene is associated with adulthood obesity in the Mexican population. Obesity (Silver Spring) 2008;16:2296-301.
5. Song Y, You NC, Hsu YH, Howard BV, Langer RD, Manson JE, et al. FTO polymorphisms are associated with obesity but not diabetes risk in postmenopausal women. Obesity (Silver Spring) 2008;16:2472-80.
6. Meyre D, Delplanque J, Chèvre JC, Lecoeur C, Lobbens S, et al. Genome-wide association study for early-onset and morbid adult obesity identifies three new risk loci in European populations. Nat Genet 2009;41:157-9.
7. Wing MR, Ziegler J, Langefeld CD, Ng MC, Haffner SM, Norris JM, et al. Analysis of FTO gene variants with measures of obesity and glucose homeostasis in the IRAS Family Study. Hum Genet 2009;125:615-26.
8. Villalobos-Comparán M, Flores-Dorantes MT, Villarreal-Molina MT, Rodríguez-Cruz M, García-Ulloa AC, et al. The FTO gene is associated with adulthood obesity in the Mexican population. Obesity 2008;16:2296-2301.
9. Tan JT, Dorajoo R, Seielstad M, Sim XL, Ong RT, Chia KS, et al. FTO variants are associated with obesity in the Chinese and Malay populations in Singapore. Diabetes 2008:57:2851-7.
10. Qi L, Kang K, Zhang C, van Dam RM, Kraft P, Hunter D, Lee CH, et al. Fat mass-and obesity-associated (FTO) gene variant is associated with obesity: longitudinal analyses in two cohort studies and functional test. Diabetes 2008;57:3145-51
11. Franks PW, Jablonski KA, Delahanty LM, McAteer JB, Kahn SE, Knowler WC, et al.; Diabetes Prevention Program Research Group. Diabetes Prevention Program Research Group. Assessing gene treatment interactions at the FTO and INSIG2 loci on obesity-related traits in the Diabetes Prevention Program. Diabetologia 2008;51:2214-23.
12. Sjögren M, Lyssenko V, Jonsson A, Berglund G, Nilsson P, Groop L, et al. The search for putative unifying genetic factors for components of the metabolic syndrome. Diabetologia 2008;51:2242-51.
13. Legry V, Cottel D, Ferrières J, Arveiler D, Andrieux N, Bingham A, et al. Effect of an FTO polymorphism on fat mass, obesity, and type 2 diabetes mellitus in the French MONICA Study. Metabolism 2009;58:971-5.
14. Yajnik CS, Janipalli CS, Bhaskar S, Kulkarni SR, Freathy RM, Prakash S, et al. FTO gene variants are strongly associated with type 2 diabetes in South Asian Indians. Diabetologia 2009;52:247-52.
15. Hotta K, Nakata Y, Matsuo T, Kamohara S, Kotani K, Komatsu R, et al. Variations in the FTO gene are associated with severe obesity in the Japanese. J Hum Genet 2008;53:546- 53.
16. Omori S, Tanaka Y, Takahashi A, Hirose H, Kashiwagi A, Kaku K, et al. Association of CDKAL1, IGF2BP2, CDKN2A/B, HHEX, SLC30A8, and KCNJ11 with susceptibility to type 2 diabetes in a Japanese population Diabetes 2008;57:791-5.
17. Horikoshi M, Hara K, Ito C, Shojima N, Nagai R, Ueki K, et al. Variations in the HHEX gene are associated with increased risk of type 2 diabetes in the Japanese population. Diabetologia 2007;50:2461-6.
18. Matsuda M, Shimomura I, Sata M. Role of adiponectin in preventing vascular stenosis. The missing link of adipo-vascular axis. J Biol CHem 2002;277:37487-91.
19. Kumada M, Kihara S, Sumitsuji S. Association of hypoadiponectinemia with coronary artery disease in men. Arterioscler Thromb Vasc Biol 2003;23:85-9.
20. Shimomoura I, Hammer RE, Ikemoto S. Leptin reverses insulin resitance and diabetes mellitus in mice with congenital lipodystrophy. Nature 1999;401:73-6.
21. Steppan CM, Bailey ST, Bhat S. The hormone resistin links obesity to diabetes. Nature 2001;409:307-12.
22. Matsuzawa Y. Adipocytokines: Emerging therapeutic targets. Current Atherosclerosis Reports 2005;7:58-62.
23. Zimmermann E, Skogstrand K, Hougaard DM, Astrup A, Hansen T, Pedersen O, et al. Influences of the common FTO rs9939609 variant on inflammatory markers throughout a broad range of body mass index. PLoS One 2011;6(1):e15958.
24. Fang H, Li Y, Du S, Hu X, Zhang Q, Liu A, et al. Variant rs9939609 in the FTO gene is associated with body mass index among Chinese children. BMC Med Genet 2010;22(11):136.
25. Qi L, Kang K, Zhang C, van Dam RM, Kraft P, Hunter D, et al. Fat mass-and obesity-associated (FTO) gene variant is associated with obesity: longitudinal analyses in two cohort studies and functional test. Diabetes 2008;57(11):3145-51.
26. Duart MJ, Arroyo CO, Moreno JL. Validation of a insulin model for the reactions in RIA. Clin Chem Lab Med 2002;40:1161-7.
27. Mathews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher Df. Homesotasis model assessment: insulin resistance and beta cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia 1985;28:412-4.
28. Pfutzner A, Langefeld M, Kunt T, Lobig M. Evaluation of human resistin assays with serum from patients with type 2 diabetes and different degrees of insulin resistance. Clin Lab 2003;49:571-6.
29. Meier U, Gressner M. Endocrine regulation of energy metabolism: review of pathobiochemical and clinical chemical aspects of leptin, Ghrelin, adiponectin, and resistin. Clinical Chemstry 2004;50:1511-25.
30. Lubrano V, Cocci F, Battaglia D, Papa A. Usefulness of high-sensitivity IL6 measurment for clinical characterization of patients with coronary artery disease. J Clin Lab Anal 2005;19:110-4.
31. Khan SS, Smith MS, Reda D, Suffredini AF, Mc Coy JP. Multiplex bead array assays for detection of soluble cytokines: comparisons of sensitivity and quantitative values among kits from multiple manufactures. Cytometry B Clin Cytom 2004;61:35-9.
32. Suominen P. Evaluation of an enzyme immunometric assay to measure serum adiponectin concentrations. Clin Chem 2004;50:219-21
33. Pichard C, Slosman D, Hirschel B, Kyle U. Bioimpedance analysis: an improved method for nutritional follow up. Clin Res 1993;41:53.
34. Mataix J, Mañas M. Tablas de composición de alimentos españoles. Ed: University of Granada; 2003.
35. Do R, Bailey S, Desbiens K, Belisle A, Montpetit A, Bouchard C, et al. Genetic variants of FTO influence adiposity, insulin sensitivity, leptin levels, and resting metabolic rate in the Quebec Family study. Diabetes 2008;57:1147-50.
36. Dina C, Meyre D, Gallina S. Variation in FTO contributes to childhood obesity and severe adult obesity. Nat Genet 2007;39:724-6.
37. Freathy RM, Timpson NJ, Lawlor DA, Pouta A. Common variation in the FTO gene alters diabetes-related metabolic traits to the extent expected given its effect on BMI: Diabetes 2008;57:1419-26.
38. Zabena C, González Sánchez JL, Martínez Larrad MT, Torres García A, Álvarez Fernández J. The FTO obesity gene, Genotyping and gene expression analysis in morbidly obese patients. Obes Surg 2009;19:87-95
39. Labayen I, Ruiz JR, Ortega FB, Dalongeville J. Association between the FTO rs9939609 polymorphism and leptin in European adolescents: a possible link with energy balance control. The HELENA study. International Journal of Obesity 2011;35;66-71.

40. Tan S, Scherag A, Janssen O, Hahn S. Large effects on BMI and insulin resistance of fat mass and obesity associated gene (FTO) variants in patients with PCOS: BMC medical genetics 2010;11:12-7.
41. Attaoua R, Ait Sm, Radian S, Fica S, Hanzu F. FTO gene associates to metabolic syndrome un women with PCOS. Biochem Byophys Res Commun 2008;373;230-4.
42. Grunnet LG, Brons C, Jacobsen S, Nilsson E, Astrup A, Hansen T, et al. Increased recovery rates of phosphocreatine and inorganic phosphate after isomeric contraction in oxidative muscle fibers and elevated hepatic insulin resistance in homozygous carriers of the A-allele of FTO rs993969. J Clin Endocrinol Metab 2009;94:596-602
43. Berentzen T, Kring SI, Holst C, Zimmermann E, Jess T, Hansen T, et al. Lack of association of fatness-related FTO gene variants with energy expenditure or physical activity. J Clin Endocrinol Metab 2008;93:2904-8.
44. Quan LL, Wang H, Tian Y, Mu X, Zhang Y, Tao K. Association of fat-mass and obesity-associated gene FTO rs9939609 polymorphism with the risk of obesity among children and adolescents: a meta-analysis. Eur Rev Med Pharmacol Sci 2015;19:614-23.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Obesidad y síndrome metabólico

Good weight loss responders and poor weight loss responders after Roux-en-Y gastric bypass: clinical and nutritional profiles

Buenos y malos respondedores después de bypass *gástrico en Y de Roux: perfiles clínicos y nutricionales*

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Abstract

Background: Bariatric surgery is one of the main treatments for severity obesity, but weight regain after surgery is an important issue.

Objectives: To compare the clinical and nutritional profiles of good and poor weight loss responders in the late postoperative period after bariatric surgery.

Methods: A cross-sectional study with patients undergoing Roux-en-Y gastric bypass in a University Hospital. Patients were divided into good weight loss responders (GWLR) and poor weight loss responders (PWLR) defined as ≥ 50% or < 50% excess weight loss (EWL), respectively, at least 2 years post-surgery.

Results: The sample included 204 individuals (87.7% women; mean age 50.15 ± 11.1 years; mean time after surgery 67.38 ± 30.76 months). Two years post-surgery, 71.1% were considered GWLR and 28.9% PWLR (mean EWL 72.33% ± 13.86%, and 35.06% ± 12.10%, respectively; p = 0.000). Weight regain was < 10% for 36.3% of patients, 10.1-20% for 36.3%, and > 20% for 21.3%, compared with the lowest post-surgery weight. Among PWLR, 49.0% regained > 20% of the lowest post-surgery weight. GWLR lost most weight at all time points analyzed (p < 0.05). GWLR presented improvement or remission of diabetes, dyslipidemia and hypertension more frequently compared to PWLR (p < 0.05). Eating patterns was similar between GWLR and PWLR (p > 0.05, study's power 100%). Quality of life improved in 79.5% of the total study sample, with greater improvements in the GWLR (p < 0.05).

Conclusions: Greater weight loss correlated with improved remission in comorbidities and better quality of life.

Key words:

Gastric bypass. Long-term post-surgery. Weight loss. Nutrition. Co-morbidity.

Resumen

Introducción: la cirugía bariátrica es uno de los principales tratamientos para la obesidad, pero la recuperación de peso después de la cirugía es una cuestión importante.

Objetivo: comparar los perfiles clínicos y nutricionales de los buenos y malos respondedores en postoperatorio (PO) tardío de la cirugía bariátrica.

Método: estudio transversal con pacientes sometidos a *bypass* gástrico en Y de Roux en un hospital universitario. La muestra se divide en buenos respondedores (BR) y respuesta deficiente (MR), teniendo en cuenta el porcentaje de pérdida de exceso de peso (PEP) del 50,0%, después de al menos 2 años de PO.

Resultados: un total de 204 personas (87,7% mujeres, con una edad media de 50,15 ± 11,1 años y 67,38 ± 30,76 meses después de la operación). Después de 2 años de la operación, el 71,1% se consideraron BR y el 28,9% MR (PEP promedio 72,33 ± 13,86% y 35,06 ± 12,10%, respectivamente) (p < 0,05). La recuperación de peso fue < 10% para el 36,3% de los pacientes, 10,1 a 20% a 36,3% y > 20% a 21,3% en comparación con el menor peso después de la cirugía. Entre MR, el 49,0% recuperó más del 20% del peso más bajo después de la cirugía. El BR perdió la mayor parte de sobrepeso en los diferentes tiempos analizados PO (p < 0,05). El BR mostró mejoría o remisión de la diabetes mellitus, dislipidemia e hipertensión con más frecuencia, en comparación con los MR (p < 0,05). El patrón de dieta fue similar entre la BR y MR (p > 0,05; 100% de la potencia del estudio). La calidad de vida mejoró en el 79,5% del total del grupo, con la mejor evolución en los BR (p < 0,05).

Conclusión: la pérdida de peso mayor se correlaciona con la mejora de la remisión de comorbilidades y una mejor calidad de vida.

Palabras clave:

Cirugía bariátrica. Postoperatorio tardío. Pérdida de peso. Nutrición. Comorbilidad.

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INTRODUCTION

The prevalence of obesity has increased worldwide in the last two decades, reaching epidemic proportions and becoming a serious public health problem. More than 10% of the global adult population is obese. In Brazil, the prevalence of obesity is 17%. Causes of weight excess include hypercaloric diet, low physical activity, and genetic factors. Nutritional counseling, exercise and/or pharmacological treatments often fail to treat severe obesity (body mass index [BMI] >35 kg/m^2), and more effective interventions are necessary. Bariatric surgery has emerged as the most effective treatment for severe obesity, with Roux-en-Y gastric bypass (RYGB) being the most commonly used surgical technique. It combines gastric restriction with reduction in food intake and bowel surface contact (1,2).

The number of bariatric surgeries is rising each year. In Brazil, the number increased from 16,000 in 2003 to 86,840 in 2013 (3). RYGB results in excess weight loss (EWL) of between 65% and 70%, decreased and/or resolution of obesity-related comorbidities, quality of life (QOL) improvement, and increased life expectancy (1).

However, EWL can diminish over time, and weight regain is frequent in the long-term. Mechanisms that may underlie weight regain include dilatation of the gastric pouch because of consumption of larger amounts of food, hypercaloric food ingestion, physiologic increase in nutrient absorption capacity in bowel, alcohol consumption, sedentarism, and hormonal adaptations (4,5).

Few studies have compared the clinical and nutritional profile of people with adequate EWL with those failing to maintain EWL in the late postoperative period, or compared good and poor weight loss responders after RYGB. Studies performed by the same surgical team, with long-term multidisciplinary follow-up, are of particular value. Therefore, the aim of this study is to compare the clinical and nutritional profile of good weight loss responders (GWLR) with poor weight loss responders (PWLR) after RYGB in the late postoperative period.

METHODS

This cross-sectional study included patients aged >18 years who had received bariatric surgery ≥ 2 years previously (long-term postoperative period). Pregnant women were excluded. All patients underwent RYGB and were monitored by a multidisciplinary team of the Service of Multidisciplinary Care of Surgical Obese Patients in the National Brazilian Health Care System (NBHCS). Retrospective data were collected from medical records of patients who underwent RYGB between 1998 and 2009. Prospective data were collected from October 2011 to March 2013 during the clinical and nutritional consultation. Experienced trained health care providers (physicians and dieticians) collected all data.

The institutional ethics committee approved the study (n. 2572.179/2011-08). The study design conformed to the guidelines of the Declaration of Helsinki. All subjects were informed about the study objectives/procedures and data confidentiality, and provided written informed consent to participate.

All surgeries were supervised by one experienced surgeon. RYGB included a small gastric reservoir to between 20 and 50 mL and secondary dysabsorption with bypass of the duodenum and proximal jejunum, leaving an alimentary limb of 100 cm. The surgery was performed by laparotomy with a silastic ring insertion between the stomach pouch and small bowel.

Data collected from medical records included age, sex, education level, ethnicity, date of surgery, obesity history (years), smoking, alcohol consumption, weight (kg), height (m), and BMI (kg/m^2). Data were also collected on comorbidities in the preoperative period, plateau phase duration (months) and early postoperative complications and mortality (30 days after surgical procedure). Plateau phase corresponds to the time with lower weight achieved or with maximum weight loss. Data collected at the clinical and nutritional consultation included duration of postoperative period (months), physical activity, alcohol consumption, food intake, smoking, weight (kg and %), height (m), BMI (kg/m^2), weight loss (kg and %), excess weight loss (%EWL), weight regain (kg), waist circumference (cm), comorbidities and metabolic control. QOL was assessed using the *Bariatric Analysis and Reporting Outcome System* (6).

Regular physical activity (7) and alcohol consumption (8) were classified according to the World Health Organization. Food consumption was analyzed with one 24-hour dietary recall (R24h), applied at the nutritional consultation by experienced trained dietician. Energy and macronutrient intake were estimated using the software Avanutri® online version 3.0 (Avanutri LTDA., Rio de Janeiro, RJ, Brazil), and carbohydrate, protein and lipid intake was estimated in absolute (g) and proportional values of total energy intake. Smoking was estimated from smoking pack-years.

Weight regain was defined as the final weight at the single nutritional consultation in October 2011 to March 2013 compared with the lowest weight achieved after surgery (recovery). Cut-off points of 10% and 20% were established to indicate important and very important weight regain, respectively.

The %EWL was obtained as follows: [(operative weight – follow-up weight)/initial excess weight] × 100. Initial excess weight was obtained subtracting operative weight and ideal body weight, where ideal body weight was estimated as BMI 25 kg/m^2. %EWL was estimated from four different timepoints after surgery: 6 months, at the postoperative time with lowest weight, at 2 years, and at the clinical consultation. The sample was divided into two groups: patients with %EWL < 50% at the clinical consultation were considered PWLR, and patients with %EWL of ≥ 50% at the clinical consultation were considered GWLRs (9).

Metabolic control was assessed by the criteria of Mechanick et al. (10), measured by improvement or resolution of the following comorbidities: type 2 diabetes mellitus (T2DM) (fasting glucose ≤ 126 mg/dL); dyslipidemia (total cholesterol ≤ 200 mg/dL, LDL cholesterol ≤ 130 mg/dL and triglycerides ≤ 150 mg/dL); and hypertension (systolic blood pressure [BP] ≤ 140 mmHg, diastolic BP ≤ 90 mmHg). Waist circumference was measured in the standing position at the end of expiration midway between the lowest rib and the iliac crest. Hip circumference was measured at the greater trochanters. Absolute values were used for analysis.

Statistical analyses were performed using Statistical Package for the Social Science for Windows version 22.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics are presented as mean ± standard deviation, and minimum and maximum values for data with normal distribution. Median, standard error of the mean, minimum and maximum values were used or variables without symmetrical distribution. Normal distribution of continuous variables was determined using the Shapiro-Wilk test. Variables without symmetrical distributions were corrected with Z scores, and means from two different samples were compared with Student's t-test. Categorical variables were shown as percentages. Chi-square test was used for categorical variables. Fisher's exact test was used where there were less than five observations in a variable. When we identified important variables that lacked statistical difference, the study's power analisys to detect such difference was performed using G*Power version 3.0.10 (Departament of Psychology, University Dusseldorf, Dusseldorf, Germany). Statistical significance was set at the 95% confidence interval, considered to be significant when $p < 0.05$.

RESULTS

From 1998 and 2009, 569 patients underwent RYGB at the public hospital. The early mortality rate was 2.3% (n = 13). Six patients (1%) died after surgical complications, and seven because of nonsurgical reasons. The final sample comprised 204 subjects (87.7% female, mean age 50.1 ± 11.1 years, 22.1% ≥ 60 years old). Overall, 28.9% (n = 59) were classified as PWLR (Table I).

Table I. Preoperatory patient's characteristics

	TS n = 204	n	GWLR n = 145	n	PWLR n = 59	n	p value	χ^2
Age (years)*€α	50.1 ± 11.1	204	50.8 ± 11.4	145	48.6 ± 10.1	59	0.193	-
Minimum to maximum	19.0 – 75.0		19.0 – 75.0		29.0 – 70.0			
Gender (%)£								
Female	87.7	179	88.3	128	86.4	51	0.814	0.131
Male	12.3	25	11.7	17	13.6	8		
Scholarity (%)β								
Unlettered/ semi-literate	2.9	6	3.4	5	1.7	1	0.777	1.099
Less than high school	48.1	98	47.6	69	49.1	29		
High school	33.3	68	34.5	50	30.6	18		
College degree	15.7	32	14.5	21	18.6	11		
Ethnicity (%)£								
Caucasian	84.8	173	84.1	122	86.4	51	0.830	0.137
Non caucasian	15.2	31	15.9	23	13.6	8		
Smoking (%)£	15.7	32	15.2	22	16.9	10	0.917	0.011
Alcoholic beverage (%)β								
Never	78.4	160	79.3	115	76.3	45	0.726	0.123
Social drinking	21.6	44	20.7	30	23.7	14		
Alcohol addiction	0.0	0	0.0	0	0.0	0		
*Obesity history (years)**€α*	19.0 ± 0.7	204	19.0 ± 0.9	145	20.0 ± 1.3	59	0.477	-
Minimum to maximum	4.0 – 50.0		4.0 – 50.0		4.0 – 41.0			
Preoperatory weight (kg)**€α	122.5 ± 1.6	204	120.0 ± 1.9	145	125.8 ± 3.0	59	0.147	-
Minimum to maximum	83.7 – 200.2		83.7 – 200.2		89.8 – 190.0			
Preoperatory BMI (kg/m^2)**€α	47.9 ± 0.5	204	47.7 ± 0.6	145	49.1 ± 0.9	59	0.184	-
Minimum to maximum	36.7 – 77.1		36.7 – 74.4		39.4 – 77.1			
Comorbities (%)£								
SAH	80.4	164	80.7	117	79.7	47	0.848	0.028
T2DM	33.8	69	33.8	49	33.9	20	1.000	0.000
Dyslipidemia	48.5	99	47.6	69	50.8	30	0.758	0.159

*TS: total sample; GWLR: good weight loss responders; PWLR: poor weight loss responders; kg: kilogram; BMI: Body Mass Index; *mean ± SD; m: meters; **median ± SEM; £Chi-square test; €Student´s t Test; βFisher´s exact test; α Coefficient of variation ≤25%.*

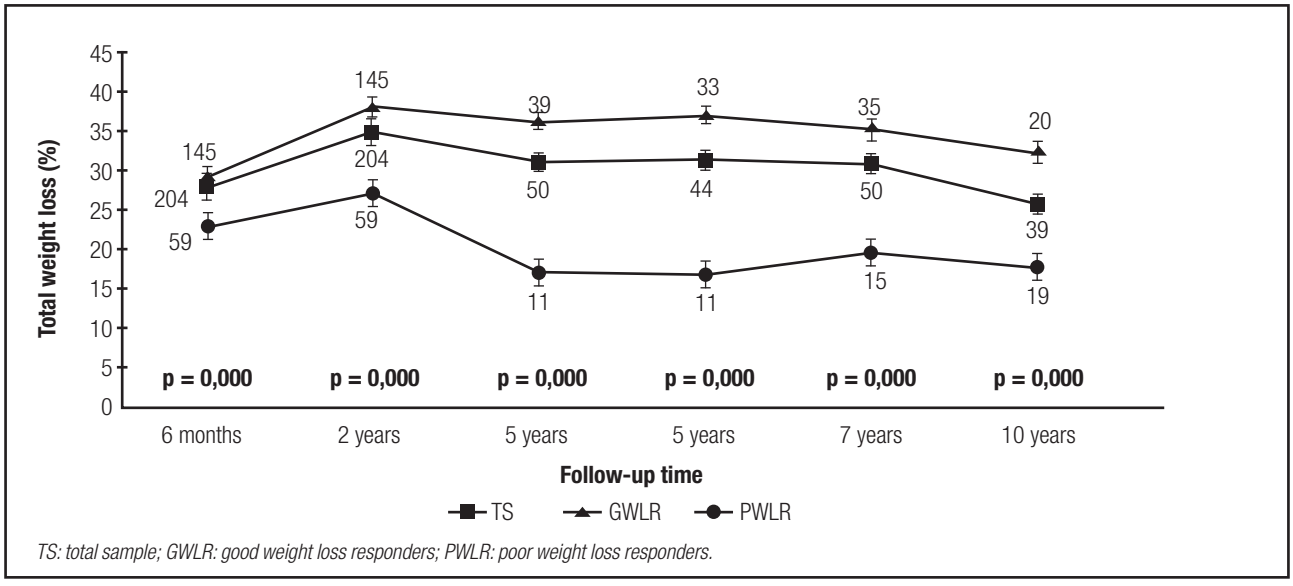
Table I shows the similarity between GWLR and PWLR characteristics ($p > 0.05$). Most patients had preoperative BMI > 40 kg/m^2 (mean preoperative BMI 47.9 ± 0.5 kg/m^2). There were 46% (n = 67) postmenopausal women in the GWLR and 44% (n = 26) in the PWLR ($p = 0.902$). The postoperative period was lower in the GWLR compared with PWLR ($p < 0.05$). PWLR reached plateau earlier than GWLR ($p < 0.05$), and had higher total weight, weight regain, waist circumference and BMI assessed at the last nutritional consultation ($p < 0.05$) (Table II).

There was better total weight loss among the GWLR ($p < 0,05$) (Fig. 1), and PWLR had higher weight regain than GWLR ($p < 0.05$). Current %EWL was estimated with the lowest post-surgical weight

Table II. Clinical and nutritional profile compararison between good and poor weight loss responders post roux-en-Y gastric bypass

	TS	GWLR	PWLR	p-value£
PO period (months) †*	67.38 ± 30.76	63.05 ± 29.96	78.01 ± 30.34	0.001
Minimum to maximum	24.00 – 151.00	24.00 – 151.00	25.00 – 130.00	
Plateau phase (months) †*	21.92 ± 12.85	23.10 ± 13.68	18.96 ± 10.00	0.039
Minimum to maximum	6.00 – 60.00	6.00 – 60.00	5.00 – 60.00	
*Weight (kg)** α*	86.95 ± 1.32	81.00 ± 1.16	101.00 ± 2.33	0.000
Minimum to maximum	54.50 – 157.00	54.50 – 132.00	75.00 – 157.00	
*EWL (%)**	61.55 ± 21.56	72.33 ± 13.86	35.06 ± 12.10	0.000
Minimum to maximum	1.56 – 106.15	50.06 – 106.15	1.56 – 49.75	
*Waist circumference (cm)** α*	105.00 ± 1.01	101.00 ± 0.99	120.00 ± 1.44	0.000
Minimum to maximum	77.00 – 150.00	77.00 – 141.00	92.00 – 150.00	
*BMI (kg/m^2)** α*	33.93 ± 0.44	32.04 ± 0.35	41.04 ± 0.72	0.000
Minimum to maximum	22.98 – 54.32	22.98 – 48.78	32.24 – 54.32	
*Weight regain (kg)** α*	8.85 ± 0.62	7.55 ± 0.49	15.45 ± 1.43	0.000
Minimum to maximum	0.00 – 51.50	0.00 – 31.10	1.50 – 51.50	

*TS: total sample; GWLR: good weight loss responders; PWLR: poor weight loss responders; PO: postoperative period; kg: kilogram; cm: centimeters; EWL: excess weight loss; BMI: Body Mass Index; *mean ± SD; **median ± SEM; £Student´s t test; αCoefficient of variation ≤ 25%; †Coefficient of variation > 25%.*



TS: total sample; GWLR: good weight loss responders; PWLR: poor weight loss responders.

Figure 1.

Total weight loss of good and poor weight loss responders in follow-up time.

for 6.1% (n = 11) of the patients, and was higher in GWLR. To classify weight loss, results were stratified according to postoperative time: 2, 3, 5, 7, and 10 years after surgery. Weight loss was 35%, 31.3%, 33.7%, 29.6% and 25.9% in these groups, respectively. For 36.3% (n = 74) of patients, weight regain was < 10%, 36.3% (n = 74) had weight regain of 10.1%-20%, and 21.3% (n = 45) had weight regain > 20%, compared with the lowest post-surgical weight. Among the PWLR, 49.0% (n = 29) regained > 20% of the lowest weight after surgery.

Before surgery, 80.4% (n = 164) of the patients had hypertension, 33.8% (n = 69) had T2DM, and 48.5% (n = 99) had dyslipidemia (Table I). After RYGB, metabolic control improvement or T2DM, dyslipidemia and hypertension resolution was higher in the GWLR group than the PWLR group ($p < 0.05$) (Fig. 2).

After surgery, there were 23% (n = 34) and 34% (n = 20) of GWLR and PWLR, respectively, using antidepressants ($p = 0.174$).

Energy and macronutrient intake (absolute values) were similar between the GWLR and PWLR groups ($p > 0.05$). Macronutrient distribution in total energy also was similar between groups ($p > 0.05$, study's power 100%) (Table III).

QOL was examined in 76.5% (n = 156) of the total sample. It was insufficient for 5.8% (n = 9) of patients, acceptable or good for 50.6% (n = 79), and very good or excellent for 43.6% (n = 68). None of the PWLR group were classified as having excellent QOL, and all insufficient results were found in the PWLR (18.8%; n = 9), demonstrating better QOL in the GWLR group ($p = 0.000$; χ^2=44.966).

After surgery 8.3% (n = 17) of the participants are smokers. Regarding to alcoholic beverage, 78.4% (n = 160) did not use alcohol, 20.1% (n = 41) are social drinkers and 1.5% (n = 3) were classified as alcohol addiction.

Only 14.7% (n = 30) of patients reported practicing some type of physical activity of more than 150 minutes per week, 17.1% (n = 35) practice less than 150 minutes per week and 139 (68.2%) of patients are sedentary.

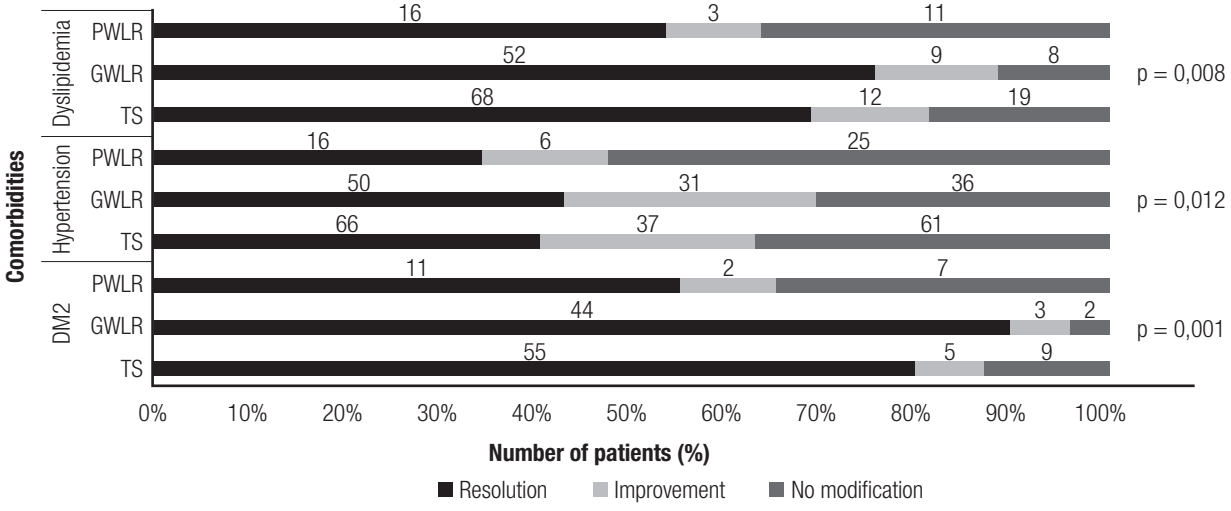
There was no difference between the GWLR and PWLR groups in frequency of smoking, alcohol comsuption and in physical activity ($p > 0.05$).

DISCUSSION

The results of the study demonstrate similar characteristics between the GWLR and PWLR groups in the preoperative period. PWLR achieved the plateau phase before GWLR, and had higher weight regain. However, GWLRs had better %EWL, QOL, and improvement or resolution of comorbidities, compared with PWLRs. Energy and macronutrient intake, alcohol consumption and physical activity were similar between groups following surgery.

There is no consensus definition of success or failure after bariatric surgery. The classification of GWLR and PWLR must include weight loss and weight recovery, alongside improvement or resolution preoperative comorbidities, prevention of nutrient deficiency, and better QOL.

We found that the minimum weight was reached between 18 and 24 months after surgery, and that the weight loss proportion decreases through the postoperative period, as observed in other studies (2,4,11-15). As demonstrated by our results and in other studies, rates of weight loss are higher during the first year after surgery, primarily in the first 6 months, followed by slower progressive weight loss two years after surgery, brief stabilization, then weight regain (2,5,12). Therefore, the %EWL at six months is a potentially valid index of surgical success.



TS: Total sample; GWLR: good weight loss responders; PWLR: poor weight loss responders; Chi-square test.

Figure 2.

Comorbities resolution and improvement of good and poor weight loss responders.

Table III. Daily intake of energy, carbohydrate, protein and lipid by good and poor weight loss responders post roux-en-Y gastric bypass

	TS	GWLR	PWLR	p-value£
*Energy (kcal)*α*	1151.25 ± 31.45	1114.60 ± 38.18€	1173.13 ± 52.85€	0.321
Minimum to maximum	184.49 – 3047.88	184.49 – 3047.88	565.48 – 2522.73	
*Energy (kcal/ Kg IBW)*α*	18.13 ± 0.53	17.14 ± 0.66€	18.60 ± 0.88€	0.619
Minimum to maximum	3.15 – 51.41	3.15 – 51.41	7.30 – 37.98	
*Carbohydrate (g)*α*	135.11 ± 4.21	135.76 ± 4.98€	135.11 ± 7.93€	0.411
Minimum to maximum	35.90 – 395.88	35.90 – 395.88	75.17 – 317.15	
*Carbohydrate (%kcal)*α*	50.08 ± 0.87	49.95 ± 1.02	50.62 ± 1.68	0.922
Minimum to maximum	22.33 – 83.02	24.26 – 83.02	22.33 – 77.31	
*Protein (g)*α*	49.50 ± 1.84	48.95 ± 2.17	56.98 ± 3.47	0.399
Minimum to maximum	5.48 – 151.69	5.48 – 151.69	22.89 – 129.02	
*Protein (g/kg IBW)*α*	0.77 ± 0.03	0.76 ± 0.04	0.83 ± 0.07	0.309
Minimum to maximum	0.09 – 2.56	0.09 – 2.56	0.31 – 1.94	
*Protein (%kcal)*α*	17.72 ± 0.47	17.81 ± 0.51	16.78 ± 1.03	0.499
Minimum to maximum	6.43 – 43.05	6.43 – 43.05	7.59 – 30.71	
*Lipid (g)*α*	41.25 ± 1.59	41.11 ± 1.92	42.43 ± 2.87	0.680
Minimum to maximum	1.41 – 157.96	1.41 – 157.96	12.58 – 118.25	
*Lipid (%kcal)*α*	31.55 ± 0.65	31.50 ± 0.78	31.89 ± 1.19	0.829
Minimum to maximum	4.04 – 51.26	4.04 – 51.26	15.11 – 50.95	

*TS: total sample; GWLR: good weight loss responders; PWLR: poor weight loss responders; kcal: kilocalories; kg: kilogram; IBW: ideal body weight; g: grams; *median ± SEM; £Student´s t test; €Study's power 100%; α Coefficient of variation ≤ 25%.*

In the late postoperative period, we observed 93.9% of the patients with weight regain in the final nutritional consultation, and 57.6% of the total sample had important or very important weight regain, mainly among the PWLR. This weight regain is dramatic compared with the ≥15% weight regain in 15% of the patients after surgery reported by Odom et al. (2010) on avarage 28 months after surgery (4). However, our results are more similar to other studies that suggest that the longer the postoperative period after surgery, the higher the weight regain (4,12,14).

Weight regain usually starts at 24 months after surgery and is similar at 2, 5, 6 and 10 years after surgery, varying between 7% and 8.7% (2,12,13,16). Lowest values are demonstrated 3 years after surgery, showing 3% proportional weight regain (17).

Socioeconomic factors may also play a role in the long-term success of bariatric surgery. In Brazil, despite of the universal availability of the NBHCS, low-income patients attend public health services more often. Studies suggest that lower socioeconomic status contributes to weight regain after bariatric surgery (11,14,18,19).

In addition to changes in the anatomy of the digestive tract after RYGB, some researchs have demonstrated that there are physiological changes involved in complex gut-brain nutrient and neural signaling after surgery, such as the influence of some gastrointestinal hormones involved in the control of hunger and satiety, for example, increased secretion of Glucagon-like peptide-1 (GLP-1) and peptide YY, and decrease ghrelin, with their central and peripheral effects on glycaemia and food intake, affecting glucose homeostasis and weight control (20-22).

Also the genetic factors and epigenetic mechanisms have been associated with variability in weight loss in response to surgical intervention (23). Polymorphisms in genes related to RYGB response after 1 year post-surgery were identified (24). Several common genetic variants may influence weight loss results after RYGB as shown by Rinella et al. (25) when compared genetic polymorphisms between patients with lower and higher %EWL.

Regarding metabolic parameters, T2DM, dyslipidemia and hypertension improvement or resolution was higher after RYGB in GWLR compared with PWLR. In spite of the weight regain, we observed improvement or resolution of comorbidities in late the postoperative period. However, earlier assessment, 2–3 years after surgery, demonstrates better results in T2DM, hypertension and dyslipidemia resolution than found in the present study and in other studies with longer postoperative time, because higher weight loss is associated with better improvement of comorbidities (13-15,18,26-28). After one year the remission of type 2 diabetes can be up to 90% as shown by Pinhel et al. (29). Weight regain after 24 months of surgery is related to less remission and increased recurrence of comorbidities (13-15,18,26,27).

Our results show similar energy and macronutrient intake between the GWLR and PWLR groups. Energy intake and macronutrient distribution observed in our study were similar to a food quality, physical activity and nutritional follow-up study of 100 patients after RYGB (14). In our study, protein intake was lower than daily recommendations for both GWLR and PWLR. This may be important, as a protein rich diet contributes to satiety, and stimulates weight loss and lean mass maintenance (30,31).

Available methods to assess food intake are not precise and the need of individual report is a limitation (18). It is known that energy intake is underreported on the first R24h and three R24h appear ideal for assessing food intake (32). Usually, obese people underestimate energy intake between 20% and 30%, and they reduce their energy intake near to nutritional consultations (14,18). In our study, we compared energy and nutrient intake between groups, and one R24h is enough because all subjects, of both groups, were submitted at the same condition, despite to be a limitation.

We found a better QOL in GWLR compared with PWLR. A study in which bariatric surgery patients were followed-up for 10 years showed a very good or excellent QOL in 84% of patients, similar to our results (33). Positive effects on QOL are reached with 10% of weight loss. Hence, QOL is associated with the magnitude of weight loss, since better results were obtained after one year of surgery, with gradual decline after 6 years, coinciding with weight regain (34).

We found no difference between GWLR and PWLR in smoking frequency, alcohol consumption and physical activity. Regular physical activity was lower than demonstrated in other studies, suggesting regular physical activity as a predictive factor of weight loss maintenance after surgery (14,35). As described in other studies (36,37), we did not find a relationship between alcohol consumption and weight loss.

Limitations of our study include the dropout rate (64.1%), that may affect the study results because the all 569 patients heterogeneity at pre- and post-surgery and that the Service of Multidisciplinary Care of Surgical Obese Patients, providing assistance to pre- and postoperative patients, was started approximately seven years ago, and therefore did not support 60.8% (n = 124) of the patients of the sample before surgery. Other limitations were that precise instruments were not used before surgery to assess alcohol consumption, smoking and comorbidities, and that the food intake investigation only included one R24h.

CONCLUSION

GWLRs have better %EWL, QOL, and improvement or resolution of comorbidities, compared with PWLRs. Alcohol consumption and physical activity are similar between groups following surgery. There are no difference in nutritional GWLR with PWLR after RYGB in the late postoperative period. However, obesity treatment does not end with the bariatric procedure. Further studies are necessary to elucidate factors that assure good response to surgery, to guide the multidisciplinary team, and to elucidate metabolic and hormonal mechanisms underlying weight regain.

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STATEMENT OF INFORMED CONSENT

The authors declare that informed consent was obtained from all individual participants included in the study.

STATEMENT FOR HUMAN RIGHTS

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments.

REFERENCES

1. Mechanick JI, Youdim A, Jones DB, Garvey WT, Hurley DL, McMahon MM, et al. Clinical Practice Guidelines for the Perioperative Nutritional, Metabolic, and Nonsurgical Support of the Bariatric Surgery Patient - 2013 Update: Cosponsored by American Association of Clinical Endocrinologists, The Obesity Society, and American Society. Endocr Pract 2013;19(2):e1-36. PMID: 2352935.
2. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med 2013;273(3):219-34. PMID: 23163728.
3. Angrisani L, Santonicola A, Iovino P, Formisano G, Buchwald H, Scopinaro N. Bariatric surgery worldwide 2013. Obes Surg 2015;25(10):1822-32. PMID: 25835983.
4. Odom J, Zalesin KC, Washington TL, Miller WW, Hakmeh B, Zaremba DL, et al. Behavioral predictors of weight regain after bariatric surgery. Obes Surg 2010; 20:349-56. PMID: 19554382.
5. Nicoletti CF, de Oliveira BA, de Pinhel MA, Donati B, Marchini JS, Salgado Junior W, et al. Influence of Excess Weight Loss and Weight Regain on Biochemical Indicators During a 4-Year Follow-up After Roux-en-Y Gastric Bypass. Obes Surg 2015;25(2):279-84. PMID: 24996801.
6. Oria, EH; Moorehead K. Bariatric Analysis and Reporting System (BAROS). Obes Surg 1998;8:487-99. PMID: 9819079.
7. World Health Organization (2010). Global Recommendations on Physical Activity for Health. Genebra: WHO, 2010. Available from: <http://whqlibdoc.who.int/publications/2010/9789243599977_spa.pdf> (accessed August 2010).
8. World Health Organization (WHO) (2004). Global status report on alcohol. Genebra: WHO, 2004. Available from: <http://www.who.int/substance_abuse/publications/global_status_report_2004_overview.pdf> (accessed August 2010).
9. Deitel M. Overview of operations for morbid obesity. World J Surg 1998; 22:913-8. PMID: 9717416.
10. Mechanick JI, Kushner RF, Sugerman HJ, González-Campoy JM, Collazo-Clavell ML, Guven S, et al. American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery Medical Guidelines for Clinical Practice for the Perioperative Nutritional, Metabolic, and Nonsurgical Support of the Bariatric Surgery Patient. Surg Obes Relat Dis 2008;4:S109-S184.
11. Christou NV, Look D, Maclean LD. Weight gain after short- and long-limb gastric bypass in patients followed for longer than 10 years. Ann Surg 2006;244(5):734-40. PMCID: 1856611.

12. Magro DO, Geloneze B, Delfini R, Pareja BC, Callejas F, Pareja JC. Long-term weight regain after gastric bypass: a 5-year prospective study. Obes Surg 2008;6:648-51. PMID: 18392907.
13. Adams TD, Davidson LE, Litwin SE, Lamonte MJ, Pendleton RC, Strong MB, et al. Health benefits of gastric bypass surgery after 6 Years. JAMA 2012; 308(11):1122-31. PMID: 22990271.
14. Freire RH, Borges MC, Álvarez-Leite JI, Toulson Davisson Correia MI. Food quality, physical activity, and nutritional follow-up as determinant of weight regain after Roux-en-Y gastric bypass. Nutrition 2012;28(1):53-8. PMID: 21885246.
15. Courcoulas AP, Christian NJ, Belle SH, Berk PD, Flum DR, García L, et al. Weight Change and Health Outcomes at 3 Years After Bariatric Surgery Among Individuals With Severe Obesity. JAMA 2013;310(22):2416-25.
16. Barhouch AS, Zardo M, Padoin A V, Colossi FG, Casagrande DS, Chatkin R, et al. Excess weight loss variation in late postoperative period of gastric bypass. Obes Surg 2010;20(11):1479-83. PMID: 20552412.
17. Blume CA, Boni CC, Casagrande DS, Rizzolli J, Padoin AV, Mottin CC. Nutritional profile of patients before and after Roux-en-Y gastric bypass: 3-year follow-up. Obes Surg 2012;22(11):1676-85. PMID: 22684818.
18. Shah M, Simha V, Garg A. Review: long term impact of bariatric surgery on body weight, comorbities, and nutritional status. J Clin Endocrinol Metab 2006;91:4223-31. Epub 2006 Sep 5. PMID: 16954156.
19. JúniorWS, Amaral JL, Nonino-Borges CB. Factors related to weight loss up to 4 years after bariatric surgery. Obes Surg 2011;21(11):1724-30. PMID: 21509481.
20. Dirksen C, Jørgensen NB, Bojsen-Møller KN, Kielgast U, Jacobsen SH, Clausen TR, et al. Gut hormones, early dumping and resting energy expenditure in patients with good and poor weight loss response after Roux-en-Y gastric bypass. Int J Obes 2013;37(11):1452-9.
21. De Hollanda A, Jiménez A, Corcelles R, Lacy AM, Patrascioiu I, Vidal J. Gastrointestinal hormones and weight loss response after Roux-em-Y gastric bypass. Surg Obes Relat Dis 2014;10:814-21.
22. Abdeen G, Le Roux CW. Mechanism Underlying the Weight Loss and Complications of Roux-en-Y Gastric Bypass. Obes Surg 2016;26:410-21.
23. Rasmussen-Torvik LJ, Baldridge AS, Pacheco JA, Aufox SA, Kwang-Youn AK, Silverstein JC, et al. Rs4771122 Predicts Multiple Measures of Long-Term Weight Loss After Bariatric Surgery. Obes Surg 2015;25:2225-9.
24. Seip RL, Papasavas P, Stone A, Thompson S, Ng J, Tishler DS, et al. Comparative physiogenomic analyses of weight loss in response to 2 modes of bariatric surgery: demonstration with candidate neuropsychiatric and cardiometabolic genes. Surg Obes Relat Dis 2016;12:369-78.
25. Rinella ES, Still C, Shao Y, Wood GC, Chu X, Salerno B, et al. Genome-wide Association of Single-Nucleotide Polymorphisms With Weight Loss Outcomes After Roux-en-Y Gastric Bypass Surgery. J Clin Endocrinol Metab 2013;98(6):E1131-E1136.
26. Buchwald H, Avidor Y, Braunwald E, Jensen MD, PoriesW, Fahrbach K, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004;292:1724-37.
27. Laurino Neto RM, Herbella FAM, Tauil RM, Silva FS, de Lima SE. Comorbidities remission after Roux-en-Y Gastric Bypass for morbid obesity is sustained in a long-term follow-up and correlates with weight regain. Obes Surg 2012;22(10):1580-5. PMID: 22907795.
28. Sjostrom L, Lindroos AK, Peltonen M, Torgerson J, Bouchard C, Carlsson B, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 y after bariatric surgery. N Engl J Med 2004;351:2683-93.
29. Pinhel MA, Nicoletti CF, de Oliveira BA, Chaves RC, Parreiras LT, Sivieri T, et al. Weight loss and metabolic outcomes 12 months after roux-en-y gastric bypass in a population of southeastern brazil. Nutr Hosp 2015;32(3):1017-21.
30. Faria SL, Faria OP, Buffington C, de Almeida Cardeal M, Ito MK. Dietary protein intake and bariatric surgery patients: a review. Obes Surg 2011;21(11):1798-805. PMID: 21590346.
31. Pateiro LF, Pampillón N, Coqueugniot M, De Rosa P, Pagano C, Reynoso C, et al. Gráfica alimentaria para la población bariátrica argentina. Nutr Hosp 2014;29(6):1305-10.
32. Yunsheng MA, Olendzki BC, Pagoto SL, Hurley TG, Magner RP, Ockene IS, et al. Number of 24-Hour Diet Recalls Needed to Estimate Energy Intake. Ann Epidemiol 2009;19(8):553-9.
33. Awad WF, Garay AM, Martínez CB, Oñate VM, Turu IK, Yarmuch JG. Experiencia de 10 años con el bypass gástrico. Rev Chil Cir 2007;59(6):443-7.
34. Karlsson J, Taft C, Rydén a, Sjöström L, Sullivan M. Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. Int J Obes (Lond) 2007;31:124861. PMID: 17356530.
35. Welch G, Wesolowski C, Zagarins S, Kuhn J, Romanelli J, Garb J, et al. Evaluation of clinical outcomes for gastric bypass surgery: results from a comprehensive follow-up study. Obes Surg 2011;21(1):18-28. PMID: 20087678.
36. King WC, Chen J-Y, Mitchell JE, Kalarchian MA, Steffen KJ, Engel SG, et al. Prevalence of alcohol use disorders before and after bariatric surgery. JAMA 2012;307(23):2516-25. PMID: 22710289.
37. Lent MR, Hayes SM, Wood GC, Napolitano MA, Argyropoulos G, Gerhard GS, et al. Smoking and alcohol use in gastric bypass patients. Eat Behav 2013;14(4):460-3.

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ARÁN

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Trabajo Original

Valoración nutricional

Comparison of body fat calculations by sex and puberty status in obese schoolchildren using two and four compartment body composition models

Comparación de modelos de dos y cuatro compartimentos para grasa corporal en escolares obesos según su sexo y desarrollo puberal

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Abstract

Introduction: Determine body composition changes in adiposity can assess an individual.

Objective: The objective of this study was to evaluate total body fat percentage based on two and four compartment models in obese Chilean school children, adjusting for differences in sex and puberty status.

Methods: Sixty-one obese school children (33 boys and 28 girls) between 8 and 13 years of age were evaluated. Two compartment measurements of body fat percentage considered isotope dilution, plethysmography, radiographic absorptiometry and bioelectrical impedance; using the four compartment model as a benchmark.

Results: Each method explained between 43-87% of the variance in body fat percentage in Tanner stage I and II children and between 78-96% in Tanner stage III and V children. In both groups of children methods differed significantly for stage I, with the exception of plethysmography. High R^2 values were observed for girls in all Tanner stages. Each method explained between 34-92% of the variance in body fat percentage for girls in stages I and II and between 63-93% for stages III and V. In obese boys, R^2 values were high for stages III and V. In girls and boys in Tanner stage III and V, the smallest differences were observed for isotopic dilution, and DXA (dual-energy X-ray absorptiometry) scan for stages I and II.

Conclusions: For obese boys and girls, the two compartment model with isotopic dilution and DXA had the best precision and smallest differences in determining body fat percentage compared to the benchmark.

Key words:

Body fat percentage. Four compartment model. Two compartment model. Isotopic dilution. Radiographic absorptiometry. Plethysmography. Bioelectrical impedance.

Resumen

Introducción: determinar la composición corporal permite valorar cambios en la adiposidad de un individuo.

Objectivo: el objetivo de este estudio fue evaluar la grasa corporal total basada en modelos de dos compartimentos (2C) y compararlos con el modelo de cuatro compartimentos (4C) en escolares chilenos obesos, considerando potenciales diferencias por sexo y desarrollo puberal.

Métodos: 61 escolares obesos (33 niños y 28 niñas), de entre 8 y 13 años. La medición de la grasa corporal por 2C consideró dilución isotópica, pletismografía, absorciometría radiográfica y bioimpedanciometría; utilizando como patrón de referencia el modelo de 4 compartimentos.

Resultados: cada método dio cuenta de 43-87% de la varianza para determinar el porcentaje de grasa corporal en niños en etapa I y II y 78-96% en etapa III y IV. En ambos grupos de niños, las pendientes difirieron significativamente en la etapa I, con la excepción de la pletismografía. En niñas los valores de R^2 altos se observaron en todas las etapas del desarrollo puberal. Cada método dio cuenta de 34-92% de la varianza para determinar el porcentaje de grasa corporal en niñas etapa I y II y 63-93% en etapa III y IV, respectivamente. En niños obesos, los valores de R^2 fueron altos, principalmente en el grupo de etapa III y IV. En niños y niñas de Tanner III y IV, las menores diferencias con el patrón de referencia fueron con dilución isotópica; en cuanto a Tanner I y II, las menores diferencias se obtuvieron con DEXA.

Conclusiones: en ambos sexos, el modelo de dos compartimentos con dilución isotópica y DEXA tuvo la mayor precisión y las menores diferencias para determinar la grasa corporal en los niños y adolescentes obesos, en comparación con el patrón de referencia.

Palabras clave:

Porcentaje de grasa corporal. Modelo de cuatro compartimentos. Modelo de dos compartimentos. Dilución isotópica. Absorciometría radiográfica. Pletismografía. Bioimpedanciometría.

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INTRODUCTION

The prevalence of obesity in Chilean school children is 25.3%, with slightly higher levels among boys compared to girls (28.3% *vs.* 22.3%) (1). Increases in adiposity associated with childhood obesity is a risk factor for glucose intolerance, insulin resistance, dyslipidemia, non-alcoholic fatty liver disease, hypertension, heart attack, stroke and premature death (2-6). Although body mass index (BMI) is widely used as an index of body fat (BF), it is not a direct measurement of adiposity. BMI cannot distinguish between different types of body mass *(e.g.* fat mass, fat free mass, bone mass), thus the use of BMI can lead to errors in the estimation of BF, especially in the context of obesity. Changes in weight and height associated with normal growth are responsible for a 50% increase in BMI, which further complicates the interpretation of this index for children and adolescents. The increase in BMI during adolescence is primarily a result of an increase in fat free mass (7,8). BMI is a global indicator of nutritional status and does not distinguish between lean and fat mass (9). Thus, measuring fat mass would allow for the quantification of metabolic risk associated with an increase in obesity.

In the classic two compartment model of body composition, body weight is divided into fat mass and fat free mass. This model is used widely for clinical practice and nutritional follow-up. BODPOP uses the relationship between pressure and volume to calculate body volume and density (10) Isotopic dilution quantifies total body water, which can be used to predict fat free mass, as a proportion of water known in fat free mass by age and sex (11) DXA differentiates between fat and fat free mass based on the differential attenuation of x-rayes (12). Bioelectrical impedance, BIA, is an indirect method to measure the total body water and fat free mass (13).

The most precise method, considered the gold standard, for determining body composition is the four compartment model. For this method, fat free mass is divided into water, minerals and proteins (10). Although multi-compartment models of body composition have better precision, few studies have used them to validate simpler methodology in obese children and adolescents (14). The current study aimed to determine the predictive capacity of the two compartment model of BF% (body fat percentage) compared to the four compartment model in a sample of obese Chilean school children, adjusting for possible differences by sex and pubertal stage.

METHODS

SUBJECTS

We worked with a sample of 61 obese children years (males = 33 and females = 27) between 8 and 13, from a school in the Macul neighborhood of Santiago, Chile. The school was chosen for convenience, given the proximity of the school to the place of measurements. Inclusion criteria included: BMI ≥ 95th percentile according to CDC-NCHS references (15), full-time attendance at an educational institution, parental consent and child assent. The exclusion criteria included: medical diagnosis of psychomotor disorder, use of drugs that can alter body composition, performing physical activity, and/or biochemical parameters. This research was approved by the Ethics Committee of the University of Chile.

BIOLOGICAL AGE

Pubertal development was classified using Tanner staging, considering breast development in females and genital in males (16). Developmental stages were determined by visual inspection during a physical examination by a pediatrician.

ANTHROPOMETRY

Weight and height were assessed in the morning after an overnight fast. Children wore minimal clothing, standing in front of the scale, with feet together at the center of it, arms attached to the body, the head forming a straight line parallel to the floor to join the corner of the eye and the birth of the ear. An electronic balance (SECA® Model 767) was used with sensitivity of 10 grams for weight and Holtain stadiometer (SECA) with sensitivity 0.1 cm for height, both imported by Precision Hispana. Four skin folds (biceps, triceps, subscapular and suprailiac), with a Lange caliper millimeter (1 mm), were assessed in triplicate using the technique described by Lohman et al. (17).

ISOTOPIC DILUTION

Total body water was determined with deuterium dilution. The isotope (4 grams of deuterium oxide 99.8%) was administered orally according to body weight of the subject. The amount of body water was measured by determining the concentration of deuterium oxide, according to the Plateau method. This required that the subjects were in total fasting for a period of three hours, which corresponds to the period of equilibrium and minimizes changes in total body water content (11). After the fast, a saliva sample (2 mL, baseline) was taken. Subsequently, the deuterium dose and an additional 20 ml of tap water were given to ensure dose ingestion. After three hours, during which participants were not allowed to urinate, eat or drink anything additional, the second saliva sample (post dose) was taken and frozen at -20 °C. For analyzing the concentration of deuterium in saliva, the sample was thawed, equilibrated in hydrogen gas, adding 5% platinum on aluminum with time of three days to reach equilibrium. The deuterium/hydrogen ratio in the gas released was analyzed by mass spectrometry (Hydra, Europe Scientific, Crewe, Cheshire, United Kingdom).

PLETHYSMOGRAPHY

Volume and body density were measured with an air displacement plethysmograph (BODPOD, mod 2000, Life Measurement,

Inc., Concord, USA). Children were tested with underwear, without metal objects and a swimming cap to compress the hair. Later, children were weighed on a calibrated scale with an accuracy of 5 g. The system performs a pressure measurement with the chamber empty, then the equipment is calibrated using a 50 liter calibration cylinder, after which the subject is measured 2-3 times. Body size obtained by this method was used for the 4C (four compartment) equation.

DUAL-ENERGY X-RAY ABSORPTIOMETRY

Bone mineral density was estimated using dual energy x-ray absorptiometry using Lunar Prodigy Ghc DPX-NT (Lunar Radiology, WI, USA) technology, which assesses the entire body in a five-minute sweep. Children were placed supine wearing a light robe.

BIOELECTRICAL IMPEDANCE

Bioelectrical impedance was measured using Tanita BC-418MA, eight-electrode, hand-to-foot system, manufactured by the Tanita Corporation (Tokyo, Japan). Measurements were collected according to manufacturer's guidelines using a 50 kHz frequency. Height, sex and age were entered manually, whereas weight was recorded automatically. Measurements were taken in the morning after limited physical exercise and empty bladders.

4C MODEL

The 4C model divides the body in fat, water, protein, and minerals (18-20). The ability of the model to adjust core body mineral mass can result in a more accurate estimate of hydration and lean mass density compared with the 3C model. The 4C model is considered the "gold standard" because it takes into account the variability of its components. The equation has been previously validated in children of the same group (21).

The 4C equation used was a follows:

BF (kg) = [(2,747*BV) – (0,710*TBW)] + [(1,460*BMC) – (2,050*W)]

BV = body volume in liters (plethysmography), TBW = total body water in liters (isotope dilution), BMC = bone mineral content in kg. (DXA) and W = body weight (kg).

STATISTICAL ANALYSIS

Descriptive statistics were used: minimum, maximum and frequency tables. Continuous variables were analyzed with the goodness of fit test of Shapiro Wilk test of homogeneity of variance. For variables that met normality assumptions we reported the average and standard deviation, otherwise the median and interquartile range were shown. Differences by gender and pubertal development were analyzed using Student's t test.

Each of the methods (isotopic dilution, DXA and plethysmography BIA) were compared with the results of the 4C model. This comparison was made using the Lin (22) concordance coefficient and Bland-Altman method (23). The Bland-Altman analysis was calculated as the mean difference value between the reference (4C model) and each of the methods and the 95% distribution (confidence intervals).

A regression analysis was done to compare the 4C model and the simplest methods (isotope dilution, DXA, plethysmography and BIA) for determining BF%. The slopes and intercepts were assessed and the standard error of the estimate (SEE) was calculated. $p < 0.05$ was established as the cutoff for statistical significance. The study data were analyzed using STATA program version 10.1 (24).

RESULTS

Physical and body composition of the sample by gender and pubertal development characteristics are shown in table I. There was no interaction between sex and pubertal development. However, several significant sex differences were found. Boys had significantly higher values in the variables: age, weight, height, total body water and bone mineral density. As well, in body composition for both BF (kg) and (fat free mass) FFM in kg and percentage for the 4C model, isotopic dilution, DXA, BIA and plethysmography. Also, boys had higher values in the determination of BF% by BIA. Similarly, there were significant differences associated with pubertal development. Both males and females with advanced puberty, showed significantly higher results in age, weight, height, total body water and bone mineral density. BF (kg) and FFM (kg) in the 4C model, isotope dilution, DXA, BIA and plethysmography. Lean mass (%) for boys only in the BIA and 4C model. Girls with pubertal development I and II had significantly higher values of FFM (%).

Lin coefficients for the different methods estimating BF% compared to the "gold standard" 4C model, by sex and pubertal development are shown in table II. Males in stage I and II, had concordance coefficients ranging between 0.352 and 0.866 and between 0.721 and 0.959 for stage III and V. In males, the greatest agreement was obtained with DXA (stage I and II) and isotope dilution in stage III and V. The lowest concordance was observed for the BIA (0.352 and 0.721 for boys and girls, respectively). In females of all stages, the greatest agreement was with plethysmography.

Table III shows the R^2 value, intercepts and slopes for the regressions for BF% according to the 4C model and each of the different methods, along with SEE stratified by gender and pubertal development. R^2 values were high for males, mainly in stage III and V. Each method explained between 43-87% of the variance in BF% for males in stage I and II and 78-96% for males in stage III and V.

In both groups of children, the slopes differed significantly from 1 except for plethysmography. Lower values of SEE were observed in stage III and V males.

Table I. Body composition and physical characteristics of the sample, by sex and pubertal development

Variable	Boys		Girls	
	Genital I & II (n = 19)	Genital III & V (n = 14)	Breast I & II (n = 5)	Breast III & V (n = 23)
Age (years)[1,2]	11.5 ± 1.1	13.6 ± 1.0	8.4 ± 0.8	11.5 ± 1.7
Weight (kg)[1,2]	60.9 ± 13.5	76.3 ± 11.7	38.5 ± 5.1	58.2 ± 14.3
Height (cm)[1,2]	149.4 ± 12.0	161.4 ± 4.8	131.1 ± 3.7	147.8 ± 8.0
Total body water (L)[1,2]	26.9 ± 5.5	35.6 ± 5.0	17.8 ± 2.1	25.6 ± 5.2
Bone mineral density (kg)[1,2]	1.8 ± 0.5	2.4 ± 0.3	1.2 ± 0.1	1.7 ± 0.4
4-Component model				
BF (%)	41.2 ± 6.0	36.9 ± 7.9	37.2 ± 4.3	40.4 ± 6.2
BF (kg)[1,2]	25.3 ± 7.9	28.6 ± 9.3	14.4 ± 3.1	24.1 ± 8.5
FFM (%)[1,2]	58.8 ± 6.0	63.1 ± 7.9	62.8 ± 4.3	59.6 ± 4.3
FFM (kg)[1,2]	35.6 ± 7.7	47.7 ± 6.4	24.1 ± 2.6	34.1 ± 6.9
Isotopic dilution BF (%)	40.3 ± 5.7	36.8 ± 6.7	39.9 ± 3.6	41.3 ± 4.3
Isotopic dilution BF (kg)[1,2]	24.8 ± 7.8	28.4 ± 8.2	15.4 ± 2.9	24.4 ± 7.8
Isotopic dilution FFM (%)	59.7 ± 5.7	63.2 ± 6.7	60.1 ± 3.6	58.7 ± 4.3
Isotopic dilution FFM (kg)[1,2]	36.1 ± 7.3	47.9 ± 6.8	23.1 ± 2.7	33.8 ± 7.1
DXA BF (%)	41.5 ± 5.6	39.0 ± 7.0	38.3 ± 3.0	41.6 ± 4.7
DXA BF (kg)[1,2]	25.6 ± 8.2	30.1 ± 8.8	14.8 ± 2.8	24.6 ± 8.0
DXA FFM (%)	58.5 ± 5.6	61.0 ± 7.0	61.7 ± 3.0	58.4 ± 4.7
DXA FFM (kg)[1,2]	35.3 ± 6.7	46.2 ± 6.5	23.7 ± 2.6	33.6 ± 6.9
Plethysmography BF (%)	44.4 ± 6.7	39.2 ± 9.0	39.1 ± 6.1	42.6 ± 7.9
Plethysmography BF (kg)[1,2]	27.2 ± 8.3	30.6 ± 10.5	15.2 ± 3.6	25.5 ± 9.5
Plethysmography FFM (%)	55.6 ± 6.7	60.8 ± 9.0	60.9 ± 6.1	57.4 ± 7.9
Plethysmography FFM (kg)[1,2]	33.7 ± 8.0	45.7 ± 5.9	23.3 ± 7.3	32.7 ± 7.0
BIA BF (%)[1,2]	34.8 ± 4.4	36.3 ± 4.1	35.2 ± 4.9	41.5 ± 4.7
BIA BF (kg)[1,2]	21.3 ± 6.6	28.0 ± 7.0	13.7 ± 3.5	24.7 ± 8.4
BIA FFM (%)[1,2]	61.6 ± 4.4	63.7 ± 4.1	64.8 ± 4.9	58.5 ± 4.7
BIA FFM (kg)[1,2]	39.6 ± 8.1	48.3 ± 5.6	24.8 ± 1.8	33.5 ± 6.3

x: mean; SD: standard deviation.
[1]Significant difference by sex, $p < 0.05$. [2]Significant difference by pubertal stage, $p < 0.05$.

Table II. Coefficient of concordance between the four compartment model and different methods to estimate total body fat, adjusted for sex and pubertal development

Variable	Boys						Girls					
	Genital I & II (n = 19)			Genital III & V (n = 14)			Breast I & II (n = 5)			Breast III & V (n = 23)		
	*r**	*Dif+*	*[95% CI]*	*r*	*Dif*	*[95% CI]*	*r*	*Dif*	*[95% CI]*	*r*	*Dif*	*[95% CI]*
Isotopic dilution	0.851	0.941	-5.04-6.92	0.959	0.155	-3.93-4.24	0.689	-2.684	-6.420-1.052	0.809	-0.861	-7.081-5.359
DXA	0.866	-0.241	-6.10-5.62	0.886	-2.124	-7.81-3.56	0.722	-1.052	-6.129-4.025	0.785	-1.116	-7.857-5.625
Plethysmography	0.819	-3.172	-7.92-1.58	0.932	-2.359	-6.333-1.614	0.838	-1.952	-6.347-2.444	0.893	-2.151	-7.086-2.785
BIA	0.352	6.449	-2.41-15.31	0.721	0.596	-8.56-9.75	0.516	2.059	-6.30-10.42	0.754	-1.041	-8.351-6.270

**r: correlation; +95% CI: confidence interval.*

In girls, the highest R^2 values were observed with the plethysmography method for all stages of pubertal development. Each method explained 34-92% of the variance in female BF% for stage I and II and 63-93% for girls in stage III and V, respectively.

Figure 1 presents the analysis of specific agreement by Bland and Altman test in estimating BF% between the 4C model and the other methods (isotopic dilution, DXA and plethysmography BIA). In males, an underestimation of BF% with DXA and plethys-

Table III. Regression analysis modeling different methods to estimate total body fat mass, adjusted for sex and pubertal development

Variable	Boys								Girls							
	Genital I & II (n = 19)				Genital III & V (n = 14)				Breast I & II (n = 5)				Breast III & V (n = 23)			
	R^2	*Intercept*	*Slope*	*SEE*	R^2	*Intercept*	*Slope*	*SEE*	R^2	*Intercept*	*Slope*	*SEE*	R^2	*Intercept*	*Slope*	*SEE*
Isotopic dilution	0.75	-1.29	1.06	0.07	0.94	-6.19	1.17	0.02	0.81	-11.33	1.22	0.22	0.77	-19.08	1.44	0.06
DXA	0.75	-2.79	1.06	0.06	0.87	-6.93	1.12	0.07	0.66	-18.71	1.46	0.23	0.69	-14.39	1.32	0.07
Plethysmography	0.87	1.63	0.89	0.07	0.96	2.61	0.87	0.03	0.92	9.09	0.72	0.23	0.93	7.13	0.78	0.03
BIA	0.43	-5.51	1.34	0.12	0.78	-32.34	1.91	0.08	0.34	6.23	0.88	0.34	0.63	-13.91	1.31	0.09

All slopes are significantly different from 1 ($p < 0.05$).

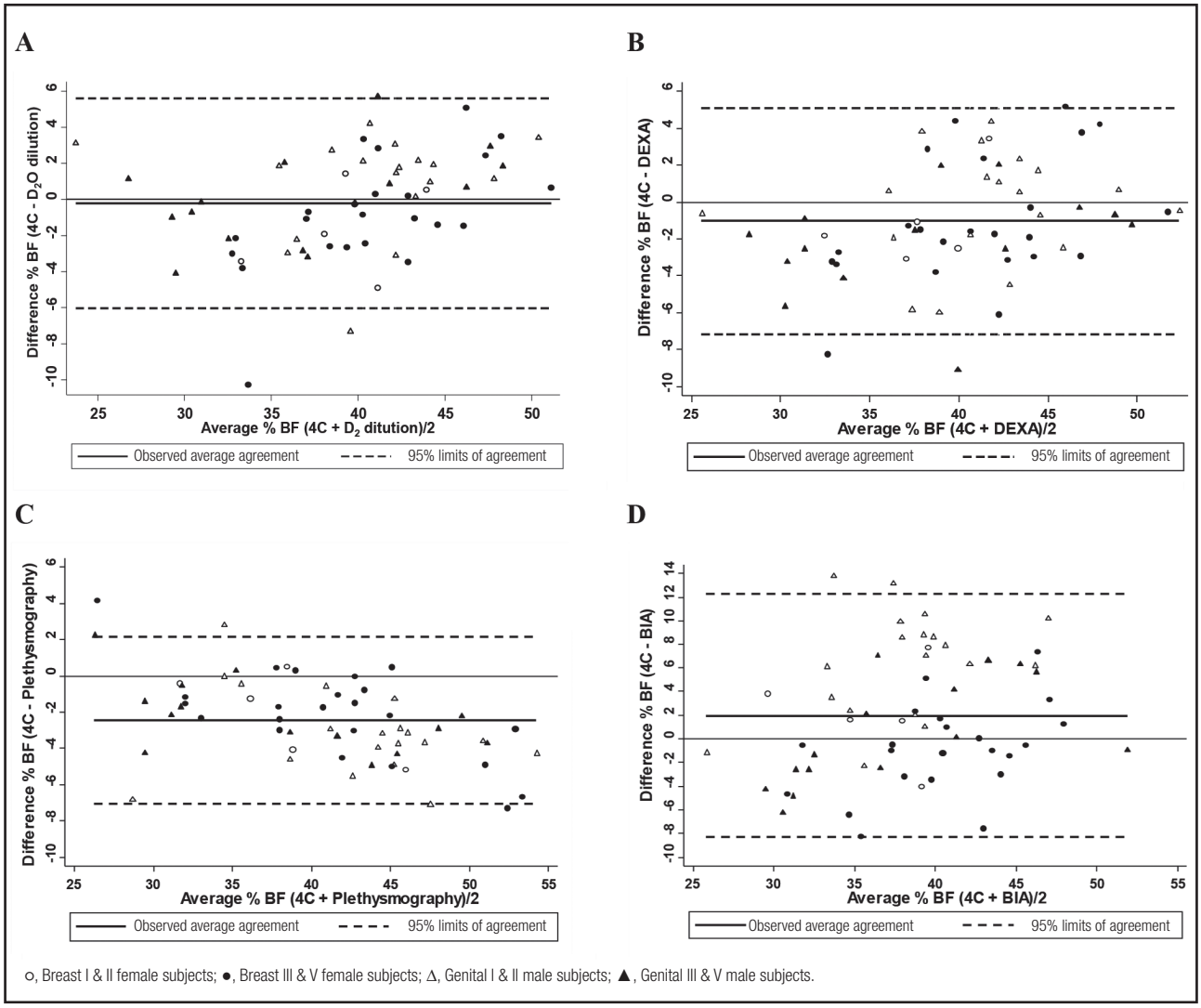

Figure 1.

A: Difference in BF% from 4 compartment (4C) model - Isotopic dilution (D_2O dilution) model *vs.* Average BF% (4C + D_2O dilution) /2. B: Difference in BF% from 4C model - Dual-energy X-ray absorptiometry (DXA) model *vs.* Average BF% (4C + DXA) /2. C: Difference in BF% from 4C model - Plethysmography (BOD POD) *vs.* Average BF% (4C + Plethysmography) /2. D: Difference in BF% from 4C model - BIA *vs.* Average BF% (4C + BIA) /2.

mography was observed. Isotope dilution overestimated by 0.941 for stage I and II and 0.155 for stages III and V, implying a lack of agreement. Also in males, we observed an overestimation of FM (fat mass) by 6.449 for stages I and II and 0.596 for stages III & V,

where there is clear disagreement between both measurements. For girls in stage III and V, we observed an overestimation (2.059) in total BF% estimated by BIA.

DISCUSSION

Most methods for assessing body composition are 2C and involve measuring one compartment and body weight difference with another is estimated *(e.g.,* total BF is evaluated and fat free mass is obtained). These methods incorporate theoretical assumptions about the composition of lean tissue, which are not valid in all cases, especially not in the context of obesity and during growth. Therefore, to minimize error, a combination of measurements is suggested to determine body composition. The 4C model allows the quantification of BF and lean mass, with a degree of precision not achievable with a single method (21). Methods has been demonstrated that there are Significant differences in the properties of fat-free tissue in obese, compared to normal weight, children and adolescents have been demonstrated (25-27). Hydration increases and density is lower in lean tissue of obese, compared to normal weight, individuals (25). These differences have been attributed in part to the expansion of extracellular water space (28,29); but also to lower bone mineralization (30). In this study, the 4C model was used as the gold standard to verify the validity of methods for 2C models in estimating total BF% in obese boys and girls with different levels of development of secondary sex characteristics. It is important to have methods that estimate BF% in school age and adolescent children because, even at the same weight, the risk of developing cardiovascular problems is increased with higher proportion of BF and lower lean mass ratio (31).

In our study, the best matching methods of the 2C and 4C models were obtained with DXA and isotopic dilution. Males in stage I & II with DXA ($r = 0.87$) and stage III & V males with isotope dilution ($r = 0.95$). In contrast, girls in both categories of pubertal development, the best agreement was obtained with plethysmography (I & II females $r = 0.84$ and $r = 0.89$ for the group III & V). These results are comparable to those obtained in a British study, conducted with 30 obese adolescents aged 14.10 ± 1.83 years. In boys, the correlation with plethysmography was $r = 0.97$ and $r = 0.96$ for DXA and isotope dilution, respectively. For girls, highest agreement was with plethysmography ($r = 0.94$) (32). An American study, which evaluated 25 children 11.4 ± 1.4 years, the model showed greater concordance with isotope dilution was 4C ($r = 0.98$), plethysmography ($r = 0.97$) and DXA ($r = 0.95$) (33). A study conducted with Mexican adolescents in school-age children (12.2 ± 2.0 years), showed greatest concordance with DXA, regardless of gender and pubertal stage ($r = 0.95$) (34).

In turn, in both sexes and stages of development, less agreement and correlation was obtained between the BIA and the 4C model. Our findings are similar to those of Aguirre et al. (35) who studied 424 Chilean students between 7-10 years and described the inaccuracy of the BIA for body composition estimation in prepubertal children. Bray et al. (36) also concluded that the BIA method was less acceptable.

The differences in BF% by pubertal stage, between the 2C and 4C models ranged from -3.17 to 6.50 in boys and girls and between -2.68 for 2.060 for both sexes.

Goran et al. (37) found underestimates similar to those reported in our study, from -6.45 (-7.37, - 5.53) and in the case of Deurenberg et al. differences ranged from +1.91 (1.18 to 2.63) (38).

One of the possible explanations for the limited functionality of the BIA for obese subjects may relate to the characteristics of the population in which the equations were created from. Differences in ethnicity, nutritional status, bone geometry, body composition and pubertal maturation may influence the relevance of the equations for other populations (21,39-41).

Our data are of particular interest because they allow for the comparison of validity of the models versus the gold standard (4C) to determine which methods are more reliable for assessing BF in obese adolescents of different pubertal development. In this cross-sectional study, comparing DXA and isotope dilution to the 4C model, we found that Tanner III and V stage children had minor differences for isotope dilution compared with the gold standard and that DXA had the best comparison to the gold standard for Tanner I & II children. Thus, isotopic dilution and DXA seem to have the highest accuracy and reliability for measuring BF in obese children and adolescents.

One of the strengths of this research was utilizing four compartments, which yields high precision and accuracy and is considered the gold standard in determining BF in vivo. Another advantage of the study was in the evaluation of differences in BF estimation using different methods, while considering gender and pubertal stage of development. However, a potential limitation is the narrow age range of the study group, which prevents extrapolation to a larger population.

In conclusion, it has been shown that isotopic dilution and DXA are methods sufficiently reliable compared to the gold standard method (4C) for determining BF% in obese children and adolescents, considering sex and stage of pubertal development. In the case of isotope dilution, it is a simple method that can be performed on site (e.g., schools, health centers) and only requires that samples be sent to a laboratory for validation, if sites do not have equipment. DXA requires equipment that is available in clinical centers or hospitals, which facilitates the measurement of fat and bone mineral density in obese patients.

Being able to reliably assess BF, which is associated with other metabolic variables, in obese adolescents could encourage better monitoring and thus help in the treatment of obese subjects. Moreover, we believe that having the proper methods is a contribution to the nutritional surveillance of pediatric obesity, providing reliable information to estimate the change in adiposity, in the global assessment of nutritional status for obese adolescents.

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REFERENCES

1. National Council for School Assistance. Map Nutritional 2013. [Online]. Available from: URL: http://bpt.junaeb.cl:8080/MapaNutricionalGx/. [Accessed Jan. 23, 2015].
2. Demerath EW, Reed D, Rogers N, Sun SS, Lee M, Choh AC, et al. Visceral adiposity and its anatomical distribution as predictors of the metabolic syndrome and cardiometabolic risk factor levels. Am J Clin Nutr 2008;88:1263-71.
3. Goran MI, Alderete TL. Targeting adipose tissue inflammation to treat the underlying basis of the metabolic complications of obesity. Nestle Nutr Inst Workshop Ser 2012;73:49-66.
4. Dulloo AG, Montani JP. Body composition, inflammation and thermogenesis in pathways to obesity and the metabolic syndrome: an overview. *Obes Rev* 2012;13:1-5.
5. Warolin J, Coenen KR, Kantor JL, Whitaker LE, Wang L, Acra SA, et al. The relationship of oxidative stress, adiposity and metabolic risk factors in healthy Black and White American youth. Pediatr Obes 2013. DOI: 10.1111/j.2047-6310.2012.00135.x. [Epub ahead of print].
6. Shashaj B, Bedogni G, Graziani MP, Tozzi AE, DiCorpo ML, Morano D, et al. Origin of cardiovascular risk in overweight preschool children: a cohort study of cardiometabolic risk factors at the onset of obesity. JAMA Pediatr 2014;168:917-924. DOI: 10.1001/jamapediatrics.2014.900.
7. Prentice AM, Jebb SA. Beyond body mass index. Obes Rev 2001;2:141-7.
8. Demerath EW, Schubert CM, Maynard LM, Sun SS, Chumlea WC, Pickoff A, et al. Do changes in body mass index percentile reflect changes in body composition in children? Data from the Fels Longitudinal Study. Pediatrics 2006;117:e487-495.
9. Goacher PJ, Lambert R, Moffatt PG. Can weight-related health risk be more accurately assessed by BMI, or by gender specific calculations of Percentage Body Fatness? Med Hypotheses 2012;79:656-62.
10. Goin SB. Densitometry. In: Roche A, Heymsfield S, Lohman TG, editors. Human body composition. New York: Human Kinetics; 1996. p. 3-23.
11. Schoeller DA. Hydrometry. In: Roche A, Heymsfield S, Lohman TG, editors. Human body composition. New York: Human Kinetics; 1996. p. 25-43.
12. Mazess RB, Cameron JR, Sorenson JA. Determining body composition by radiation absorption spectrometry. Nature 1970;228:771-2.
13. Fuller NJ, Elia M. Potential use of bioelectrical impedance of the 'whole body' and of body segments for the assessment of body composition: comparison with densitometry and anthropometry. Eur J Clin Nutr 1989;43:779-91.
14. Roemmich JN, Clark PA, Weltman A, Rogol AD. Alterations in growth and body composition during puberty. I. Comparing multicompartment body composition models. *J Appl Physiol* 1997;83:927-35.
15. National Center for Health Statistical (NCHS) - Centers for Disease Control and Prevention (CDC) [Online]. [2002?] [citado 17 Diciembre de 2014]. Available from: URL:http://www.cdc.gov/GrowthCharts/
16. Tanner JM. Fetus into man. Physical growth from conception to maturity. 2nd ed.Harvard University Press; 1989.
17. Lohman TG, Boileau RA, Slaughter RA. Body composition in children. In: Lohman TG. Editor. Human body composition. New York: Human Kinetics; 1984. p. 29-57.
18. Fuller NJ, Jebb SA, Laskey MA, Coward WA, Elia M. Four-component model for the assessment of body composition in humans: comparison with alternative methods, and evaluation of the density and hydration of fat-free mass. Clin Sci (Lond) 1992;82:687-93.
19. Bellisari A, Roche A. Anthropometry and Ultrasound. In: Heymsfield S, Lohman T, Wang Z, Going S. Editors. Human Body Composition. 2nd ed. United States: Human Kinetics; 2005. p. 109-28.
20. Sopher A, Shen W, Pietrobelli A. Pediatric Body Composition Methods. In: Heymsfield S, Lohman T, Wang Z, Going S. Editors. Human Body Composition. 2nd ed. United States: Human Kinetics; 2005. p. 129-39.
21. Wells J, Fuller N, Dewit O, Fewtrell M, Elia M, Cole T. Four-component model of body composition in children: density and hydration of fat-free mass and comparison with simpler models. Am J Clin Nutr 1999;69:904-12.
22. Lin LI. A concordance correlation coefficient to evaluate reproducibility. Biometrics 1989;45:255-68.
23. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986;1:307-10.
24. Stata Corp LP. Stata Statistical Software: Release 10. StataCorp LP: College Station, TX: College Station, TX, 2007.
25. Haroun D, Wells JC, Williams JE, Fuller NJ, Fewtrell MS, Lawson MS. Composition of the fat-free mass in obese and nonobese children: matched case-control analyses. Int J Obes (Lond) 2005;29:29-36.
26. Wells JC, Fewtrell MS, Williams JE, Haroun D, Lawson MS, Cole TJ. Body composition in normal weight, overweight and obese children: matched case-control analyses of total and regional tissue masses, and body composition trends in relation to relative weight. Int J Obes (Lond) 2006;30:1506-13.
27. Vásquez F, Díaz E, Lera L, Vásquez L, Anziani A, Burrows R. Métodos de composición corporal y modelo de cuatro compartimentos en escolares obesos chilenos. Nutr Hosp 2012;27:1079-85.
28. Marken Lichtenbelt WD, Fogelholm M. Increased extracellular water compartment, relative to intracellular water compartment, after weight reduction. J Appl Physiol 1999;87:294-8.
29. Leone PA, Gallagher D, Wang J, Heymsfield SB. Relative overhydration of fat-free mass in postobese versus never-obese subjects. Ann NY Acad Sci 2000;904:514-9.
30. Goulding A, Taylor RW, Jones IE, McAuley KA, Manning PJ, Williams SM. Overweight and obese children have low bone mass and area for their weight. Int J Obes Relat Metab Disord 2000;24:627-32.
31. Barker DJ. The developmental origins of insulin resistance. Horm Res 2005;64:2-7.
32. Gately PJ, Radley D, Cooke CB, Carroll S, Oldroyd B, Truscott JG, et al. Comparison of body composition methods in overweight and obese children. J Appl Physiol 2003;95:2039-46.
33. Fields DA, Goran MI. Body composition techniques and the four-compartment model in children. J Appl Physiol 2000;89:613-20.
34. Ramírez E, Valencia ME, Moya-Camarena SY, Alemán-Mateo H, Méndez RO. Four-compartment model and validation of deuterium dilution technique to estimate fat-free mass in Mexican youth. Nutrition 2009;25:194-99.
35. Aguirre CA, Salazar GD, López de Romaña DV, Kain JA, Corvalán CL, Uauy RE. Evaluation of simple body composition methods: assessment of validity in prepubertal Chilean children. Eur J Clin Nutr 2015;69:269-73.
36. Bray GA, DeLany JP, Volaufova J, Harsha DW, Champagne C. Prediction of body fat in 12-y-old African American and white children: evaluation of methods. Am J Clin Nutr 2002;76:980-90.
37. Goran MI, Kaskoun MC, Carpenter WH, Poehlman ET, Ravussin E, Fontvieille AM. Estimating body composition of young children by using bioelectrical resistance. J Appl Physiol 1993;75:1776-80.
38. Deurenberg P, Kusters CS, Smit HE. Assessment of body composition by bioelectrical impedance in children and young adults is strongly age-dependent. Eur J Clin Nutr 1990;44:261-8.
39. Osborne DL, Weaver CM, McCabe LD, McCabe GP, Novotny R, Van Loan MD, et al. Body size and pubertal development explain ethnic differences in structural geometry at the femur in Asian, Hispanic, and white early adolescent girls living in the U.S. Bone 2012;51:888-95.
40. Rush EC, Puniani K, Valencia ME, Davies PSW, Plank LD. Estimation of body fatness from body mass index and bioelectrical impedance: comparison of New Zealand European, Maori and Pacific Island children. Eur J Clin Nutr 2003;57:1394-401.
41. Haroun D, Taylor SJC, Viner RM, Hayward RS, Darch TS, Eaton S, et al. Validation of bioelectrical impedance analysis in adolescents across different ethnic groups. Obesity 2010;18:1252-9.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Valoración nutricional

Nutritional status and food intake of HCV/HIV coinfected patients

Evaluación del estado nutricional y de la ingesta de alimentos de los pacientes coinfectados por el HCV/HIV

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Abstract

Introduction: Hepatitis C virus (HCV) and human immunodeficiency virus (HIV) coinfection may cause nutrient deficiency and affect the nutritional status.

Objetive: To assess nutritional status, and energy and macronutrient intake in HCV/HIV coinfected patients.

Methods: Cross-sectional study on HIV/HCV-coinfected patients treated in a public hospital. Nutritional status was assessed by measurements of weight, height, waist circumference (WC), arm circumference (AC), triceps skinfold thickness (TST), non-dominant hand grip strength (NDHGS), body mass index (BMI) and mid-upper arm circumference (MUAC). Dietary intake was assessed by 24-hour recall.

Results: Fifty-seven patients (59.6% women) with mean age of 46 ± 11.2 years were studied. According to BMI, more than half of patients were overweight or obese, and 41% of men and 68% of women had increased or substantially increased WC. The prevalence of malnutrition varied between the methods –10.5% (BMI), 29.8% (AC), 56.2% (TST), 17.6% (MUAC), and 12.3% (NDHGS). We found a high percentage of patients with inadequate intake of protein, fat and energy. The percentage of total energy intake (%TEI) from carbohydrates inversely correlated with WC and AC. A positive correlation was observed between %TEI from protein and NDHGS, and between %TEI from fat and BMI, WC and AC.

Conclusion: We found a high prevalence of increased body weight and WC, and inadequate dietary intake in HCV/HIV coinfected patients. We observed a positive association between protein intake and muscle function, and between fat intake and obesity.

Key words:

HCV/HIV-coinfection.
Nutritional status.
Food consumption.

Resumen

Introducción: la coinfección con el virus de la hepatitis C (HCV) y el virus de la inmunodeficiencia humana (HIV) puede comprometer el estado nutricional y causar deficiencia de nutrientes.

Objetivo: evaluar el estado nutricional y la ingesta de energía y macronutrientes en pacientes coinfectados por el HCV/HIV *(human immunodeficiency virus).*

Métodos: estudio transversal con pacientes coinfectados por el HCV/HIV de un hospital público. El estado nutricional se evaluó por mediciones de peso, altura, circunferencia de la cintura (CC), circunferencia del brazo (CB), pliegue cutáneo del tríceps (DCT), fuerza de prensión mano no dominante (FAM), índice de masa corporal (IMC) y circunferencia muscular del brazo (CMB). La evaluación del consumo de alimentos se realizó mediante encuesta de recordatorio de 24 horas.

Resultados: se evaluaron 57 pacientes (59,6% mujeres) con una edad media de 46 ± 11,2. De acuerdo con el IMC, más de la mitad de los participantes eran obesos o con sobrepeso. Además, el 40,9% de los hombres y el 67,6% de las mujeres tenían CC aumentada. La prevalencia de desnutrición varió entre los métodos: IMC (10,5%), CB (29,8%), DCT (56,2%), CMB (17,6%), FAM (12,3%). Hubo un alto porcentaje de consumo insuficiente de proteínas, lípidos y energía. El porcentaje del valor energético total (%VET) de carbohidratos se asoció inversamente con las medidas de CC y CB. El %VET de proteínas se correlacionó positivamente con las medidas de FAM. El %VET de lípidos mostró una asociación positiva con el IMC, CC y CB.

Conclusión: se encontró una alta prevalencia del aumento de peso corporal y CC, y una ingesta dietética inadecuada. Se observó una asociación positiva entre la ingesta de proteínas y la función muscular, y entre la ingesta de grasa y la obesidad.

Palabras clave:

Coinfección HCV/HIV.
Estado nutricional.
Consumo alimentício.

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INTRODUCTION

Hepatitis C virus (HCV) and human immunodeficiency virus (HIV) coinfection is a public health problem, that may cause nutrient deficiencies and affect nutritional status (1,2). HIV infection may exacerbate the clinical manifestations of HCV, increase the risk for cirrhosis, liver failure and hepatocellular carcinoma, and hence worsen the prognosis of these patients due to higher morbidity and mortality (3).

Weight loss has been indicated as a marker of high risk for morbidity and mortality in HIV patients (4). Along with low food intake, it exacerbates energy-protein malnutrition and reduce life expectancy (5,6). Antiretroviral therapy (ART) has increased the life span among HIV-patients, although it has been associated with metabolic changes, including obesity, dyslipidemia, insulin resistance, hyperglycemia, and lipodystrophy, which are risk factors for cardiovascular diseases (7). In addition, the occurrence of some of these conditions, such as lipodystrophy may affect the diagnosis of the nutritional status.

Therefore, nutritional assessment is an important component of the ART, contributing to the management of obesity or malnutrition, and hence improving treatment tolerance and reducing the risk of opportunistic infections and cardiovascular diseases. The aim of the present study was to evaluate the nutritional status by different methods and assess energy and macronutrient intake in HCV/HIV patients.

METHODS

This was a cross-sectional study using a convenience sample of HCV/HIV-coinfected patients, treated at the outpatient clinic of infectious diseases of a public hospital in the south of Brazil from August 2013 to June 2014.

Inclusion criteria were: HCV/HIV-coinfected patients, of both sexes, aged greater than 18 years. Diagnosis of hepatitis C and viremia were confirmed by the detection of anti-HCV antibodies and polymerase chain reaction, respectively. Diagnosis of HIV was confirmed according to the Ministry of Health ordinance no. 151 of 2009 (8). Exclusion criteria included patients in nutritional therapy, patients with cirrhosis, psychiatric disorders, neurological diseases (such as Alzheimer's and Parkinson's diseases), digestion and absorption disorders (including inflammatory bowel disease and celiac disease) or electrolyte disorder *(e.g.* edema and/or ascites), and pregnant and lactating women.

Patients answered a questionnaire on HIV therapy and sociodemographic data, including age, sex, educational attainment, marital status, and household income. Household income was classified according to the Brazilian Association of Research Companies criteria (9).

Nutritional status was assessed by measurements of body weight, height, triceps skinfold thickness (TST), arm circumference (AM), waist circumference (WC), non-dominant hand grip strength (NDHGS), body mass index (BMI) and mid-upper arm circumference (MUAC).

Body weight was measured to the nearest 0.1 kg using a digital scale (150 kg capacity), and height was measured using a portable stadiometer. BMI was calculated by dividing body weight (kilograms) by the square of the height (meters), and categorized using the World Health Organization (WHO) cut-off values for adults (10) and the classification proposed by Lipschitz (11) for elderly patients. WC was measured once using a flexible anthropometric tape at the midpoint between the iliac crest and the lowest rib, on the mid-axillary line, and classified according to WHO criteria (12). AC and TST were measured at the midpoint between the acromion and the olecranon. TST was measured according to the protocol by Harrison et al. (13), and MUAC was calculated from the AC and TST measures. Patients were classified by AC, TST and MUAC based on the standards described by Frisancho (14).

Muscle function was assessed by NDHGS using a dynamometer. The measurements were taken in triplicate at 1-minute intervals with patients in the sitting position and the elbow (of non-dominant arm) flexed at 90 degrees. Patients were classified according to the reference values proposed by Budziareck et al. (15).

Dietary intake was assessed by 24-hour food recall. Three 24-hour recalls were collected, including one weekend day or holiday as an atypical day. The first was conducted face-to-face, with the aid of pictures of food portions (16). The other two were collected by telephone, with a mean of 20 days between the interviews. The percentage of total energy intake from each macronutrient was calculated using the Avanutri® software (Avanutri Ltda).

The recommendation of macronutrient intake for HCV/HIV coinfected patients is not different from that for the general population, *i.e.* 50%-60% of total energy intake (TEI) from carbohydrates and 30-35% from lipids. The recommended daily intake of protein is 1.2g of protein/kg body weight during the stable phase of disease (6), and of energy is 25 kcal/kg/day for obese or overweight patients, 35 kcal/kg/day for normal weight and 40 kcal/kg/day for malnourished patients (6, 17).

Normally distributed data according to Shapiro-Wilk test ($p > 0.05$) were analyzed using parametric statistics. Continuous variables were described as mean ± standard deviation, and discrete variables, as absolute and relative frequency. Differences in nutritional status by sex were analyzed using the Pearson's Chi-square test. Correlations between data of dietary intake were analyzed using Spearman's rank correlation coefficient. Data processing and statistical analysis were performed using Microsoft Excel and the SPSS software version 19.0, respectively. A significance level of 0.05 was set for the analyses.

The study was approved by the Ethics Committee of Conceição Hospital Group in Porto Alegre, Brazil (protocol number 11-226), and all participants signed the informed consent form.

RESULTS

Fifty-seven patients (59.6% women) with mean age of 46 ± 11.2 years were studied. All patients were receiving ART, and 35.2% belonged to social class D/E (Table I).

Table I. Sociodemographic characteristics of hepatitis C/HIV coinfected patients

Variables	n = 57	%
Sex		
Male	23	40.4
Female	34	59.6
Educational attainment		
< 8 years	35	61.4
> 9 e < 11 years	16	28.1
> 12 years	6	10.5
Marital status		
Single	22	38.6
Married	24	42.1
Divorced	9	15.8
Widow/er	2	3.5
*Social class (n = 54)**		
D/E (< BRL 895)	19	35.2
C2 (BRL 896-1,277)	3	5.6
C1 (BRL 1,278-1,865)	13	24.1
B2 (BRL 1,866-3,118)	10	18.5
B1 (BRL 3,119-6,006)	9	16.7

**3 patients did not answer the questionnaire.*

According to BMI, 37% of patients were overweight, and 17% obese. Forty-one percent of men and 68% of women (p=0.002) were at risk of obesity-related metabolic disorders according to WC measurement. The prevalence of malnutrition varied between the methods –10.5% (BMI), 29.8% (AC), 56.2% (TST), 17.6% (MUAC), and 12.3% (NDHGS) (Table II).

Daily energy intake was 100 kcal higher and 300 kcal lower than the mean recommended intake in men and women, respectively. The intake of fat and carbohydrate was higher than recommended values, but insufficient in protein in men, whereas in women, the intake of the three macronutrients was lower than recommendations (Table III).

Significant correlations were found between the percentage of TEI from carbohydrate, protein and fat and the variables of nutritional status (Table IV). The percentage of TEI from carbohydrate inversely correlated with WC (ρ = - 0.3660, p = 0.0076), and AC (ρ = - 0.3440, p = 0.0125). The percentage of TEI provided by protein positively correlated with NDHGS (ρ = 0.3531; p = 0.0102), and that provided by fat showed a positive correlation with BMI ρ = 0.2987; p = 0.0315), WC (ρ = 0.3357; p = 0.0150) and AC (ρ = 0.3727; p = 0.0065). The intake of protein (in g of protein / kg body weight /day) inversely correlated with TST (ρ = - 0.3168, p = 0.0221) and positively correlated with MUAC values ρ = 0.3175, p = 0.0218).

DISCUSSION

The present study identified a high prevalence of overweight and obesity in HCV/HIV coinfected patients. This finding is in agreement with the studies by Jame et al. (18) and Ladeira and Silva (19), which reported a prevalence of 30.5% and 32.5%, of overweight, respectively, in HIV patients. These results may be related to inadequate dietary intake, currently observed in the western culture, characterized by high consumption of saturated fat and refined sugar. In addition, chronic use of ART may cause several side effects, such as lipodystrophy and metabolic syndrome (20).

The high prevalence of malnutrition detected by TST measures and abdominal obesity by WC suggests the occurrence of lipodystrophy, which is commonly observed among HIV patients using ART, and is an important risk factor for noncommunicable diseases (20). In the study by Ladeira and Silva (19), WC was used as an indicator of abdominal fat accumulation, which was higher among women than men, similarly to our results. Also, the study found a predisposition of HIV patients to cardiovascular disease. Others have suggested that WC is associated with obesity-related adverse effects in these patients (21).

The prevalences of malnutrition detected by AC (30%) and MUAC (18%) measurements in our study were different from those found by Paim (22), who reported higher prevalence of malnutrition (51% by AC and 58% by MUAC) in HCV/HIV coinfected patients. However, since we studied HCV/HIV patients in the stable stage of disease and receiving ART, we would expect a relatively lower prevalence of malnutrition and a greater number of obese and overweight patients.

In addition, we also detected a 12.3% prevalence of malnutrition using hand grip strength. This relatively low percentage may also be related to disease stability and lack of complications related to coinfection. We did not find other studies on nutritional assessment using this method in HCV/HIV patients. However, hand grip strength was indicated as the most sensitive method for diagnosing malnutrition in HCV cirrhotic patients by another study conducted in Brazil (23).

It is worth mentioning that different methods of nutritional assessment, such as triceps skinfold thickness (TST) and mid-upper arm circumference (MUAC) measure different body components. TST, for example, indirectly evaluates energy fat stores, whereas MUAC assesses muscle mass. The presence of lipodystrophy may affect these measurements, due to a reduction in energy stores on upper limbs and increase of abdominal adiposity. Therefore, the rates of malnutrition should be interpreted with caution in patients receiving ART. Also, we believe that hand grip strength should be included in the nutritional assessment and follow-up of HCV/HIV patients, since it is a functional measure of the nutritional status, not affected by the ART.

Table II. Classification of nutritional status of hepatitis C/HIV coinfected patients

Variables	Total (n = 57)		Men (n = 23)		Women (n = 35)		p-value**
	n	%	n	%	n	%	
BMI (kg/m²)							*0.958*
Malnutrition	6	10.5	2	8.7	4	11.8	
Normal weight	20	35.1	9	39.1	11	32.4	
Overweight	21	36.9	8	34.8	13	38.2	
Obesity	10	17.5	4	17.4	6	17.6	
*Waist circumference (cm)**							*0.002*
Normal	24	42.9	13	59.1	11	32.4	
Increased risk	14	25	8	36.4	6	17.6	
Substantially increased risk	18	32.1	1	4.5	17	50	
Arm circumference (cm)							*0.023*
Normal	40	70.2	12	52.2	28	82.3	
Moderate malnutrition	9	15.8	7	30.4	2	5.9	
Severe malnutrition	8	14	4	17.4	4	11.8	
Triceps skinfold thickness (mm)							*0.139*
Normal	25	43.8	13	56.5	12	35.3	
Moderate malnutrition	20	35.1	8	34.8	12	35.3	
Severe malnutrition	12	21.1	2	8.7	10	29.4	
Mid-upper arm circumference (cm)							*0.006*
Normal	47	82.4	15	65.3	32	94.1	
Moderate malnutrition	7	12.3	5	21.7	2	5.9	
Severe malnutrition	3	5.3	3	13	0	0	
Hand grip strength (kgf)							*0.423*
Normal	50	87.7	19	82.6	31	91.2	
Malnutrition	7	12.3	4	17.4	3	8.8	

**n = 56 (one patient had abdominal hernia). **Pearson's Chi-square test.*

Table III. Daily intake and percentage of inadequacy of energy and macronutrient intake in hepatitis C/HIV coinfected patients

Nutrients	Men (n = 23)				Women (n = 34)			
	Daily intake		Rec	Inad	Daily intake		Rec.	Inad
	M	DP	M	%	M	DP	M	%
Energy (kcal)	2231.4	803.9	2133.6	47.8	1529.5	501.6	1844.4	76.5
Carbohydrate (g)	310.8	124.9	293.4	21.7	213.9	73.1	253.6	11.8
Protein (g)	67.6	32	86.7	47.8	60	24.9	76	73.5
Fat (g)	94.3	30.8	71.1	69.6	48.2	20.4	61.5	58.8

M: mean; DP: standard deviation; Rec: recommendation; Inad: inadequacy; %: percentage of inadequacy.

Table IV. Pearson's correlation analysis of percentage of total energy intake (TEI) provided by macronutrients and nutritional assessment variables in HCV/HIV coinfected patients

	BMI	WC	AC	TST	MUAC	NDHGS
Carbohydrates, %TEI						
Rho	- 0. 2023	- 0. 3660*	- 0. 3440*	- 0. 1046	- 0. 2352	- 0. 1914
p-value	0. 1505	0. 0076	0. 0125	0. 4606	0. 0932	0. 1741
Proteins, %TEI						
Rho	0. 1160	0. 2630	0. 1779	- 0. 0628	0. 0783	0. 3531*
p-value	0. 4127	0. 0596	0. 2071	0. 6583	0. 5809	0. 0102
Lipids, %TEI						
Rho	0. 2987*	0. 3357*	0. 3727*	0. 1994	0. 2344	- 0. 0176
p-value	0. 0315	0. 0150	0. 0065	0. 1563	0. 0944	0. 9013

TEI: total energy intake; BMI: body mass index; WC: waist circumference; AC: arm circumference; TST: triceps skinfold thickness; MUAC: mid-upper arm circumference; NDHGS: non-dominant hand grip strength.

With respect to energy and macronutrient intake, although the mean intake of the study group was near the recommended values, we found a high percentage of patients with inadequate intake, especially among women. This result may be related to the occurrence of obesity, overweight and even malnutrition. A study by Carreira and Pereira (24) on the nutritional status of HCV patients, showed a direct relationship between excessive weight and fat intake. This result is in accordance with our findings, which showed a correlation between the intake of this macronutrient and BMI, WC and AC. Therefore, a lipid-rich diet is related to energy storage, which is important in cases of malnutrition, but a risk factor for obesity and overweight in this population.

Protein intake was associated with higher values of NDHGS, suggesting an inverse relationship between the intake of this macronutrient and malnutrition. Protein metabolism disorders have been associated with chronic liver disease, due to a reduction in hepatic function and increased catabolism. Low protein intake can cause malnutrition, which is related to higher mortality index (6).

There were a number of limitations which should also be noted. We used the 24-hour food recall to assess dietary intake, which is a method that relies on subjects' memory (25). Also, the administration of the instrument by telephone may affect the reliability of the results due to the difficulty in estimating portion size (26). However, previous studies have shown that 24-hour dietary recall can be conducted successfully both face-to-face or over the phone (27-29).

CONCLUSION

In the present study on HCV/HIV coinfected patients, altered nutritional status was detected in these patients, with high prevalence of overweight, obesity and increased WC, and inadequate intake of macronutrients and energy. Protein intake was directly related to muscle function, whereas excessive fat intake was related to high obesity rates in this population.

Different malnutrition indexes were found according to the method of assessment employed. Due to lipodystrophy caution should be taken in interpreting results of anthropometrical indexes in clinical practice and functional measures should be taken into consideration in individual assessments.

REFERENCES

1. Dietitians of Canada. Hepatitis C: nutrition care Canadian guidelines for health care providers. Can J Diet Pract Res 2003;64:139-41.
2. Food and Agriculture Organization/World Health Organization. Living well with HIV/AIDS - A manual on nutritional care and support for people living with HIV/AIDS; 2002.
3. Puoti M, Bruno R, Soriano V, Donato F, Gaeta GB, Quinzan GP. Hepatocellular carcinoma in HIV-infected patients: epidemiological features, clinical presentation and outcome. AIDS 2004;18:2285-93.
4. Barbosa RMR, Fornés NS. Avaliação nutricional em pacientes infectados pelo vírus da imunodeficiência adquirida. Rev Nutr 2003;16:461-70.
5. Dutra CNN, Basso C. Alterações nutricionais em portadores de hepatite C. Disc Scientia 2006;7:109-20.
6. Waitzberg DL. Nutrição oral, enteral e parenteral na prática clínica. 4.ª ed. São Paulo: Atheneu; 2009.
7. Smith DK, Hanson DL, Graham NH, Flynn M, Greenberg B, Sowell Ding A. Nutritional status and is behavioral and clinical correlates in the hers cohort of HIV infected and at-risk uninfected women. International Conference on Aids; 1996.
8. Brasil. Ministério da Saúde. Portaria N.º 151, de 14 de outubro de 2009. Bvsms.saude 2009.
9. Associação Brasileira de Empresas de Pesquisa. Critério de Classificação Econômica Brasil. São Paulo; 2012. http://www.abep.org/criterioBrasil (acessado em 06/ago/2014).
10. World Health Organization. Technical report series - Physical status: the use and interpretation of anthropometry. Geneva: Wolrd Health Organization; 2005.
11. Lipschitz DA. Screening for nutritional status in the elderly. Prim Care 1994;21:55-67.
12. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. Geneva; 2000.
13. Frisancho AR. Anthropometric standards: an interactive nutritional reference of body size and body composition for children and adults. 4.ª ed. University of Michigan Press; 2011.

14. Harrison GC. Skinfold thickness and measurement technique. In: Anthropometric standardization reference manual. Champaing: Human Kinetics, 1988. p. 55-80.
15. Budziareck MB; Duarte PRR; Barbosa-Silva MC. Reference values and determinants for handgrip strength in healthy subjects. Clin Nutr 2008;27:357-62.
16. Vitolo MR. Pesos e volumes de alimentos e medidas caseiras, 1.ª ed. In: Nutrição: da gestação ao envelhecimento. Rio de Janeiro: Rubio; 2008. p. 594-611.
17. Cuppari L. Guia de nutrição: nutrição clínica no adulto. 2.ª ed. Barueri: Manole; 2005.
18. Jaime PC, Florindo AA, Latorre MRDO, Brasil BG, Santos ECM, Segurado AAC. Prevalência de sobrepeso e obesidade abdominal em indivíduos portadores de HIV/AIDS, em uso de terapia antiretroviral de alta potência. Rev bras epidemiol 2004;7:8.
19. Ladeira P, Silva DC. Estado nutricional e perfil alimentar de pacientes assistidos pelo programa de DST/Aids e hepatites virais de um Centro de Saúde de Itaperuna-RJ. DST J bras doenças sex transm 2012;24:28-31.
20. Filho AC, Abrão P. Alterações metabólicas do paciente infectado por HIV. Arq Bras Endocrinol Metab 2007;51:5-7.
21. Rami Bailony M, Scherzer R, Huhn G, Plankey MW, Peters MG, Phyllis CT. Association of HIV Infection, Hepatitis C Virus Infection, and Metabolic Factors With Liver Stiffness Measured by Transient Elastography. J Infect Dis 2013;208:1776-83.
22. Paim APAC. Estado nutricional e estadiamento histológico de pacientes mono ou coinfectados com os vírus da hepatite C e HIV [dissertation]. [Bahia]: Universidade Federal da Bahia; 2011. p. 97.
23. Gottschall CBA, Álvares-da-Silva MR, Camargo ACR, Burtett RM, Silveira TR. Avaliação nutricional de pacientes com cirrose pelo vírus da hepatite C: a aplicação da calorimetria indireta. Arq Gastroenterol 2004;41:220-24.
24. Carreira CM, Pereira PCM. Perfil nutricional e dietético de indivíduos com hepatite C. Semina cienc biol saude 2011;32:143-54.
25. Willet WC. Nutritional epidemiology. New York: Oxford University Press; 1998.
26. Fisberg R, Martini L, Slater B. Métodos de inquéritos alimentares. In: Fisberg R, Slater B, Marchioni D, et al. Inquéritos alimentares: métodos e bases científicos São Paulo: Manole; 2005.
27. Monteiro C, Moura E, Jaime P, et al. Validity of food and beverage intake data obtained by telephone survey. Rev Saude Publica 2008;42:582-9.
28. Matarazzo H, Marchioni D, Figueiredo R, et al.Reprodutibilidade e validade do questionário de frequência de consumo alimentar utilizado em estudo caso-controle de câncer oral. Rev Bras Epidemiologia 2006;9:316-24.
29. Moshfegh A, Rhodes D, Baer D. The US Department of Agriculture Automated Multiple-pass method reduces bias in the collection of energy intakes. Am J Clin Nutr 2008;88:324-32.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Valoración nutricional

Validity and reliability of beverage intake questionnaire: evaluating hydration status

Validez y fiabilidad de un cuestionario de ingesta de bebidas: evaluación del estado de hidratación

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Abstract

Objective: The purpose of this investigation is to test the validity and reliability the assessment methods for the true beverage consumption of adults.

Methods: This cross-sectional study was carried out 291 healthy volunteers. The beverage intake questionnaire (BIQ) was prepared in combination with a new one which is developed based on basic principles and the existing one developed for the beverages consumed the most with respect to frequency and amount by Turkish populations. During the initial visit the participants completed BIQ1 and then provided a urine sample to determine urinary specific gravity(USG). For validity, participants recorded the type and quantity of foods and beverages consumed on the same day and previous two days. Two weeks later, for reliability, participants completed the same beverage intake questionnaire (BIQ2).

Results: Mean daily total fluid intake was estimated at 1,773 ± 49.4mL using the dietary intake record (DIR), 2,120 ± 49.5 mL with BIQ1 and 1,990 ± 46.3 mL for BIQ2. The largest contribution to total fluid intake was plain water. The response on the two assessment tools (DIR and BIQ1) all beverage intakes were significantly correlated ($p < 0.01$) except for alcoholic beverage intake. One could see a significant correlation between BIQ1 and BIQ2 in relation to total fluid intakes ($r = 0.838, p < 0.01$). The USG measurement was negatively correlated with three assessment tools (DIR, BIQ1 and BIQ2), the amount of plain water and the amount of total fluid intake.

Conclusions: The self-administered instrument described in this study may be useful for researchers interested in assessing habitual beverage consumption patterns or evaluating hydration status for adults.

Key words:

Beverage intake questionnaire. Validity. Reliability. Urine gravity. Fluid intake.

Resumen

Objetivo: el objetivo de este estudio es evaluar la validez y la fiabilidad de los métodos utilizados para medir el consumo de bebidas de los adultos correctamente.

Método: este estudio transversal fue conducido con 291 voluntarios sanos. El cuestionario de consumo de bebidas (BIQ) fue desarrollado como una nueva encuesta con la adición de las bebidas más consumidas por la población turca en términos de frecuencia y cantidad. Los participantes realizaron el cuestionario BIQ1 en la primera reunión y después se tomaron muestras de orina con el fin de determinar la densidad urinaria (USG). Se registró la validez, el tipo y la cantidad de alimentos y bebidas consumidos por los participantes en el mismo día y dos días antes. Para comprobar la fiabilidad, se realizó a los participantes el mismo cuestionario de consumo de bebidas (BIQ2) dos semanas más tarde.

Resultados: el consumo total diario de líquidos fue estimado en 1.773 ± 49,4 ml por los registros de alimentos (DIR), en 2.120 ± 49,5 ml por el BIQ1 y en 1.990 ± 46,3 ml por el BIQ2. La mayor contribución a la ingesta total de líquidos es debida al agua. Ambas herramientas de evaluación (DIR y BIQ1) mostraron una correlación significativa en todas las bebidas con excepción de las bebidas alcohólicas ($p < 0,01$). Una de la correlación más significativa se encontró en el consumo total de líquidos entre BIQ1 con BIQ2 ($r = 0,838$, $p < 0,01$). Se encontró que la medición de la USG está correlacionada negativamente con las tres herramientas (DIR, BIQ1 ve BIQ2) de evaluación para el agua y la ingesta total de líquidos.

Conclusión: los cuestionarios para evaluar el estado de hidratación o y los hábitos de consumo de bebidas en adultos pueden ser de utilidad para aquellos investigadores interesados.

Palabras clave:

Cuestionario de consumo de bebidas. Validez. Fiabilidad. Densidad urinaria. Ingesta de líquidos.

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INTRODUCTION

Total fluid intake and its biomarkers have been associated with health and hydration status (1). Therefore, it is important to balance the hydration status of individuals in terms of health and function as it provides an indication regarding drinking behavior.

Guidelines for adequate total water intake for the general adult population have been proposed by several international governing bodies. Yet these recommendations are based on population median water intakes, with limited consideration of links between water intake and hydration status and without links between water intake and health. Moreover, the recommendations do not provide a method for individuals to ensure that they are consuming enough water to meet their specific hydration needs (2,3).

Establishing the adequacy of fluid intake based on physiological indicators of hydration is challenging, because there are multiple biological indicators of hydration in average adults in free-living conditions, each sensitive to a different aspect of hydration. Another common hardship in this area is a reliance on self-reported measures of habitual intake (4,5). Various markers have been proposed to assess the state of hydration (plasma osmolality, urine specific gravity (USG), urine osmolality), which can be used in different laboratory conditions, clinical practice or sports. However, to date, there has been no universally accepted biomarker that reflects an increase in hydration status in response to an increase in beverage intake. Therefore, no markers are defined as gold standard (4,6).

Interest in the type and quantity of beverage consumption is not new, and numerous approaches have been used to assess beverage intake, but the validity of these approaches has not been well established. While some research objectives have focused on the assessment of beverage-associated nutrients or intakes of individual beverages, other investigators have extrapolated beverage intakes from previously collected diet records or diet questionnaires (7,8). The available questionnaires were designed to measure beverage intake in children and adolescents, and most do not exclusively measure beverage intake (9). There is currently no rapid method for determining habitual beverage intake in Turkish adults. A brief, self-administered, valid and reliable beverage intake assessment tool could enhance nutrition research targeting beverage intake patterns. Thus, our objective is to test the validity and reliability of a newly developed self-administered beverage intake questionnaire (BIQ) as compared to dietary intake records (DIRs) and USG.

METHODS

PARTICIPANTS

This cross-sectional study was carried out on a haphazard sample of 291 volunteers (56% male and 44% female) whose ages ranged between 19 and 55 (31.4 ± 10.1 years), located in Ankara, Turkey, between October and December 2014. Most participants (about 59%) were educated to secondary school level. A total of 331 subjects took part in the study, with 321 subjects completing both the beverage intake questionnaire (BIQ) and the dietary intake records (DIRs), and providing a urinary sample, and 30 subjects being excluded because of an energy intake below 900 kcal or greater than 5,000 kcal. The completion rate was 88%. The inclusion criteria for the study were absence of major diseases affecting nutritional status or the ability to keep a diet record, and no major diet changes in the past 6 months. Exclusion criteria included use of medication likely to interfere with water balance, such as hypertensive or diuretic treatment; history of metabolic or gastrointestinal disease; renal, hepatic or cardiac failure; abstention from strenuous physical activity; or high daily consumption of alcohol (more than two units or three units per day for women and men, respectively). Information on self-reported age (year), height (cm), weight (kg), education and profession was also collected. Body mass index (BMI) was calculated and participants were classified, according to their BMI, into three groups as underweight (BMI ≤ 18.5 kg/m^2), normal weight (BMI: 18.5-24.9 kg/m^2) and overweight (BMI > 25.0 kg/m^2) (10).

The study was conducted according to the guidelines set out in the Declaration of Helsinki, and written informed consent was obtained from all subjects.

DIETARY ANALYSIS

Participants were visited twice in a 15-day period. During the initial visit, participants completed the beverage intake questionnaire (BIQ1) and then provided a urine sample to determine USG. Participants recorded the type and quantity of food and beverages consumed on the same day and following two days, which were consecutive –in total, 24-hour dietary records (DIRs). Two weeks later, on the second visit, participants completed the same beverage intake questionnaire (BIQ2).

The beverage intake questionnaire (BIQ) was adapted from Hedrick (11) and the most recent form consisted of the beverages consumed the most with respect to the frequency and amount by Turkish populations. The BIQ estimates habitual mean daily intake of water and beverages across 17 beverage categories [including water (plain), black and herbal tea, Turkish and instant coffee, buttermilk/kefir, milk (whole, reduced-fat, low-fat/skimmed), soda, cola and soft drinks (regular/diet), fruit juice drinks (natural/flavored), vegetable juice, sport drinks, energy drinks, most alcoholic beverages: beer (light, regular), raki, wine, mixed alcoholic drinks] plus one open-ended section for "other" beverages not listed. The BIQ included how often, which kind, what amounts and which portion size questions for each beverage. The frequency of servings was classified from "never" to "how many times a day/week/month" and the kind was categorized as diet/natural with or without sugar/cream, etc. In terms of amounts, common beverage sizes and amount used depended on beverages kinds (*e.g.* glass, bottle, box, can etc, and for portion size we used small, medium and large sizes).

URINE ANALYSIS

All visits were conducted between 6 and 12 a.m. to avoid the differences in USG measurements that may occur through-

out the day. USG, an objective indicator of total fluid intake (hydration status and compliance), was determined using a handheld refractometer (ATAGO 4410 Digital Urine Specific Gravity Refractometer, Bellevue, WA). A urine sample from a "hydrated" subject typically falls within the range of 1.005 to 1.030 (12). All participants were completed the urine measurement.

DATA ANALYSIS

The analyses were performed using the SPSS package program version 15.0 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics (mean ± standard error of the mean (SEM)) are reported for mean total consumption of beverage and beverage categories. To assess validity, the BIQ1 (test) responses were compared to DIR responses, and, for assessing reliability (retest), BIQ1 responses were compared to BIQ2. Spearman correlation coefficients were calculated to determine the strength of the relationship between DIR and BIQ1, and BIQ1 and BIQ2, and among associated specific gravity (USG).

The agreement between BIQ and DIR, and BIQ1 and BIQ2, was calculated using the intra-class correlation coefficient (ICC) and the Cronbach's alpha statistic. Each Cronbach's alpha statistic was compared with recognized standards of agreement as follows: "fair" (< 0.4), "moderate" (0.4-0.75), "good" (0.75-0.90) and "perfect" (> 0.90) (13). Bland-Altman plots were also generated and the mean difference (BIQ1-DIR) and limits of agreements (2 SD of the mean difference) were interpreted. This was performed using MedCalc for Windows, version 9.6.0.0 (MedCalc Software, Mariakerke, Belgium). *p*-values of < 0.01 and < 0.05 (two-tailed) were regarded as statistically significant.

RESULTS

The mean BMI of participants was 24.2 ± 4.05 kg/m^2. Over half (54.3%) of our sample had a normal weight, while 40.2% were overweight. The mean daily total fluid intake and kinds of beverage are given in table I. Mean daily total fluid intake was estimated at 1773 ± 49.4 mL using the DIR, 2,120 ± 49.5 mL

Table I. Mean daily total fluid intakes and correlations between intakes reported on DIR and BIQ1 and BIQ2

Beverages (mL)	Validity [a]				Reliability [b]		
	DIR Mean ± SEM	BIQ1 Mean ± SEM	Correlation (r)	Difference with BIQ1 Mean ± SEM	BIQ2 (re-test) Mean ± SEM	Correlation (r)	Difference with BIQ1 Mean ± SEM
Water, plain	1029 ± 37.2	1135 ± 36.4	0.744*	-106 ± 25.4	1103 ± 34.4	0.850*	32 ± 19.0
Tea, black	483 ± 26.9	561 ± 28.2	0.662*	-78 ± 24.5	513 ± 24.1	0.857*	48 ± 17.7
Tea, herbal	18 ± 4.3	32 ± 4.8	0.527*	-14 ± 3.1	32 ± 4.9	0. 929*	-0.3 ± 1.5
Coffee, Turkish	6 ± 1.5	12 ± 1.5	0.416*	-6 ± 1.4	10 ± 1.3	0.905*	1.5 ± 0.6
Coffee, Instant	41 ± 6.9	53 ± 6.8	0.599*	-12 ± 5.2	49 ± 6.3	0.880*	4 ± 2.1
Buttermilk/kefir	46 ± 5.6	63 ± 3.7	0.314*	-17 ± 5.2	57 ± 3.3	0.882*	7 ± 2.1
Milk	17 ± 3.8	43 ± 4.8	0.379*	-25 ± 3.7	41 ± 4.7	0.912*	1.4 ± 1.6
Soda	24 ± 3.8	56 ± 4.9	0.480*	-32 ± 4.2	54 ± 4.9	0.881*	2 ± 2.2
Cola	30 ± 6.1	55 ± 6.1	0.480*	-26 ± 2.7	49 ± 5.3	0.992*	6 ± 2.5
Soft drinks	38 ± 6.5	29 ± 4.4	0.441*	9 ± 7.5	16 ± 2.9	0.854*	13 ± 3.3
Fruit juices	40 ± 6.3	64 ± 6.6	0.503*	-25 ± 3.8	56 ± 6.4	0.887*	9 ± 2.2
Vegetable juices	1 ± 0.7	1.5 ± 0.7	0.742*	-0.3 ± 0.1	1.3 ± 0.7	0.857*	0.2 ± 0.1
Sport drinks	0.05 ± 0.03	0.5 ± 0.2	0.777*	-0.4 ± 0.2	0.5 ± 0.2	0.896*	0.1 ± 0.01
Energy drinks	0.9 ± 0.69	3 ± 1.5	0.605*	-2 ± 0.8	3 ± 1.4	0.803*	0.3 ± 0.3
Beer	0 ± 0	10 ± 2.9	0	-10 ± 2.9	5 ± 1.6	0.872*	5 ± 2.4
Rakı	0 ± 0	2 ± 0.9	0	-2 ± 0.9	0.3 ± 0.2	0.779*	2 ± 0.9
Wine	0 ± 0	0.6 ± 0.4	0	-0.6 ± 0.4	0.02 ± 0.02	0.287*	0.6 ± 0.4
Total fluid intake	1773 ± 49.4	2120 ± 49.5	0.723*	-347 ± 37	1990 ± 46.3	0.838*	130 ± 27

[a] Validity was assessed by comparing dietary intake recall (DIR) with beverage intake questionnaire (BIQ1) results.

[b] Reliability was assessed by comparing BIQ1 and BIQ2.

**p < 0.01*

with BIQ1 and 1,990 ± 46.3 mL per day for BIQ2. Differences in total fluid intake between DIR and BIQ1 were -347 ± 37 mL per day and differences between BIQ1 and BIQ2 were 130 ± 27 mL per day (Table I).

When analyzing table I, the responses in the two assessment tools (DIR and BIQ1 = validity) were significantly correlated (all beverages $p < 0.01$) except for alcoholic beverages (beer, raki and wine). The correlation coefficients between the DIR and BIQ1 ranged from 0.314 (buttermilk/kefir) to 0.777 (sport drinks). Significant correlations were detected between all BIQ1 and BIQ2 variables, although the correlation for wine was lower than that for other beverage categories. The correlation coefficients between BIQ1 and BIQ2 ranged from 0.287 (wine) to 0.992 (cola) ($p < 0.01$). And a significant correlation was found between DIR and BIQ1 ($r = 0.723$, $p < 0.01$) and between BIQ1 and BIQ2 in total fluid intakes ($r = 0.838$, $p < 0.01$).

The largest contributor to total fluid intake was plain water, representing 58.6 ± 1.12%, 53.0 ± 0.9% and 55.0 ± 0.9% of DIR, BIQ1 and BIQ2. Other beverage types that accounted for more than 10% of total fluid intake were hot beverages (tea and coffee) (14.0 ± 19%) and sweetened beverages (cola, soda, soft, sport and energy drinks) (12.0 ± 19%). Milk, diet beverages, flavored water and alcohol made up the remaining 13% of fluid intake.

The mean ± SEM for USG was 1.019 ± 0.0003 mOsm/kg. While 55.3% of individuals had a normal hydration status, 5.9% were cases of dehydration (≤ 1.005).

Spearman's correlations were calculated for participants with complete USG and three assessment tools (DIR, BIQ1 and BIQ2) (table II). USG measurement was negatively correlated with three assessment tools (DIR, BIQ1 and BIQ2), with amounts of plain water (respectively, $r = -0.237$, $p = 0.000$; $r = -0.208$, $p = 0.000$; $r = -0.135$, $p = 0.021$) and with amounts of total fluid intake (respectively, $r = -0.126$, $p = 0.032$; $r = -0.160$, $p = 0.006$; $r = -0.112$, $p = 0.041$) (Table II).

Comparing DIR and BIQ1, the agreement was classified according to Cronbach's alpha statics as "perfect" on cola, fruit juices and vegetable juices; as "good" on water, black tea, instant coffee, milk, energy drinks and total fluid intake; and as "moderate" on Turkish coffee, buttermilk/kefir, soda and sports drinks. Comparing BIQ1 and BIQ2, the agreement was classified as "perfect" on 14 items and as "good" on 3 items (Table III).

The Bland-Altman plot for total fluid intake showed that the agreement between the DIR and BIQ1 in Figure 1 and BIQ1 and BIQ2 in Figure 2 was dependent on intake level. Differences in the daily intake of total fluid with DIR and BIQ1; BIQ and BIQ2 plotted against the mean daily intake estimated by the two methods. Mean difference and 95% limits of agreement (1.96 × SD of mean difference) are included.

These plots show that the DIR and BIQ1 and BIQ1 and BIQ2 are very likely to agree on total fluid intake, since the range obtained for the 95% limits of agreement was -890.6 + 1,583.8 for DIR-BIQ1 and -776.7 + 1037.5 for BIQ1-BIQ2 in total fluid intake. The observed limits of agreement are quite strongly influenced by a few outliers (Figs. 1-2).

Table II. Spearman's correlations between USG and DIR, BIQ1 and BIQ2

Beverages	DIR		BIQ1		BIQ2	
	r	p	r	p	r	p
Water, plain	-0.237	0.000	-0.208	0.000	-0.135	0.021
Tea, black	0.048	0.411	-0.033	0.573	-0.040	0.495
Tea, herbal	0.131	0.056	0.054	0.362	0.040	0.500
Coffee, Turkish	0.070	0.231	0.047	0.421	0.049	0.405
Coffee, Instant	-0.078	0.184	-0.030	0.614	-0.021	0.722
Buttermilk/kefir	-0.021	0.717	-0.070	0.232	-0.030	0.616
Milk	0.033	0.580	-0.152	0.059	-0.126	0.052
Soda	0.030	0.612	-0.025	0.676	-0.004	0.943
Cola	-0.010	0.870	-0.017	0.771	0.007	0.910
Soft drinks	-0.015	0.793	-0.125	0.052	-0.122	0.058
Fruit juices	0.063	0.285	0.023	0.698	0.022	0.713
Vegetable juices	-0.114	0.052	-0.094	0.111	-0.058	0.320
Sport drinks	0.026	0.659	0.041	0.481	0.011	0.852
Energy drinks	0.031	0.604	-0.410	0.555	0.039	0.506
Beer	0	0	0.009	0.873	0.030	0.608
Rakı	0	0	-0.095	0.108	-0.056	0.338
Wine	0	0	0.014	0.809	-0.092	0.119
Total fluid intake	-0.126	0.032	-0.160	0.006	-0.112	0.041

Table III. Intra-class correlation coefficients (ICC) (95% confidence interval) and Cronbach alfa between DIR- BIQ1 and BIQ1-BIQ2

Beverages	DIR-BIQ1			BIQ1-BIQ2		
	ICC	95%CI	Cronbach alfa	ICC	95%CI	Cronbach alfa
Water	0.765	0.713-0.809	0.867	0.859	0.825-0.886	0.924
Tea, black	0.605	0.527-0.623	0.754	0.771	0.720-0.814	0.871
Tea, herbal	-0.098*	-0.161-0.069	-0.047	0.951	0.939-0.961	0.975
Coffee, Turkish	0.538	0.451-0.615	0.700	0.901	0.877-0.921	0.948
Coffee, Instant	0.711	0.649-0.764	0.831	0.951	0.939-0.961	0.975
Buttermilk/kefir	0.387	0.285-0.481	0.558	0.819	0.777-0.854	0.901
Milk	0.638	0.565-0.701	0.779	0.939	0.924-0.952	0.969
Soda	0.539	0.453-0.616	0.701	0.896	0.870-0.916	0.945
Cola	0.905	0.882-0.924	0.950	0.903	0.879-0.922	0.949
Soft drinks	0.082*	-0.033-0.195	0.152	0.618	0.541-0.684	0.764
Fruit juices	0.827	0.787-0.860	0.905	0.941	0.927-0.953	0.970
Vegetable juices	0.982	0.978-0.986	0.991	0.982	0.977-0.985	0.991
Sport drinks	0.254	0.143-0.358	0.405	0.998	0.998-0.999	0.999
Energy drinks	0.755	0.701-0.800	0.860	0.985	0.981-0.988	0.992
Beer	0.000*	-0.115-0.115	0.000	0.510	0.420-0.591	0.676
Rakı	0.000*	-0.115-0.115	0.000	0.074*	-0.041-0.188	0.138
Wine	0.000*	-0.115-0.115	0.000	0.006*	-0.109-0.121	0.012
Total fluid intake	0.714	0.653-0.766	0.833	0.836	0.798-0.868	0.911

**p > 0.05.*

DISCUSSION

The purpose of this study was to assess the hydration status with rapid, accurate and simple beverage intake questionnaire and to determine the validity and reliability of it's in healthy, sedentary individuals. This questionnaire was designed to capture the usual beverage intake. Dietary records have been used successfully to estimate energy and nutrient intakes. Numerous dietary records have been used to assess beverage intake. Some research objectives have extrapolated beverage intakes from previously collected diet records or diet questionnaires (7,8,14). Other investigators have focused on the assessment of beverage associated nutrients or intakes of individual beverages (15,16). In addition, three days of recalls or records may not adequately represent total fluid intake or kinds of beverage, particularly for items that have high intra-individual variation (*i.e.* are consumed sporadically) (17). Moreover, the validity of these approaches has not been well established.

In this study, compared with the dietary intake record, the BIQ tended to over-report total fluid intake by 346.6 mL. When the difference between BIQ1 and BIQ2 was analyzed, the BIQ1 over-reporting was only 130.4 mL. Comparing DIR and BIQ1, the total fluid intake agreement was classified as "good" and "perfect" according to Cronbach's alpha statics respectively comparing DRI-BIQ1 and BIQ1-BIQ2.

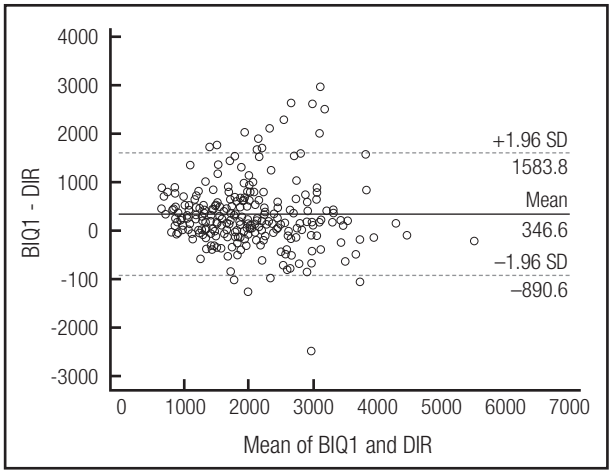

Figure 1.
Bland-Altman plots comparing total fluid intakes assessed by DIR and BIQ1.

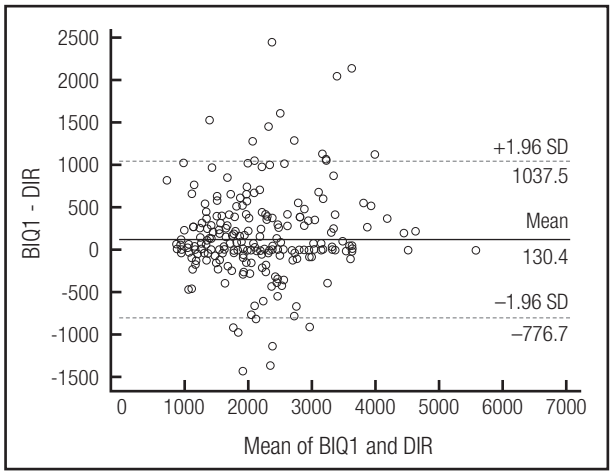

Figure 2.

Bland-Altman plots comparing total fluid intakes assessed by BIQ1 and BIQ2.

It is well known that fluid intake is difficult to monitor. Although there is a lack of biomarkers to reflect hydration status in response to beverage intake, various markers have been proposed for assessing the state of hydration (1). Some dietary intake methods have used biomarkers to validate the data collected. Biomarkers of intake are able to objectively assess dietary intake/status without the bias of self-reported dietary intake errors and also overcome the problem of intra-individual diet variability (18,19).

In this study, we used urinary specific gravity as a reference biomarker of the self-reported intake of total fluid and kinds of beverages (BIQ) (1). As would be expected for a possible biomarker of total fluid intake, USG was negatively correlated with the amount of total fluid intake for three assessment tools (DIR, BIQ1, BIQ2); thus, the BIQ appears to be a valid and reliable and easily administered questionnaire for assessing beverage intakes among adults. The reliability and validity coefficients for the BIQ were similar in magnitude to those reported elsewhere. Malisova's study (20) reported no correlations between beverage intake estimated from the water balance questionnaire against USG ($r = -0.107$, $p = 0.403$). However, they found moderate correlations with the other biomarkers measured. Hedrick's study (11) found that USG was negatively correlated with grams of total daily beverage consumption at different time (-0.202, $p < 0.05$ and -0.238, $p < 0.05$).

In our study, of the 17 beverage variables assessed, 14 of beverages were significantly correlated with DIR ($p < 0.05$). The results of our study suggest that a quantitative beverage intake questionnaire provides more useful data about consumption of total fluid and kinds of beverage intakes than a 3-day dietary record and urinary specific gravities. In other studies, beverage frequency records (11) appear to be a better measuring method for assessing (20) beverage intake than the 3-day dietary questionnaire when compared with biomarkers. It is clear that the development of a properly validated beverage frequency questionnaire may improve the evidence behind hydration outcomes.

CONCLUSION

As a conclusion, the self-administered instrument described in this study shows reproducibility in a range observed for similar dietary intake record used with adults. This tool may be useful for researchers interested in assessing habitual beverage consumption patterns to evaluate hydration status for adults, particularly in large-scale investigations where lengthier, resource-intensive dietary intake assessment techniques are not feasible. Among nutrition practitioners, this tool could be utilized as a rapid method to assess total fluid intake and kinds of beverages in Turkey.

Although several hydration status studies have investigated the response of various biomarkers to changes in beverage intake, important theoretical considerations have also been published (21,22). We still do not have enough data available in the literature to set robust biomarkers proxies for fluid intake.

LIMITATIONS

Two primary limitations exist in this investigation. Firstly, participants completed the self-administrated BIQ and DIR. So subjects were prone to underestimate their beverage intake when they kept dietary records.

Secondly, In Turkish society, alcoholic beverages are not consumed in high amounts and at high frequency. Therefore, the amount of alcoholic beverages in DIR was less than in the BIQ. In addition, every alcoholic beverage should be combined into only one category, "alcoholic beverages". A need for studies that systematically examine the correlation of beverage intake and hydration biomarkers in different populations has been demonstrated.

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REFERENCES

1. Sontro, JM, Dixon SN, Garg AX, Buendía-Jiménez I, Dohein O, Huang SH, et al. Association between water intake, chronic kidney disease, and cardiovascular disease: a cross-sectional analysis of NHANES data. Am J Nephrol 2013;7:434-42.
2. EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA). Scientific Opinion on Dietary reference values for water. EFSA Journal 2010;8(3):1459-62.
3. Institute of Medicine (IOM). Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. The National Academies Press; Washington, DC; 2004.
4. Cheuvront SN, Ely BR, Kenefick RW, Sawka M.N. Biological variation and diagnostic accuracy on dehydration assessment markers. Am J Clin Nutr 2010;92:565-73.
5. Cheuvront SN, Fraser CG, Kenefick RW, Ely BR, Sawka MN. Reference change values for monitoring dehydration. Clin Chem Lab Med 2011;49:1033-37.

6. Armstrong LE, Maresh CM, Castellani JW, Bergeron MF, Kenefick RW, LaGasse KE, et al. Urinary indices of hydration status. Int J Sport Nutr 1994;4:265-79.
7. Sohn W, Heller KE, Burt BA. Fluid consumption related to climate among children in the United States. J Public Health Dent 2001;61:99-106.
8. Hirvonen T, Pietinen P, Virtanen M, Albanes D, Virtamo J. Nutrient intake and use of beverages and the risk of kidney Stones among male smokers. Am J Epidemiol 1999;150:187-94.
9. Hedrick VE, Savla J, Comber DL, Flack KD, Estabrooks PA, Nsiah-Kumi PA, Ortmeier S, et al. Development of a brief questionnaire to assess habitual beverage intake (BEVQ-15): sugar-sweetened beverages and total beverage energy intake. J Acad Nutr Diet 2012;112:840-49.
10. WHO/FAO. Diet, Nutrition and the Prevention of Chronic Diseases, WHO Technical Report Series, 916, Geneva; 2003.
11. Hedrick VE, Comber DL, Estabrooks PA, Savla J, Davy BM. The Beverage Intake Questionnaire: Determining Initial Validity and Reliability. J Am Diet Assoc 2010;110:1227-32.
12. Williamson MA, Snyder LM. Wallach's Interpretation of Diagnostic Tests. 9th ed. Lippincott Williams & Wilkins: Philadelphia, USA; 2011.
13. Fleiss J. Reliability of Measurement. The Design and Analysis of Clinical Experiments, Wiley Classics Library Edition published John Wiley & Sons, Inc., Canada; 1992. p. 1-32.
14. Barbieri P, Crivellenti LC, Nishimura RY, Sartorelli DS. Validation of a food frequency questionnaire to assess food group intake by pregnant women. J Hum Nutr Diet 2015;28:38-44.
15. Combet E, Lean MEJ. Validation of a short food frequency questionnaire specific for iodine in UK females of childbearing age. J Hum Nutr Diet 2014;27:599-605.
16. Ferreira-Pêgo C, Babio N, Fenández-Alvira JM, Iglesia I, Moreno LA, Salas-Salvadó J. Fluid intake from beverages in Spanish adults; cross-sectional study. Nutr Hosp 2014;29:1171-78.
17. Willett WC. Nutritional Epidemiology, Third Edition. New York: Oxford University Press; 2012.
18. Institute of Medicine (IOM). Dietary reference intakes: Research synthesis workshop summary. The National Academies Press, Washington, DC; 2007.
19. Hardin DS. Validating dietary intake with biochemical markers. J Am Diet Assoc 2009;109:1698-99.
20. Malisova O, Bountziouka V, Panagiotakos DB, Zampelas A, Kapsokefalou. M. The water balance questionnaire: design, reliability and validity of a questionnaire to evaluate water balance in the general population. Int J Food Sci Nutr 2012;63:138-44.
21. Popowski LA, Oppliger RA, Lambert GP, Johnson RF, Johnson AK, Gisolfi CV. Blood and urinary measures of hydration status during progressive acute dehydration. Med Sci Sports Exerc 2001;33:747-53.
22. Mears SA, Shirreffs SM. Assessing Hydration Status and Reported Beverage Intake in the Workplace. Am J Lifestyle Med 2014;21:1-12.

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Nutrición Hospitalaria

Trabajo Original

Valoración nutricional

Análisis nutricional en atletas de fondo y medio fondo durante una temporada deportiva

Nutritional analysis in long and middle distance athletes during a sport season

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Resumen

Objetivo: el objetivo de este estudio fue analizar la ingesta nutricional de atletas de alto nivel de las especialidades de fondo y medio fondo, durante una temporada atlética, para detectar posibles deficiencias.

Métodos: para llevar a cabo el estudio, se procedió a evaluar la dieta y las diferentes concentraciones de los macronutrientes (glúcidos, lípidos y proteínas) y los diferentes tipos de ácidos grasos, en cuatro momentos diferentes de la temporada: al inicio y a los 3, 6 y 9 meses de entrenamiento. La muestra estuvo constituida por un grupo formado por 23 atletas de fondo y medio fondo con un mínimo de 5 años de entrenamiento, una carga semanal de entre 14-20 horas y un volumen de 100-120 km semanales. El procedimiento consistió en el registro nutricional durante un periodo de tres días consecutivos, en los cuatro momentos establecidos.

Resultados: los resultados obtenidos muestran incrementos significativos ($p < 0,05$) en la ingesta de proteínas entre los 3-9 meses.

Conclusión: la ingesta energética en atletas de fondo y medio fondo va aumentando a lo largo de la temporada deportiva, con cantidades de macronutrientes inferiores a las recomendadas por la comunidad científica, y con incrementos en la ingesta de proteínas en periodos de primavera y verano, coincidiendo con momentos de competición.

Palabras clave:

Nutrición. Macronutrientes. Ácidos grasos. Atletas de resistencia.

Abstract

Objective: The main objective of this study was to analyze the nutritional intake of high-level athletes specialties in long and middle distance during an athletic season to identify possible deficiencies.

Methods: To carry out the study, we proceeded to assess the diet and different intake levels of macronutrients (carbohydrates, fat and proteins); and changes that occur in the concentration of these elements were analyzed 4 different times of the season: at baseline and at 3, 6 and 9 months of training. The sample consisted of a group of 23 elite endurance athletes with a minimum of 5 years of training, a weekly charge between 14-20 hours, and an average of 100-120 miles a week. The procedure consisted of nutritional register for a period of three consecutive days in the 4 different moments of the season.

Results: The results show significant increases ($p < 0,05$) in protein intake between 3-9 months.

Conclusion: Nutritional intake in endurance athletes increases throughout the athletic season, with lower intake in macronutrients than recommended by the scientific community, and increases in protein intake during periods of spring and summer, according to competition periods.

Key words:

Nutrition. Macronutrients. Fatty acids. Endurance athletes.

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INTRODUCCIÓN

Las necesidades nutritivas y la alimentación que debe realizar un deportista de forma habitual, sin diferir mucho de la que realiza un individuo no deportista, tienen algunas peculiaridades (1,2). La nutrición deportiva es una rama de la nutrición, dirigida a establecer patrones alimenticios equilibrados, completos, variados y bien calculados para potenciar y complementar la actividad psicofísica del atleta (3) y de sujetos no deportistas. Estudios recientes muestran cómo prácticamente la mitad de la ingesta diaria de energía se realiza en el almuerzo (46%), seguida de la cena (31%), con diferentes distribuciones de macronutrientes a lo largo del día (2). Mucho se ha escrito sobre las necesidades nutricionales de los atletas, pero no acaba de haber un consenso sobre cuáles son realmente dichos requerimientos. En este sentido, la alimentación del deportista, como la de cualquier otra persona, debe realizarse atendiendo a sus necesidades nutricionales. Estas necesidades están en relación con una triple función que cumplen dichos nutrientes: por un parte, la energética, es decir, la de proporcionar la energía necesaria para poder realizar todas las funciones orgánicas y más específicamente, en este caso, el movimiento voluntario y los procesos termorreguladores; por otra parte, la reguladora, que permite mantener una adecuado metabolismo energético y un compensado estado de equilibrio anabólico-catabólico, principalmente a nivel muscular; y por último, la función plástica o estructural, gracias a la cual cada deportista va a intentar mantener aquella composición corporal que le es más favorable para conseguir el rendimiento esperado (4).

En el equilibrio energético se recomienda que la mayor parte se realice en forma de hidratos de carbono, dado que estos macronutrientes son sustancias que aportan energía que puede ser rápidamente utilizada para compensar el gasto ocasionado por la actividad física (5,6), de manera que suponga un 55-65% de la ingesta calórica total, o bien, ingerir entre 5-7 g/kg/día (7), si bien en periodos de alta intensidad de entrenamiento se pueden alcanzar hasta los 12 g/kg/día (8). Se aconseja que los carbohidratos ingeridos sean complejos, porque ayudan a mantener de forma más constante los niveles de glucosa sanguínea (9).

Por otra parte, la alimentación del deportista debe ser rica en proteínas de alto valor biológico. En general, las proteínas no son consideradas como fuente energética durante la actividad física, ya que los hidratos de carbono y las grasas desempeñan esta función. Las proteínas deberían aportar aproximadamente un 8-15% de las calorías totales ingeridas por la persona, modificándose muy poco atendiendo al período de entrenamiento, precompetición o competición (10).

Otro de los macronutrientes imprescindibles son los lípidos. Los lípidos son un componente necesario de la dieta que proporciona energía y elementos esenciales, como las vitaminas A, D, K y E. El rango aceptable es de 20-35% (el 20%, durante el periodo competitivo y el 35% solo cuando la ingesta de ácidos grasos monoinsaturados AGM es superior a un 15-20%) de la ingesta energética total, teniendo en cuenta una proporción del 7-10% para grasas saturadas (AGS), 10% para poliinsaturadas (AGP) y superior a 10-15% de grasas monoinsaturadas (AGM) (11).

A raíz de la revisión bibliográfica realizada, los objetivos que nos planteamos fueron los siguientes:

- Valorar la dieta y las diferencias en las concentraciones de macronutrientes (glúcidos, lípidos y proteínas) y ácidos grasos en deportistas de élite, concretamente atletas de fondo y mediofondo.
- Analizar y comparar los cambios que se produjeron en la concentración de dichos elementos en la dieta de los atletas en diferentes etapas del entrenamiento; al inicio del entrenamiento y a los 3, 6 y 9 meses de entrenamiento.

MATERIAL Y MÉTODO

El presente trabajo se ajusta a un diseño de estudio cuasiexperimental y longitudinal en el que se estudiaron deportistas de alto nivel en diferentes etapas del entrenamiento, recogiendo para tal estudio 4 tomas diferentes durante la temporada 2014/2015 (inicio, 3, 6, 9 meses). Los periodos competitivos de la temporada correspondieron a la tercera y cuarta valoración, es decir, a los 6 y los 9 meses de entrenamiento.

La muestra participante en el estudio estuvo compuesta por un grupo de 23 atletas de fondo y medio fondo varones (GA), cuyas características se detallan en la tabla I, con un mínimo de cinco años de entrenamiento, una carga semanal entre 14-20 horas, y un volumen de 100-120 km semanales, junto con unos resultados significativos en campeonatos regionales, nacionales e internacionales.

Todos los sujetos participantes en el estudio fueron informados del contenido de este y aceptaron su participación voluntaria mediante la firma de un consentimiento informado, bajo la regulación de las directrices éticas dictadas en la declaración de Helsinki de la Asociación Médica Mundial (actualizadas en la Asamblea Médica Mundial de Seúl de 2008) para la investigación con seres humanos.

Para la valoración antropométrica se utilizó una báscula de la marca Seca© (Hamburgo, Alemania), con una precisión de ± 100 g; un tallímetro de la marca Seca© (Hamburgo, Alemania), con una precisión de ± 1 mm; un compás de pliegues cutáneos Holtain© (Crymych, Reino Unido), con una precisión de ± 0,2 mm; un compás de diámetros óseos Holtain© (Crymych, Reino Unido), con precisión de ± 1 mm; y una cinta métrica de la marca

Tabla I. Características antropométricas de la muestra

Características	Atletas
Peso (kg)	65,50 ± 7,30
Altura (m)	1,77 ± 0,05
Masa grasa (kg)	5,59 ± 1,23
Masa muscular (kg)	32,19 ± 4,00
% graso	8,23 ± 1,37
% muscular	49,23 ± 6,11

Seca© (Hamburgo, Alemania) con una precisión de ± 1 mm. Las ecuaciones empleadas para calcular la masa muscular (ecuación de Porta y cols.), grasa (ecuación de Yuhasz) y ósea (ecuación de Van Doblen y Rocha) fueron las que establecen Porta y cols. en el Grupo Español de Cineantropometría (12). Las mediciones fueron realizadas en el mismo lugar, por el mismo explorador y siguiendo todas las correcciones del Grupo Español de Cineantropometría. Las medidas antropométricas que se obtuvieron fueron las siguientes: talla (medida en m), peso (medido en kg), pliegues cutáneos (medidos en mm) (abdominal, suprailíaco, subescapular, tricipital, muslo y pierna), diámetros óseos (medidos en cm) (biestiloideo, bicondiloideo humeral y bicondiloideo femoral) y perímetros musculares (medidos en cm) (brazo relajado y pierna relajada). El peso muscular y el peso graso se determinó mediante la diferencia entre el peso total y el resto de pesos: óseo, residual, graso y muscular (13).

Para conocer el estado nutricional de los sujetos estudiados se realizó el siguiente protocolo:

- Se repartieron encuestas nutricionales estructuradas a los sujetos. Estas encuestas nutricionales recogían lo que el sujeto ingería durante un periodo de tres días consecutivos, clasificado en cinco comidas: desayuno, almuerzo, comida, merienda y cena, coincidiendo uno de los días en fin de semana y siempre antes de competición. Cada atleta rellenaba su cuestionario acto seguido de la ingesta nutricional.
- Para la evaluación se utilizaron las tablas de Moreiras y cols. (14). Para ello se objetivaron y protocolizaron previamente las diferentes cantidades, estableciendo así un conjunto de normas para minimizar el error en la introducción de las encuestas en la base de datos.

Durante el tiempo que duró el estudio los sujetos no fueron sometidos a ningún programa de suplementación nutricional.

El análisis estadístico fue realizado mediante el programa informático SPSS Inc. (versión 19 para Windows). Para comprobar la normalidad de los datos, se realizaron las pruebas de Kolmogorov-Smirnov y Shapiro-Wilks. Para la comparación de medias en los diferentes momentos de la temporada (al inicio y a los 3, 6 y 9 meses) se utilizó el test de medidas repetidas ANOVA de un factor, aceptándose como significativas aquellas diferencias con una probabilidad de ser debidas al azar menor al 5% ($p < 0,05$). Los resultados se expresan como la media ± la desviación estándar.

RESULTADOS

A continuación se presentan los principales resultados obtenidos en el presente estudio. Las características de la muestra experimental al inicio del estudio se muestran en la tabla I.

En la tabla II se presentan los resultados antropométricos durante los 9 meses del estudio. La tabla III recopila las ingestas medias del grupo de atletas en las diferentes etapas del periodo de entrenamiento, tanto en kcal totales al día, como en hidratos de carbono (HC), proteínas y lípidos.

Tal y como se puede observar, los resultados muestran incrementos significativos en la ingesta de proteínas por parte de los atletas ($p < 0,05$) entre los 3 y los 9 meses, mientras que, en el caso de los hidratos de carbono, el mayor incremento se observa a los 6 meses de entrenamiento, aunque en este caso no se encuentran diferencias significativas. Se observa también una tendencia al incremento en la ingesta de calorías en periodos

Tabla II. Resultados antropométricos a lo largo de la temporada atlética

Características	Inicio	3 meses	6 meses	9 meses
Peso (kg)	65,50 ± 7,30	65,45 ± 7,36	64,67 ± 7,03	64,80 ± 7,34#
Peso graso (kg)	5,59 ± 1,23	5,42 ± 1,07	5,24 ± 0,83*	5,24 ± 0,96**
Peso muscular (kg)	32,19 ± 4,00	32,36 ± 4,01	31,83 ± 3,93	31,88 ± 4,12
% graso	8,23 ± 1,37	8,28 ± 1,63	8,1 ± 1,28	8,08 ± 1,48
% muscular	49,23 ± 6,11	49,44 ± 6,12	49,21 ± 6,07	49,19 ± 6,35

#p < 0,05 en comparación 3 vs. *6-9; *p < 0,05 en comparación 0* vs. *6; **p < 0,05 en comparación 3* vs. *9.*

Tabla III. Ingesta de macronutrientes a lo largo de la temporada atlética

	Inicio de temporada	%	3 meses	%	6 meses	%	9 meses	%
Energía (kcal/d)	2.880,6 ± 621,3		2.535,5 ± 400,2		2.918,4 ± 598,6		3.175,5 ± 973,2	
HC (g/kg/d)	5,35 ± 1,32	60,14%	5,15 ± 1,22	62,42%	6,48 ± 1,43	65,58%	6,17 ± 1,63	60,8%
Proteínas (g/kg/d)	1,72 ± 0,42	19,4%	1,68 ± 0,27	20,37%	1,99 ± 0,62	20,20%	2,20 ± 0,70#	21,7%
Lípidos (g/kg/d)	1,82 ± 0,85	20,44%	1,42 ± 0,57	17,20%	1,40 ± 0,44	14,20%	1,77 ± 0,86	17,4%

#p < 0,05 en comparación 3 vs. *6-9; ##p < 0,01 en comparación 3* vs. *6-9.*

competitivos, como son a los 6 y a los 9 meses, coincidiendo con la temporada de campo a través y al aire libre en pista.

La tabla IV recoge los resultados obtenidos en la ingesta de ácidos grasos en las diferentes etapas del periodo de entrenamiento divididos en ácidos grasos saturados, monoinsaturados, poliinsaturados, ω6, ω3, y la relación obtenida entre estos dos últimos, no obteniendo diferencias significativas en ningún momento de la temporada.

DISCUSIÓN

En primer lugar, analizando los resultados antropométricos de los atletas, se observaron diferencias estadísticamente significativas ($p < 0,05$) en el peso graso entre las pruebas realizadas en los primeros meses de entrenamiento (0 y 3 meses) y las realizadas en la temporada más estival (6 y 9 meses), que implican una disminución de estos a lo largo de la temporada. Los valores de peso graso fueron inferiores a los de otros atletas de similares características (15) y del mismo modo fueron inferiores a otros estudios de similares características llevados a cabo en triatletas (considerados atletas de media-larga distancia) (16). El descenso del peso graso se relaciona con una mayor utilización de los lípidos como fuente de energía, y con un aumento de masa muscular en el tren inferior (17,18).

En cuanto a los resultados nutricionales, podemos establecer que tras el análisis de los resultados expuestos anteriormente, se observó cómo la ingesta nutricional de los atletas de fondo y medio fondo va variando según se encuentren en una fase u otra de la temporada, aunque con muy pocas diferencias. Al igual que en nuestro estudio, investigaciones similares obtuvieron variaciones similares a las nuestras, pero con algunas diferencias significativas en la ingesta nutricional de atletas (19). Cabe destacar también que una vez realizado un análisis en profundidad de los resultados, se observaron unos desequilibrios en la ingesta nutricional, como se han producido en otros estudios de similares características (20-22).

En este sentido, resulta interesante destacar que el primer periodo competitivo coincidió con el tercer registro realizado a los 6 meses y que corresponde con la temporada de campo a través. De la misma manera, la última toma realizada a los 9 meses coincidió con otro pico de rendimiento, concretamente con la temporada de aire libre en pista, momento este en el que curiosamente se obtuvieron los resultados más elevados de todo el año en algunos macronutrientes, alcanzando algunos de ellos diferencias estadísticamente significativas como veremos a continuación. Es posible que algunos factores como el volumen, la intensidad y la frecuencia de entrenamiento, así como los alimentos característicos de las diferentes estaciones del año, puedan influir en las cantidades ingeridas a través de la dieta. Efectos muy similares a estos fueron obtenidos en un estudio realizado en un equipo de balonmano de élite en el que se analizó la ingesta de macronutrientes a las 8 semanas y las 16 semanas y se observó un incremento tanto en proteínas como en hidratos de carbonos y grasas, siendo estos cambios significativos en hidratos de carbono y proteínas tanto a las 8 semanas como a las 16 semanas (23).

En general, en nuestro estudio se observaron incrementos en todos ellos a partir de la tercera toma; es decir, cuando comenzó uno de los periodos competitivos como hemos mencionado anteriormente entre los 6 y 9 meses de la temporada deportiva. Se produjo un incremento no significativo de hidratos de carbono por parte de los atletas, posiblemente de forma paralela al aumento en la intensidad y duración de los entrenamientos, con el objetivo de mantener los depósitos corporales y optimizar la disponibilidad de glucógeno muscular y hepático y de glucosa sanguínea, para aumentar y mantener la oxidación de los carbohidratos. Este incremento en la ingesta de hidratos de carbono podría estar relacionado con la orientación del entrenamiento en estos periodos, donde se incrementa su intensidad y requiere mayor demanda de glucógeno para poder afrontar dichos entrenamientos (24). Teniendo en cuenta el peso corporal, se puede observar, en nuestro estudio, cómo los atletas ingirieron unas cantidades medias de 5,78 g/kg/día de hidratos de carbono a lo largo de toda la temporada, cantidades por debajo de lo descrito anteriormente por algunos autores en los periodos de 0 y 3 meses, que determinan ingestas de 5-7g/kg/día para atletas que entrenan aproximadamente 1 hora al día y 6-10 g/kg/día para deportistas de resistencia que entrenan una media de 1-3 horas diarias, y en esta última es donde se encuadran nuestros atletas (25). Sin embargo, en las tomas de los 6 y 9 meses la ingesta de hidratos de carbono sí estuvo dentro de los valores que describen los autores. Ingestas por debajo de las cantidades recomendadas provocan la aparición de fatiga asociada al agotamiento de los depósitos de glucógeno muscular y por consiguiente la reducción

Tabla IV. Ingesta de ácidos grasos a lo largo de la temporada atlética

Ácidos grasos	Inicio de temporada	%	3 meses	%	6 meses	%	9 meses	%
Saturados (g/d)	37,86 ± 21,12	31,26%	24,85 ± 11,62	25,05%	26,96 ± 14,83	27,32%	36,14 ± 19,00	31,69%
Monoinsaturados (g/d)	52,27 ± 29,24	43,16%	40,76 ± 17,16	41,09%	38,03 ± 12,24	38,54%	43,45 ± 22,08	38,1%
Poliinsaturados (g/d)	11,97 ± 5,35	9,88%	12,11 ± 4,69	12,21%	11,56 ± 3,93	11,71%	13,08 ± 8,58	11,46%
ω6 (g/d)	9,28 ± 4,82	7,66%	9,05 ± 4,83	9,12%	9,47 ± 4,00	9,59%	10,52 ± 7,71	9,22%
ω3 (g/d)	1,08 ± 0,44	0,89%	0,84 ± 0,53	0,84%	0,93 ± 0,44	0,94%	1,33 ± 1,13	1,16%
ω6/ω3 (g/d)	8,64 ± 3,11	7,13%	11,57 ± 3,26	11,66%	11,72 ± 6,14	11,87%	9,52 ± 5,41	8,34%

de glucosa en la sangre, y el glucógeno muscular y hepático es esencial para un rendimiento óptimo (26).

Por otro lado, la ingesta de proteínas experimentó un aumento significativo entre los 3 y 9 meses ($p < 0,05$), que podría ser debido a la fase anabólica y de recuperación en la que se encontrarían los atletas. En este sentido, destaca su utilización como recuperador, y su función de reparación y mantenimiento de los tejidos corporales, y en estos periodos los atletas necesitan una mayor ingesta de proteínas por su función regenerativa debido a las altas cargas de ejercicio físico a las que son sometidos durante los entrenamientos. Se debería tener en cuenta la suplementación de proteínas y de aminoácidos ramificados, ya que hay estudios que indican que esto produce efectos positivos en la disminución del daño muscular postejercicio y la leucina puede tener efectos en la recuperación y síntesis proteica (27). Otros estudios determinan que el consumo de proteínas durante el ejercicio posiblemente sirva como una ayuda ergogénica, retardando el tiempo hasta llegar al agotamiento en aquellas pruebas que requieren de una gran resistencia física (28). Según Saunders y cols. (29), determinar la cantidad adecuada de proteínas y aminoácidos esenciales en la dieta en diferentes estados fisiológicos es de gran importancia para los atletas, ya que un déficit proteico produce una disminución de la capacidad de generar la máxima potencia muscular. Teniendo en cuenta el peso corporal, se puede observar cómo los atletas ingirieron unas cantidades medias de 1,89 g/kg/día de proteínas, cantidades próximas a lo descrito anteriormente por algunos autores, que determinan ingestas de entre 1,2-1,7 gr/kg/día para deportistas de resistencia, en los cuales el volumen de entrenamiento es muy elevado (30). En las tomas de 0 y 3 meses se obtuvieron resultados dentro de lo descrito por otros autores; sin embargo, en las tomas 6 y 9 meses la ingesta de proteínas fue mayor a lo recomendado por estos autores. Por otro lado, otros estudios determinan que un consumo de proteínas mayor al recomendado por la modalidad deportiva podría tener efectos perjudiciales para el organismo (31).

En relación con la cantidad de lípidos, estos desempeñan un papel muy importante, ya que es una fuente de combustible vital durante el entrenamiento de resistencia. El músculo esquelético puede almacenar casi el equivalente energético de glucógeno en forma de triacilglicerol intramuscular, que es una fuente de combustible viable durante el ejercicio de intensidad moderada y prolongada hasta aproximadamente el 85% del VO_2 max (32). Los lípidos que los atletas ingirieron fueron variando a lo largo de la temporada y no se han encontrado cambios significativos, aunque los diferentes tipos de ácidos grasos experimentaron un ligero aumento en todos sus valores al finalizar la temporada a los 9 meses. Igualmente, el índice $\omega 6/\omega 3$, incrementó, aunque no se encontraron diferencias significativas. La cantidad diaria de lípidos requeridos para la reposición de triacilglicerol intramuscular después del entrenamiento de resistencia ha sido estimado en 2 g/kg/d. Teniendo en cuenta el peso corporal, se puede observar como los atletas ingirieron unas cantidades medias de 1,6 g/kg/día de lípidos, cantidades más bajas a lo descrito por otros autores (33). En ciertas épocas del año, tales como la fase de competición, la ingesta de lípidos debe ser limitada para lograr la optimización de la composición corporal. Este efecto se aprecia en nuestro estudio, ya que cuando se acerca la fase competitiva a los 6 y 9 meses las cantidades de lípidos se ven disminuidas. Sin embargo, en todas las fases de entrenamiento los lípidos son siempre necesarios para ayudar a la absorción de vitaminas liposolubles y para la síntesis de hormonas, así como para la estructuración de la membrana celular y la integridad de la vaina de mielina (26).

El estudio presenta algunas limitaciones, como por ejemplo el número de días de registro nutricional, que puede que fuera escaso, ya que un registro nutricional más prolongado en el tiempo nos habría dado una información más exacta, precisa y el error del estudio habría sido menor.

La segunda limitación del estudio fue el tamaño de la muestra, ya que al tratarse de un grupo de atletas de alto rendimiento fue difícil reunir una muestra de un mayor tamaño.

CONCLUSIONES

Tras la realización de la investigación, se pueden extraer diversas conclusiones para ampliar el bagaje científico sobre la ingesta y nutrición que realizan los atletas de fondo y medio fondo durante una temporada deportiva. Entre ellas, podemos destacar:

- El aporte energético o la cantidad de energía ingerida en atletas de fondo y medio fondo va aumentando a lo largo de la temporada deportiva.
- Los atletas de fondo y medio fondo incrementan la ingesta de proteínas en periodos de primavera y verano, coincidiendo con momentos de competición.

BIBLIOGRAFÍA

1. Girard S. Timing fuel for peak racing. En: Girard S, editor. Endurance sports nutrition. Champaign, Illinois: Human Kinetics; 2000. p. 51-79.
2. Moreno R, Fernández A, García J, Cámara F, Amaro M, Ros G, et al. Estimación de la distribución diaria de nutrientes en la dieta estándar en España. Nutr Hosp 2015;31(6):2660-7.
3. Palavecino N. Nutrición para el alto rendimiento. Buenos Aires: Libros en Red; 2002.
4. Pendergast DR, Meksawan K, Limprasertkul A, Fisher NM. Influence of exercise on nutritional requirements. Eur J Appl Physiol 2011;111:379-90.
5. Burke LM, Kiens B, Ivy JL. Carbohydrates and fat for training and recovery. J Sport Sci 2004; 22(1):15-30.
6. Brown RC, Cox CM, Goulding A. High-carbohydrate versus high-fat diets: effect on body composition in trained cyclists. Med Sci Sports Exer 2002;32(3):690-4.
7. Martínez JM, Urdampilleta A, Mielgo-Ayuso J. Necesidades energéticas, hídricas y nutricionales en el deporte. Eur J Hum Mov 2013;30:37-52
8. Stellingwerff T, Maughan RJ, Burke LM. Nutrition for power sports: Middle-distance running, track cycling, rowing, canoeing/kayaking, and swimming. J Sport Sci 2011;29:79-89
9. Asif M, Rooney LW, Ali R, Riaz MN. Application and opportunities of pulses in food system. A review. Crit Rev Food Sci Nutr 2013;53(11):1168-79.
10. Urdampilleta A, Vicente-Salar N, Martínez JM. Necesidades proteicas de los deportistas y pautas diététetico-nutricionales para la ganancia de masa muscular. Rev Esp Nutr Hum Diet 2012;16(1):25-35.
11. Rodríguez NR, Di Marco NM, Langley S. American college of sports medicine position stand. Nutrition and athletic performance. Med Sci Sport Exer 2009;41(3):709-31.

12. Porta J, Galiano D, Tejedo A, González JM. Valoración de la composición corporal. Utopías y realidades. En: Manual de Cineantropometría. Pamplona: Monografías FEMEDE; 1993. p. 113-70.
13. Porta J, González, JM, Galiano, Tejado A. Valoración de la composición corporal. Análisis crítico y metodológico. Parte I. Car News 1995;7:4-13.
14. Moreiras O, Carbajal A, Cabrera L, Cuadrado C. Tabla de composición de alimentos. 16.ª edición. Madrid: Ed. Pirámide; 2013.
15. Thompson J, Manore MM. Predicted and measured resting metabolic rate of male and female endurance athletes. J Am Diet Assoc 1996;96(1):30-4.
16. Guillén L, Mielgo J, Norte A, Cejuela R, Cabañas MD, Martínez JM. Composición corporal y somatotipo en triatletas universitarios. Nutr Hosp 2015;32(2):799-807.
17. Heyward, VH. Evaluación de la aptitud física y prescripción del ejercicio. Madrid: Panamericana; 2008.
18. Wilmore JH, Costill DL. Fisiología del esfuerzo y del deporte. Barcelona: Paidotribo; 2007.
19. Erdman KA, Tunnicliffe J, Lun VM, Reimer RA. Eating Patterns and Composition of Meals and Snacks in Elite Canadian Athletes. Int J Sport Nutr Exerc Metab 2013;23:210-9.
20. Úbeda N, Palacios N, Montalvo Z. Food habits and body composition of Spanish elite athletes in combat sports. Nutr Hosp 2010;25(3):414-21.
21. Molina-López J, Molina JM, Chirosa LJ, Florea D, Sáez L, Jiménez J, et al. Implementation of a nutrition education program in a handball team; consequences on nutritional status. Nutr Hosp 2013;28(3):1065-76.
22. Bernad L, Reig M. Ingesta energética y de macronutrientes en mujeres atletas. Nutr Hosp 2015;32(5):1936-48.
23. Cermak NM, van Loon LJC. The Use of Carbohydrates During Exercise as an Ergogenic Aid. Sport Med 2013;43:1139-55.
24. Coyle E. Fluid and fuel intake during exercise. J Sport Sci 2005;22:39-55.
25. Burke LM, Hawley JA, Wong SH, Jeukendrup AE. Carbohydrates for training and competition. J Sport Sci 2011;29(1):17-27.
26. Jeukendrup AE. Nutrition for endurance sports: Marathon, triathlon, and road cycling. J Sport Sci 2011;29(1):91-9.
27. Salinas ME, Martínez JM, Urdampilleta A, Mielgo J, Norte A, Ortiz R. Efectos de los aminoácidos ramificados en deportes de larga duración: revisión bibliográfica. Nutr Hosp 2015;31(2):577-89.
28. Espino E, Muñoz MJ, Candia R. Efectos en el rendimiento físico de la ingesta de suplementos con carbohidratos y proteína durante el ejercicio: revisión sistemática. Nutr Hosp 2015;32(5):1926-35.
29. Saunders MJ, Moore RW, Kies AK, Luden ND, Pratt CA. Carbohydrate and Protein Hydrolysate Coingestion's Improvement of Late-Exercise Time-Trial Performance. Int J Sport Nutr Exerc Metabol 2009;19(2):136-49.
30. Phillips SM, Van Loon LJ. Dietary protein for athletes: From requirements to optimum adaptation. J Sport Sci 2011;29(S1):S29-S38.
31. Phillips SM. Dietary protein requirements and adaptive advantages in athletes. Brit J Nutr 2012;108:158-67.
32. Stellingwerff T, Boon H, Jonkers RA, Sendem JM, Spriet LL, Koopman R, et al. Significant intramyocellular lipid use during prolonged cycling in endurance trained males as assessed by three different methodologies. Am J Physiol Endocrinol Metab 2009;292:E1715-E23.
33. Decombaz J. Nutrition and recovery of muscle energy stores after exercise. Schweiz Z Med Traumatol 2003;51:31-8.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Epidemiología y dietética

Impact of the two different iron fortified cookies on treatment of anemia in preschool children in Brazil

Impacto de dos galletas diferentes enriquecidas con hierro en el tratamiento de la anemia en niños en edad preescolar en Brasil

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Abstract

Introduction: Nutritional intervention in pre-school children using cookies prepared with wheat flour enriched with iron and folic acid (CWFFeFA) and cookies prepared with cowpea *(Vigna unguiculata (L.) Walp)* flour fortified with iron and zinc and wheat flour enriched with iron and folic acid (CCFFeZn + WFFeFA).

Objective: To assess the impact of the ingestion of CWFFeFA and CCFFeZn + WFFeFA by pre-school children, using the cowpea variety BRS-Xiquexique, to control iron-deficiency anaemia.

Methods: Nutritional intervention was conducted in municipal day care centres selected at random (n = 262) involving pre-school children aged 2 to 5 years living in Teresina, state of Piauí, Brazil. To assess the socioeconomic data, BMI-for-age, haemoglobin levels before and after intervention, and dietary intake, the children were divided into group 1 (G1), which received CWFFeFA (30 g), and group 2 (G2), which received CCFFeZn + WFFeFA (30 g). Food acceptance was evaluated daily.

Results: The prevalence of anaemia in G1 and G2 before the nutritional intervention was 12.2% (n = 18) and 11.5% (n = 30), respectively. After intervention, the prevalence decreased to 1.4% in G1 (n = 2) and to 4.2% in G2 (n = 11). Food acceptance by pre-school children in G1 and G2 was 97.4% and 94.3%, respectively.

Conclusion: The use of both types of cookie formulations decreased the prevalence of anaemia among pre-school children, and CCFFeZn + WFFeFA yielded the greatest decrease.

Key words:

Nutritional intervention. Anaemia. Pre-school children. Fortification. Cowpea.

Resumen

Introducción: intervención nutricional en niños en edad preescolar con dos galletas: galletas de harina de trigo enriquecidas con hierro y ácido fólico (BFTF) y galletas con harina de *feijão-caupi,* biofortificados con zinc y hierro, y harina de trigo enriquecida con hierro y ácido fólico (BFFCb + FTF).

Objetivo: evaluar el impacto del consumo de galletas a base de harina de trigo fortificada con hierro y ácido fólico y de galletas enriquecidas con harina de feijão-caupi (*Vigna unguiculata* (L.) Walp) variedad BRS-Xiquexique, biofortificados con hierro y zinc, por los preescolares para controlar la anemia ferropriva.

Métodos: intervención en guarderías municipales seleccionados aleatoriamente (n = 262), niños en edad preescolar de 2 a 5 años en Teresina, Brasil. Con el fin de evaluar los datos socioeconómicos, o IMC para la edad y exámenes de hemoglobina antes y después de la intervención, y el consumo de alimentos se dividen en grupos: grupo 1 (G1) recibió el BFTF (30 g) y el grupo 2 (G2), que recibió el BFFCb + FTF (30 g); analizar la aceptación diaria de galletas.

Resultados: la prevalencia de anemia antes de la intervención en los grupos G1 y G2 fue de 12,2% (n = 18) y 11,5% (n = 30), respectivamente. Después de la intervención en el G1 se redujo a 1,4% (n = 2) y en el G2 a 4,2% (n = 11). La aceptación de las galletas por los niños en edad preescolar en G1 y G2 fue del 97,4% y 94,3%, respectivamente.

Conclusión: el uso de dos galletas disminuyó la prevalencia de anemia en niños preescolares, destacándose que en la BFFCb+FTF hubo una mayor reducción.

Palabras clave:

Intervención nutricional. Anemia. Niños en edad preescolar. Biofortificacion. Feijão-caupi.

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INTRODUCTION

Anaemia is defined by the World Health Organization (WHO) as the condition in which the haemoglobin content in the blood is lower than the normal as a result of the shortage of one or more essential nutrients, no matter what is the cause of disability (1). It is estimated that iron deficiency is responsible for about 50% of all the cases of anaemia (2). Other possible causes are haemolysis malaria, glucose-6-phosphate dehydrogenase deficiency, a genetic defect in haemoglobin synthesis and nutritional deficiencies, such as vitamin A, B12, C and folic acid (3).

Anaemia is the last stage of iron deficiency, which is characterized by a reduction of haemoglobin levels with impairment of body functions, which are more severe according to the level of that reduction. In addition, this reduction is the universal parameter to set this anaemia.

Anaemia is a public health problem that affects populations in both rich and poor countries (4). Previous studies (5-7) have reported the nutritional changes that occurred in the last three decades and have indicated that the prevalence of anaemia assumed epidemic proportions and became the main deficiency problem in Brazil in terms of magnitude.

Given the importance of this pathology in the world, numerous countries conduct interventions to reduce anaemia; particularly in the groups most susceptible to its devastating effects: pregnant women and young children. Among the measures adopted to prevent and control iron-deficiency anaemia in Brazil, the Ministry of Health (Ministério da Saúde-MS) has intensified actions aimed at reducing iron deficiency by means of the weekly supplementation of food products with iron sulphate, as recommended by the National Iron Supplementation Program (Programa Nacional de Suplementação de Ferro-PNSF), and using universal fortification, which involves the addition of micronutrients to food products consumed by most of the population (8).

Another strategy currently used with the goal of decreasing micronutrient deficiency involves the increase in the nutrient content of food products using conventional breeding or genetic engineering, thereby allowing the identification of genotypes with high levels of iron, zinc, and protein, among other elements. These genotypes are assessed as to their performance in cross-breeding experiments and, consequently, their capacity for transmission of superior genetic traits, *i.e.,* genotypes exhibiting an increased capacity to extract sufficient amount of minerals to adequately supply human needs (9,10). These fortified crops include cowpeas (*Vigna unguiculata* (L). Walp) enriched in iron (average content of 61.3 $mg.kg^{-1}$) and zinc (average content of 44.7 $mg.kg^{-1}$) belonging to various cultivars, such as BRS-Aracê, BRS-Xiquexique, and BRS-Tumucumaque (11).

Considering the magnitude of nutritional deficiency, its importance as a public health problem, and its deleterious effects on human health, this study conducted a nutritional intervention program among pre-school children attending municipal day-care centres using two dry cookies formulation: one cookie prepared with wheat flour enriched with iron and folic acid and other prepared with cowpea flour (Xiquexique cultivar) fortified with iron and zinc. The effect of this formulation on the control of anaemia and/or increasing haemoglobin levels was evaluated among pre-school children.

MATERIALS AND METHODS

PARTICIPANTS

The study involved 262 pre-school children aged 2 to 5 years who attended two Municipal Childhood Education Centres (Centros Municipais de Ensino Infantil-CMEIs) in Teresina, state of Piauí. The sample size was determined using Epi Info software, version 6.04 based on the study by Moreira-Araújo et al. (2009) (12), wherein the anaemia prevalence was 30%. The procedure for determining the sample size was as follows: 1) Teresina was divided into four zones containing CMEIs: 27 CMEIs in the southeast, 37 in the east, 47 in the south, and 40 in the north; 2) study areas were selected by the drawing of lots; 3) CMEIs of a specific area were selected by the drawing of lots, and 4) in each CMEI selected, an invitation to participate was issued to all parents and/or guardians of pre-school children. The following children were included in the study: pre-school children attending CMEIs whose parents and/or guardians signed an informed consent form, except children with clinical complications that could affect the results, such as malabsorptive diseases, inflammation, and bleeding, or for whom the consent of parents and/or guardians was not obtained.

The study sample was divided into two groups: intervention group 1 (G1), with 115 (43.9%) pre-school children who received cookies prepared with wheat flour fortified with iron and folic acid (CWFFeFA), and intervention group 2 (G2), with 147 (56.1%) pre-school children who received cookies prepared with cowpea flour fortified with iron and zinc in addition to wheat flour enriched with iron and folic acid (CCFFeZn + WFFeFA). Sample selection was performed at random.

This study was approved by the Research Ethics Committee of the Federal University of Piauí through Brazil Platform under protocol CAAE 01140312000005214. After obtaining the consent of parents and/or guardians, data were collected on scheduled days at CMEIs by the researcher and previously trained collaborators.

DATA COLLECTION

First phase

a) Collection of information using a structured questionnaire: Socioeconomic status (parental education, age, occupation, family income, sanitation conditions, housing type, and control of parasite infections).
b) Anthropometric measurements: Weight was obtained using a portable digital scale, model ultra slim Wiso W910, with a capacity of up to 150 kg with 100 g accuracy, and height was measured using a portable vertical anthropometer,

model *person-check* (KaWe), graduated in centimetres. To perform these measurements, pre-school children were required to be barefoot, wear standardised uniforms, and maintain their heads in the Frankfort plane.

c) Diagnosis of anaemia before and after intervention: To investigate the prevalence of anemic deficiency, haemoglobin level was measured using the cyanmethemoglobin method (13,14), after disposing of children with other diseases or other forms of anaemia. During venipuncture, a 20-µL blood sample was collected in Drabkin solution using a Sahli pipette, and readings were performed in a spectrophotometer, model E-210D (CELM), with an absorbance accuracy of three decimal places. Children with haemoglobin levels < 11 g/dL were considered anaemic, and children with levels < 9.5 g/dL were considered severely anaemic, as previously described (15). Two age categories were considered: 1-3 years and 3-6 years.

Second phase

a) Cookie preparation: The two formulations were prepared following a protocol detailed by Frota et al. (16). For CCFFeZn, 30% of the wheat flour was replaced with fortified cowpea flour.

b) The cookie ingredients were mixed to ensure homogeneity of the dough. For cookie preparation, approximately 8 g of the dough was rolled manually. Raw cookies were placed on trays and baked in a domestic oven at approximately 220 °C for approximately 20 minutes. After baking, the cookies were left in the open air to cool and were then transferred to polyethylene bags (30 g capacity) without stamping, and each student in both G1 and G2 was identified in the package by the school name, shift, class period, class ID, student name, and student number.

c) Proximate composition: The moisture was determined by drying in an oven (314D242 model, Quimis, São Paulo, Brazil) at 105 °C until a constant weight was obtained. The ash content was determined after calcination in a muffle furnace (model Q-318 M21, Quimis, São Paulo, Brazil) at 550 °C. The protein concentration was determined using the macro-Kjeldahl method with a conversion factor of 6.25, and the lipid content was determined by hot extraction using hexane as solvent in a Soxhlet apparatus (TE-044, Tecnal, São Paulo, Brazil) (17). The carbohydrate content was calculated by difference. These analyses were performed in triplicate at the Laboratory of Food Science and Food Biochemistry (Department of Nutrition-UFPI).

d) Mineral content: The calcium (Ca), copper (Cu), iron (Fe), phosphorus (P), sodium (Na), magnesium (Mg), manganese (Mn) and zinc (Zn) mineral contents were determined using an adapted inductively coupled plasma-optic emission spectrometry (ICP OES) technique according to Horwitz and Latimer (2000) (18) after mineralisation of the samples in a muffle furnace at 450 °C (model Q-318 M21, Quimis, São Paulo, Brazil). The original method was adapted regarding the wavelengths to analyse each mineral as follows: calcium, 317,933; copper, 324,754; iron, 259,940; phosphorus, 213,618; sodium, 589,592; magnesium, 279,553; manganese, 257,610; and zinc 206,200. Prior to the determination of the minerals, the materials used were decontaminated in a 20% nitric acid solution for 24 hours. These analyses were performed in triplicate at the Food Science and Quality Centre, ITAL, São Paulo (SP).

e) Nutritional intervention: During the study and in addition to the normal CMEI diet, pre-school children from G1 ingested CWFFeFA, whereas G2 ingested 30 g of CCFFeZn + WFFeFA (BRS-Xiquexique cultivar) for two months, three times a week, which ensured a daily iron intake of 0.6 mg and 4.0 mg for G1 and G2, respectively.

DATA ANALYSIS

The data were processed using the Statistical Package for the Social Sciences (SPSS) software, version 13.0. In addition, the paired t-test was used to assess the difference in the mean haemoglobin levels before and after the nutritional intervention with the two formulations, Student's t test was used to assess potential associations, and the chi-square and McNemar tests were used to evaluate the differences between the prevalence rates of anaemia before and after intervention with the two formulations. A value of $p < 0.05$ was considered statistically significant for all tests.

RESULTS

The study involved 131 boys and 131 girls (n = 262) with a mean age of 60.7 months and 57.2 months, respectively, with a significant difference ($p = 0.010$) in the mean age in regard to gender.

The participating families comprised 4 family members on average. The average education level of the mother and father was 9.7 and 9.2 years, respectively, and a higher frequency of primary education level was found for the mother and father. Regarding the family monthly income, 71% received between one and two times the minimum wage (MW) at the time of the study, and approximately 18.7% received < 1 MW.

Table I lists the variables evaluated in G1 and G2 before and after intervention: height, weight, gender, and haemoglobin levels. The results indicate that the mean values were very similar between the two study periods, except the haemoglobin level in G2, which was significantly different before and after intervention.

Figure I shows the results before and after the intervention for G1 and G2. The haemoglobin level significantly increased from 12.4 before the intervention to 14.7 after the intervention in G2 ($p = 0.003$). However, no significant difference ($p = 0.0754$) was observed in this parameter in G1. In addition, no significant increase in haemoglobin levels ($p = 0.0587$) was observed in the total population after the intervention. With regard to the occurrence

Table I. Weight heigh, and haemoglobin levels of children before and after the study. Teresina, PI, 2013

Groups/ variables	In the study	
	Before	After
G1- Cookie CWFFeFA		
Height (cm)		
Male	110.0 ± 0.3[a]	110.5 ± 0.5[a]
Female	108.3 ± 0,1[a]	109.3 ± 0.2[a]
Average	109.3 ± 0.6[a]	109.4 ± 0.1[a]
Weight (cm)		
Male	19.4 ± 0.1[a]	19.9 ± 0.1[a]
Female	18.2 ± 0.1[a]	18.5 ± 0.1[a]
Average	18.8 ± 0.2[a]	19.3 ± 0.3[a]
Haemoglobin		
Male	12.5 ± 0.1[a]	12.6 ± 0.2[a]
Female	12.6 ± 0.2[a]	12.8 ± 0.2[a]
Average	12.6 ± 0.1[a]	12.7 ± 0.2[a]
G2 – Cookie CCFFeZn + WFFeFA		
Height (cm)		
Male	107.7 ± 0.1[a]	110.5 ± 0.2[a]
Female	105.4 ± 0.1[a]	109.1 ± 0.1[a]
Average	107.3 ± 0.1[a]	109.9 ± 0.1[a]
Weight (cm)		
Male	18.5 ± 0.2[a]	19.2 ± 0.2[a]
Female	17.0 ± 0.1[a]	17.5 ± 0.2[a]
Average	17.6 ± 0.3[a]	18.3 ± 0.2[a]
Haemoglobin		
Male	12.4 ± 0.2[a]	14.9 ± 0.2[b]
Female	12.4 ± 0,2[a]	14.8 ± 0.1[b]
Average	12.4 ± 0.1[a]	14.7 ± 0.2[b]

The same letter between columns does not show significant differences between the average before and after the level of p < = 0.05. t test paired.

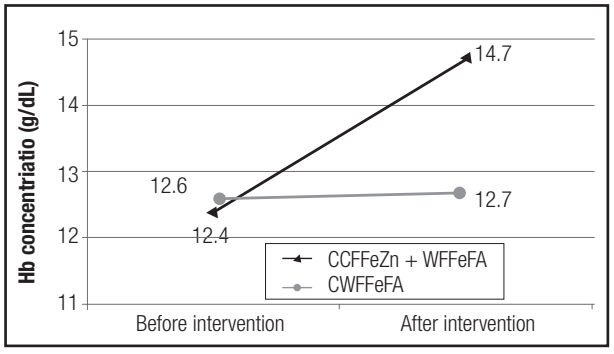

Figure 1.

Haemoglobin levels before and after the intervention in both intervention groups.

of anaemia among pre-school children who ingested CCFFeZn + WFFeFA, the prevalence rate decreased significantly ($p < 0.001$) from 12.2% (n = 18) before the intervention to 1.4% (n = 2) after the intervention. However, no significant difference ($p = 0.284$) was observed in the group offered CWFFeFA.

In Table II, it is shown the chemical composition of cookies that were used in this study. The results showed that the cookie with cowpea + wheat flour fortified with folic acid and iron (CCFFeZn WFFeFA +) presented the best contents both macro and micronutrients, especially the iron with 4.0 mg/100 g-1.

Table III shows that the acceptance rate of CCFFeZn + WFFeFA and CWFFeFA among pre-school children was 94.3% and 97.4%, respectively. Considering this high acceptance rate, the use of both cookie formulations as a nutritional supplement in the diet of pre-school children is effective in lowering iron-deficiency anaemia.

The diet provided in the two CMEIs consisted of one daily meal (morning or afternoon snack) because the CMEIs had two shifts with distinct classes. A one-week menu was examined with respect to calories and levels of proteins, calcium, iron, vitamin C, and vitamin A. Considering that children remained only part-time at the CMEIs, the recommended calories and nutrient intake that should be consumed in the CMEIs corresponded to 30% of the recommended daily intake (RDI).

Table II. Chemical composition of cowpea cookie fortified with iron and zinc + fortified wheat flour with iron and folic acid (CCFFeZn + WFFeFA) and cookie with fortified wheat flour with iron and folic acid (CWFFeFA). Teresina, PI, 2013

Nutrients	Cookies	
	CCFFeZn + WFFeFA Average ± DP	CWFFeFA Average ± DP
Humidity*	11.28 ± 0.73[a]	7.62 ± 0.28[b]
Ash*	2.65 ± 0.01[a]	2.48 ± 0.15[b]
Protein*	17.15 ± 1.19[a]	9.26 ± 0.40[b]
Lipids*	5.64 ± 0.14[a]	12.14 ± 1.25[b]
Carbohydrates*	63.28 ± 2.13[a]	68.50 ± 2.09[b]
Calcium**	27.0 ± 3.0	ND
Iron**	4.0 ± 0.3[a]	0.66 ± 0.02[b]
Phosphorus**	210.0 ± 16.0a	316.3 ± 2.90[b]
Magnesium**	69.0 ± 5.0a	16.23 ± 0.04[b]
Potassium**	486.0 ± 28.0a	141.9 ± 1.60[b]
Sodium**	207.0 ± 11.0	ND
Zinc**	1.7 ± 0.2[a]	0.42 ± 0.01[b]

Different letters between columns show significant differences between the average level of significance.
$p < 0.05$, according to the Student t-test. ND = not done.
**(g/100g^{-1}).*
***(mg/100g^{-1}).*

Table III. Consumption of CWFFeFA and CCFFeZn + WFFeFA by the study groups

Children	Consumption (%)			
	CWFFeFA		CCFFeZn + WFFeFA	
	30 g	*< 30 g*	*30 g*	*< 30 g*
Maternal	97.6	2.4	94.2	5.8
Period I	97.4	2.6	91.7	8.3
Period II	97.1	2.9	93.6	6.4
Mean %	97.4	2.6	94.3	5.7

With respect to nutritional adequacy of the diet offered according to age in both CMEIs., it was observed that in all age groups, the consumption of calories, protein, and vitamin C exceeded the 30% recommendation in both CMEIs. By contrast, the amount of minerals (iron, calcium) and vitamin A was inadequate and below the values recommended (19). Furthermore, in the group offered CCFFeZn + WFFeFA, a nutritional level above the 30% recommendation was achieved for all age groups regarding calorie intake (64.5% and 52% in G1 and G2, respectively), protein intake (198.5% and 135.8% in G1 and G2, respectively), and iron intake (31.7%).

DISCUSSION

Pre-school children at the CMEIs exhibited a similar profile, making the study sample homogeneous because the participants were located in the same area and neighbourhood and had similar socioeconomic and cultural status.

Iron-deficiency anaemia transcends the biological aspects and includes social and cultural dimensions. In this context, among the family-related variables, the education of the mother has been reported to influence the development of anaemia because it affects the care provided to the children (20,21). This variable averaged 9.2 years (higher education), similar to the results obtained by Goes et al. (22), wherein 80.7% of the mothers had more than eight years of education (at least incomplete secondary education), which corroborates the low prevalence of anaemia observed in this study because the increased education translates into more knowledge, awareness, and access to information and better understanding when choosing food.

The prevalence of anaemia among pre-school children decreased from 11.5% (n = 30) before the intervention to 4.2% (n = 11) after the intervention. These results indicate a lower prevalence of anaemia than has been reported in other studies, such as the work of Gondim et al. (23), with a prevalence of 36.5%, Souza et al. (24), with a prevalence of 51.8%, and Rocha et al. (25), with a prevalence of 30.8%. This decreased prevalence was positively affected by the improvement in housing conditions, income, and education level.

Studies show that the prevalence of anaemia is from moderate to severe magnitude in many countries, including European countries (26) and highlight the importance of doing interventions to control it as if it was a serious public health problem.

The control of anaemia can be achieved with preventive measures such as the provision of foods with wheat flour fortified with iron and folic acid to vulnerable populations, including pre-school children, following the recommendations of RDC 344 issued by the Ministry of Health (27). Other strategies include diet diversification, nutritional education programs, and promotion of breastfeeding. Furthermore, the control of anaemia involves drug therapy with ferrous sulphate through the iron supplementation program of the Ministry of Health (2005) (28,29,14). Iron deficiency in childhood stems from diet inadequacy (balance between iron sources and substances that increase or decrease iron bioavailability) and not from the unavailability of iron-containing food products. Studies conducted in Brazil have indicated that food fortification has succeeded in decreasing the prevalence of anaemia at the national level and overseas and that this strategy is easy, safe, inexpensive, effective in the short and medium term, and able to improve food quality for the population (25,30).

This study proposed the use of cookie formulation containing the cowpea cultivar BRS-XiqueXique as the iron source as well as honey, which is also a source of iron that is highly appreciated and consumed by the Brazilian population. The cookie was prepared with wheat flour enriched with iron and folic acid. The cookie formulations were prepared carefully to ensure quality, with the aim of obtaining the safest product possible within the quality standards established by the legislation.

Both cookies had a good acceptance by children, because the results and the daily monitoring of the intervention showed that almost all of the children ate the whole package (30 g daily) during the intervention period (Table III). However, the results presented in table II infer that the cookie consumed by G2 with cowpea meal (CCFFeZn + WFFeFA) contributed to a lower supply of lipids and carbohydrates and increased the delivery of proteins and may contribute to the most appropriate control of weight gain. In addition, they had a greater amount of iron, with greater effectiveness in controlling anaemia and increased haemoglobin.

The nutritional intervention adopted yielded excellent results in decreasing the prevalence of anaemia in both G1 and G2. The prevalence rate decreased from 10.4% (n = 12) to 7.8% (n = 9) in G1 after the intervention and from 12.2% (n = 18) to 1.4% (n = 2) in G2. The use of wheat flour fortified with iron and folic acid, as required by the RDC No. 344 (27), helped to decrease the prevalence of iron-deficiency anaemia, as demonstrated in the study by Souza Filho et al. (31). In that study, the authors compared haemoglobin levels and the occurrence of anaemia in pregnant women before and after flour fortification and reported a prevalence rate of 27.2% in the unfortified group and 11.5% in the fortified group ($p < 0.001$). The study by Bagni et al. (32) used rice fortified with iron in anaemic pre-school children and indicated that the prevalence of anaemia decreased significantly ($p < 0.01$) from 37.8% to 23.3% in the intervention group and from 45.4% to 33.3% in the control group. Moreira-Araújo et al. (7) conducted a nutritional intervention with cookie formulations

containing chickpea, bovine lung, and corn and observed that the prevalence of anaemia decreased from 61.5% to 11.5%.

In this context, Moreira-Araújo et al. (12) used a cookie formulation prepared with cowpea using the cultivar BRS-Guaribas during a nutritional intervention among pre-school children, of which 36 (31%) were anaemic. After intervention, the formulation significantly decreased the prevalence of anaemia from 31% (n = 36) to 0.8% (n = 1), thereby confirming the importance of fortification for anaemia control and/or increasing haemoglobin levels.

Figure I shows that after the administration of CWFFeFA to G1 and CCFFeZn + WFFeFA to G2, haemoglobin levels increased significantly (p = 0.0754) from 12.4 to 14.7 in G2, while the increase in G1 was lower (from 12.6 to 12.7) and not significant (p = 0.587), indicating that the suggested intervention ensured a significant increase in haemoglobin levels among pre-school children.

By the adequacy of the diet offered at the CMEIs, it was found that the nutritional recommendation of 30% of the RDI proposed by the CMEIs, according to the National School Meals Program (PNAE) (19) for the age groups 1-3 years and 4-6 years –considering that these children remained part-time at the CMEIs– was met in both age groups with respect to the intake of calories, proteins, and vitamin C. The iron levels offered in the CMEIs did not achieve the 30% RDI and corresponded to 10.8% of the RDI for all age groups. The RDI for iron is 6 g/day for children aged 1-6 years (33). With the addition of CCFFeZn + WFFeFA in the diet, iron supply was adequate for all age groups.

Of note, the impact of the nutritional intervention was higher than the impact of drug therapy because the acceptance rate of cookies and the level of enrolment in the study were high. Moreover, supplementation with ferrous sulphate faces resistance among children and their parents because of adverse effects including vomiting, diarrhoea, stained teeth, constipation, and cramps, in addition to forgetting to take the ferrous sulphate supplement and rejection by the child (34).

CONCLUSION

The use of two types of fortified cookie formulations (one prepared with fortified cowpea flour and the other prepared with fortified wheat flour) decreased the prevalence of anaemia among preschool children, and the consumption of the food product prepared with enriched cowpea flour led to a more pronounced decrease in anaemia. Therefore, cowpea is a viable option for use in nutritional intervention because of its low cost and routine use by the population, and this ingredient resulted in a food product with adequate composition and acceptance by the population. In addition, its effectiveness as a dietary supplement in the control of iron-deficiency anaemia was demonstrated.

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REFERENCES

1. Reithinger R, Ngondi JM, Graves PM, Hwang J, Getachew A, Jima D; Group Ethiopia Malaria Indicator Survey Working. Risk factors for anemia in children under 6 years of age in Ethiopia: Analysis of the data from the cross-sectional Malaria Indicator Survey, 2007. Transactions of the Royal Society of Tropical Medicine and Hygiene 2013;107(12):769-76.
2. WHO/FAO. Guidelines on food fortification with micronutrients. World health Organization, Food and Agricultural Organization of the United Nations; 2006.
3. Marques MR, Silva LMO, Pessoa MLSB, Araújo MAM, Moreira-Araújo RSR. Risk and Prevalence of Anemia among Women Attending Public and Private Universities. Ecol Food Nutr 2015;54(5):520-8.
4. De Benoist B, McLean E, Egli I, Cogswell M (eds.). Worldwide Prevalence of Anaemia 1993-2005. Geneva: World Health Organization; 2008. WHO Global Database on Anaemia: http://www.who.int/vmnis/publications/anaemia_prevalence/en/index.html. [last accessed January 2016].
5. Heijblom GS, Santos, LMP. Anemia ferropriva em escolares da primeira série do ensino fundamental da rede pública de educação de uma região de Brasília, DF. [Iron-deficiency anaemia in first grade students of public primary schools in Brasília, Federal District.] Revista Brasileira de Epidemiologia 2007;10(2):258-66.
6. Batista Filho M, Souza AI, Bresani CC. Anemia como problema de saúde pública: uma realidade atual. [Anaemia as a public health problem: a current reality.] Ciência e Saúde coletiva, Rio de Janeiro 2008;13(6):1917-22.
7. Moreira-Araújo RSR, Araújo MAM, Arêas JA. Fortified food made by extrusion of a mixture of chickpea corn and bovine lung controls iron-deficiency anaemia in preschool children. Food Chemistry 2008;107:158-64.
8. Allen L, de Benoist B, Dary O, Hurrell R, editors. Guidelines on food fortification with micronutrients. Geneva: WHO; 2006.
9. Cakmak, I. Enrichment of cereal grains with zinc: Agronomic or genetic biofortification? Plant Soil 2008;302:1-17.
10. Rios SA, Alves KR, Costa NMB, Martino HD. Biofortificação: culturas enriquecidas com micronutrientes pelo melhoramento genético. [Biofortification: crops enriched with micronutrients through plant breeding.] Revista Ceres 2009.
11. Freire-filho FR, Ribeiro VQ, Rocha MM, Silva KJD, Nogueira MSR, Rodrigues EV. Produção, Melhoramento Genético e Potencialidades do Feijão-Caupi no Brasil. [Production, Breeding and Potential of cowpea in Brazil.] IV Reunião de Biofortificação [Biofortification Meeting]. Teresina, PI; 2011. p. 21.
12. Moreira-Araújo RSR, Martins LS, Meneses NA, Frota KM, Morgano MA, Araújo MAM. Utilização de biscoito à base de farinha de feijão-caupi em pré-escolares com anaemia ferropriva. [Use of cookies prepared with cowpea flour in pre-school children with iron-deficiency anaemia.] Anais do II CONAC: Congresso Nacional de Feijão-caupi; 2009.
13. Hainlaine A. Standard methods of clinical chemistry**.** New York: Academic Press; 1958. p. 2-52.
14. Moreira-Araújo RSR. Utilização do Snack com elevado conteúdo de ferro em pré-escolares para controle da anaemia ferropriva. [Use of snacks with high iron content in pre-school children for the control of iron-deficiency anaemia.] São Paulo:SP, FCF, 2000. Originally presented as a part of a PhD thesis, Universidade de São Paulo (University of São Paulo); 2000.
15. Organização Mundial de Saúde. Lucha contra la anaemia nutricional, especialmente contra la carencia de hierro: Informes ADI/OIEA/OMS. [World Health Organization. Fight against nutritional anaemia, especially iron deficiency anaemia: ADI/IAEA/WHO reports.] Série de informes Técnicos, 580. Genebra: OMS; 2001.
16. Frota KMG, Morgano MA, Silva MG, Araújo MAM, Moreira-Araújo RSR. Utilização da farinha de feijão-caupi (*Vigna unguiculata* (L.) Walp) na elaboração de produtos de panificação. [Use of cowpea (*Vigna unguiculata* (L.) Walp) flour in the preparation of bakery products.] Ciência e Tecnologia de Alimentos. Campinas 2010;30:44-50.
17. Association of Official Analytical Chemistry (AOAC). Official Methods of Analysis of the AOAC International. 18th ed. Gaithersburg, MD, USA: AOAC; 2011. p. 1025.

18. Horwitz W, Latimer JRG (eds.). Official Methods of Analysis of the Association of Official Analytical Chemists. 17th ed. Gaithersburg, Maryland: AOAC; 2000, v. 2, chap. 50 (met. 985.35; 984.27, p. 15-18).
19. Brasil, Conselho Deliberativo. Resolução /CD/FNDE nº 26 de 17 de junho de 2013. Dispõe sobre o atendimento escolar aos alunos da atenção básica no âmbito do programa nacional de alimentação escolar-PNAE. Available at </www.fnde.gov.br/legislacão/resoluções/>. [Deliberative Council. Resolution/CD/ENDF No. 26 of 17 June 2013 provides on school attendance for students assisted by primary health care services under the national school meals program - PNAE. Available at </www.fnde.gov.br/legislacão/resoluções/>.] Accessed on:12/09/2013.
20. Osório MM. Fatores determinantes da anaemia em crianças. [Determinants of anaemia in children.] *Jo*rnal de Pediatria 2002;78(4):269-78.
21. Spinelli MGN, Marchioni DML, Souza JMP, Souza SB, Szarfarc SC.Fatores de risco para anaemia em crianças de 6 a 12 meses no Brasil. [Risk factors for anaemia in children aged 6 to 12 months in Brazil.] Revista Panamericana Salude Publica/Panamerican American Journal Públic Health 2005;17(2): 84-91.
22. Goes VF, et al. Avaliação do estado nutricional e do consumo alimentar de pré-escolares atendidos nos centros municipais de educação infantil de Guarapuara- PR. [Assessment of the nutritional status and dietary intake of pre-school children attending childhood municipal education centres in Guarapuara, state of Paraná.] Alimentos e Nutrição. Araraquara 2012;13(1): 121-29.
23. Gondim SSR, et al. Magnitude, tendência temporal e fatores associados à anaemia em crianças do Estado da Paraíba. [Magnitude, temporal trends, and factors associated with anaemia in children in the state of Paraíba.] Revista Saúde Pública 2012;46(4):649-56.
24. Souza OF, Macedo L F, Oliveira, CSM, Araújo TS, Muniz PT. Prevalence and Associated Factors to Anaemia in Children. Journal of Human Growth and Development 2012;22(3):307-13.
25. Rocha DS, Capanema FD, Netto MP, Franceschini SCC, Lamounier JA. Prevalência e fatores determinantes da anaemia em crianças assistidas em creches de Belo Horizonte–MG. [Prevalence and determinants of anaemia in children attending day-care centres in Belo Horizonte, state of Minas Gerais.] Revista Brasileira de Epidemiologia 2012;15(3): 675-84.
26. Eussen S, Alles M, Uijterschout L, Brus F, Van der Horst-Graat J. Iron intake and status of children aged 6-36 months in Europe: A systematic review. Ann Nutr Metab 2015;66:80-92.
27. Brasil. Agência Nacional de Vigilância Sanitária. Resolução RDC nº 344, de 13 de dezembro de 2002. [National Health Surveillance Agency. RDC Resolution No. 344 of December 13, 2002.] Diário Oficial da União. Brasília, 2002. Available at <portal.anvisa.gov.br > Accessed on: 06/08/2013.
28. Organização Mundial de Saude (OMS) [World Health Organization (WHO)]. Learning from large-scale community-based programmes to improve breastfeeding practices. Geneva. World Health Organization, United Nations Children's Fund/ UNICEF, Academy for Educational development/EAD, 2008. Available at <http:// www.who.int/nutrition/publications/infantfeeding/> Accessed on: 07/01/2013.
29. Brasil. Ministério da Saúde. Manual operacional do Programa Nacional de Suplementação de Ferro. [Ministry of Health. Operating Manual of the National Iron Supplementation Program.] Brasília: Ministério da Saúde, 2005. Available at < bvsms.saude.gov.br> Accessed on: 05/04/2012.
30. Heijblom GS, Santos LMP. Anemia ferropriva em escolares da primeira série do ensino fundamental da rede pública de educação de uma região de Brasília, DF. [Iron-deficiency anaemia in first grade students of public primary schools in Brasilia, Federal District] Revista Brasileira de Epidemiologia 2007;10(2):258-66.
31. Sousa-Fillho MD, Damasceno CVX, Szarfarc SC, Fujimori E, Araújo MAM, Moreira-Araújo RSR. Fortificação das farinhas com ferro e controle da anaemia em gestantes de Teresina, Piauí, Brasil. [Fortification of flour with iron and anaemia control in pregnant women in Teresina, state of Piauí, Brazil.] Revista de Nutrição. Campinas 2011;24(5):679-88.
32. Bagni UV, Baião MR, Santos MMAS, Luíz RR, Veiga GV. Efeito da fortificação semanal do arroz com ferro quelato sobre a frequência de anaemia e concentração de hemoglobina em crianças de creches municipais do Rio de Janeiro, Brasil. [Effect of weekly fortification of rice with iron chelate on the prevalence of anaemia and haemoglobin concentration in children attending day care centres in Rio de Janeiro, Brazil.] Cadernos de saúde Pública, Rio de Janeiro 2009;25(2):291-302.
33. Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução RDC nº 269, de 22 de Setembro de 2005. Regulamento Técnico sobre a Ingestão Diária Recomendada (IDR) de proteína, vitaminas e minerais. [Ministry of Health. Technical Regulations on Recommended Daily Intake (RDI) of protein, vitamins, and minerals.] Diário Oficial da República Federativa do Brasil, Poder Executivo, Brasília, August 22, 2005. Available at < http://portal.anvisa.gov.br> Accessed on: 09/22/2013.
34. Azeredo CM, Cotta RMM, Silva LS, Franceschini SCC, Sant'ana LFR, Lamounier JA. A problemática da adesão na prevenção da anaemia ferropriva e suplementação com sais de ferro no município de Viçosa (MG). [The problem of adherence for the prevention of iron-deficiency anaemia and supplementation with iron salts in Viçosa, state of Minas Gerais.] Ciência & Saúde Coletiva 2013;18(3):827-36.

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ARÁN

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Trabajo Original

Epidemiología y dietética

Prevalence of overweight, obesity, abdominal-obesity and short stature of adult population of Rosario, Argentina

Prevalencia de sobrepeso, obesidad, obesidad abdominal y baja estatura de la población adulta de Rosario, Argentina

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Abstract

Introduction: The aim of this work was to assess the prevalence of overweight, obesity, abdominal-obesity and short stature among Rosario (Argentina) adult population.

Materials and methods: A cross-sectional nutritional survey was carried out in Rosario (2012-2013). A random sample (n = 1194) of adult population (18-70 years old) was interviewed. Anthropometric measurements and a general questionnaire incorporating questions related to socio-demographic and lifestyle characteristics, education level and physical activity were used.

Results: The current study detected a high prevalence of overweight and obesity among adult population in Rosario. The prevalence of overweight was 32.7% (43.9% in men and 27.6% in women, $p < 0.001$), of obesity was 23.5% (21.6% in men and 24.3% in women), and of abdominal obesity was 57.5% (63.5% in men *vs.* 54.8% in women, $p < 0.005$). Multivariate analysis showed that the prevalence of overweight/obesity and abdominal obesity increased according the age and abdominal obesity decreased with high physical activity in men. In women prevalence of overweight/obesity, and abdominal obesity increased with age, marital status (married or coupled), presence of at least one child at home and low educational level.

Conclusion: The prevalence of short stature was higher in women (16.4% *vs.* 8.4%, $p < 0.001$) and was related with age, overweight and abdominal obesity.

Key words:

Overweight. Obesity. Short stature. Adult. Rosario.

Resumen

Introducción: el objetivo de este trabajo fue evaluar la prevalencia de sobrepeso, obesidad, obesidad abdominal y baja estatura entre la población adulta de Rosario (Argentina).

Material y métodos: se llevó a cabo un estudio nutricional transversal en Rosario (2012-2013), entrevistando una muestra aleatoria (n = 1.194) de la población adulta (18-70 años). Se realizaron mediciones antropométricas y un cuestionario general de características sociodemográficas, estilo de vida, nivel de educación y actividad física.

Resultados: este estudio encontró una alta prevalencia de sobrepeso y obesidad entre la población adulta en Rosario. La prevalencia de sobrepeso fue del 32,7% (43,9% en hombres y 27,6% en las mujeres, $p < 0,001$), de obesidad fue 23,5% (21,6% en hombres y 24,3% en las mujeres) y de obesidad abdominal fue de 57,5% (63,5% en los hombres y 54,8% en las mujeres, $p < 0,005$). El análisis multivariado mostró que la prevalencia de sobrepeso/obesidad y obesidad abdominal aumentó según la edad y la obesidad abdominal se redujo en hombres con elevada práctica de actividad física. En las mujeres, la prevalencia de sobrepeso/obesidad y obesidad abdominal aumentó con la edad, el estado civil (casado o en pareja), la presencia de al menos un niño en casa y bajo nivel educativo.

Conclusión: la prevalencia de talla baja fue mayor en las mujeres (16,4% *vs.* 8,4%, $p < 0,001$) y estaba relacionada con la edad, el sobrepeso y la obesidad abdominal.

Palabras clave:

Sobrepeso. Obesidad. Baja estatura. Adulto. Rosario.

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INTRODUCTION

During the last century, industrialization, urbanization, economic development and the globalization have led to changes in the diet and lifestyle of people, with deep consequences on the health and nutritional status of the population. The economic transition that followed the industrialization came associated with demographic, epidemiological and nutritional transitions that have impacted producing important nutritional changes in urban and rural households, due to a multiplicity of factors that have influenced the lifestyle and food consumption patterns (1,2).

The World Health Organization (WHO) recognizes high blood pressure, tobacco use, high blood glucose, physical inactivity, and overweight and obesity as the leading global risk for mortality in the world. Overweight and obesity are responsible for 5% of deaths globally. A high body mass index (BMI) is a risk factor which account for cardiovascular and ischemic heart disease, the leading cause of death worldwide (3). WHO has defined obesity as the epidemic of the 21st century, which has high impact on morbidity and mortality, health and quality of life. The worldwide prevalence of obesity has almost doubled between 1980 and 2008 (4). Latin America has changed from a condition of high prevalence of low weight and deficit of growth towards a scenario marked by an increase in obesity and chronic diseases such as cardiovascular diseases, diabetes and cancer (5-8). Levels of overweight and obesity across low- and middle-income countries have approached levels found in higher-income countries (9).

The aim of this work was to assess the prevalence of overweight, obesity, abdominal-obesity and short stature among Rosario (Argentina) adult population.

MATERIALS AND METHODS

STUDY DESIGN

The present study is a population based cross-sectional nutritional survey carried out in the Rosario city (Argentina) between October 2012 and June 2013.

SAMPLE

The target population consisted of all inhabitants living in Rosario aged 18-70 years. The theoretical sample size was calculated take into account the prevalence of overweight and obesity (53.0%), inadequate energy intake (57.0%), low physical activity (51%) of Argentinian National Nutritional Survey (10) and the prevalence of overweight and obesity (53.4%), smoking habit (27.1%) and daily consumption of fruits (35.7%) and vegetables (37.6%) of Argentinian National Risk Factors Survey (11) and then was adjusted according to the Rosario census (12). The sample was set at a minimum of 365 men and 374 women in order to provide a specific relative precision of 5% (type I error = 0.05; type error II = 0.10) and 95% of confidence. The sampling technique included stratification according to age and sex of inhabitants, and random selection within subgroups in each Rosario Municipal District Centers (MCD) located in the six areas of the city (center, north, south, east, southwest, northwest) being the primary sampling units, and individuals within these district comprising the final sample units. Participants were recruited by opportunistic sampling at all Municipal District Centers (MCD) of Rosario. The final sample size was 1194 individuals, 373 men and 827 women. Pregnant and lactating women were excluded.

ETHICS

The project was approved by the Committee of Ethics in Research of the Public Health Secretary of Rosario Municipality (Resolution no. 1816/2010) on September 5, 2012, and authorized by the Sub Secretariat General of the Rosario Municipality.

All the aspects involved in the development of this project be undertaken by adhering to national and international regulations and the criteria referred to in the principles contained in the Declaration of Helsinki and of the law on secret statistical no. 17622 which guarantees the anonymity of the participants and the confidentiality of the information during the processing of the data. Each participant signed an informed consent prior to the survey.

ANTHROPOMETRIC MEASUREMENTS

Body weight was determined using a digital scale (OMROM® HBF - 500INT, Kyoto, Japan) to the nearest 100 g. The subjects were weighed in bare feet and minimum clothes wear, which was accounted for by subtracting the weight of the clothing that had not been removed, taking standard reference values. Height was determined using a portable anthropometer (CAM®, Buenos Aires, Argentina) to the nearest millimeter, with the subject standing, back to stadiometer, in bare feet, with the subject's head in the Frankfurt plane (the line from the auditory meatus to the lower border of the eye orbit). Waist circumference was determined using an inextensible and flexible measuring tape (Sanny medical®, SN- 40, Jaipur, India) to the nearest millimeter, and was measured with the subject of foot, on the horizontal plane equidistant between the bottom edge of the last rib and iliac crest, after an inspiration and deep exhalation, both were measured without clothes. Anthropometric measurements were performed by well-trained students of the last year of nutrition carrier in order to avoid the inter-observer coefficients of variation. According to the WHO classification the prevalence of overweight (BMI 25 to 29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) was calculated. Waist-to-height ratio (WHtR) was also calculated, and a cut-off of 0.5 was used to define abdominal obesity for men and women (13). Short stature in adulthood was defined as height < 153 cm among females and < 164 cm among males, according to the percentile 10 of national references (14).

GENERAL QUESTIONNAIRE

A questionnaire incorporating the following questions was used: age, marital status (single; married/coupled; unmarried/divorced/widowed), living with at least one children (yes; no), education level (grouped according to complete years of formal education: low, ≤ 7 years; medium, 8-11 years; high ≥ 12 years), professional profile (grouped into student; unemployed; employed), smoking habits (yes; no), alcohol intake (yes; no) were utilized.

Physical activity level was evaluated according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) (15) in the short form (SF) to Argentina. The IPAQ-SF assesses four domains of physical activity over the previous week, including vigorous activity *(i.e.* activities that make breathing much harder than normal), moderate activity *(i.e.* activities that make breathing somewhat harder than normal), walking and time spent sitting. Data from the IPAQ-SF were scored as per the IPAQ-SF scoring protocol and classifieds into three categories (low; moderate; high) (16) according to the total time and METs (Estimated Metabolic Equivalents) by week.

STATISTICAL METHODS

Analyses were performed using SPSS version 21.0 (SPSS Inc., Chicago, IL, USA) and STATA version 12.1 (StataCorp, College Station, Texas, USA). Differences between group means were tested by an unpaired Students' t-test. Logistic regression models with the calculations of corresponding odds ratio (OR) and 95% confidence interval (CI) were used to examine the possible association between socio-demographic and lifestyle characteristics (independent variables) and overweight/obesity, abdominal-obesity and short stature (dependent variables). Multivariate analysis with adjustment for age was first carried out for all the socio-demographic and lifestyle variables that could be associated with the frequency of overweight/obesity, abdominal obesity and short stature. Multivariate analyses with adjustment for all variables were also used to examine the effect of the sociodemographic and lifestyle variables on the prevalence of overweight/obesity, abdominal obesity and short stature. Level of significance for acceptance was $p < 0.05$.

RESULTS

Table I shows the characteristics of participants. Married or coupled was the most representative marital status in both sexes. More than half of participants lived with children. There were more men employed and more students among women. Smoking habit didn't show differences between sexes while alcohol consumption was higher in men. Women were less active than men.

The overall prevalence of overweight and obesity estimated for the adult population of Rosario was 32.7% (CI 95% 30.1-35.4) and 23.5% (CI 95% 21.1-25.9%) respectively (Table II). Overweight was higher in men than women (43.9 *vs.* 27.6%, $p < 0.001$) while obesity was similar in both (21.6% *vs.* 24.3%). The prevalence of abdominal obesity (WtHR > 0.5) was 57.5%, higher in men than women (63.5% *vs.* 54.8%, $p < 0.005$).

Weight, height and waist circumference showed significant differences between men and women of all age groups; weight and waist circumference increased with age, while height decreased. The mean BMI was lower than 25 kg/m^2 only in 18-30 y.o. subjects, with no differences between sexes. The prevalence of overweight was higher in men at all studied ages, while the prevalence of obesity didn't show differences between sexes. Abdominal obesity increased according to age and was higher among men (Table II).

Overweight/obesity and abdominal obesity in men showed positive relation only with age (Table III). The risk of overweight/obesity tripled between age groups; the risk of abdominal obesity was 2.85 times higher at age 31-50 years and 9.08 times at age 51-70 years in comparison to the youngest group (18-30 years). Both showed significant differences after adjustment by all explanatory variables. Abdominal obesity had negative association with physical activity level. There were not significant differences in the prevalence of overweight/obesity and abdominal obesity according to the socio-demographic and lifestyle characteristics (Table III).

In women overweight/obesity and abdominal obesity were related with age, marital status, presence of children at home and educational level. The age was the variable that showed a greater relationship with overweight/obesity and abdominal obesity. From a group to the following one, the prevalence increased 2-3 fold, being significant after adjusting for all covariates; the same scenario was observed among men. Married or coupled women showed higher risk. Although the risk of abdominal obesity remained after adjustment for all covariates, the risk of overweight/obesity disappeared after adjustment by all explanatory variables. The risk of overweight/obesity and abdominal obesity, after adjustment by age, was double in women with at least one child at home. The prevalence of overweight/obesity and abdominal obesity decreased according to the increase of educational level. The risk of overweight/obesity, adjusted by all covariates, was lower 65% in women with medium level and 81% among those with high education level, whereas the risk of abdominal obesity was lower four times in women with medium education level and nine times in women with high level; this association was different after adjustment for all the explanatory variables. Abdominal obesity was higher in non-smokers women and in those that not consume alcohol. Women with medium physical activity level showed the highest risk of abdominal obesity, being significant after adjustment by all explanatory variables (Table IV).

The prevalence of short stature was 16.4% in women and 8.4% in men ($p < 0.001$). Men with less education ($p = 0.031$) and unemployed ($p = 0.016$) showed higher prevalence of height below p10, while in women the prevalence of short stature increased according to age ($p = 0.001$), decreased according to the educational level ($p = 0.005$), was lower in single women ($p = 0.009$), higher in women who did not consume alcohol ($p = 0.007$) and decreased according to the increase of physical

Table I. Socio-demographic characteristics of study participants

	Total (n = 1,194)	Men (n = 371)	Women (n = 823)	p*
%		31.1	68.9	
Age (years)†	39.5 ± 15.0	39.7 ± 14.7	39.4 ± 15.1	0.710
18 - 30	39.3	37.7	40.0	
31 - 50	34.3	35.8	33.7	
51 - 70	26.4	26.4	26.4	
Educational level (%)‡				0.140
Low	24.8	21.6	26.2	
Medium	60.8	62.0	60.3	
High	14.4	16.4	13.5	
Marital status (%)‡				0.024
Single	37.6	41.0	36.1	
Married or coupled	52.7	52.6	52.7	
Separated, divorced, widowed	9.7	6.5	11.2	
Living with children (%)‡				< 0.001
None	43.2	33.4	47.6	
At least one child at home	56.8	66.6	52.4	
Professional profile (%)‡				< 0.001
Student	10.1	7.0	11.6	
Unemployed	22.0	12.7	26.3	
Employed	67.8	80.3	62.2	
Smoking habits (%)‡				0.251
No	78.0	76.0	78.9	
Yes	22.0	24.0	21.1	
Alcohol consumption (%)‡				< 0.001
No	32.3	20.2	37.8	
Yes	67.7	79.8	62.2	
PA level (%)‡				< 0.001
Low	51.9	46.4	54.4	
Medium	31.9	30.5	32.6	
High	16.2	23.2	13.0	

*Data were expressed as †mean ± standard deviation, and ‡%; *Gender differences were tested by means of* χ^2.

activity practice (p = 0.027). Women with overweight and abdominal obesity showed higher prevalence of short stature. The risk of short stature in women, adjusted by age, was higher according to the age, to the lower education level, to the alcohol consumption, and to overweight and abdominal obesity. After adjustment for all explanatory variables, age, abdominal obesity and medium physical activity level showed association with short stature (Table V).

DISCUSSION

The present results reveal the magnitude of overweight/obesity and abdominal obesity among adult population of Rosario, Argentina. Levels of overweight and obesity across low- and middle-income countries showed similar levels to those found in higher-income countries, particularly in the Middle East, North Africa, Latin America and the Caribbean[9]. The observed prevalence of overweight and obesity (32.7% and 23.5% respectively) is closely related with the observed at the Argentinian national level in successive years that was conducted by the National Survey of Risk Factors for No Communicable Diseases (NSRF) (11,17,18). The prevalence of overweight and obesity in 2005 was 34.4% and 14.6% (11); in 2009 35.4% and 18.0% (17); in 2013 37.1% and 20.8% (18), respectively. The higher prevalence of overweight observed in men (43.9 *vs.* 27.6%, p < 0.0001) also matches to the NSRF at Argentinian national level (43.2% in men and

Table II. Anthropometric characteristics, overweight, obesity and abdominal-obesity prevalence among adult population[1,2]

	Men		Women		
	n	mean ± SD, %	n	mean ± SD, %	p[2]
Weight (kg)†	371	81.6 ± 14.7	823	67.9 ± 15.5	< 0.001
18-30 years-old	140	75.1 ± 12.6	329	62.3 ± 13.1	< 0.001
31-50 years-old	133	85.0 ± 14.5	277	70.9 ± 16.5	< 0.001
51-70 years-old	98	86.5 ± 14.7	217	72.6 ± 14.9	< 0.001
Height (cm)†	371	173.6 ± 7.1	823	160.0 ± 6.5	< 0.001
18-30 years-old	140	174.3 ± 7.2	329	161.5 ± 6.0	< 0.001
31-50 years-old	133	174.3 ± 6.9	277	159.8 ± 6.7	< 0.001
51-70 years-old	98	171.7 ± 6.9	217	158.2 ± 6.4	< 0.001
BMI (kg/m^2)†	371	27.1 ± 4.6	823	26.6 ± 6.3	0.136
18-30 years-old	140	24.6 ± 3.5	329	23.9 ± 5.0	0.073
31-50 years-old	133	28.0 ± 4.6	277	27.8 ± 6.7	0.788
51-70 years-old	98	29.3 ± 4.6	217	29.1 ± 6.0	0.687
Prevalence of overweight (%)‡	371	43.9	823	27.6	< 0.001
18-30 years-old	140	35.7	329	19.5	< 0.001
31-50 years-old	133	48.9	277	30.3	< 0.001
51-70 years-old	98	49.0	217	36.4	0.035
Prevalence of obesity (%)‡	371	21.6	823	24.3	0.301
18-30 years-old	140	7.1	329	10.9	0.206
31-50 years-old	133	25.6	277	30.0	0.356
51-70 years-old	98	36.7	217	37.3	0.920
Waist circumference (cm)†	370	93.3 ± 13.7	818	84.5 ± 15.6	< 0.001
18-30 years-old	140	84.7 ± 9.8	329	76.9 ± 12.8	< 0.001
31-50 years-old	133	95.2 ± 11.7	274	87.1 ± 15.7	< 0.001
51-70 years-old	97	103.1 ± 13.5	215	92.8 ± 13.9	< 0.001
WHtR†	370	0.54 ± 0.08	818	0.53 ± 0.10	0.112
18-30 years-old	140	0.49 ± 0.05	329	0.48 ± 0.08	0.165
31-50 years-old	133	0.55 ± 0.07	274	0.55 ± 0.10	0.945
51-70 years-old	97	0.60 ± 0.08	215	0.59 ± 0.09	0.209
Prevalence of abdominal-obesity (%)‡	370	63.5	818	54.8	0.005
18-30 years-old	140	37.1	329	30.1	0.135
31-50 years-old	133	71.4	274	62.8	0.085
51-70 years-old	97	90.7	215	82.3	0.055

BMI: body mass index; WHtR: waist-to-height ratio. [1]Data were expressed as †mean ± standard deviation, and ‡%. [2]Gender differences were tested by an †unpaired Students' t-test, and by ‡χ^2.

28.4% in women) and in Santa Fe province (45.8% in men and 27.0% in women) (17). Obesity prevalence was no different between sexes, being slightly higher in women (21.6% in men and 24.3% in women), although the NRFS showed a higher prevalence in men at Argentinian national level (19.1% *vs.* 17.1%) and in Santa Fe province (20.5% *vs.* 19.7%) (17).

The association between sociodemographic and lifestyle factors and overweight/obesity and abdominal obesity in Rosario adult population showed that age is one of the strength factors associated with the prevalence, whereas in women the educational level was strongly associated with overweight/obesity and abdominal obesity. NSRF showed that the prevalence of overweight and

Table III. Socio-demographic and lifestyle characteristics among men classified as overweight/obesity (BMI ≥ 25 kg/m²) and abdominal-obese (WHtR ≥ 0.5)[1,2]

	Overweight/obesity				Abdominal-obesity			
	BMI < 25 kg/m²	BMI ≥ 25 kg/m²	Age-adjusted OR[1] (95% CI)	Additionally-adjusted OR[2] (95% CI)	WHtR < 0.5	WHtR ≥ 0.5	Age-adjusted OR[1] (95% CI)	Additionally-adjusted OR[2] (95% CI)
Age group								
18-30 years-old	57.1	42.9	1.00 (ref.)	1.00 (ref.)	62.9	37.1	1.00 (ref.)	1.00 (ref.)
31-50 years-old	25.6	74.4	3.88 (2.32-6.49)***	2.97 (1.57-5.63)**	28.6	71.4	4.23 (2.54-7.04)***	2.85 (1.50-5.41)**
51-70 years-old	14.3	85.7	8.00 (4.15-15.44)***	6.72 (2.92-15.44)***	9.3	90.7	16.55 (7.69-35.62)***	9.08 (3.69-22.33)***
Marital status								
Single	50.0	50.0	1.00 (ref.)	1.00 (ref.)	57.2	42.8	1.00 (ref.)	1.00 (ref.)
Married/coupled	24.1	75.9	1.26 (0.71-2.23)	1.02 (0.51-2.04)	22.7	77.3	1.32 (0.73-2.38)	1.41 (0.69-2.88)
Unmarried/ divorced/ widowed	20.8	79.2	1.06 (0.33-3.40)	1.07 (0.33-3.49)	16.7	83.3	1.12 (0.31-4.07)	1.76 (0.49-6.27)
Living with children								
None	41.7	58.3	1.00 (ref.)	1.00 (ref.)	44.5	55.5	1.00 (ref.)	1.00 (ref.)
At least one child at home	20.2	79.8	1.56 (0.88-2.75)	1.38 (0.69-2.74)	20.3	79.7	1.25 (0.68-2.30)	1.36 (0.66-2.82)
Educational level								
Low	23.8	76.3	1.00 (ref.)	1.00 (ref.)	25.0	75.0	1.00 (ref.)	1.00 (ref.)
Medium	38.7	61.3	0.64 (0.34-1.20)	0.63 (0.34-1.20)	41.5	58.5	0.63 (0.32-1.23)	0.62 (0.32-1.20)
High	32.8	67.2	0.57 (0.25-1.26)	0.49 (0.21-1.12)	32.8	67.2	0.53 (0.23-1.25)	0.60 (0.25-1.43)
Professional profile								
Student	61.5	38.5	1.00 (ref.)	1.00 (ref.)	65.4	34.6	1.00 (ref.)	1.00 (ref.)
Unemployed	36.2	63.8	1.00 (0.19-1.88)	0.78 (0.25-2.40)	28.3	71.7	0.79 (0.23-2.67)	1.10 (0.33-3.66)
Employed	31.9	68.1	1.32 (0.55-3.16)	1.47 (0.59-3.62)	35.2	64.8	0.90 (0.36-2.24)	0.60 (0.25-1.43)
Smoking habit								
No	32.1	67.9	1.00 (ref.)	1.00 (ref.)	36.0	64.0	1.00 (ref.)	1.00 (ref.)
Yes	40.6	59.4	0.84 (0.51-1.38)	0.77 (0.45-1.30)	37.7	62.3	1.29 (0.76-2.21)	1.19 (0.68-2.06)
Alcohol consumption								
No	33.3	66.7	1.00 (ref.)	1.00 (ref.)	34.7	65.3	1.00 (ref.)	1.00 (ref.)
Yes	34.8	65.2	0.97 (0.55-1.74)	1.04 (0.57-1.90)	36.9	63.1	0.96 (0.52-1.77)	1.06 (0.56-2.00)
PA level								
Low	29.7	70.3	1.00 (ref.)	1.00 (ref.)	28.7	71.3	1.00 (ref.)	1.00 (ref.)
Medium	34.5	65.5	0.86 (0.50-1.50)	0.86 (0.49-1.51)	30.1	69.9	1.09 (0.60-1.98)	1.08 (0.60-1.96)
High	44.2	55.8	0.85 (0.48-1.53)	0.76 (0.42-1.38)	60.5	39.5	0.42 (0.22-0.77)**	0.37 (0.20-0.68)**

BMI: body mass index; WHtR: waist-to-height ratio; OR: odds ratio; CI: confidence interval; PA: physical activity.
*[1]Univariate analysis (logistic regression analysis considering the effect of one explanatory variable).*p < 0.05, **p < 0.01, ***P < 0.001.*
*[2]Multivariate analyses (multiple logistic regressions considering the simultaneous effect of all the explanatory variables).*p < 0.05, **p < 0.01, ***p < 0.001.*

obesity at Argentinian national level was rising according the age (17.9% and 3.9% at 18 to 24y to 41.7% and 22.8% at 60 to 64y, overweight and obesity respectively) (11).

In Argentina, previous studies have seen that among women, higher education was associated with better risk factor profiles for non-communicable diseases in all areas and more strongly in more urban than in less urban areas (19). Rosario is an urban city, according with the last census in Rosario live 1193605 inhabitants, and 739025 are 20 to 69 year old adults (12), becoming the third city with most population in Argentina. The NSRF (17) showed that obesity were the most prevalent in women with low educational level. Between 2005 and 2009, the prevalence of obesity in women with low education increased 7.5 points (23.6% in 2005 to 31.1% in 2009) while in high education just increased 1.7 points (10.1% to 11.8%). However, in men the increase of obesity was around 4 points in all educational levels (20). In Latin America women with higher levels of education showed the lowest levels of obesity (21-24). Maternal overweight and obesity are associated with maternal morbidity, preterm birth, and increased infant mortality (25). Prevalence of overweight (BMI ≥ 25 kg/m²) and obesity (BMI ≥ 30 kg/m²)

Table IV. Socio-demographic and lifestyle characteristics among women classified as overweight/obesity (BMI ≥ 25 kg/m²) and abdominal-obese (WHtR ≥ 0.5)[1,2]

	Overweight/obesity				Abdominal-obesity			
	BMI < 25 kg/m²	BMI ≥ 25 kg/m²	Age-adjusted OR[1] (95% CI)	Additionally-adjusted OR[2] (95% CI)	WHtR < 0.5	WHtR ≥ 0.5	Age-adjusted OR[1] (95% CI)	Additionally-adjusted OR[2] (95% CI)
Age group								
18-30 years-old	69.6	30.4	1.00 (ref.)	1.00 (ref.)	69.9	30.1	1.00 (ref.)	1.00 (ref.)
31-50 years-old	39.7	60.3	3.48 (2.48-4.87)***	2.29 (1.49-3.52)***	37.2	62.8	3.92 (2.79-5.50)***	2.40 (1.53-3.76)***
51-70 years-old	26.3	73.7	6.43 (4.38-9.43)***	4.34 (2.67-7.06)***	17.7	82.3	10.82 (7.09-16.51)***	7.00 (4.10-11.97)***
Marital status								
Single	67.0	33.0	1.00 (ref.)	1.00 (ref.)	68.6	31.4	1.00 (ref.)	1.00 (ref.)
Married/coupled	38.5	61.5	1.75 (1.23-2.50)**	1.49 (0.99-2.24)	33.0	67.0	2.14 (1.49-3.09)***	2.02 (1.32-3.09)**
Unmarried/divorced/ widowed	32.6	67.4	1.25 (0.68-2.27)	1.32 (0.71-2.45)	27.2	72.8	1.30 (0.69-2.46)	1.49 (0.77-2.89)
Living with children								
None	60.8	39.2	1.00 (ref.)	1.00 (ref.)	59.3	40.7	1.00 (ref.)	1.00 (ref.)
At least one child at home	34.2	65.8	1.98 (1.45-2.71)***	1.32 (0.90-1.92)	29.6	70.4	2.08 (1.50-2.88)***	1.21 (0.81-1.82)
Educational level								
Low	25.0	75.0	1.00 (ref.)	1.00 (ref.)	18.7	81.3	1.00 (ref.)	1.00 (ref.)
Medium	54.4	45.6	0.31 (0.21-0.45)***	0.35 (0.24-0.53)***	52.1	47.9	0.22 (0.14-0.33)***	0.26 (0.17-0.42)***
High	64.9	35.1	0.17 (0.10-0.29)***	0.19 (0.11-0.33)***	65.8	34.2	0.10 (0.05-0.17)***	0.11 (0.06-0.20)***
Professional profile								
Student	69.5	30.5	1.00 (ref.)	1.00 (ref.)	70.5	29.5	1.00 (ref.)	1.00 (ref.)
Unemployed	33.8	66.2	1.53 (0.85-2.73)	1.12 (0.60-2.07)	26.2	73.8	1.94 (1.07-3.53)*	1.34 (0.70-2.58)
Employed	50.3	49.7	1.06 (0.64-1.76)	1.17 (0.68-2.04)	48.6	51.4	0.98 (0.58-1.65)	1.32 (0.74-2.36)
Smoking habit								
No	47.0	53.0	1.00 (ref.)	1.00 (ref.)	43.3	56.7	1.00 (ref.)	1.00 (ref.)
Yes	51.4	48.6	0.93 (0.67-1.31)	0.79 (0.55-1.12)	51.0	49.0	0.80 (0.57-1.14)	0.63 (0.43-0.92)*
Alcohol consumption								
No	33.3	66.7	1.00 (ref.)	1.00 (ref.)	37.5	62.5	1.00 (ref.)	1.00 (ref.)
Yes	34.8	65.2	0.74 (0.54-1.00)	0.94 (0.68-1.30)	49.9	50.1	0.64 (0.46-0.88)**	0.92 (0.65-1.30)
PA level								
Low	48.2	51.8	1.00 (ref.)	1.00 (ref.)	46.5	53.5	1.00 (ref.)	1.00 (ref.)
Medium	46.3	53.7	1.07 (0.77-1.49)	1.07 (0.76-1.50)	38.3	61.7	1.48 (1.05-2.09)*	1.51 (1.05-2.18)*
High	52.3	47.7	1.06 (0.68-1.66)	1.28 (0.79-2.06)	57.0	43.0	0.82 (0.52-1.31)	1.01 (0.61-1.67)

BMI: body mass index; WHtR: waist-to-height ratio; OR: odds ratio; CI: confidence interval; PA: physical activity.

*[1]Univariate analysis (logistic regression analysis considering the effect of one explanatory variable). *p < 0.05, **p < 0.01, ***p < 0.001.*

has been rising in all regions, together reaching more than 70% in the Americas and the Caribbean and more than 40% in Africa by 2008 (26,27), but Americas showed the highest proportion of overweight and obese women (25).

It is well recognized that WHtR is a good predictor for morbidity and mortality (28). Even though BMI is commonly used as a measure of overall adiposity and classify risk level to various chronic illnesses (29,32), growing evidence suggests that a central (abdominal) fat distribution pattern, evidenced by a higher waist circumference or WHtR, might be a better measure of risk (33-41). Growing and strong evidence supports the use of the WHtR as a more sensitive measurement than BMI as an early warning of health risks (42-44) and it could be more closely associated with central obesity than BMI (45) and even better than waist circumference by the adjustment to different statures (46,47). The risk level in the current study was rated to WHtR ≥ 0.50, according this cut off point the prevalence of abdominal obesity was 57.5%. The risk level across gender was also increased, with WHtR of 63.5% and 54.8% among men and women, respectively, with men to have more central obesity than women ($p < 0.005$). In Argentina, population-based studies which used WHtR to estimate central obesity were not found. In Bahia (Brazil) the observed prevalence was 65,3% among women and 44,5% in men (48), while in Florianópolis (Brasil) was 38,9% and 50,5%, respectively (49).

Table V. Socio-demographic and lifestyle characteristics among adult population classified as short stature (< p10)[1,2]

	Men				Women			
	Height < p10	Height ≥ p10	Age-adjusted OR[1] (95% CI)	Additionally-adjusted OR[2] (95% CI)	Height < p10	Height ≥ p10	Age-adjusted OR[1] (95% CI)	Additionally-adjusted OR[2] (95% CI)
Age group								
18-30 years-old	7.1	92.9	1.00 (ref.)	1.00 (ref.)	9.7	90.3	1.00 (ref.)	1.00 (ref.)
31-50 years-old	6.8	93.2	0.94 (0.37-2.40)	1.09 (0.33-3.64)	17.3	82.7	1.95 (1.21-3.14)**	1.56 (0.85-2.87)
51-70 years-old	12.2	87.8	1.81 (0.75-4.38)	1.36 (0.37-4.99)	25.3	74.7	3.15 (1.96-5.07)***	2.01 (1.06-3.81)*
Marital status								
Single	8.6	91.4	1.00 (ref.)	1.00 (ref.)	12.1	87.9	1.00 (ref.)	1.00 (ref.)
Married/coupled	7.7	92.3	0.52 (0.20-1.38)	0.38 (0.11-1.31)	17.5	82.5	1.00 (0.62-1.62)	0.91 (0.53-1.56)
Unmarried/divorced/widowed	12.5	87.5	0.78 (0.17-3.56)	0.72 (0.13-3.94)	25.0	75.0	1.12 (0.56-2.26)	1.22 (0.59-2.51)
Living with children								
None	8.9	91.1	1.00 (ref.)	1.00 (ref.)	18.6	81.4	1.00 (ref.)	1.00 (ref.)
At least one child at home	8.1	91.9	0.93 (0.42-2.06)	1.84 (0.63-5.35)	14.4	85.6	1.04 (0.71-1.54)	0.76 (0.48-1.20)
Educational level								
Low	15.0	85.0	1.00 (ref.)	1.00 (ref.)	23.1	76.9	1.00 (ref.)	1.00 (ref.)
Medium	7.4	92.6	0.50 (0.22-1.12)	0.47 (0.20-1.11)	14.7	85.3	0.66 (0.44-0.99)*	0.73 (0.46-1.15)
High	3.3	96.7	0.20 (0.04-0.91)*	0.26 (0.05-1.28)	10.8	89.2	0.44 (0.22-0.87)*	0.57 (0.27-1.21)
Professional profile								
Student	7.7	92.3	1.00 (ref.)	1.00 (ref.)	9.5	90.5	1.00 (ref.)	1.00 (ref.)
Unemployed	19.1	80.9	2.14 (0.36-12.70)	2.66 (0.43-16.45)	19.0	81.0	1.04 (0.44-2.45)	0.94 (0.38-2.29)
Employed	6.7	93.3	0.72 (0.15-3.52)	1.10 (0.20-5.98)	16.6	83.4	1.16 (0.54-2.50)	1.30 (0.57-2.97)
Smoking habit								
No	8.7	91.3	1.00 (ref.)	1.00 (ref.)	8.7	91.3	1.00 (ref.)	1.00 (ref.)
Yes	7.5	92.5	0.93 (0.40-2.18)	1.03 (0.42-2.55)	7.5	92.5	1.02 (0.66-1.58)	1.08 (0.69-1.70)
Alcohol consumption								
No	12.0	88.0	1.00 (ref.)	1.00 (ref.)	20.9	79.1	1.00 (ref.)	1.00 (ref.)
Yes	7.4	92.6	0.59 (0.26-1.35)	0.66 (0.27-1.56)	13.7	86.3	0.64 (0.44-0.93)*	0.70 (0.47-1.04)
PA level								
Low	8.7	91.3	1.00 (ref.)	1.00 (ref.)	19.4	80.6	1.00 (ref.)	1.00 (ref.)
Medium	11.5	88.5	1.38 (0.63-3.03)	1.12 (0.48-2.62)	13.8	86.2	0.65 (0.43-0.99)*	0.60 (0.38-0.92)*
High	3.5	96.5	0.43 (0.12-1.56)	0.39 (0.10-1.48)	10.3	89.7	0.54 (0.28-1.06)	0.57 (0.29-1.14)
BMI (kg/m^2)								
< 25	7.0	93.0	1.00 (ref.)	1.00 (ref.)	10.9	89.1	1.00 (ref.)	1.00 (ref.)
≥ 25	9.1	90.9	1.08 (0.46-2.56)	0.98 (0.28-3.43)	21.5	78.5	1.74 (1.14-2.64)*	0.85 (0.47-1.53)
WHtR								
< 0.5	5.9	94.1	1.00 (ref.)	1.00 (ref.)	8.4	91.6	1.00 (ref.)	1.00 (ref.)
≥ 0.5	9.8	90.2	1.40 (0.55-3.60)	1.35 (0.36-5.04)	22.8	77.2	2.53 (1.59-4.03)***	2.83 (1.47-5.46)**

BMI: body mass index; WHtR: waist-to-height ratio; PA: physical activity.

*[1]Multivariate analysis (multiple logistic regression analysis considering the effect of one explanatory variable adjusted for age (continuous)). *p < 0.05, **p < 0.01, *** p <0.001.*

*[2]Multivariate analyses (multiple logistic regressions considering the simultaneous effect of all the explanatory variables).*p < 0.05, **p < 0.01, ***p < 0.001.*

In Chile the prevalence of WHtR among people of rural area was 57.6% in women and 51% in men (50), while in other Chilean study considering WHtR > 0.55, 55.6% of adult population were abdominally obese (51).

Women showed higher prevalence of short stature, although the prevalence decreases according to age increase, which could be related to better living conditions that those underwent by the Argentinian population in the past decades. In last five dec-

ades the life expectancy increased 11 years (65 years in 1960 and 76 years in 2012 in whole population, and from 68.2 years to 79.8 years in female (52)), and the mortality under 5 years dropped from 73.3 per 1000 in 1969 to 13.3 per 1000 in 2013 (52). The improvement of health care and health conditions has contributed to reduce the prevalence of short stature in women, which is in conjunction with the decrease of iron deficiency anaemia and hence the risk of death of the mother at delivery. Maternal short stature is a risk factor for caesarean delivery, and largely related to cephalopelvic disproportion (53). It is well known that maternal height influences offspring linear growth over the growing period, which includes genetic and non-genetic factors, including nutrition-related intergenerational influences on growth that prevent the attainment of genetic height potential in low- and middle-income countries (54-57).

Short stature was associated with overweight and abdominal obesity in women but not in men, several studies have shown that short adult stature, a marker for early undernutrition, is a risk factor for obesity among women, but not men (58-64).

STRENGTHS AND LIMITATIONS OF THE STUDY

This is the first study that analyzes nutritional status and food habits of adult population of Rosario (Argentina). The main strength of the present study includes a large population-based sample that provides greater support for generalization, and take the sample in the six districts of the city ensures the inclusion of individuals of different geographical points. The use of anthropometric measurements in replacement of the self-report is other advantage of the present study. However, this article also has several limitations. First, the cross-sectional study design reduced the ability to show causality compared with longitudinal studies. Second, questionnaires have inherent limitations, mainly because they are subjective in nature.

CONCLUSIONS

The current study was able to detect a high prevalence of overweight and obesity among adult population in Rosario, increasing the risk of many health conditions that may imply high health care expenses in the next future. Short stature, a marker for early undernutrition, was most prevalent among women than in men, with lower prevalence among younger women.

Argentina, like other countries in the region, is now in a post nutritional transition stage, with high prevalence of overweight and obesity. Then, the nutrition policy, which has been successful in reducing undernutrition in the past decades, now it should be focused in to decrease the prevalence of obesity with integral strategies which should include nutrition in early life and during reproductive age, as well to promote physical activity, food and nutrition education, and industry and marketing food regulation.

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REFERENCES

1. Popkin BM: The nutrition transition and obesity in the developing world. J Nutr 2001;131(3):871S-873S.
2. Popkin BM, Gordon-Larsen P: The nutrition transition: worldwide obesity dynamics and their determinants. Int J Obes Relat Metab Disord 2004;28(3):S2-S9.
3. World Health Organization: Global Health Risks. Mortality and burden of disease attributable to selected major risks. Geneva; 2009.
4. Pérez Rodrigo C. Current mapping of obesity. Nutr Hosp 2013; 28(5):21-31.
5. Vio F, Albala C. Nutrition policy in the Chilean transition. Public Health Nutr 2000;3(1):49-55.
6. Albala C, Vio F, Kain J, Uauy R. Nutrition transition in Latin America: the case of Chile. Nutr Rev 2001;59(6):170-6.
7. Albala C, Vio F, Kain J, Uauy R. Nutrition transition in Chile: determinants and consequences. Public Health Nutr 2002;5(1A):123-8.
8. Rivera JA, Barquera S, González-Cossio T, Olaiz G, Sepulveda J. Nutrition transition in Mexico and in other Latin American countries. Nutr Rev 2004;62(7):s149-s157.
9. Popkin BM, Slining MM: New dynamics in global obesity facing low- and middle-income countries. Obes Rev 2013;14(02):11-20.
10. Ministerio de Salud de la Nación: Encuesta Nacional de Nutrición y Salud; 2007.
11. Ministerio de Salud de la Nación. Encuesta Nacional de Factores de Riesgo. Argentina 2005. Informe de resultados [National Survey of Risk Factors for Noncommunicable Diseases]; 2005.
12. Instituto Nacional de Estadísticas y Censos: Censo nacional de población, hogares y viviendas; 2010.
13. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. Nutr Res Rev 2010;23:247-69.
14. Ministerio de Salud de la Nación. Gráfico elaborado a partir del Estudio multicéntrico de la OMS sobre patrón de crecimiento, 2006; y Lejarraga H y Orfila G. Archivos Argentinos de Pediatría 1987; 85:209. In Evaluación del estado nutricional de niños, niñas, adolescentes y embarazadas mediante antropometría. República Argentina; 2007.
15. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ). Short and Long Forms. [https://sites.google.com/site/theipaq/.]
16. International physical activity questionnaire: Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ), short and long forms; 2005.
17. Ministerio de Salud de la Nación: Segunda Encuesta Nacional de Factores de Riesgo para enfermedades no transmisibles; 2011.
18. Ministerio de Salud de la Nación: 3.a Encuesta Nacional de Factores de Riesgo para enfermedades no transmisibles. Presentación de los principales resultados; 2014.
19. Fleischer NL, Díez Roux AV, Alazraqui M, Spinelli H, De Maio F. Socioeconomic Gradients in Chronic Disease Risk Factors in Middle-Income Countries: Evidence of Effect Modification by Urbanicity in Argentina. Am J Public Health 2011;101(2):294-301.

20. Linetzky B, De Maio F, Ferrante D, Konfino J, Boissonnet C. Sex-stratified socio-economic gradients in physical inactivity, obesity, and diabetes: evidence of short-term changes in Argentina. Int J Public Health 2013;58(2): 277-84.
21. Martorell R, Kettel Khan L, Hughes ML, Grummer-Strawn LM. Obesity in Latin American Women and Children. J Nutr 1998;128(9):1464-73.
22. Monteiro CA, Moura EC, Conde WL, Popkin BM. Socioeconomic status and obesity in adult populations of developing countries: a review. Bull World Health Organ 2004;82(12).
23. Martorell R, Kettel Khan L, Hughes ML, Grummer-Strawn LM. Obesity in women from developing countries. European Journal of Clinical Nutrition 2000;54:247-52.
24. Monteiro CA, Conde WL, Popkin BM. Independent effects of income and education on the risk of obesity in the Brazilian adult population. Journal of Nutrition 2001;131:881S-886S.
25. Black RB, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;382:427-51.
26. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. Lancet 2011;377:557-67.
27. Stevens GA, Singh GM, Lu Y, Danaei G, Lin JK, Finucane MM, et al. National, regional, and global trends in adult overweight and obesity prevalences. Popul Health Metr 2012;10:22.
28. Ashwell M, Gibson S. A proposal for a primary screening tool: 'Keep your waist circumference to less than half your height'. BMC Medicine 2014;12:207.
29. Brown CD, Higgins M, Donato KA, Rohde FC, Garrison R, Obarzanek E, et al. Body mass index and the prevalence of hypertension and dyslipidemia. Obes Res 2000;8:605-19.
30. Guh D, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health 2009;9:88.
31. Lamon-Fava S, Wilson PW, Schaefer EJ. Impact of body mass index on coronary heart disease risk factors in men and women. The Framingham Offspring Study. Arterioscler Thromb Vasc Biol 1996;16:1509-15.
32. Wilson P, d'Agostino R, Sullivan L, Parise H, Kannel W. Overweight and obesity as determinants of cardiovascular risk: the Framingham experience. Arch Intern Med 2002;162:1867-72.
33. Folsom AR, Kushi LH, Anderson KE, Mink PJ, Olson JE, Hong CP, et al. Associations of general and abdominal obesity with multiple health outcomes in older women: the Iowa Women's Health Study. Arch Intern Med 2000;160:2117-28.
34. Feller S, Boeing H, Pischon T. Body mass index, waist circumference, and the risk of Type 2 diabetes mellitus: implications for routine clinical practice Deutsches Arzteblatt Int 2010;107:470-U424.
35. MacKay MF, Haffner SM, Wagenknecht LE, d'Agostino RB, Hanley AJG. Prediction of Type 2 diabetes using alternate anthropometric measures in a multi-ethnic cohort. Diabetes Care 2009;32:956-8.
36. Marcadenti A, Fuchs SC, Moreira LB, Wiehe M, Gus M, Fuchs FD: Accuracy of anthropometric indexes of obesity to predict diabetes mellitus Type 2 among men and women with hypertension. Am J Hypertens 2011;24:175-80.
37. Huang Z, Willett WC, Colditz GA, Hunter DJ, Manson JE, Rosner B, et al. Waist circumference, waist:hip ratio, and risk of breast cancer in the Nurses' Health Study. Am J Epidemiol 1999;150:1316-24.
38. Huxley R, Mendis S, Zheleznyakov E, Reddy S, Chan J. Body mass index, waist circumference and waist:hip ratio as predictors of cardiovascular risk-a review of the literature. Eur J Clin Nutr 2010;64:16-22.
39. Wang YF, Rimm EB, Stampfer MJ, Willett WC, Hu FB. Comparison of abdominal adiposity and overall obesity in predicting risk of type 2 diabetes among men. Am J Clin Nutr 2005;81:555-63.
40. Visscher TL, Seidell JC, Molarius A, van der Kuip D, Hofman A, Witteman JC: A comparison of body mass index, waist-hip ratio and waist circumference as predictors of all-cause mortality among the elderly: the Rotterdam study. Int J Obes Relat Metab Disord 2001;25:1730-5.
41. De Koning L, Merchant A, Pogue J, Anand S. Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. Eur Heart J 2007;28:850-6.
42. Cox BD, Whichelow MJ, Ashwell MA, Prevost AT. Comparison of anthropometric indices as predictors of mortality in British adults. Int J Obes Relat Metab Disord 1996;20(4):141.
43. Patel S, Unwin N, Bhopal R, White M, Harland J, Ayis SA, et al. A comparison of proxy measures of abdominal obesity in Chinese, European and South Asian adults. Diabet Med 1999;10:853:60.
44. Jayawardana R, Ranasinghe P, Sheriff MHR, Matthews DR, Katulanda P. Waist to height ratio: A better anthropometric marker of diabetes and cardio-metabolic risks in South Asian adults. Diabetes Res Clin Pract 2013;99(3):292-9.
45. Hsieh SD, Yoshinaga H, Muto T, Sakurai Y, Kosaka K. Health risks among Japanese men with moderate body mass index. Int J Obes Relat Metab Disord 2000;24(3):358-62.
46. Hsieh SD, Yoshinaga H. Abdominal fat distribution and coronary heart disease risk factors in men: waist/height ratio as a simple and useful predictor. Int J Obes Relat Metab Disord 1995;19:585-9.
47. Sayeed MA MH, Latif ZA, Khanam PA, Ahsan KA, Banu A, Azad Khan AK. Waist-to-height ratio is a better obesity index than body mass index and waist-to-hip ratio for predicting diabetes, hypertension and lipidemia. Bangladesh Med Res Counc Bull 2003;29(1):1-10.
48. Soares DA, Barreto SM. Overweight and abdominal obesity in adults in a quilombo community in Bahia State, Brazil. Cad Saúde Pública 2014;30(2):341-54.
49. Ferreira de Sousa T, Nahas MV, Santos Silva DA, Firpo del Ducal G, Peres MA. Factors associated with central obesity in adults from Florianópolis, Santa Catarina: a population based-study. Rev Bras Epidemiol 2011;14(2):296-309.
50. Valenzuela K, Bustos P. Índice cintura estatura como predictor de riesgo de hipertensión arterial en población adulta joven: ¿Es mejor indicador que la circunferencia de cintura? Archivos Latinoamericanos de Nutrición 2012;62(3):220-6.
51. Kock E, Romero T, Sandoval D, Romero CX, Bravo M, Henríquez O, et al. Is height an independent marker of metabolic syndrome in a developing society? A cross-sectional study of 22,180 Chilean adults. European Heart Journal 2011;32:887-8.
52. Banco Mundial. Banco de datos del Banco Mundial; 2014.
53. Black RE, Allen LH, Bhutta ZA, Caulfi LE, de Onis M, Ezzati M, et al.; Group MaCUS: Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 2008;371:243-60.
54. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L. Maternal and child undernutrition: consequences for adult health and human capital. Lancet 2008;371:340-57.
55. Ramakrishnan U, Martorell R, Schroeder DG, Flores R. Role of intergenerational effects on linear growth. J Nutr 1999;129(2):544S-549S.
56. Yaw Addo O, Stein AD, Fall CH, Gigante DP, Guntupalli AM, Horta BL, et al. Maternal Height and Child Growth Patterns. J Pediatr 2013;163(2):549-54.
57. Ozaltin E, Hill K, Subramanian SV. Association of maternal stature with offspring mortality, underweight, and stunting in low- to middle-income countries. JAMA 2010;303:1507-16.
58. Valdez R, Athens MA, Thompson GH, Bradshaw BS, Stern MP. Birth weight and adult health outcomes in a biethnic population in the USA. Diabetologia 1994;37:624-34.
59. Prentice AM: The emerging epidemic of obesity in developing countries. Int J Epidemiol 2006;35:93-9.
60. Sichieri R, Siqueira KS, Moura AS. Obesity and abdominal fatness associated with undernutrition early in life in a survey in Rio de Janeiro. Int J Obes Relat Metab Disord 2000;24:614-8.
61. Sichieri R, dos Santos Barbosa F, Moura EC. Relationship between short stature and obesity in Brazil: a multilevel analysis. British Journal of Nutrition 2010;103:1534-8.
62. Velásquez-Meléndez G, Martins IS, Cervato AM, Fornés NS, Marucci MF, Coelho LT. Relationship between stature, overweight and central obesity in the adult population in Sao Paulo, Brazil. Metab Disord Int J Obes Relat 1999;23:639-44.
63. Curhan CG, Willett WC, Rimm EB, Spiegelman D, Ascherio AL, Stampfer MJ. Birth weight and adult hypertension, diabetes mellitus, and obesity in USA men. Circulation 1996;94:1310-5.
64. Han TS, McNeill G, Seidel JC, Lean ME. Predicting intraabdominal fatness from anthropometric measures: the influence of stature. Int J Obes Relat Metab Disord 1997;21:587-93.

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Nutrición Hospitalaria

Trabajo Original

Epidemiología y dietética

Adecuación de las peticiones de los niveles de vitamina D al laboratorio

An adequacy of laboratory requests of vitamin D levels

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Resumen

Introducción: ante las nuevas implicaciones atribuidas a la vitamina D y la asociación con enfermedades tales como el cáncer, diabetes, enfermedades cardiovasculares, autoinmunes y mortalidad, no es de extrañar que se haya defendido la medición de los niveles de vitamina D en la población general. Sin embargo, no existen datos experimentales que demuestren la viabilidad y rentabilidad de la estrategia de cribado en la población y tampoco se ha comprobado la existencia de beneficios para la salud, por lo que en la actualidad solo es aconsejable la medida de 25 (OH) vitamina D en los grupos de personas de alto riesgo como indican las guías clínicas internacionales.

Objetivos: analizar las peticiones de vitamina D comprobando si se adecuan a las guías clínicas.

Métodos: realizamos un estudio descriptivo transversal en el Área de Salud de Badajoz (España) estudiando las peticiones de determinación de vitamina D durante 12 meses consecutivos (n = 3.907). En dicho estudio revisamos el diagnóstico de petición y la historia clínica del paciente para discriminar entre peticiones que se adecuaban a las guías clínicas y peticiones injustificadas. Por último, realizamos el estudio económico.

Resultados: en nuestros resultados encontramos que casi un tercio de peticiones no se adecuaban a las guías clínicas, en patologías tales como diabetes, dislipemias e hipertensión en las que no está recomendada la medición de los niveles de vitamina D, por lo que suponía un exceso de gasto para el sistema sanitario. Gasto que se incrementa cada año, tanto es así que se ha producido un aumento en las peticiones de más del 1.000% en los últimos 6 años.

Conclusiones: concluimos la necesidad de crear protocolos de petición de vitamina D que se ajusten a las guías clínicas hasta que existan más estudios experimentales sobre las nuevas implicaciones de la vitamina D y así conseguir una correcta utilización de los recursos económicos del hospital.

Palabras clave:

Vitamina D. Adecuación. Gasto sanitario. Protocolo petición. Guías clínicas.

Abstract

Introduction: Regarding the new implications assigned to vitamin D and its association with diseases such as cancer, diabetes, heart and autoimmune diseases and mortality, it isn't surprising that the measurements of the levels of vitamin D in general population had been defended. Nevertheless, there aren't any experimental data which show the viability and rentability of the screening strategy in population, and there is a lack of benefits for health. That's why, currently, it is only advisable the measurement of 25 (OH) vitamin D in groups of people at high risk as international clinical guides indicate.

Objectives: Analyse vitamin D petitions confirming if they adequate to clinical guides.

Methods: We carried out a descriptive study in the health area of Badajoz (Spain) studying the petitions for vitamin D analysis for 12 consecutive months (n = 3,907), in which we checked the diagnosis requested and the medical records of the patient to select between

petitions that fit in the clinical guides, and those unjustified. Lastly, we also carried out an economical study.

Results: In our results we found that almost a third of the petitions didn't fit the clinical guides, in pathologies like diabetes, dyslipidemia and hypertension where the measurement of the vitamin D levels is not recommended, so this would mean an enormous expense for public health. This cost it is growing every year, so it has been an increase in requests over 1,000% in the last 6 years.

Conclusions: We conclude with the idea of creating vitamin D petition protocols which fit the clinical guides until more experimental studies about the new implications on vitamin D are published, and finally achieve a correct use of the economical resources of the hospital.

Key words:

Vitamin D. Adaptation. Economical expense. Petition protocol. Clinical guides.

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INTRODUCCIÓN

La vitamina D es una de las principales hormonas implicadas en el metabolismo óseo y la homeostasis del calcio. La presencia de receptores de la vitamina D en una amplia variedad de células sugiere que también desempeña un papel muy importante en diferentes procesos fisiológicos y de diferenciación y proliferación celular. En la actualidad, numerosos artículos en su mayoría descriptivos, han puesto de manifiesto la asociación entre el déficit de vitamina D y multitud de patologías, entre ellas el cáncer, dislipemias, hipertensión arterial, diabetes, enfermedades cardiovasculares, infecciones, enfermedades metabólicas y mortalidad (1-7), aunque, por el contrario, no existen estudios experimentales que confirmen tal relación.

En España se han realizado diferentes estudios que indican que la población española en general presenta déficit de vitamina D. Un estudio realizado en la población española ambulatoria mayor de 64 años sin factores de riesgo conocidos de hipovitaminosis presentaba unos niveles de 25 (OH) vitamina D en rango de deficiencia del 87% (8). También existen estudios en población joven, como el realizado en Canarias a estudiantes universitarios y que reflejó que el 61% presentan niveles de insuficiencia o deficiencia (9). Más recientemente se ha realizado un estudio para ver la situación de la población pediátrica y se ha encontrado una alta prevalencia de deficiencia de vitamina D sobre todo en primavera (10).

El 70% de vitamina D se produce de forma endógena por un proceso de fotobiogénesis a partir del 7-dehidrocolesterol y el 30% restante procede de la ingesta de alimentos ricos en vitamina D como los pescados grasos (caballa, sardina, salmón), el huevo y, principalmente, los alimentos fortificados con esta vitamina, como pueden ser la leche, yogur y mantequilla. Su déficit primario principalmente parece estar asociado a la baja exposición solar, pero también puede deberse a la escasa ingesta de alimentos ricos en vitamina D. Los déficits secundarios son debidos a diversas enfermedades que impiden la correcta absorción o hidroxilación de la vitamina D, por lo que los niveles séricos están disminuidos. Los principales factores que influyen en los niveles de vitamina D son:

- Exposición solar: la cantidad necesaria de radiación UVB se ve afectada por el tiempo de exposición, estación del año, latitud, superficie corporal expuesta (el uso de protector solar disminuye la síntesis de vitamina D), pigmentación de la piel (individuos de piel oscura necesitan más tiempo de exposición), envejecimiento de la piel (menor cantidad de 7-dehidrocolesterol en la piel de ancianos).
- Ingesta de alimentos ricos en vitamina D: una ingesta baja de estos alimentos produce una insuficiencia.
- La obesidad se asocia a un déficit de vitamina D circulante, debido a que la vitamina D se deposita junto con la grasa y no se libera a la circulación.
- Enfermedades y situaciones clínicas que producen la malabsorción de las grasas: celiaquía, enfermedad inflamatoria intestinal, insuficiencia pancreática, fibrosis quística, colestasis hepática, enfermedad de Crohn, cirugía gástrica.
- Enfermedades hepáticas y renales que pueden impedir la correcta hidroxilación de la vitamina D
- Ciertos fármacos se asocian con déficit, ya que aumentan el catabolismo de la 25 (OH) D como pueden ser los antiepilépticos y glucocorticoides.

La medición de los niveles séricos de 25 (OH) vitamina D total es la mejor prueba para evaluar las reservas corporales de vitamina D (11), permitiéndonos el diagnóstico y el seguimiento de la deficiencia de vitamina D, pero, aunque la deficiencia de vitamina D es frecuente, la medición de niveles de 25 (OH) D en suero es cara y el cribado universal no se admite.

El aumento exponencial de las peticiones de determinación de los niveles séricos de 25 (OH) D en los últimos años hace que sea necesaria la adecuación de la demanda de tal determinación, por lo que solo es razonable la medida de 25(OH) D en los grupos de personas de alto riesgo de déficit de vitamina D que recomiendan las guías clínicas internacionales.

Por lo tanto, nuestro objetivo es determinar la adecuación y el sobrecoste generado por las peticiones inadecuadas, para ello analizamos las peticiones de vitamina D en el Área de Salud de Badajoz (España), atendiendo a criterios de petición de las sociedades científicas, discriminando entre peticiones justificada y no justificada, si no se adecuaban a los criterios de petición de las guías clínicas, con el objetivo final de implantar un protocolo de petición y conseguir una adecuación de los recursos económicos.

MATERIALES Y MÉTODOS

Se realizó un estudio epidemiológico descriptivo transversal de las peticiones de vitamina D realizadas en el Área de Salud de Badajoz durante 12 meses consecutivos, con un total de 3.907 peticiones. Cada petición se estudió detalladamente, cotejando el diagnóstico de la petición de vitamina D y la historia clínica del paciente para así poder confirmar si la petición de vitamina D fue correctamente realizada. Para realizar la discriminación entre petición de vitamina D justificada e injustificada nos guiamos por tres guías clínicas en las que se enumeran las patologías o situaciones en las que sería necesario medir los niveles de vitamina D séricos y la bibliografía más reciente sobre el tema. Son las guías clínicas de la Sociedad Americana de Endocrinología (12), la guía de la Sociedad Española de Bioquímica Clínica (SEQC) (13) y el Consenso de la Alta Autoridad Sanitaria Francesa sobre la petición de vitamina D (14). Siguiendo las tres guías y la bibliografía reciente, elaboramos un protocolo de petición con los casos en los cuales sería adecuado determinar los niveles séricos de vitamina D:

- Raquitismo.
- Osteomalacia.
- Osteoporosis.
- Insuficiencia renal crónica (solo estadios 3-5).
- Trasplante renal.
- Hiperparatiroidismo.
- Insuficiencia hepatocelular.
- Síndromes de malabsorción (celiaquía, Crohn, pancreatitis, fibrosis quística, etc.).

– Tras cirugía bariátrica.
– Tratamientos crónicos con ciertos fármacos (glucocorticoides, antiepilépticos, medicación antirretroviral).
– Caídas repetidas.
– Ciertos linfomas.
– Enfermedades granulomatosas (tuberculosis y sarcoidosis).

Siguiendo estas guías analizamos las 3.907 peticiones de vitamina D del año 2013. En primer lugar, las dividimos en peticiones justificadas y peticiones no justificadas; después, analizamos más detenidamente las peticiones no justificadas y las organizamos por patología del paciente, por un lado, y por servicio peticionario, por otro, así veíamos las patologías más frecuentes en las que se pedía determinación de vitamina D innecesaria y cuáles eran los servicios que más lo hacían. Además, realizamos un estudio para observar cómo se había incrementado el número de determinaciones de vitamina D en los últimos 6 años (2009-2014).

También estudiamos el impacto económico que tuvo en nuestra zona (Área de Salud de Badajoz) las peticiones de vitamina D no justificadas, para ello utilizamos el coste directo de la determinación aislada de vitamina D para calcular el coste total en nuestra región en dicho año; por último, realizamos una extrapolación de nuestros resultados al resto de Áreas de Salud del Servicio Extremeño de Salud (SES) para calcular el gasto en peticiones de vitaminas D no justificadas según los protocolos de petición en toda Extremadura.

RESULTADOS

En el año 2013 se realizaron un total de 3.907 determinaciones de 25 (OH) vitamina D en el Área de Salud de Badajoz. Si seguimos las guías clínicas mencionadas anteriormente, solo el 68% (2.638 peticiones) eran justificadas según la historia y el diagnóstico del paciente y el 32% (1.271 peticiones) no se adecuaba a las guías clínicas, por lo que se trataba de peticiones no justificadas. En la tabla I se expresa el número de peticiones de los principales diagnósticos de las peticiones justificadas, así podemos comprobar que la insuficiencia renal (60,5%) es la patología más frecuente que produce déficit de vitamina D, seguida de osteoporosis-osteopenia (18%).

En la tabla II se expresa el número de peticiones de las principales patologías en las que se pide determinación de vitamina D que no está justificada, siendo la más frecuente la hipertensión con un 21,71%, seguida de la diabetes con 10,38% y de las dislipemias con un 9,04%. En la tabla III se puede observar cuáles son los servicios que más realizan peticiones no justificadas, y resalta la atención primaria (centros de salud) con más del 50% de las peticiones no justificadas.

Cuando realizamos este estudio para investigar si había variación en el número de determinaciones de vitamina D en los últimos años, como sucedía a nivel nacional e internacional, descubrimos los siguientes resultados: en la figura l podemos comprobar el aumento que se ha producido de peticiones de vitamina D en los últimos años en el Área de Salud de Badajoz y en la tabla IV se observan los números absolutos del número de peticiones por año, reflejando un aumento de más del 1.000% en 6 años.

Tabla I. Distribución de las 2.636 peticiones justificadas según el diagnóstico

Diagnóstico	N.º de peticiones	% total
Insuficiencia renal crónica	1.596	60,5
Osteoporosis-osteopenia	502	18
Fractura de cadera	198	7,5
Trasplante renal	31	1,2
Otros (síndromes malabsorción, Crohn, pancreatitis, etc.)	309	12,8

Tabla II. Distribución de las 1.271 peticiones no justificadas según el diagnóstico

Diagnóstico	N.º de peticiones	% total
Hipertensión arterial	276	21,71
Diabetes	132	10,38
Dislipemia	115	9,04
Enfermedades reumatológicas	75	5,90
Hipo e hipertiroidismo	68	5,35
Anemia	60	4,72
Cáncer	16	1,25
Otros (alergias, controles rutinarios, problemas neurológicos, etc.)	529	41,62

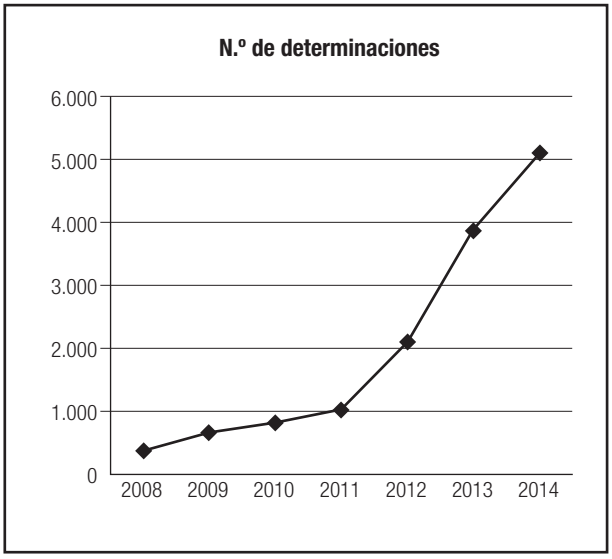

Figura 1.
Evolución de peticiones de vitamina D en el Área de Salud de Badajoz (últimos 6 años).

Tabla III. Distribución de las 1.271 peticiones no justificadas según el servicio peticionario

Servicio peticionario	N.º de peticiones	%
Centro de salud	637	50,11
Nefrología Pediátrica	108	8,49
Nefrología	64	5,03
Neurología	64	5,03
Medicina Interna	90	7,08
Otorrinolaringología	34	2,67
Reumatología	44	3,46
Endocrinología	46	3,61
Otros	184	14,47

Los resultados sobre la repercusión económica que tiene este estudio de adecuación de la demanda de vitamina D en el Área de Salud de Badajoz se ponen de manifiesto de manera clara, ya que cada prueba de vitamina D tiene un precio por determinación de 4,2 euros (costes directos), sin contar los costes indirectos. Por lo que si tenemos 1.271 peticiones cuya determinación no sería adecuada, estaríamos ante un exceso de gasto sanitario de 5.331,6 euros. Además, conociendo la población de cada Área de Salud de Extremadura y el número de determinaciones realizadas en cada área, podemos hacer una extrapolación de nuestros resultados y calculamos el exceso de gasto en determinaciones de vitamina D que se produjo en 2013 en Extremadura. En el Área de Salud de Badajoz se realizaron un total de 14,33 peticiones/1.000 habitantes, de las cuales si nos guiamos por las guías clínicas solo estarían justificadas 9,68 peticiones/1.000 habitantes, como la patología es similar en toda Extremadura o incluso mayor en el Área de Salud de Badajoz (mayor número de especialidades médicas), se extrapola utilizando 9,68 peticiones correctas/1.000 habitantes al resto de Áreas de Salud de Extremadura y se calcula el exceso de gasto, que ascendió a un total de 82.900 euros al año. Los resultados reflejaron cómo las áreas de Salud de Cáceres, Plasencia y Coria, presentaban un elevado número de peticiones por cada 1.000 habitantes.

DISCUSIÓN

Como podemos observar en los resultados obtenidos en este estudio, alrededor de un tercio de las peticiones de vitamina D en 2013 en nuestra Área de Salud son no recomendadas por las guías clínicas, por lo que su determinación es innecesaria y además supone un gasto sanitario que podría invertirse en otras actividades sanitarias. Dentro de este grupo de peticiones innecesarias según diagnóstico e historia clínica, se pone de manifiesto que las principales patologías en las que se pide determinación de vitamina D son la hipertensión con un 21,71%, seguida de la diabetes con 10,38% y de las dislipemias con un 9,04%; no existen evidencias científicas que apoyen la necesidad de determinar los niveles de 25 (OH) vitamina D en estas patologías, lo que sí hay en la actualidad son numerosos estudios descriptivos que ponen de manifiesto la asociación entre una deficiencia de vitamina D y

Tabla IV. Evolución de las peticiones en el Área de Salud de Badajoz durante los últimos 6 años

Año	2008	2009	2010	2011	2012	2013	2014
N.º de determinaciones de vitamina D	428	681	818	1.029	2.131	3.907	5.117

Tabla V. Exceso de gasto al no seguir el protocolo de petición de vitamina D en todas las áreas del SES

Área de salud	N.º de peticiones	N.º de habitantes	N.º de peticiones/1.000 habitantes	Gasto no justificado (euros)
Badajoz	3.907	272.477	14,33882493	5.331,6
Mérida	3.047	167.190	18,22477421	6.000,1
Don Benito-Villanueva	1.858	142.464	13,04189128	2.011,6
Llerena-Zafra	2.438	106.646	22,86067926	5.903,8
Cáceres	10.982	198.717	55,26452191	38.045,3
Coria	1.535	47.250	32,48677249	4.526
Plasencia	5.998	112.960	53,09844193	20.599
Navalmoral de la Mata	646	54.706	11,80857676	489,1

estas patologías (hipertensión, diabetes y dislipemias), la mayoría son estudios epidemiológicos, pero sin evidencias claras que indiquen que los suplementos de vitamina D tengan un papel en la prevención o mejora de estas enfermedades (15,16). Al igual que sucede con otras patologías como la artritis reumatoide, anemia y cáncer, en las que no existen evidencias sobre la mejora de esta patologías con suplementos de vitamina (1,6,7,17), por lo que la determinación de los niveles de 25 (OH) D no estaría recomendada.

Como más del 50% de las peticiones no recomendadas por las guías clínicas procedían de atención primaria (centros de salud), opinamos que sería importante la restricción de la petición de vitamina D desde los servicios de atención primaria sin una justificación que atendiera a criterios clínicos. Además, independientemente del servicio peticionario se ha producido un aumento casi exponencial en el número de determinaciones de vitamina D en los últimos años, y todo parece indicar que se debe al aumento de estudios descriptivos sobre nuevas implicaciones de la vitamina D, aunque las guías clínicas no aconsejan la determinación de sus niveles en estas situaciones hasta que no haya más datos concluyentes. Este aumento en nuestra Área de Salud fue de más del 1.000% en los últimos 6 años. También el aumento exponencial se está produciendo a escala mundial: en Francia se produjo un aumento del 250% de determinaciones de vitamina D entre 2007 y 2009, y de un 1.000% entre 2005 y 2009 (14). Las estadísticas del Gobierno australiano reflejan un aumento de 100 veces entre 2000 y 2010. Por ello se hace necesaria la implantación de un protocolo de petición en toda la región, para evitar que las peticiones sigan aumentando en los próximos años sin ningún criterio clínico.

La mala racionalización de la determinación de 25 (OH) D supone un exceso de gasto para los sistemas sanitarios, al igual que otras pruebas de laboratorio. Si nos fijamos en los resultados de todas las áreas de salud del Sistema Extremeño de Salud (SES), nos percatamos de que principalmente en el Área de Salud de Cáceres y Plasencia no existe ningún control de la demanda, y son las que mayor gasto suponen al SES. El sobrecoste sanitario que se produjo en el SES en 2013 ascendió a 82.900 euros, gasto que sigue aumentando año a año, por lo que la implantación de protocolos de petición de vitamina D en toda Extremadura ayudaría a una correcta adecuación de la demanda y, lo que es más importante, a una correcta utilización de los recursos sanitarios. Este problema de racionalización de la vitamina D no solo afecta a Extremadura, sino que también sería interesante realizar estudios en otras comunidades y si es necesario tomar medidas al respecto.

CONCLUSIÓN

Como conclusión final, podemos resaltar que las peticiones de determinación de vitamina D que no se atengan a ninguna indicación de las guías clínicas no solo suponen un gasto sanitario extra, sino que además no reportan beneficios para los pacientes. Por ello se ha propuesto la implantación del protocolo de petición en el Área de Salud de Badajoz, para después implantarlo al resto de Áreas del SES.

BIBLIOGRAFÍA

1. Manson JE, Mayne ST, Clinton SK. Vitamin D and Prevention of Cancer. Ready for Prime Time? N Engl J Med 2011; 364:1385-7.
2. Cook NR. Vitamin D and Cancer: Can We Believe the Evidence from Observational Studies? Clinical Chemistry 2013;59(5):726-8.
3. Afzal S, Bojesen S, Nordestgaard BG. Low 25-Hydroxyvitamin D and Risk of Type 2 Diabetes: A Prospective Cohort Study and Metaanalysis. Clinical Chemistry 2013;59(2):381-91.
4. Moyano C, López F, Castilla M. Vitamina D e hipertensión arterial. Med Clin 2012;138(9):397-401.
5. Schnatz PF, Manson JE. Vitamin D and Cardiovascular Disease: An Appraisal of the Evidence. Clinical Chemistry 2014;60(4):600-9.
6. Aloia JF. The 2011 Report on Dietary Reference Intake for Vitamin D: Where Do We Go From Here? J Clin Endocrinol Metab 2011;96(10):2987-96.
7. Rosen CJ, Adams JS, Bikle DD, Black DM, Demay MB, Manson JE, et al. The non skeletal effects of vitamin D: an endocrine society scientific statement. Endocr Rev 2012;33(3):456-92.
8. González-Padilla E, Soria-López A, González-Rodríguez E, García-Santana S, Mirallave-Pescador A, Groba-Marco M, et al. Elevada prevalencia de hipovitaminosis D en los estudiantes de medicina de Gran Canaria, Islas Canarias (España). Endocrinol Nutr 2011;58(6):267-73.
9. Vaqueiro M, Baré M, Antón A, Andreu E, Moya A, Sampere R, et al. Hipovitaminosis D asociada a exposición solar insuficiente en la población mayor de 64 años. Med Clin 2007;129(8):287-91.
10. Durá-Travé T, Gallinas-Victoriano F, Chueca-Guindulain MJ, Berrade-Zubiri S. Deficiencia de vitamina D en escolares y adolescentes con un estado nutricional normal. Nutr Hosp 2015;32(3):1061-6.
11. Thacher TD, Clarke BL. Vitamin D Insufficiency. Mayo Clin Proc 2011;86(1):50-60.
12. Holick MF, Binkley NC, Bischoff-Ferrri HA, Gordon CM, Heaney RP, Murand H, et al.; Endocrine Society. Evaluation, Treatment and Prevention of Vitamin D Deficienccy: and Endocrine Society Clinical practice Guideline. J Clin Endocrinol Metab 2011;96(7):1911-30.
13. Córdoba C, Granado F. Vitamina D: Una perspectiva actual. Sociedad Española de Bioquímica Clínica y Patología Molecular (SEQC); 2013.
14. Rapport D'Evaluation technologique: Utilité clinique du dosage de la vitamine D. Haute Autorité de Santé; 2013.
15. Elamin MB, Abu Elnour NO, Elamin KB, Fatourechi MM, Alkatib AA, Almandoz JP, et al. Vitamin D and cardiovascular outcomes: a systematic review and meta-analysis. J Clin Endocrinol Metab 2011;96:1931-42.
16. Wang L, Manson JE, Song Y, Sesso HD. Systematic review: vitamin D and calcium supplementation in prevention of cardiovascular events. Ann Intern Med 2010;152:315-23.
17. Ross AC, Manson JE, Abrams SA, Aloia JF, Brannon PM, Clinton S, et al. The 2011 Report on Dietary Reference Intakes for Calcium and Vitamin D from the Institute of Medicine: What Clinicians Need to Know. J Clin Endocrinol Metab 2011;96(1):53-8.

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Trabajo Original

Epidemiología y dietética

Design and evaluation of a campaign to promote the consumption of vegetables and fruits in Mexican school-age children

Diseño y evaluación de una campaña de promoción del consumo de verduras y frutas en escolares mexicanos

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Abstract

Introduction: In Mexican school-age children the consumption of vegetables and fruits (V&F) is less than 25% of the amount recommended by the World Health Organization.

Objectives: Evaluate the effectiveness of a promotion campaign about the consumption of V&F in urban school children from Hidalgo, Mexico.

Methods: A non controlled community trial in 226 school-age children from private and public schools was conducted, we designed and distributed printed material for promoting the consumption of V&F among the school population, access to V&F was provided through planning and sales at school stores, and consumption was supervised by the teachers.

Results: At the end of the intervention vegetable consumption increased by 50 g and plain water in 100 mL (T-test, $p < 0.05$); the proportion of school-age children who identified the health benefits of the consumption of V&F increased significantly (68% initial, 87% final) and greater support from parents (61% initial, 92 final%) was achieved.

Conclusions: A promotion campaign and improved access to vegetables, fruits and water in the school environment which is supported by parents and teachers can encourage healthier eating at school.

Key words:

Promotion of school health. Vegetables. Fruits. Healthy eating.

Resumen

Introducción: en escolares mexicanos el consumo de verduras y frutas y (VyF) es menor del 25% de la cantidad recomendada por la Organización Mundial de la Salud.

Objetivos: evaluar la efectividad de una campaña de promoción del consumo de VyF en niños de escuelas urbanas de Hidalgo, México.

Métodos: se realizó un ensayo comunitario no contralado en 226 escolares de una escuela privada y una pública; se diseñó y distribuyó material impreso de promoción del consumo de VyF entre la población escolar; se facilitó el acceso a VyF mediante una planificación y venta en establecimientos de consumo escolar, y se supervisó el consumo por los profesores.

Resultados: al finalizar la intervención, se incrementó el consumo de verduras en 50 g y el de agua simple en 100 ml (T-test, $p < 0,05$); se aumentó significativamente la proporción de escolares que identificaban los beneficios en su salud del consumo de VyF (68% inicial, 87% final) y se logró mayor apoyo de los padres de familia (61% inicial, 92% final).

Conclusiones: una campaña de promoción y mejoramiento del acceso a verduras, frutas y agua en el contexto escolar, que cuente con el apoyo de padres de familia y profesores, puede favorecer una alimentación más saludable en la escuela.

Palabras clave:

Promoción de la salud escolar. Verduras. Frutas. Alimentación saludable.

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INTRODUCTION

Regular consumption of vegetables and fruits (V&F) could prevent 60% of the burden of chronic non-communicable diseases (CNCDs), such as obesity, diabetes, cardiovascular disease and several types of cancer (1); scientific evidence suggests that consumption of at least 400 grams of V&F a day, is associated with decreased risk of these diseases (2,3). A varied consumption of V&F can prevent micronutrient deficiencies, such as iron, and vitamins A, C and B12; provide a sufficient quantity of dietary fiber and non nutrient essential substances; in addition, V&F consumption can create a feeling of fullness, thereby reducing the total calorie intake (2).

The Mexican population has one of the lowest rates of fruit and vegetable consumption in Latin America, on average their consumption does not exceed 110 grams per day and only 30% of the Mexican population has an adequate intake of V&F (1). According to the United Nations Organization for Food and Agriculture (FAO); Chile, Mexico and Brazil have an offer of V&F in their markets of more than 146 kilos/person/year, whereas in other countries it ranges between 80 to 138 kilos, so in Mexico V&F availability is sufficient, varied and accessible in most regions of the country. The causes of low consumption have not been sufficiently studied but a change in eating patterns has been identified in almost the entire population which is increasingly oriented towards the consumption of processed foods with high energy density, high in saturated fats, sugar, salt and low in dietary fiber, which could be contributing to this lower consumption (4). This eating lifestyle, along with physical inactivity, is a global problem which largely explains the high prevalence of obesity and CNCDs existing in most countries (5).

Various initiatives have been launched to promote the consumption of V&F; as the "5 a Day" program, aimed at increasing the average consumption to five or more servings per day of V&F among the United States population. Currently, this initiative is implemented in more than forty countries and has the support of international organizations such as WHO and the International Association for Cancer Research; it performs various actions, such as advertising campaigns and specific activities in schools, workplaces or supermarkets to ensure that people know and assume the importance of eating five or more daily servings of fruits and vegetables (6). Different evaluations of the "5 a Day" program have reported an increase between 0.2 and 1.7 servings per day in the consumption of vegetables and fruits in various population groups. This initiative has been taken by the World Health Organization (WHO) in its Global Strategy on Diet, Physical Activity and Health, 2004, creating a joint initiative to promote V&F, guiding sustainable measures at community, national and global level, which, taken as a whole, lead to reduced risk for CNCDs through increased consumption of V&F (8).

In the state of Hidalgo, Mexico, an evaluation conducted in 2010 reported that only a third of school-age children carried an average of 200 g of V&F in their school snack, and three out of ten children were overweight or obese (9). From this diagnosis, different intervention strategies have been implemented to promote the consumption of healthy foods, reduce sedentary lifestyle and prevent the risk of obesity and chronic diseases in school-age children from public and private schools; so the purpose of this research was to evaluate the effectiveness of a campaign to promote the consumption of vegetables and fruits in children from urban schools in Hidalgo, Mexico.

DATA AND METHODS

STUDY DESIGN

We conducted a non controlled community trial comparing the results of the effect studied in the same group of individuals before and after receiving the intervention (10). Students from first to sixth grade from a private and a public elementary school in the 2014-2015 school year located in an urban area from the municipality of Tula, in the state of Hidalgo, Mexico, participated.

POPULATION AND SAMPLE

A sample size was calculated to find significant differences in consumption of 50 grams of vegetables between the initial (before) and final (after) evaluation of the intervention; an average consumption of V&F of 200 grams in the school snack as reported in the study of Nutritional Profile of School-age children of Hidalgo 2010 (9), and a standard deviation of 30 grams in each measurement (two measurements of the same subject), an precision of 0.05 and a power of 0.80 was considered; thus it was determined that 6 school-age children were required in each group and grade from each school (11). The private school had 23 groups and the public school 18 groups, giving a total of 246 school children. School children were selected randomly from the list provided by the teachers of each group, three men and three women who at the time of the initial evaluation were present were selected, otherwise we proceeded to select another student, and we implemented the evaluation tools to these children at the beginning and end of the intervention. In the sample we included the school children who agreed to participate and who had the informed consent from their parents, who did not have any disease that interfered with the results, and that his attendance was at least 80% during the term of the intervention.

DESIGN OF THE INTERVENTION

In figure 1, the stages of the design intervention to promote the consumption of vegetables and fruits (V&F) in the school setting are presented.

Stage 1. Formative research

We applied a questionnaire to all pupils in the second, third and fourth grade of the selected schools; in the first question

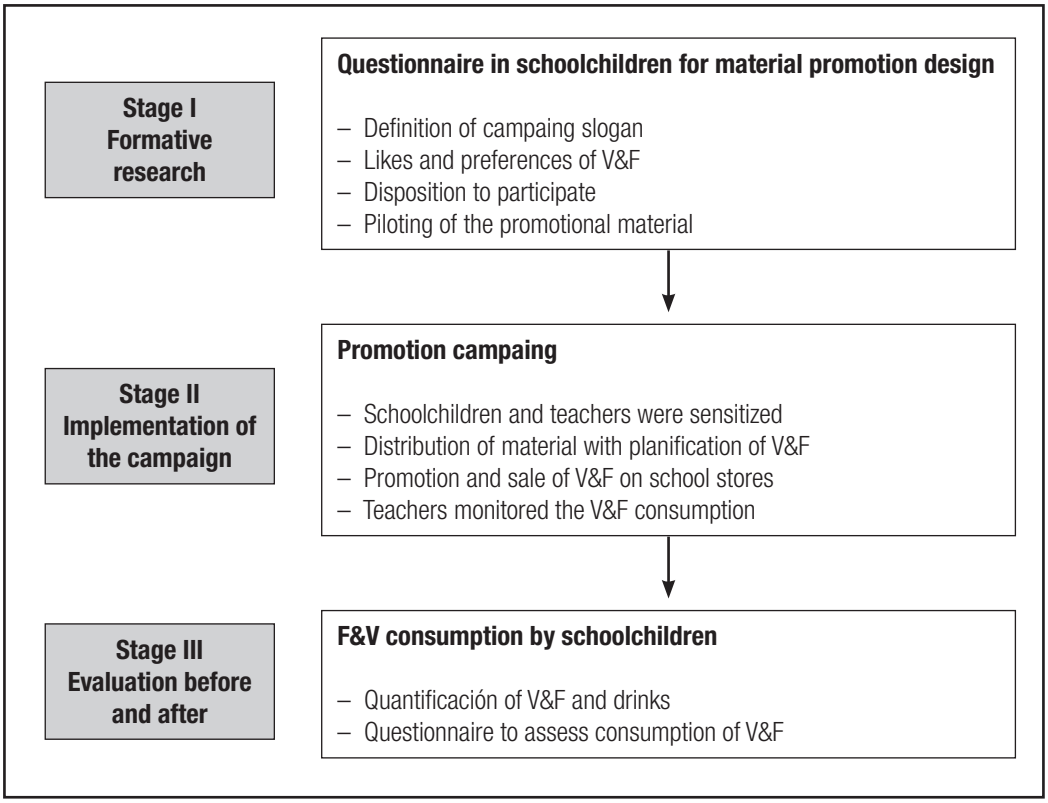

Figure 1.
Design of campaign promotion consumption of vegetables and fruits (V&F) in the school context.

they were presented with three options to choose a motto that would motivate them to increase their intake of V&F at school; in questions 2 and 3, they were asked to write down five vegetables and five fruits they would like to eat at school, and finally they were asked if they would be willing to participate in a campaign to promote the consumption of V&F at school. For the application of the instrument, trained personnel went to each classroom, gave the children the printed questionnaire and the instructions to answer the questions individually.

At this stage, 72% of the students selected the motto *Choose to Be Healthy! Eat vegetables and fruits*, as the highlight of the campaign to encourage the consumption of V&F at school. Vegetables and fruits that were located in the preference of school children were: carrots (84%), broccoli (63%), cucumber (63%), lettuce (52%) and tomatoes (34%); and fruits were: apple (74%), banana (55%), watermelon (45%), orange (42%), mango (38%), grapes (36%) and strawberries (32%). 97% of school children who were surveyed said they would be willing to participate in a campaign promoting the consumption of vegetables and fruits in school.

With this information the expert team conformed by marketing, nutrition and psychology professionals created the messages to promote V&F taking into account social marketing elements tested in other interventions: provide basic and practical concepts based on scientific evidence, avoid confusion and bad information, generate significant messages that were client centered and with relevance of content according to the opinion of teachers and school principals (12,13). This resulted in a brochure with key information that gave answers to simple questions that school children would make themselves about the consumption of vegetables and fruits: *Why should we eat vegetables and fruits?, How can I increase the consumption of vegetables and fruits at school and at home?, Why should I disinfect vegetables and fruits?, and, How many vegetables and fruits should I eat a day?;* plus some good tips were added to enhance the flavor of V&F and the consumption of drinking water. According to consumer preferences of V&F detected, a daily planning of the type of vegetables and fruits with the amount in home measures that the children should bring as lunch was defined, recommending vegetables three days a week and fruit two days a week, for three weeks, and the fourth week as free choice.

We performed a test of the promotional material with the same children that were interviewed; teachers were asked to distribute the brochure in class, the children read the information and identified the words which were difficult to understand and expressed what the images and the campaign motto represented to them. An observer of the research team recorded the suggestions so a team of experts could make relevant adjustments in consensus.

Stage 2. Implementation of the campaign

The promotional campaign is a 30-minute session to raise awareness with all groups of students and teachers involved, where they were given the diffusion material (brochure) and

their content was explained, as well as daily planning of the type of vegetable and/or fruit that the children should bring to school in their lunch box to eat at school for three weeks; for the fourth week the school children together with the teacher agreed on the V&F they would consume each day. Those responsible for the school stores of both schools, placed a promotional notice in a visible place to encourage the consumption of V&F in their business (canvas of 92 cm x 142 cm) and were instructed to promote each day, the vegetable and/or fruit indicated in the daily planning, so in case the children did not bring it from home, they could have access to it. During the three months of the campaign, teachers monitored the V&F as well as the beverage the school children carried in their lunchbox every day.

Stage 3. Evaluation before and after

At the beginning (before) and ending (after) of the intervention an evaluation was performed on the sample of selected school children. The evaluation was made in one day and consisted in the weighing of V&F, recording the amount and type of drinks they brought from their home for lunch, and applying an individual questionnaire to assess consumption of V&F. The weight of V&F was measured on a scale for weighing food from the brand SECA, model 852; once the weight was displayed, the value in grams was entered in the assessment tool; to ensure food safety in these procedures, the field staff used coif, face masks, gloves and disposable materials. The amount of the drinks in milliliters was recorded in accordance with the indications on the container or with a measuring cup; the beverages with water, but with no additives, were registered as plain water; registered as fruit juice were those containing sucrose mixed with any unprocessed fruit, and registered as flavored water or processed juice, the beverages containing flavorings and/or artificial sweeteners, plus any additives for preservation or stabilization. The assessment questionnaire about the consumption of V&F consisted of 5 questions, aimed at evaluating the frequency of consumption of V&F, consumer preference of V&F, health benefits from the consumption of V&F, purchase of V&F in school stores in case they did not bring them from home and parental support so the children could have access to V&F as well as their consumption.

DATA ANALYSIS

A descriptive analysis with percentages, averages and standard deviations of the total sample was performed by gender and type of school (private and public). McNemar test was applied to compare responses related to the school children by gender and type of school; and the Student t test was used for related samples to compare means at the beginning and end of the intervention. A $p < 0.05$ value was considered significant. For the analysis STATA 12 statistical software was used.

ETHICAL CONSIDERATIONS

This research is part of the project Prevention of Overweight and Obesity in School Children of Hidalgo (PESOEH) approved by the Ethics Committee of the School of Health Sciences at the Autonomous University of Hidalgo, which is governed by principles for medical research involving human subjects (Declaration of Helsinki). In all cases we have an informed consent letter which was signed in due course by the parent or guardian and took into account the consent of the child to perform evaluations.

RESULTS

We analyzed data from a total of 226 school children from first to sixth grade; from the initial sample, 20 cases were eliminated for not having some of the criteria defined or for having incomplete data; 49.9% were male and the rest female, the age range was 6 to 12 years, 56% of school children were from private schools and the rest from public schools (Table I).

In the total sample, in men and in public schools, an increase of more than 50 g ($p < 0.05$) was recorded in the intake of vege-

Table I. Vegetables, fruits and drinks average basal and final consumption at school context in the total sample by sex and school type

	Total (n = 226)		Men (n = 112)		Women (n = 114)		Private (n = 127)		Public (n = 99)	
	Initial	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
Food	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*
Vegetables	74 ± 39*	128 ± 52*	69 ± 41*	130 ± 66*	81 ± 36	126 ± 44	73 ± 42	119 ± 50	76 ± 32*	137 ± 58*+
Fruits	146 ± 92	140 ± 58	145 ± 80	135 ± 59	148 ± 66	145 ± 56	142 ± 62	141 ± 58	161 ± 74	139 ± 58
Drinks	*ml/day*	*ml/day*	*ml/day*	*ml/day*	*ml/day*	*ml/day*	*ml/day*	*ml/day*	*ml/day*	*ml/day*
Plain water	503 ± 231*	597 ± 234*	532 ± 240*	613 ± 248*	487 ± 222	518 ± 211	488 ± 219*	534 ± 221*	544 ± 248*	617 ± 248*
Fruit Water	488 ± 205*	531 ± 186*	518 ± 216	514 ± 145	441 ± 185	560 ± 244	425 ± 179	460 ± 103	548 ± 215	619 ± 229
Flavored water or industrialized juice	326 ± 92*	408 ± 132*	361 ± 98	436 ± 170	261 ± 60	388 ± 141	350 ± 110	420 ± 147	305 ± 78	393 ± 160

**p < 0.05 with T-test for related samples.*

tables, without any changes in the amount of fruits. In the total sample, in men and in private and public schools, a significant increase of 100 mL was found in the consumption of plain water. About the consumption of fruit water and flavored water or processed juice, an increase in the amount consumed in the total sample was observed, but only 20% of school children consumed such beverages (Table I).

In the final evaluation a higher proportion of school children who consumed V&F on a daily basis in the total sample and in the private school (McNemar, $p < 0.05$) was recorded; and in these same school children a decrease in the proportion of those who consumed V&F, from 3 to 5 times a week (McNemar, $p < 0.05$) was recorded. No significant changes were observed in public schools (Fig. 2).

Generally speaking, 46% of school children mentioned they prefered to consume vegetables incorporated into a stew, with no significant differences at the beginning and end of the evaluation. In the private school a decrease of 9 points in the preference of consuming raw V&F, and an increase of 8 points in the preference of consuming cooked vegetables was recorded; while in the public school the preference for consuming raw vegetables increased by 8 points (McNemar, $p < 0.05$) (Table II). In the total sample, 90% of school children said they prefered to consume V&F with lemon, chili and salt, and the rest with some seasoning such as cream or yogurt, without differences at the beginning and end of the evaluation (Table II).

In the final evaluation the proportion of school children who identified the health benefits from the consumption of V&F increased by 20 points (68% initial *vs.* 87 final%, McNemar, $p < 0.05$); for example they mentioned that V&F helps them in their development and growth, protects them from diseases and contributes to their health, to have a proper and healthy diet, and because

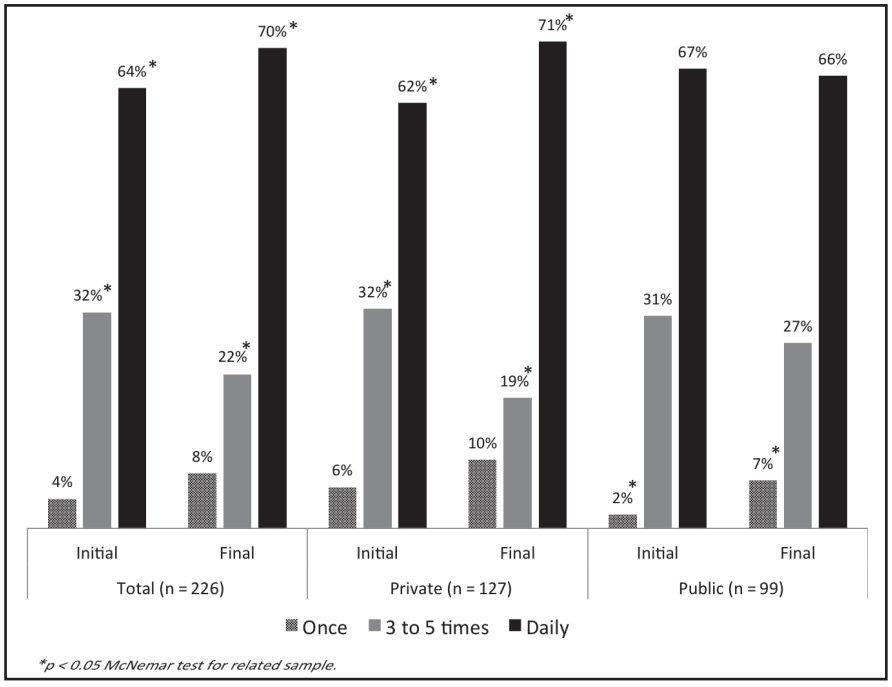

Figure 2.

Frecuence of weekly consumption of vegetables and fruits (V&F) in the total sample of schoolchildren and by school type.

Table II. Preference proportion of schoolchildren vegetables and fruit consumption in the total sample, by sex and school type

	All (%)		Men (%)		Women (%)		Private (%)		Public (%)	
Preference of consumption of V and F	**Intial**	**Final**	**Intial**	**Final**	**Intial**	**Final**	**Intial**	**Final**	**Intial**	**Final**
Raw	25	24	27	26	26	27	30*	21*	19*	29*
Coooked	27	31	29	28	27	26	25*	33*	30	28
In stew	48	45	44	46	47	45	45	46	51	43
With chili, salt and lemon	88	87	86	88	89	88	91	89	91	93
With dressing, cream, or yogurt	12	13	14	12	11	12	9	11	9	7

p < 0.05 McNemar test for related samples.

they provide energy, vitamins and minerals. In the final evaluation school children from private schools recorded a higher increase in the proportion of school children who selected correct answers on the health benefits from the consumption of V&F, compared to public schools (23% and 16%, respectively, McNemar, $p < 0.05$) (Fig. 3). In the final assessment the proportion of school children who reported buying vegetables and fruits (V&F) in school stores (ECE) in case they did not take them from home, increased 17 points, (McNemar, $p < 0.05$). A twofold increase in the purchase of vegetables and fruits (V&F) in school stores (ECE) in private schools, compared to public schools (22% and 11%, respectively, McNemar, $p < 0.05$ was recorded) (Fig. 3). In the final assessment the proportion of students who indicated that their parents supported them to achieve the consumption of vegetables and fruits increased 31 points (McNemar, $p < 0.05$); in both types of schools the increase in this proportion was similar (Fig. 3).

DISCUSSION

In the school children who participated, a significant increase in vegetable consumption was registered, indicating that a campaign of short duration (3 months) informing about the health benefits of vegetables and fruits, promotes its consumption through planning based on tastes and preferences of children, facilitates access in school stores and which has the support of the school community, can be effective to promote the consumption of healthier foods at school. In similar interventions which disseminate information about the benefits of healthy snacks in children and parents are involved, the preferences of healthier food consumption have improved (14); but there is little evidence of the increase in the amount of vegetables consumed. In an intervention where teachers were trained and parents were given informative workshops, only positive changes in knowledge and attitudes regarding V&F were observed, but there was not a significant increase in its consumption, which indicates that to make a quantitative impact it is necessary to modify the environment of school feeding (15), and would explain the significant increase in the consumption of vegetables found in this research, by facilitating access to vegetables and fruits in school stores and parents support.

It is much easier for children to consume fruits than vegetables (16); the latter are less accepted because of their neutral flavor and hard consistency, compared to fruits which are sweet and have a smooth consistency (17); which is an important point to note in this intervention that gave the same priority to V&F, but the significant increase was observed only in vegetables, probably because at the beginning of the intervention they were consumed in small quantities and variety. Other factors that determine the consumption of vegetables are the cost and time required in its preparation (18), so in this intervention we included vegetables that were available in local markets, and in the dissemination material we recommended parents to involve their children in buying, washing, disinfecting and preparing vegetables.

After the intervention, the participating school children consumed on average 268 g of V&F, thereby achieving 70% of the daily intake recommended by the WHO, indicating that the environment generated in schools may be the most important factor for changing consumption patterns. This is confirmed by a study made in 5 countries where the socioeconomic level is not consistently associated with the consumption of V&F, but it was identified that the environment of the area where people live has the potential to influence in their behavior (19).

At the end of the intervention a significant increase in the consumption of plain water was registered school children, indicating that monitoring the type of beverage they consume and a healthier environment in the school grounds can positively influence their consumption habits, as observed in an intervention made in school children in Mexico City, which promoted the modification of the environment and consumption of plain water (13).

Identifying the culinary preferences of consumption of vegetables and fruits in the population is very important to design promotion campaigns appropriate to the cultural practices. In this research it was a constant that half of the students mentioned that they prefer to consume vegetables incorporated into a stew, which could be determined by the cultural practices of the region, where it is common to consume soup-like dishes which feature

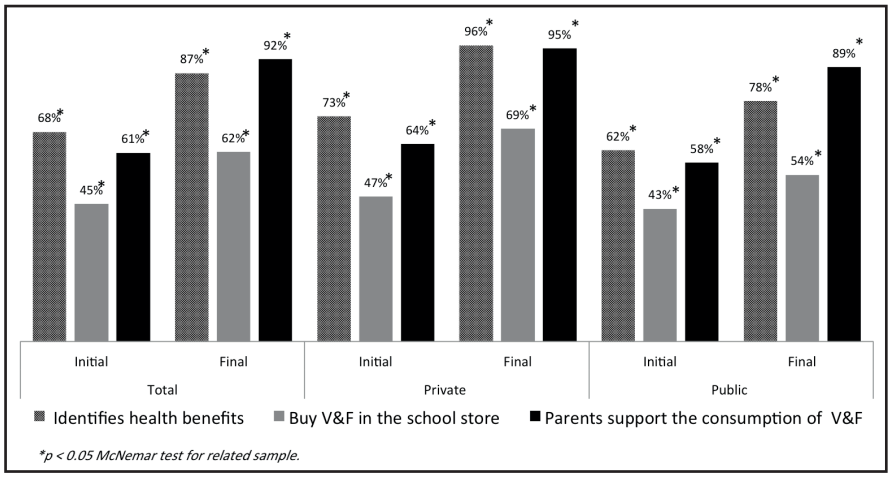

Figure 3.

Contributing factors to consume vegetables and fruits (V&F) at school context in the total sample and by school type.

vegetables. In a study of culinary practices of women in Chiapas, Mexico, it was found that 77% of wild species of vegetables were boiled and 23% cooked (20), so in future interventions correct guidelines for cooking and preserving vegetables must be given, so that the school community benefits from their nutritional properties and health protection.

Generally speaking, school children in this study prefer to add lemon, chili and salt to enhance the flavor of V&F for its consumption. This culinary practice is common among the Mexican population. It has been observed that the addition of a condiment or other food to enhance the flavor of fruits and vegetables is a facilitator for their consumption among children (21); however, it is recommended to moderate their consumption to avoid health risks due to high sodium intake (22), and the possible adverse effects of chili in the digestive tract of children (23). After the intervention, a higher proportion of school children identified the health benefits of consuming V&F, indicating that the messages of the printed material together with the planning action of the consumption of V&F can ease the appropriation of information by children. This has been observed in some interventions, where information is given but the means to adopt healthier behaviors are also provided (15).

Selling fruits and vegetables in school stores was an environment facilitator, an increase in the proportion of school children who bought their share of vegetables or fruits in these places was observed. It has been identified that one of the barriers to buying healthy food in schools is the low availability and high price, so the supply of healthy food and marketing strategies to increase consumption of these foods among school population must be increased. In a study made in Chile with the implementation of healthy kiosks in schools, a significant increase was achieved in buying fruits, milk, yogurt, juice and light juices, dried fruit, healthy sandwiches and fat free ice cream by school children who participated in the study as compared to control group (24).

In this intervention the proportion of school children who reported having the support of their parents to achieve the consumption of vegetables and fruits in school increased; it has been found in other studies that parental encouragement can influence their children to consume V&F, providing them the food and continually encouraging them to consume them (25), so interventions aimed at promoting the consumption of vegetables and fruits in children must train parents and help them prepare more attractive dishes for their children.

A favorable aspect of this study was to include the opinion of children before starting the campaign to promote consumption of vegetables and fruits, as this action prepared them to make a change in their consumption habits. Moreover, the design of the campaign to promote fruit and vegetable consumption was strengthened by the collaboration of marketing and health experts, where the communication strategy enabled to facilitate the appropriation of information by school children. It has been reported that one of the keys to increasing the demand of V&F is in the messages of promotional campaigns, addressing the issue from perspectives that go beyond disease prevention, being sufficiently clear and directed to the target group (26); however, a weakness of this study was not having a control group which allows us to affirm that the observed changes are due solely to the actions taken. In futures studies it is necessary to evaluate whether changes in the consumption of V&F remain after completion of the intervention. It can be concluded that a promotion campaign and improved access to vegetables, fruits and water in the school environment which is supported by parents and teachers can encourage healthier eating at school. It is necessary to implement campaigns to promote the consumption of V&F throughout basic education, for positioning in the minds of school children the benefits and well being provided by their consumption, thus giving them elements to make informed decisions throughout their lives.

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REFERENCES

1. World Health Organization. Diet, nutrition and the prevention of chronic diseases. Report of a Joint FAO/WHO Expert Consultation. WHO Technical Report Series, No. 916. Geneva 2003. Consultado el 19 de noviembre de 2015. Available from: http://whqlibdoc.who.int/trs/WHO_TRS_916.pdf
2. Centers for Disease Control and Prevention. Strategies to Prevent Obesity and other Chronic Diseases: The CDC Guide to Strategies to Increase the Cosuption of Fruit and Vegetables. Atlanta: U.s. Department of Health and Human Services;2011. Consultado el 3 de febrero de 2016. Avaible from: http://www.cdc.gov/obesity/downloads/FandV_2011_WEB_TAG508.pdf
3. Jetter KM, Chalfant JA, Summer DA. Does 5-a-Day Pay? Potential Gains to Growers from Increasing Consumption of Fruits and Vegetables to Recommended Levels in a Cancer Prevention Diet. Agricultural Issues Center AIC Issues Brief 2004;27:1-7. Consultado el 3 de marzo de 2016. Avaible from: http://aic.ucdavis.edu/pub/briefs/brief27.pdf
4. Olivares S, Kain J, Lera L, Pizarro F, Vio F, Moóon C. Nutritional status, food consumption and physical activity among Chilean school children: a descriptive study. Eur J Clin Nutr 2004;58:1278-85.
5. World Health Organization. Obesity, preventing and managing the global epidemic. Report of a WHO Consultation. Geneva: World Health Organization; 1998.
6. Stables G, Heimendinger J. 5 a day for Better Health Program Monograph: Bethesda, MD: National Institute of Health, National Center Institute; 1999.
7. Stables GJ, Subar AF, Patterson BH, Dodd K, Heimendinger J, Van Duyn MA, et al. Changes in vegetable and fruit consumption and awareness among US adults: results of the 1991 and 1997 5 A Day for Better Health Program surveys. J Am Diet Assoc 2002;102:809-17.
8. World Health Organization. Global Strategy on Diet, Physical Activity and Health. WHA57.17. Geneva: World Health Organization; 2004. Consultado el 19 de noviembre de 2015. Avaible from: http://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf?ua=1
9. Galván M, Amezcua-González A, López- Rodríguez G. Perfil Nutricional de Escolares de Hidalgo 2010: Estado de Nutrición y Variables del Contexto Familiar, Escolar e Individual. Pachuca, Hidalgo: Universidad Autónoma del Estado de Hidalgo; 2011. Consultado el 19 de noviembre de 2015. Avaible from: https://pesoehblog.files.wordpress.com/2013/09/libro_penuteh_2010_mg.pdf
10. Royo M, Martín J. Estudios experimentales. En: Royo M, Damiàn J, coordinadores. Método epidemiológico. Madrid: Escuela Nacional de Sanidad; 2009. p. 149-68.
11. Elashoff J.D. nQuery Advisor Version 7.0 User's Guide. Boston, U.S.A; 2007. Consultado el 3 de noviembre de 2015. Avaible from: http://www.statsols.com/wp-content/uploads/2013/10/nQ70_version2_manual.pdf

12. Upton D, Upton P, Taylor C. Increasing children's lunchtime consumption of fruit and vegetables: an evaluation of the Food Dudes programme. Public Health Nutr 2013;16:1066-72.
13. Carriedo A, Bonvecchio A, López N, Morales M, Mena C, Theodore FL, et al. [Use of social marketing to increase water consumption among school-age children in Mexico City]. Salud Publica Mex 2013;55(Suppl 3):388-96.
14. Matvienko O. Impact of a nutrition education curriculum on snack choices of children ages six and seven years. J Nutr Educ Behav 2007;39:281-5.
15. Prelip M, Kinsler J, Thai CL, Erausquin JT, Slusser W. Evaluation of a school-based multicomponent nutrition education program to improve young children's fruit and vegetable consumption. J Nutr Educ Behav 2012;44:310-8.
16. Ransley JK, Greenwood DC, Cade JE, Blenkinsop S, Schagen I, Teeman D, et al. Does the school fruit and vegetable scheme improve children's diet? A non-randomised controlled trial. J Epidemiol Community Health 2007;61:699-703.
17. Prada GE, Dubeibe-Blanco LY, Herran OF, Herrera-Anaya M. [Evaluation of the impact of a community intervention on the consumption of fruits and vegetables in Colombia]. Salud Publica Mex 2007;49:11-9.
18. Krolner R, Rasmussen M, Brug J, Klepp KI, Wind M, Due P. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part II: qualitative studies. Int J Behav Nutr Phys Act 2011;8:112.
19. Ball K, Lamb KE, Costa C, Cutumisu N, Ellaway A, Kamphuis CB, et al. Neighbourhood socioeconomic disadvantage and fruit and vegetable consumption: a seven countries comparison. Int J Behav Nutr Phys Act 2015;12:68.
20. Solís-Becerra C, Estrada-Lugo E. Prácticas culinarias y (re)conocimiento de la diversidad local de verduras silvestres en el colectivo mujeres y maíz de Teopisca, Chiapas, México. LiminaR 2014;12:148-62.
21. Baranowski T, Domel S, Gould R, Baranowski J, Leonard S, Treiber F, et al. Increasing fruit and vegetable consumption among 4th and 5th grade students: results from focus groups using reciprocal determinism. J Nutr Educ 1993;25:114-20.
22. Correia-Costa L, Cosme D, Nogueira-Silva L, Morato M, Sousa T, Moura C, et al. Gender and obesity modify the impact of salt intake on blood pressure in children. Pediatr Nephrol 2016;31:279-88.
23. Maji AK, Banerji P. Phytochemistry and gastrointestinal benefits of the medicinal spice, Capsicum annuum L. (Chilli): a review. J Complement Integr Med 2016. [Epub ahead of print].
24. Bustos N, Kain J, Leyton B, Vio F. [Changes in food consumption pattern among Chilean school children after the implementation of a healthy kiosk]. Arch Latinoam Nutr 2011;61:302-7.
25. Wolnicka K, Taraszewska AM, Jaczewska-Schuetz J, Jarosz M. Factors within the family environment such as parents dietary habits and fruit and vegetable availability have the greatest influence on fruit and vegetable consumption by Polish children. Public Health Nutr 2015;18:2705-11.
26. Olavarria S, Zacarías I. [Barriers and facilitators to increase consumption of fruits and vegetables in six countries in Latin America]. Arch Latinoam Nutr 2011;61:154-62.

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Nutrición Hospitalaria

Trabajo Original

Otros

Ingesta dietética y adherencia a la dieta mediterránea en un grupo de estudiantes universitarios en función de la práctica deportiva

Dietary intake and adherence to the Mediterranean diet in a group of university students depending on the sports practice

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Resumen

Introducción: la alimentación de los jóvenes universitarios se aleja cada vez más de la dieta mediterránea (DM). El binomio alimentación-actividad física es fundamental para mantener un adecuado estado de salud.

Objetivo: comparar la ingesta en un grupo de estudiantes universitarios deportistas frente a otro que no realiza deporte habitualmente.

Sujetos y métodos: estudio observacional transversal realizado en 49 voluntarios de la Universidad de Valladolid. Se determinaron peso, talla y actividad física (cuestionario GPAQ). La ingesta se evaluó a partir de un cuestionario de frecuencia de consumo y un registro de alimentos de 3 días. La adherencia a la DM se estimó con el Mediterranean Diet Score. Las diferencias entre las variables en función del sexo y la práctica deportiva se analizaron con la t de Student o la U-Mann-Whitney. Significación estadística: $p < 0,05$.

Resultados: todos los sujetos presentaron normopeso, sin diferencias en función de la práctica deportiva. El nivel de actividad física fue inferior en las mujeres. En todos los estudiantes la dieta fue ligeramente hiperproteica, rica en grasas y colesterol, con un inadecuado perfil lipídico y deficiente en hidratos de carbono y fibra. Se cubren los requerimientos de micronutrientes. Destaca un escaso consumo de frutas-verduras-hortalizas, cereales, aceite de oliva, pescado y frutos secos; y un exceso de carne, mantequilla, bollería-industrial, dulces, *snacks* y refrescos. El 50% de la muestra tiene una adherencia baja o muy baja a la DM.

Conclusión: las dietas de los jóvenes universitarios no cumplen los objetivos nutricionales para la población española y presentan una adherencia media-baja a la DM, independientemente de la práctica deportiva.

Palabras clave:

Dieta mediterránea. Ingesta. Estudiantes universitarios. Actividad física.

Abstract

Introduction: University students eating habits are moving away increasingly from the Mediterranean Diet (MD) Both nutrition and physical activity are essential to preserve an appropriate health.

Objective: To compare food intake between athletes and sedentary University students.

Subjects and methods: Cross-sectional study conducted on 49 students from the University of Valladolid. The weight and height were determined. The physical activity was evaluated by the GPAQ questionnaire. A food frequency questionnaire and a three-day food record were completed for the food intake analysis. The MD adherence was estimated by the Mediterranean Diet Score (MDS). Differences by sex and sport practice were analyzed with the T-test or with the Mann-Whitney-test. Statistical significance was reached at $p < 0.05$.

Results: All subjects had normal weight with no significant differences depending on the sports practice. Women had a lower physical activity level than men. The diet in the whole sample was slightly hyperproteic, rich in fats and cholesterol, with an inadequate fat profile and poor in carbohydrates and fiber. Generally, the students covered the micronutrients requirements. There was a scarce consumption of fruits and vegetables, cereals, olive oil, fish and nuts; and an excessive intake of meat, butter, processed bakery foods, sweets, snacks and soft drinks. Around 50% of the sample had a low or very low MD adherence.

Conclusion: The University student food pattern does not accomplish the nutritional objectives within the Spanish population and have a medium-low Mediterranean diet adherence, and there are no differences depending on the sports practice.

Key words:

Mediterranean diet. Intake. University students. Physical activity.

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INTRODUCCCIÓN

El acceso a la universidad puede suponer un cambio importante en el estilo de vida para muchos jóvenes: vivir fuera del domicilio familiar, adaptarse a nuevos horarios y actividades, ser responsables de la compra y la alimentación del hogar, etc.

Esta etapa se suele caracterizar por la predilección por alimentos procesados, comidas rápidas y preparadas, bebidas azucaradas y un consumo excesivo de alcohol. Además, no es infrecuente la omisión de algunas de las comidas principales del día y los picoteos entre horas. Es muy habitual que los jóvenes no desayunen y, si lo hacen, es de forma incompleta, sin llegar a aportar el 20% de la energía diaria, y consumiendo alimentos no recomendados, como bollería industrial y zumos procesados, en detrimento de cereales y frutas, lo que conduce a un exceso de azúcares simples y grasas saturadas (1). También se observa un desequilibrio en el aporte de la energía a lo largo del día, con comidas y cenas copiosas, con una elevada densidad energética y un escaso aporte de energía durante la mañana (2).

Respecto al consumo de alimentos, el patrón alimentario de los jóvenes se caracteriza por un excesivo consumo de carnes y derivados cárnicos, grasas y azúcares refinados, con una baja ingesta de frutas y verduras, cereales, legumbres, pescado y aceite de oliva (2-4). Todo ello se traduce en una ingesta elevada de azúcares simples, proteínas de origen animal, colesterol y grasas saturadas, que, en contraposición al bajo aporte de grasas insaturadas y fibra, presenta un perfil lipídico inadecuado.

Estos hábitos alimentarios inadecuados, junto con el sedentarismo, son los principales factores asociados al aumento del riesgo de enfermedades crónicas de alta prevalencia en el mundo desarrollado. Por tanto, mantener los buenos hábitos alimentarios aprendidos en la infancia, o adquirir nuevos hábitos saludables en este periodo, es crucial.

Dieta equilibrada es aquella que aporta todos los nutrientes necesarios para cubrir los requerimientos fisiológicos, mantener un adecuado nivel de actividad física y promover la salud. No existe un único modelo de dieta saludable, sino que esta se puede alcanzar combinando los alimentos de diversas maneras para conseguir una dieta equilibrada.

La dieta mediterránea (DM) es un patrón de dieta equilibrada caracterizada por un consumo elevado de frutas y verduras frescas, cereales integrales, legumbres, frutos secos, aceite de oliva como grasa principal, un consumo moderado de vino tinto, lácteos, pescados y carne magra, y un escaso consumo de carnes rojas y embutidos (5). Se trata, por tanto, de un patrón de alimentación equilibrado, rico en fibra, antioxidantes y grasas insaturadas. Además, el concepto de DM también incluye hábitos de vida saludables, como el consumo de productos locales y de temporada, una buena hidratación, la práctica de actividad física regular, etc.

Diversos estudios han observado que una alta adherencia a la DM se asocia inversamente con patologías crónicas de alta prevalencia, como algunos tipos de cáncer (6), hipertensión (7), diabetes de tipo 2 (8) o síndrome metabólico (9). Por otra parte, mantener una vida físicamente activa se ha relacionado con un descenso en la mortalidad: realizar 30 minutos de actividad moderada casi todos los días de la semana reduce la mortalidad un 27% (10).

Sin embargo, en nuestro país en los últimos años se ha impuesto el modelo de dieta occidental en detrimento del patrón de DM, siendo este alejamiento más evidente entre los jóvenes (11,12). Los pocos estudios existentes sobre los hábitos alimentarios y la calidad de la dieta en los estudiantes universitarios españoles también han evidenciado la existencia de un patrón de alimentación poco saludable (4). No obstante, actualmente no hemos encontrado estudios que analicen las diferencias en los hábitos alimentarios y en la calidad de la dieta de estudiantes universitarios en función de la práctica de actividad física, por lo que el objetivo del presente estudio fue comparar la ingesta alimentaria y el grado de adherencia a la dieta mediterránea en un grupo de estudiantes universitarios deportistas frente a otro que no realiza actividad física regular.

SUJETOS Y MÉTODOS

DISEÑO Y SUJETOS

Estudio descriptivo transversal llevado a cabo en una muestra de estudiantes voluntarios de la Universidad de Valladolid procedentes de diferentes titulaciones. Como criterios de inclusión se admitieron aquellos estudiantes que estuviesen dispuestos a participar en el estudio, a cumplimentar los cuestionarios necesarios y a acudir a la Unidad de Valoración del Estado Nutricional de la Facultad de Medicina para someterse a una valoración del estado nutricional. Finalmente se seleccionaron 49 sujetos, 27 estudiantes que no practicaban actividad física regular (no deportistas) y 22 estudiantes de los equipos de baloncesto y bádminton de la Universidad de Valladolid (deportistas). Los participantes fueron debidamente informados sobre el objetivo del estudio y el protocolo de recogida de información. Todos firmaron el consentimiento informado y se obtuvo la aprobación del Comité Ético del centro.

La recogida de información tuvo lugar entre los meses de febrero y marzo de 2015. Los voluntarios fueron citados en diferentes días para que acudieran a la Unidad de Valoración del Estado Nutricional de la Facultad de Medicina, donde se realizó una entrevista personal que incluía un cuestionario de frecuencia de consumo de alimentos y el Cuestionario Mundial sobre Actividad Física (GPAQ); se realizó una valoración antropométrica y se proporcionó a los voluntarios un registro alimentario de tres días (tres días no consecutivos, uno de ellos festivo), que debían cumplimentar siguiendo las indicaciones que les fueron facilitadas.

ANÁLISIS DE LA INGESTA

Para analizar el patrón de consumo de los participantes, la frecuencia de consumo de los principales grupos de alimentos y poder, posteriormente, evaluar la adherencia a la DM se empleó un cuestionario de frecuencia de consumo de alimentos (CFC) semi-

cuantitativo validado para la población española (13). A partir de los datos recogidos en el CFC se estimó la frecuencia de consumo de los principales grupos de alimentos (cereales y patatas, verduras y hortalizas, frutas, lácteos, aceite de oliva, carnes magras, pescados, huevos, legumbres, carnes grasas y embutidos, otras grasas y bollería y dulces), teniendo en cuenta los tamaños de ración consumidos en cada caso y el tamaño establecido para las raciones dietéticas (14). La frecuencia obtenida se comparó con las recomendaciones de la *Guía Alimentaria para la Población Sana Española* (14).

La adherencia a la dieta mediterránea se estimó mediante el cálculo del *Mediterranean Diet Score* (MDS) diseñado por Trichopoulou y cols. (6). Este índice se calcula asignando un valor de 0 o de 1 a nueve componentes de la ingesta diaria. Brevemente, se asigna un valor de 1 si el consumo de los alimentos que se consideran protectores o beneficiosos es igual o superior a la mediana de la ingesta de estos alimentos por sexo y edad, y si el consumo de los alimentos que se consideran perjudiciales es inferior a la mediana de la ingesta de esos alimentos por sexo y edad; y se asigna un valor de 0 en caso contrario. Para la ingesta de etanol, se asigna un valor de 1 si los varones consumen entre 10 y 50 g de etanol/día y las mujeres entre 5 y 25 g/d; y se asigna un 0 si están fuera de esos límites. En este estudio, para calcular el MDS, como punto de corte para la asignación del valor de cada ítem (0/1) se ha empleado la mediana de ingesta de la cohorte SUN (7,15). Aunque para el cálculo del MDS debe tenerse en cuenta la mediana de ingesta por sexo y edad de los diferentes alimentos de la población analizada, dado el reducido tamaño de la muestra estudiada, se ha decidido emplear los datos de ingesta de una gran muestra de población española de edades similares a las nuestras (7,15). El valor del MDS varía entre 0 (mínima adherencia a la DM) y 9 (máxima adherencia). Las puntuaciones del MDS se interpretan de la siguiente manera: 1) puntuación de 0 a 4: baja adherencia a la DM; 2) puntuación entre 4 y 6: adherencia intermedia, y 3) puntuación superior a 6: adherencia elevada.

La adecuación de la ingesta de energía, macronutrientes (perfil calórico), perfil lipídico y fibra se realizó mediante la comparación con los *objetivos nutricionales* para la población española (16). El análisis nutricional de la dieta se realizó con los datos obtenidos a partir del registro dietético de tres días, utilizando el programa informático Easy Diet, basado en las tablas de composición de alimentos españoles (17).

ESTIMACIÓN DEL NIVEL DE ACTIVIDAD FÍSICA

Para evaluar el nivel de actividad física de los participantes se utilizó el instrumento GPAQ (cuestionario mundial sobre la práctica de actividad física), versión 2, diseñado y validado por la Organización Mundial de la Salud (OMS) (18), en su versión en español.

DETERMINACIONES ANTROPOMÉTRICAS

Las mediciones antropométricas (peso, talla) fueron realizadas por el mismo explorador, siguiendo los protocolos del National Health and Nutrition Examination Survey (NHANES) (19) y de la OMS (20). El peso corporal se determinó con una báscula SECA (Hamburgo, Alemania), con una precisión de 100 g; y la talla se midió con un tallímetro SECA (Hamburgo, Alemania), con una precisión de 0,1 cm.

ANÁLISIS ESTADÍSTICO

El análisis estadístico se realizó con el paquete estadístico SPSS 19.0 para Windows. La normalidad de las variables se determinó mediante el test de Kolmogorov-Smirnov o Shapiro-Wilk. Para evaluar las diferencias entre las distintas variables en función de una variable dicotómica (sexo, deportista) se empleó la t de Student para medidas independientes o la U de Mann-Whitney, en función de la normalidad de las variables. La significación estadística se alcanzó con $p < 0,05$.

RESULTADOS

La muestra de estudio estuvo formada por un grupo de 49 universitarios, 17 varones (34,7%) y 32 (65,3%) mujeres, con una edad media de 22,4 (20,9-23,0) años. El índice de masa corporal (IMC) medio de los varones fue significativamente mayor que el de las mujeres: 22,9 kg/m^2 (2,0) frente a 21,3 kg/m^2 (2,1). No obstante, las diferencias no fueron significativas, ni estadística ni clínicamente (en ambos sexos el IMC indicaba normopeso). Tampoco se encontraron diferencias significativas en hombres y en mujeres en función de la práctica de actividad física regular (Tabla I).

En la figura 1 se muestra el nivel de actividad física en hombres y mujeres en función de la práctica de actividad física. Como se puede observar, el nivel de actividad física de las mujeres que practicaban deporte universitario fue inferior al de los hombres que también lo practicaban. En cambio, entre los no deportistas,

Tabla I. Características de la muestra

	Hombres		Mujeres	
	ND (n = 7)	D (n = 10)	ND (n = 20)	D (n = 12)
Edad (años)	22,8 (3,2)	22,2 (2,4)	21,7 (1,3)	23,5 (3,8)
Peso (kg)	72,7 (6,9)	78,1 (6,2)	56,7 (7,7)	56,3 (53,4-59,6)
Talla (m)	1,74 (1,72-1,86)	1,85 (0,10)	1,62 (0,07)	1,62 (1,60-1,72)
IMC (kg/m^2)	22,9 (2,0)	22,9 (2,1)	21,5 (2,3)	21,0 (1,7)

ND: no deportistas; D: deportistas; IMC: índice de masa corporal. Los resultados se describen como media (DE) o mediana (intervalo intercuartil).

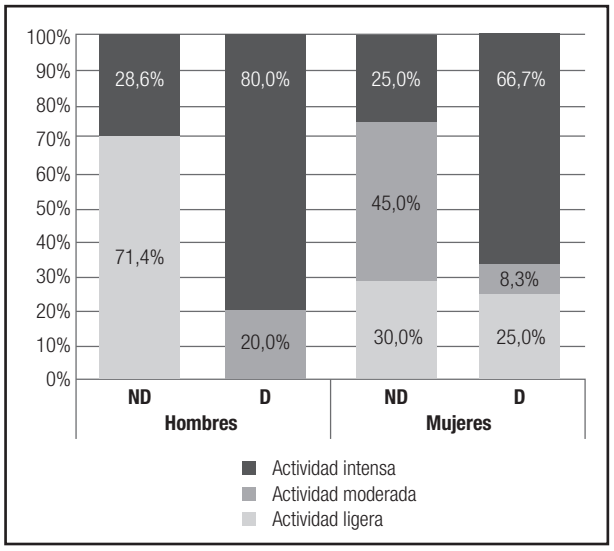

Figura 1.

Nivel de actividad física: catalogación según el cuestionario GPAG.

casi la mitad de las mujeres realizaban actividades moderadas, mientras que los varones presentaron mayoritariamente una actividad ligera.

El análisis de la ingesta dietética se muestra en la tabla II. No se observaron diferencias estadísticamente significativas en ninguna de las variables analizadas en función de la actividad física ni en los hombres ni en las mujeres, a excepción del hierro, cuyo aporte dietético en las mujeres que practicaban deporte universitario fue superior al de las que no lo practicaban. A pesar de que no se observaron diferencias estadísticamente significativas en el resto de las variables, cabe destacar que el aporte energético de la dieta fue superior en los estudiantes que practicaban actividad física regular con respecto a los que no la practicaban, tanto en hombres como en mujeres. Además, en ambos casos el incremento en el aporte energético provenía de hidratos de carbono (HCO), aunque en ninguno de los grupos se alcanzó el objetivo nutricional (> 50% del valor calórico total). El perfil lipídico y el criterio de calidad de la grasa dietética de ácidos grasos monoinsaturados (AGM) y ácidos grasos poliinsaturados (AGP)/saturados (AGS) tampoco alcanzó los objetivos nutricionales (ON) en las mujeres,

Tabla II. Análisis de la ingesta dietética

	Hombres		Mujeres	
	ND (n = 7)	D (n = 10)	ND (n = 20)	D (n = 12)
Valor calórico, perfil calórico y lipídico de la dieta				
Energía (kcal)	2.358,6 (520,6)	2.987,1 (1.236,4)	1.715,5 (402,1)	2.015,3 (470,1)
HCO (%)	42,7 (7,5)	45,1 (4,5)	41,3 (5,8)	43,9 (6,2)
Prot. (%)	18,9 (10,0)	17,3 (2,8)	18,7 (5,3)	18,2 (2,7)
Grasa (%)	35,4 (5,3)	36,8 (4,9)	39,0 (5,8)	38,2 (5,2)
AGM (%)	14,6 (1,8)	13,4 (5,3)	16,4 (3,1)	16,3 (3,2)
AGP (%)	5,4 (1,6)	5,8 (2,1)	6,2 (2,2)	5,8 (1,5)
AGS (%)	12,7 (2,9)	9,7 (4,6)	12,7 (3,5)	12,1 (3,1)
Índices de calidad de la dieta				
(AGM+AGP)/AGS	1,7 (0,5)	2,3 (1,0)	1,8 (1,5-2,2)	1,9 (0,5)
Fibra (g/1.000 kcal)	10,2 (4,1)	8,0 (7,2-13,4)	9,8 (8,0-13,8)	10,5 (2,3)
Col. (mg/1.000 kcal)	172,5 (43,7)	162,3 (140,2-178,4)	180,4 (63,4)	177,6 (53,9)
Vitamina E/AGP (mg/g)	0,69 (0,18)	0,73 (0,68-0,89)	0,71 (0,22)	0,74 (0,17)
Vitamina B6/Prot. (mg/g)	0,025 (0,023-0,029)	0,025 (0,007)	0,024 (0.022–0.029)	0,025 (0,005)
Ca/P	0,6 (0,2)	0,5 (0,1)	0,6 (0,1)	0,6 (0,1)
Na/K	0,9 (0,3)	1,0 (0,4)	0,9 (0,3)	0,9 (0,2)
Nutrientes de riesgo				
Na (mg)	3.224,8 (1.022,6)	4.119,0 (1.423,5)	2.393,4 (782,1)	2.890,2 (620,5)
Ácido fólico (µg)	356,3 (81,9)	425,3 (172,9)	272,0 (98,8)	319,4 (86,0)
Ca (mg)	1.000,4 (257,2)	933,5 (726,7-1.086,0)	762,3 (227,8)	848,5 (234,4)
Fe (mg)	16,0 (3,8)	18,3 (5,7)	10,4 (8,2-11,0)[a]	13,0 (3,8)

ND: no deportistas; D: deportistas; HCO: hidratos de carbono; Prot.: proteínas; AG: ácidos grasos monoinsaturados; AGP: ácidos grasos poliinsaturados; AGS: ácidos grasos saturados; Col.: colesterol; Ca: calcio; P: fósforo; Na: sodio; K: potasio; Fe: hierro.

Los resultados se describen como media (DE) o mediana (intervalo intercuartil).

[a]p < 0,05 respecto a los deportistas del mismo sexo.

independientemente de la práctica de deporte universitario, ni en los hombres que no practicaban actividad física regular. En cambio, en los hombres que sí practicaban actividad física el porcentaje de AGS fue inferior al 10% (ON intermedio) y el criterio de calidad de la grasa también se ajustó a los ON (> 2). La densidad nutricional del colesterol fue elevada y la de la fibra reducida tanto en hombres como en mujeres, independientemente de la práctica de actividad física. Por último, las ratios vitamina E/AGP y vitamina B6/proteína fueron adecuadas en todos los subgrupos (> 0,6 mg/g y > 0,02 mg/g, respectivamente).

En cuanto al patrón de ingesta de los estudiantes (frecuencia de consumo), en términos globales destaca por un escaso consumo de frutas, verduras y hortalizas, cereales, aceite de oliva, pescado y frutos secos, y un consumo excesivo de carne, mantequilla, bollería industrial, dulces, *snacks* y refrescos. El consumo de lácteos, huevos, vino y cerveza fue acorde a las recomendaciones. No se encontraron diferencias significativas en función de la práctica de actividad física regular, ni en los hombres ni en las mujeres (Tabla III).

Por último, el grado de adherencia a la DM fue, en términos globales, bajo. En torno al 50% de la muestra, en ambos sexos, presentó una adherencia baja o muy baja. Los hombres deportistas tenían mayor adherencia a la DM que los no deportistas, al contrario de lo que ocurrió en el grupo de mujeres. La adherencia a la DM de las mujeres deportistas fue menor que la de los hombres deportistas (Fig. 2).

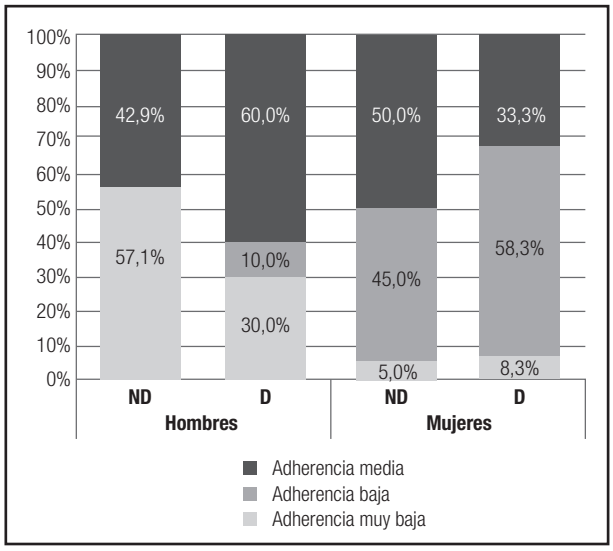

Figura 2.
Adherencia a la dieta mediterránea.

DISCUSIÓN

En este trabajo se ha estudiado la ingesta de un grupo de estudiantes de la Universidad de Valladolid comparando la de aquellos

Tabla III. Frecuencia de consumo de alimentos

	Hombres		Mujeres	
	ND (n = 7)	D (n = 10)	ND (n = 20)	D (n = 12)
Frutas (r/d)	1,5 (1,0)	2,8 (1,7)	2,1 (1,4)	2,0 (0,8)
Verduras y hortalizas (r/d)	1,3 (0,9)	1,0 (0,6-2,4)	1,8 (1,0)	1,8 (1,0)
Pan, cereales, cereales integrales, arroz, pasta, patatas (r/d)	3,2 (2,4-5,5)	2,2 (1,7-3,3)	2,1 (1,3-3,6)	2,6 (1,4)
Lácteos y derivados (r/d)	2,3 (1,1-2,5)	2,8 (1,7)	1,6 (1,1-2,8)	2,2 (0,9)
Aceite de oliva (r/d)	2,0 (1,0-2,0)	2,1 (1,4)	2,4 (1,4)	2,8 (1,7)
Pescados y mariscos (r/s)	3,0 (1,9)	3,5 (1,5)	2,8 (2,0)	2,5 (1,5)
Carnes magras (r/s)	9,2 (2,5)	8,7 (4,0)	5,4 (2,8)	5,0 (2,9)
Huevos (r/s)	3,0 (3,0-3,0)	3,0 (3,0-5,4)	3,0 (1,0-3,0)	3,0 (1,5-3,0)
Legumbres (r/s)	6,4 (3,0-6,4)	6,5 (2,6)	4,2 (3,0-5,3)	4,7 (3,9)
Frutos secos (r/s)	0,6 (0,6-2,4)	1,4 (1,0-3,0)	1,1 (0,6-2,2)	0,3 (0,0-1,1)
Carnes grasas y procesadas (r/s)	3,4 (2,3)	3,3 (2,2-6,9)	1,8 (1,4)	2,4 (1,1)
Mantequilla, margarina y bollería industrial (r/d)	2,0 (1,7-4,0)	3,9 (2,4)	2,5 (1,3)	2,9 (1,9)
Dulces, *snacks* y refrescos (r/s)	11,4 (5,1-21,4)	10,9 (5,4)	10,5 (7,0)	3,6 (2,1-24,2)
Bebidas de alta graduación (r/s)	0,6 (0,0-1,2)	1,2 (0,4-1,9)	0,6 (0,0-1,2)	0,6 (0,0-1,1)
Vino y cerveza (r/d)	0,1 (0,0-0,7)	0,3 (0,2-1,0)	0,5 (0,1-0,8)	0,2 (0,0-0,8)

D: deportistas; MD: no deportistas; r/d: raciones por día; r/s: raciones por semana.
Los resultados se describen como media (DE) o mediana (intervalo intercuartil).

que formaban parte de equipos deportivos con la de estudiantes que no practicaban actividad física habitualmente.

El valor medio del IMC de los universitarios evaluados indicó normalidad nutricional, sin diferencias significativas en función de la práctica deportiva, ni en varones ni en mujeres. Estos resultados coinciden con los obtenidos en otros estudios que han documentado que la mayoría de los universitarios españoles se encuentra dentro de la categoría de normopeso (2,4,21,22), aunque en algunas zonas, principalmente del sur de España, se ha observado una alta prevalencia de sobrepeso y obesidad entre los jóvenes (23).

La actividad física se analizó utilizando el GPAQ, que tiene en cuenta la actividad realizada en el trabajo, en los desplazamientos y en el tiempo libre. A pesar de ser un método subjetivo, su reproducibilidad es mejor que la de otros cuestionarios como el Cuestionario Internacional de Actividad Física (IPAQ) (24). El nivel de actividad física en varones fue similar al observado en otros estudios (25) y coherente con el grupo al que pertenecían, no habiendo ocurrido así en las mujeres. A este respecto, hay que tener en cuenta que el cuestionario GPAQ, a pesar de que está validado (26,27), sobreestima la actividad física de personas sedentarias (28). En este sentido, es posible que las mujeres del presente trabajo hayan sobreestimado la actividad física que realizan. Por otra parte, también conviene considerar que el deporte universitario es una actividad lúdica que, aunque tiene un componente competitivo considerable, no está sujeto a las exigencias del deporte de élite, ni en cuanto a la condición física requerida, ni al nivel de entrenamiento y competición. Por lo tanto, los sujetos estudiados deben considerarse como población general activa.

En cuanto al análisis de la ingesta, la dieta de los universitarios evaluados es adecuada desde el punto de vista energético, como se ha observado en otros estudios (4,29). No obstante, el perfil calórico es desequilibrado en ambos sexos, independientemente de la práctica deportiva, y se ha observado un excesivo aporte de grasas y proteínas en detrimento de los HCO, lo que puede explicarse por la elevada ingesta de carne y sus derivados, bollería industrial, mantequilla y *snacks*. Este perfil es muy habitual en el colectivo universitario (4,23), y en la población general (30). Otros trabajos, en cambio, han observado perfiles más adecuados en estudiantes universitarios (31).

En cuanto al perfil lipídico, las mujeres presentaron un consumo adecuado de AGM y AGP, pero elevado de AGS, igual que los varones, aunque en estos el consumo de AGM fue ligeramente inferior de lo recomendado. Estos resultados coinciden con los datos del estudio ENIDE sobre jóvenes de entre 18 y 24 años (32). La ingesta de colesterol en ambos grupos fue muy elevada. Todo ello indica que la dieta de los estudiantes evaluados era potencialmente aterogénica. Este perfil lipídico se ha documentado en otros trabajos realizados en universitarios (30,31). También se observó un aporte de fibra dietética escaso, sin diferencias significativas en función del sexo o de la práctica deportiva, lo que ya se ha documentado en otros grupos (29-31,33). Esta reducida ingesta de fibra se debe al escaso aporte de frutas, verduras y cereales.

Para analizar la adherencia a la DM se empleó el MDS diseñado por Trichopoulou y cols. (6). Este cuestionario indicó que en torno a la mitad de la muestra evaluada presentó una adherencia baja o muy baja a la dieta mediterránea, con diferencias en función del sexo y de la actividad física: los varones deportistas tenían mayor adherencia que los sedentarios, mientras que en las mujeres ocurría lo contrario. Estos resultados resultan llamativos, ya que habitualmente las principales motivaciones de las mujeres universitarias para practicar actividad física están relacionadas con el mantenimiento de la forma física, la salud y la imagen personal, mientras que en los varones están más relacionadas con la competición y las relaciones sociales (34). Por ello cabría esperar que la adherencia a la DM fuese mayor en las mujeres deportistas frente a las que no practicaban actividad física regular.

CONCLUSIONES

El análisis cuantitativo y cualitativo de la dieta evidencia que, efectivamente, los jóvenes universitarios no siguen un patrón de dieta mediterráneo, sino que se acercan más al modelo de dieta occidental, y en nuestra muestra esto es independiente de la práctica de actividad física regular.

BIBLIOGRAFÍA

1. Dura Travé T. Análisis nutricional del desayuno y almuerzo en adolescentes. Acta Pediatr Esp 2006;64:269-75.
2. Ruiz Moreno E, Del Pozo de la Calle S, Valero Gaspar T, Ávila Torres JM, Varela-Moreiras G. Estudio de hábitos alimentarios y estilos de vida de los universitarios españoles. Patrón de consumo de bebidas fermentadas. Madrid: Fundación Española de la Nutrición (FEN).
3. Bollat Montenegro P, Durá Travé T. Modelo dietético de los universitarios. Nutr Hosp 2008;23(6):619-29.
4. Cervera Burriel F, Serrano Urrea R, Vico García C, Milla Tobarra M, García Meseguer MJ. Hábitos alimentarios y evaluación nutricional en una población universitaria. Nutr Hosp 2013;28:438-46.
5. Willett WC, Sacks F, Trichopoulou A, et al. Mediterranean diet pyramid. Am J Clin Nutr 1995;61(6):1402-6.
6. Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a mediterranean diet and survival in a Greek population. N Engl J Med 2003;348(26):2599-608.
7. Seguí Gómez M, De la Fuente C, Vázquez Z, De Irala J, Martínez González MA. Cohort profile: The "Seguimiento Universidad de Navarra" (SUN) Study. Int J Epidemiol 2006;35:1417-22.
8. Estruch R, Ros E, Salas Salvadó J, Covas MI, Corella D, Arós F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. N Engl J Med 2013;368(14):1279-90.
9. Babio N, Bulló M, Basora J, Martínez-González MA, Fernández-Ballart J, Márquez-Sandoval F, et al. Adherence to the Mediterranean diet and risk of metabolic syndrome and its components. Nutr Metab Cardiovasc Dis 2009;19(8):563-70.
10. Leitzmann MF, Park Y, Blair A, Ballard-Barbash R, Mouw T, Hollenbeck AR, Schatzkin A. Physical activity recommendations and decreased risk of mortality. Arch Intern Med 2007;167(22):2453-60.
11. Durá Travé T, Castroviejo Gandarias A. Adherencia a la dieta mediterránea en población universitaria. Nutr Hosp 2011;26(3):602-8.
12. Ortiz-Moncada R, Norte Navarro AI, Zaragoza Marti A, Fernández Sáez J, Davó Blanes MC. ¿Siguen patrones de dieta mediterránea los universitarios españoles? Nutr Hosp 2012;27(6):1954-9.
13. Martín-Moreno JM, Boyle P, Gorgojo L, Maisonneuve P, Fernández-Rodríguez JC, Salvini S, et al. Development and validation of a food frequency questionnaire in Spain. Int J Epidemiol 1993;22(3):512-9.
14. Dapcich V, Salvador Castell G, Ribas Barba L, Pérez Rodrigo C, Aranceta Bartrina J, Serra Majem LI. Guía de la alimentación saludable. Madrid: Sociedad Española de Nutrición Comunitaria (SENC); 2004.

15. Martínez-González MA, García-López M, Bes-Rastrollo M, Toledo E, Martínez-Lapiscina EH, Delgado-Rodríguez M, et al. Mediterranean diet and the incidence of cardiovascular disease: A Spanish cohort. Nutr, Metab Cardiovasc Dis 2011;21(4):237-44.
16. Consenso de la Sociedad Española de Nutrición Comunitaria 2011. Objetivos nutricionales para la población española. Rev Esp Nutr Comunitaria 2011;17(4):178-99.
17. Farran A, Zamora R, Cervera P. Tablas de composición de alimentos del CESNID. 2.a ed edición. Barcelona: Edicions Universitat de Barcelona; Madrid: McGraw-Hill Intertamericana de España; 2004.
18. Global Physical Activity Questionnaire (GPAQ). Analysis guide. World Health Organization. [Consultado última vez el 26/06/2015]. Disponible en: http://www.who.int/chp/steps/resources/GPAQ_Analysis_Guide.pdf
19. NHANES. CDC. Anthropometry Procedures Manual; 2007.
20. WHO. Report of a WHO Expert Committee. Physical Status: The Use and Interpretation of Anthropometry. Geneva: WHO Technical Report Series; 1995.
21. Arroyo Izaga M, Rocandio Pablo AM, Ansótegui Alday L, Pascual Apalauza E, Salces Beti I, Rebato Ochoa E. Calidad de la dieta, sobrepeso y obesidad en estudiantes universitarios. Nutr Hosp 2006;21(6):673-9.
22. Moreno-Gómez C, Romaguera-Bosch D, Tauler-Riera P, Bennasar-Veny M, Pericas-Beltran J, Martínez-Andreu S, et al. Clustering of lifestyle factors in Spanish university students: the relationship between smoking, alcohol consumption, physical activity and diet quality. Public Health Nutr 2012;15(11):2131-9.
23. Cutillas AB, Herrero E, De San Eustaquio A, Zamora S, Pérez-Llamas F. Prevalencia de peso insuficiente, sobrepeso y obesidad, ingesta de energía y perfil calórico de la dieta de estudiantes universitarios de la Comunidad Autónoma de la Región de Murcia (España). Nutr Hosp 2013;28(3):683-9.
24. Angarita A, Camargo DM, Oróstegui I. Reproducibilidad del tiempo en posición sedente evaluado con el International Physical Activity Questionnaire (IPAQ) y el Global Physical Activity Questionnaire (GPAQ). MedUNAB 2010;13:5-12.
25. Farinola MG, Bazán NE, Laíño FA, Santa María CJ. Actividad física y conducta sedentaria en estudiantes terciarios y universitarios de la Región Metropolitana de Buenos Aires. Rev Bras Cienc Movim 2012;20:79-90.
26. Hoos T, Espinoza N, Marshall S, Elva M, Arredondo EM. Validity of the Global Physical Activity Questionnaire (GPAQ) in Adult Latinas. J Phys Act Health 2012;9(5):698-705.
27. Misra P, Upadhyay RP, Krishnan A, Sharma N, Kapoor SK. A Community Based Study to Test the Reliability and Validity of Physical Activity Measurement Techniques. Int J Prev Med 2014;5(8):952-9.
28. Claire L, Cleland CL, Ruth F, Hunter RF, Kee F, Cupples ME, et al. Validity of the Global Physical Activity Questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. Cleland et al. BMC Public Health 2014;14:1255.
29. Montero Bravo A, Úbeda Martín N, García González A. Evaluación de los hábitos alimentarios de una población de estudiantes universitarios en relación con sus conocimientos nutricionales. Nutr Hosp 2006;21(4):466-73.
30. Alegría-Lertxundi I, Rocandio AM, Telletxea S, Rincón E, Arroyo-Izaga M. Relación entre el consumo de pescado y carne y la adecuación y calidad de la dieta en mujeres jóvenes universitarias. Nutr Hosp 2014;30(5).
31. Martínez Roldán C, Veiga Herreros P, López de Andrés, Cobo Sanz JM, Carbajal Azcona A. Evaluación del estado nutricional de un grupo de estudiantes universitarios mediante parámetros dietéticos y de composición corporal. Nutr Hosp 2005;20:197-203.
32. ENIDE. Evaluación nutricional de la dieta española I. Energía y macronutrientes. Agencia Española de Seguridad Alimentaria y Nutrición (AESAN). Ministerio de Sanidad, Servicios Sociales e Igualdad. [Consultado el 23 de abril de 2015]. Disponible en: http://aesan.msssi.gob.es/AESAN/docs/docs/evaluacion_riesgos/estudios_evaluacion_nutricional/valoracion_nutricional_enide_macronutrientes.pdf
33. Valoración de la dieta española de acuerdo al Panel de Consumo Alimentario. Madrid: Fundación Española de la Nutrición (FEN); 2012.
34. Pavón Lores A, Moreno Murcia JA, Gutiérrez Sanmartín M, Silicia Camacho A. Motivos de práctica físico-deportiva según la edad y el género en una muestra de universitarios. Ciencias aplicadas a la actividad física y el deporte 2004;76:13-21.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Otros

Lifestyle and vitamin D dosage in women with breast cancer

Relación de la vitamina D y el ejercicio físico en mujeres con cáncer de mama

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Abstract

Introduction: The prevention strategy of breast cancer is still the key factor for early diagnosis and the most effective method for tracking the disease.

Objective: This study aimed to evaluate the association vitamin D level with breast cancer in women.

Methods: This hospital case-control study was conducted with 181 women with breast cancer and 197 healthy controls. Vitamin D status, calcium, phosphorus and PTH serum dosage and data collection related to lifestyle and patient's history, besides anthropometric measurements were performed. Univariate analysis (Chi-square and raw odds ratio) and multivariate analysis were performed through multivariate logistic regression.

Results: This study shows a higher value of vitamin D in health controls (26.9 mg/dL) than in breast cancer women (24.8 mg/dL). Higher numbers of women with sufficient vitamin D status (34.85%) were found in control group than cancer group. Using the multiple logistic regression model, the family history of breast cancer (OR 36.37, 95%CI 4.75-278.50) and menopause (OR 5.17, 95% CI 2.72-9.80) had a direct association with breast cancer, while the level of vitamin D (OR 0.95, 95%CI 0.91-0.99) and moderate physical activity (OR 0.31, 95%CI 0.10-0.93) maintained the inverse associations with the disease.

Conclusion: Vitamin D status and the practice of moderate physical activity were considered protective factors for breast cancer. However, menopause and family history of breast cancer were considered a risk factor for breast cancer.

Key words:

Breast cancer. Vitamin D. Menopause. Physical activity. Case-control study.

Resumen

Introducción: la estrategia de prevención del cáncer de mama sigue siendo el factor clave para el diagnóstico precoz y el método más eficaz para el seguimiento de la enfermedad.

Objetivo: este estudio tuvo como objetivo evaluar el nivel de vitamina D asociado con el cáncer de mama en las mujeres.

Métodos: este estudio de casos y controles hospitalarios se llevó a cabo con 181 mujeres con cáncer de mama y 197 controles sanas. Se estudió el nivel de vitamina D, calcio, fósforo y la dosis de suero PTH; se recopilaron de datos relacionados con el estilo de vida y com la historia de las pacientes, además se realizaron mediciones antropométricas. El análisis univariante (Chi-cuadrado probabilidades y primas ratio) y el análisis multivariado se realizó mediante regresión logística multivariante.

Resultados: este estudio muestra un valor más alto de vitamina D en los controles de salud (26,9 mg/dl) que en las mujeres con cáncer de mama (24,8 mg/dl). Se encontraron más mujeres con suficiente vitamina D (34,85%) en el grupo control que en el grupo de cáncer. Usando el modelo de regresión logística múltiple, la historia familiar de cáncer de mama (OR 36,37; IC del 95%: 4,75 a 278,50) y la menopausia (OR 5,17; IC del 95%: 2,72 a 9,80) se halló una relación directa con el cáncer de mama, mientras que el nivel de vitamina D (OR 0,95; IC del 95%: 0,91 a 0,99) y la actividad física moderada (OR 0,31; IC del 95%: 0,10 a 0,93) mantienen las asociaciones inversas con la enfermedad.

Conclusión: el estado de vitamina D y la práctica de actividad física moderada se consideraron factores de protección para el cáncer de mama. Sin embargo, la menopausia y la historia familiar de cáncer de mama se consideran un factor de riesgo para el cáncer de mama.

Palabras clave:

Cáncer de mama. Vitamina D. Menopausia. Actividad física. Estudio de casos y controles.

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INTRODUCTION

Increasing life expectancy, adoption of western lifestyle, and growing urbanization has raised the global incidence of breast cancer (1). Breast cancer has known risk factors such as the cellular aging, family history, alcohol consumption (2), overweight (3), sedentary lifestyle, and high breast tissue density (4). Other risk factors are related to women's reproductive life, which leads to increased endogenous estrogen levels, as the later age at first childbirth, early menarche, and late menopause (1,3). Some studies indicated that sun exposure and vitamin D levels are inversely proportional to the risk of developing breast cancer (5,6). Moreover, it is suggested a greater benefit if sun exposure occurs during the breast tissue development in young stages of women's life (7). Furthermore, vitamin D may act directly in tumorigenesis, and extrarenal tissues such as breast tissue, expressing the CYP27B1 enzyme, that provide instructions for the synthesis of 1-α-hydroxylase. This enzyme is responsible for converting the inactive precursor of vitamin D to the active form, namely, 1, 25-dihydroxycholecalciferol [$1,25(OH)_2D_3$]. This vitamin can have autocrine or paracrine activity, protecting the breast tissue cells from malignant transformation (8). The production of $1,25(OH)_2D_3$ is controlled by its own levels and is controlled by the parathyroid hormone, fetal growth factor 23, and calcium and phosphorus levels in serum (9).

Parathyroid hormone (PTH) along with vitamin D is involved in calcium homeostasis acting directly or indirectly in organs related to its storage, excretion, and absorption. Moreover, PTH can promote both formation and reabsorption of the bone tissue. Also, drops in calcium levels of 10% are sufficient to increase PTH serum levels (10,11).

In this study, we aimed to evaluate the associations between lifestyle, vitamin D status, PTH, calcium and phosphorus levels in serum, with breast cancer in women in the Hospital Foundation of Belo Horizonte, Minas Gerais, Brazil.

MATERIAL AND METHODS

STUDY POPULATION

This study is a part of hospital-based case-control study, whose source of patients were health services, ambulatory care; hospital; compulsory notification or registration diseases. The study was conducted with women treated in the Mastology Service of Odete Valadares Maternity, of Hospital Foundation of Minas Gerais State (FHEMIG), in Belo Horizonte, Minas Gerais, Brazil. Women who were referred to the ambulatory care were invited to participate in the study as volunteers. Those women who accepted signed the free and clarified consent term. The study followed the Declaration of Helsinki and was approved by the National Committee of Ethics in research (protocol number: 1889/2005) (12,13).

The case group (GCa) was composed by women who were referred for evaluation at the Maternity Odete Valadares, older than 18 years, living in rural or metropolitan region of Belo Horizonte, Minas Gerais, Brazil, with mammography result BI-RADS (14) (Breast Imaging Reporting and Data System) 0, 3, 4 or 5 (assessment incomplete, probably benign, suspicious abnormality and highly suspicious of malignancy, respectively) and breast cancer confirmed by biopsy. The control group (GCo) was composed by women who were older than 18 years old, lived in same area in Brazil, and mammography's result BI-RADS 1 or 2 (negative and benign findings) (14).

The exclusion criteria were: the age below 18 years old, previous history of any other cancer type, benign, suspicious or indeterminate biopsy result or not having performed mammography.

A total of 378 women were selected for the study, 181 healthy women (GCo group) and 197 women with breast cancer (GCa group). Only those women with ductal or invasive lobular carcinoma were included in GCa group. Women with *in situ* disease, or *Phyllodes* malignant or borderline breast tumor or benign disease biopsy were not included in the study.

STUDY DESIGN

Data collection was carried out in the ambulatory in two steps: In the first step, prior to diagnosis, nutritional interview, lifestyle characteristics, medical history (such as diabetes), family history data and anthropometric measurements were collected. In the second stage, after diagnosis, peripheral blood sample was collected for laboratory analysis.

The anthropometric assessment was performed considering the weight and percentage of fat using the Tanita Body Fat Monitor Scale (model TBF 531©) and height was noted using the vertical stadiometer (Altura Exata©). The waist and hip circumferences were also measured and the body mass index (BMI) was calculated (12,15).

A questionnaire previously validated by Pena et al (12) was applied to the studied population to characterize the sample with regards to socioeconomic issues, medical history (such as diabetes), lifestyle, and food consumption.

Regarding the variables related to women's gynecological history, menarche and menopause age were requested. If they had children, the number of living children, abortion, breastfeeding, duration of breastfeeding for each child, age at first pregnancy, oral contraceptive use, and hormone replacement therapy were also asked.

The patients provided information about lifestyle, as alcohol use, smoking behavior and physical activity Those women who consumed at least one dose (10 g of alcohol) of any alcoholic beverage daily or more than 3 days a week were considered alcoholics (12,16). Those who reported smoking at least one cigarette per day, regardless the time of use, were considered smokers (17). The practice of physical activity was assessed by the International Physical Activity Questionnaire (IPAQ) (18), short version, and the women were classified as sedentary, low active, or active (12) (Fig. 1).

BIOCHEMICAL ANALYSES

Blood samples (4 mL) were collected in opaque bottles containing EDTA at the Odette Valadares Maternity's ambulatory care

on interview day. The blood was centrifuged to obtain plasma and stored at –80 °C for further analysis.

Serum levels of vitamin D, calcium, phosphorus, and PTH were measured in 256 women. For the vitamin D dosage, the ABBOTT© chemiluminescence kit was used and the metabolite 25-hydroxy-vitamin D [25(OH)D] was dosed (imprecision ≤ 10%,accuracy, 8,0 ng/mL detection limit, 8,0-160 ng/mL reference range). PTH was also dosed by chemiluminescence using the Beckman Couter© Kit (imprecision ≤ 8%, accuracy, 1 pg/mL detection limit, 12-88 pg/mL reference range). Calcium and phosphorus were measured by colorimetric method according to the manufacturer's protocol (Beckman Couter©) (calcium; precision 0,95% coefficient of variation, detection limit 0,01 mmol/L, reference range 8,8-10,6 mg/dL, phosphorus: precision < 3% CV, detection limit 1 mg/dL, reference range 3.7-7.2 mg/dL). The analyses were performed in the clinical laboratory of the Health Division at the Federal University of Viçosa, Minas Gerais, Brazil.

STATISTICAL ANALYSIS

The statistical analyses were carried out using Stata program, version 9.1. Kolmogorov Smirnov normality test was performed for each continous variable. The mean values for the variables net income, age, age at first pregnancy, age of menopause, patients' age when they performed the first mammography, weight, BMI, parathyroid hormone, calcium, phosphorus and vitamin D presented asymmetric distribution. Furthermore, Student's *t* test was used to evaluate the differences between the averages of the GCa and GCo groups. The Mann-Whitney test was used for determination of asymmetric distribution. In addition, the association between the breast cancer and each categorical variable was evaluated using the Chi-square test. Univariate analysis (chi-square and raw odds ratio) and multivariate analysis were performed through multivariate logistic regression (cancer was considered dependent variable, and menopause, diabetes, age at first pregnancy, patients age when they made the first mammography, physical activity, income, contraceptive, body fat, vitamin D, alcoholism, breast cancer history family, nulliparity, age and breast-feeding were considered independent variables). A 5% level of significance was considered for the analysis.

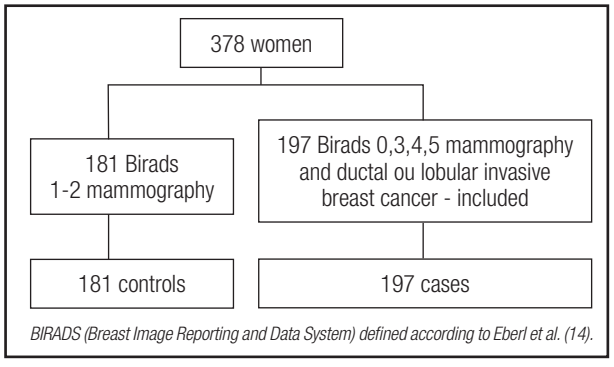

Figure 1.

Study design. Number of women selected in the case and control groups, according to inclusion and exclusion criteria.

RESULTS

The characteristics of the women in each group are shown in table I. The women with breast cancer were older than healthy controls ($p < 0.001$). There was no difference between the groups regarding the level of education and rural or urban living. A total of 378 women were evaluated, with a median age of 51 years (44-59 years). Among them, 43.09% of women were from the rural zone and 29.63% had attended full middle school (full middle school, 7th grade, or more) (data not shown).

The average net income of the family and the minimum wage was assessed. Women from control group had higher income than women from case group ($p = 0.018$) (Table I). In relation to reproductive factors, more women from GCo reported having at least one born child alive than the women from GCa ($p = 0.014$) (Table I). There was no difference between the groups regarding breastfeeding, ($p = 0.120$) and use of hormone replacement therapy ($p = 0.45$). The contraceptive use was higher in control women ($p = 0.025$). The first term pregnancy equal to or more than 30 years old was higher in GCa group ($p = 0.024$) (Table I). The average of age of women when they first underwent mammography was higher in the GCa group (43 years × 40 years, $p = 0.002$). Approximately 80.51% of cases and 41.24% of controls were in menopause ($p < 0.001$) (Table I). However, no difference was observed for the age of menopause between the groups ($p = 0.61$). The mean age of menarche was the same in both groups approximately 13 years ($p = 0.611$) (data not shown).

Differences between groups were not found for anthropometric characteristics, like BMI, weight and waist-hip ratio (WHR) ($p = 0.842$, $p = 0.402$ and $p = 0.464$). To assess the percentage of body fat, patients were classified as normal/eutrophic body fat or high body fat. More women of control group presented high percentage of body fat than in GCa ($p = 0.049$) (Table I).

The lifestyle, current or previous smoking, alcoholism, and physical activity was assessed. In GCo group, 17.68% of women reported current smoking, while in GCa group, only 12.69% reported smoking ($p = 0.014$). With regard to alcoholism, more women in GCo group did not consume alcohol in sufficient levels to configure alcoholism than in GCa ($p < 0.001$) In relation to the practice of physical activity, most of women from control group practiced mild physical activity. However, in case group, most of the women did not practice any physical activity. In GCo 13.41% had moderate physical activity, while in the GCa group 3.57% reported the same ($p = 0.001$) (Table I).

The median value of vitamin D in GCo group was higher than GCa group ($p = 0.008$). In GCo group, 34.59% had vitamin D levels above 30 ng/mL, while in the GCa group, only 21.95% had sufficient levels. Approximately 51.13 and 51.22% of controls and cases, respectively, had vitamin D levels considered as insufficient (between 21 and 29.9 ng/mL); while 14.29% in GCo group

Table I. Characteristics of women from case and control groups

Characteristics	n	Groups		p
		Case	Control	
Age (years)[a, **]	377	54 (48-62)	47.5 (42-53)	< 0.001*
Average net income (R$)[a, **]	372	600 (350-1000)	700 (400-1200)	0.018*
Income in minimum wage [a,**]	362	1.714 (1-2.85)	2 (1.14-3.42)	0.018*
Income < R$700,00 (%)[b]	362	54,31	43.09	0.044*
Rural region (%)[b]	369	45.31	40.68	0.369
Schooling (full middle school/7th grade or more) (%)[b]	378	28.43	30.94	0.864
Previous history of benign breast disease (%)[b]	374	17.77	0	< 0.001*
Family history of breast cancer (%)[b]	374	31.12	1.12	< 0.001*
Age of first pregnancy (years) [a,**]	316	23 (19.5-26)	20 (18-24)	< 0.001*
Age first pregnancy > = 30 years (%)[b]	316	14.74	6.88	0.024*
Children (yes, %)[b]		79.70	88.95	0.014*
Children (no, %)		20.3	11.05	
Use of contraceptive (%)[b]	373	51.78	62.43	0.025*
Breast-feeding (%)[b]	371	74.62	82.32	0.120
Menopause (%)[b]	372	80.51	41.24	< 0.001*
Age of first mammography (years)[a,**]	362	43 (39-52)	40 (36-46)	0.002*
High % body fat (%)[b]	363	48.11	58.43	0.049*
Weight (kg)[a, **]	372	63.8 (56.8-75.2)	66.2 (57.2-75.6)	0.402
Body mass index (BMI)[a, **]	372	26.89 (23.57-30.73)	26.95 (24.08-30.49)	0.842
Diabetes mellitus (%)[b]		13.71	7.26	0.043*
Alcoholism (n,%)[b,***]				< 0.001*
Yes	56	31 (15.74)	25 (13.81)	
No	292	139 (70.56)	153 (84.53)	
No answer	30	27 (13.71)	3 (1.66)	
Physical activity (n, %)[b,***]	375			0.001*
Sedentary lifestyle	167	102 (52.04)	65 (36.31)	
Mild	147	87 (44.39)	90 (50.28)	
Moderate	31	7 (3.57)	24 (13.41)	

*[a]Mann Whitney, [b]χ^2 Test, **Median (interquartile interval), ***estimated population size and percentage (n,%) are presented.*
**Significant difference at p < 0,05.*

and 26.83% in GCa group had deficient levels, less than 20 ng/mL (p = 0.014). The analysis of calcium, phosphorous, and PTH did not show any differences (p > 0.05) between the groups (Table II).

The results of the univariate analysis indicate a direct association between the disease and the age of women, nulliparity, age of first successful pregnancy, age the first mammography, *diabetes mellitus*, and family history of breast cancer. Inverse association was verified with moderate physical activity, percentage of body fat, use of hormonal contraceptive, and vitamin D levels (p < 0.05) (Table III).

Finally, a direct association was found between menopause (OR = 5.17, 95% CI = 2.72-9.80) and family history of breast cancer (OR = 36.37, 95% CI = 4.75-278.50), considered risk factors. Moreover, an inverse association was also observed between vitamin D levels (OR = 0.95, 95%CI = 0.91-0.99) and moderate physical activity (OR = 0.31, 95%CI = 0.10-0.93), with protective effect for breast cancer (Table IV).

DISCUSSION

The results suggest that menopause (12 months or more of amenorrhea) is associated with breast cancer. GCa had more menopausal women than GCo. This result was maintained in the

Table II. Levels of vitamin D, calcium, phosphorus and PTH in case and control groups

Characteristics	n	Groups		p
		Case	Control	
Vitamin D (ng/mL)[a,**]	256	24.8 (20.5-29.3)	26.9 (22.3-32)	0.008*
Status of vitamin D[b] (n,%)[#]	256			0.014*
Deficient		33 (27.05)	19 (14.399)	
Insufficient		62 (50.82)	67 (50.76)	
Sufficient		27 (22.13)	46 (34.85)	
Calcium level (mg/dL)[a,**]	256	9.9 (9.6-10.3)	9.7 (9.4-10.1)	0.127
Phosphorus level (mg/dL)[a,**]	256	3.7 (3.3-4)	3.7 (3.4-4.2)	0.236
PTH level (pg/mL)[b,##]	256	8.5	9.0	0.660

*[a]Mann Whitney, [b]χ^2 Test, **Median (interquartile interval), #mean, estimated population size (n) and percentage (%). ##Mean. *Significant difference at $p < 0.05$.*

Table III. Association of patients' characteristics and incidence of breast cancer among the study groups

Characteristics	OR	95% CI	p
Age	1.06	1.04-1.09	< 0.001*
Menopause	5.89	3.70-9.36	< 0.001*
Nulliparity	2.05	1.15-3.66	0.015*
Age at first successful pregnancy	1.08	1.03-1.13	0.001*
Age at first pregnancy > 30 years	2.34	1.10-4.99	0.027*
Age at first mammography	1.04	1.02-1.06	0.001*
Income	1.62	1.08-2.45	0.021*
First mammography performed after 40 years	1.93	1.27-2.94	0.002*
Diabetes mellitus	2.03	1.01-4.07	0.046*
Family history of breast cancer	39.76	9.55-165.52	< 0.001*
Physical activity - sedentary	1	-	-
Mild	0.62	0.40-0.95	0.027*
Moderate	0.19	0.08-0.46	< 0.001*
High % body fat	0.66	0.44-0.99	0.049*
Use of hormonal contraceptive	0.62	0.41-0.93	0.022*
Alcoholism	1.37	0.77-2.43	0.289
Vitamin D	0.94	0.91-0.98	0.001*
Vitamin D levels- Deficient (< 20)	1		
Insufficient (20-29,9)	0.53	0.28-1.03	0.062
Sufficient (≥ 30)	0.34	0.16-0.71	0.004*

OR: Odds Ratio; *95% CI, 95% Confidence Interval. *Significant difference at $p < 0.05$.*

Table IV. Final model of multiple logistic regression analysis of breast cancer-related characteristics

Characteristics	OR	95% CI	p
Menopause	5.17	2.72 - 9.80	< 0.001*
Vitamin D	0.95	0.91 - 0.99	0.012*
Mild physical activity	0.61	0.32 - 1.14	0.122
Moderate physical activity	0.31	0.10 - 0.93	0.037*
Family history of breast cancer	36.37	4.75 - 278.50	0.001*

OR: Odds Ratio; *95% CI, 95% Confidence Interval. *Significant difference at $p < 0.05$.*

final statistical model, even after the adjusted model for patient age. Despite the breast cancer patients were older than controls, it did not influence the association between breast cancer and menopausal status.

Although menopause is not considered a risk factor for breast cancer, the late menopause (after 55 years) is directed associated with the disease (19), due to longer exposure of endogenous hormones. The estrogen exposure has also been associated with conditions like nulliparity, late menopause age, early menarche and giving first birth at later age (20). There is an increased risk each year of late menopause, particularly in positive estrogen receptors tumors (2121). Despite of it, this study did not show difference for the age of menopause (p = 0.600) and late menopause (p = 0.083) between GCa e GCo. This result is due the close menopause age between groups.

Age is considered a risk factor for breast cancer (22). In approximately 80% of cases, the disease occurs after age 50 (4). According to Howlader et al, the risk of developing breast cancer among American women increases 0.44% at 30 years, 2.38% at age 50 and 3.82% at 70 years (23). In this study, the patients of CaG had median age higher than controls, with a direct association with breast cancer. However, this association did not persist after the adjustment in the final model. In a systematic review, Cutler et al. (24) observed an average of cumulative breast cancer inci-

dence of 0.22% each year of age in women less of 50 years and 0.23% per year among women either 50 years old or with surgically menopausal.

Family history of breast cancer is directly associated with the disease. Having a first degree relative with breast cancer is one of the most consistent risk factors for the disease (19,25). The breast cancer risk in lifetime is 7.8% in women without history family, and rises to 13.3 % with one case in family and 21.1% with two affected relatives (25). The increased risk of breast cancer is associated with different subtypes of the disease, both in cancers with hormone receptor positive and negative (26). Heredity accounts for about 27% of cases of breast cancer, for the sporadic cancer, most cases are related to the environment (27). Family history of breast cancer is also found in cases of hereditary breast cancer associated with gene mutations *BRCA*1 and *BRCA*2, and other mutations, accounting for 5-10% of cases (28).

In our study more women in GCa were reported with family history of breast cancer than in GCo ($p < 0.001$) and there was a direct association with the disease (OR = 36.37). Moreover, only 1.12% of the patients in GCo presented cases of family history of breast cancer in first-degree relatives. This value is lower than the ones reported in the national literature. For instance, Paiva et al. (29), in a case-control study observed a family history of breast cancer in 12.5% of the patients with breast cancer and in 13.1% of the controls. Matos et al. (30) also showed the prevalence of the disease in 2.3% mother, 3.9% sister and 0.2% daughter affected by the disease.

Some studies have shown that the practice of physical exercise reduces the risk of breast cancer (31-33). In United Kingdon, 3.4% of post-menopausal breast cases in 2010 were associated with lack of exercise (34). Some possible mechanisms involved in breast cancer risk reduction are the reduction of hormone levels induced by exercise (35), body fat reduction (36,37), stimulation of antitumor immune activity and the reduction of insulin-like growth factors, which may increase cell division and inhibit cell death (35,37).

In our study, an inverse association was observed between the practice of moderate physical activity and breast cancer ($p < 0.001$). A greater number of GCo patients reported moderate physical activity practice ($p = 0.001$), while sedentary lifestyle was higher among the GCa. The moderate physical activity may have a protective effect against breast cancer according to the results.

The sedentary lifestyle is associated with 8% of breast cancer cases (38). Cohen et al. (39) in 2013 showed in white women that increased physical activity was associated with less chance of developing breast cancer, while sedentary lifestyle was associated with increased risk. The sedentarism is related with weigh gain, and cancer risk, including breast cancer, increases with increasing BMI (40). In a study with Japanese women, an inverse association with breast cancer was found among those who had the habit to walk more than an hour a day than those who walked less than an hour a day (33).

The benefits of practicing physical activity go beyond the disease prevention, also influencing the prognosis of breast cancer patients (41). Friedenreich et al. (42) observed that the practice of moderate to vigorous physical activity in post-menopausal women was enough to reduce the total body fat and adiposity. Therefore, this benefit may be related to the reduced risk of breast cancer in post-menopausal women.

Although there were a greater number of women practicing mild or moderate physical activity in the control group ($p = 0.001$), higher percentage of body fat (overweight or obese) was found in this group when compared to the GCa ($p = 0.049$).

The GCo patients had higher levels of 25(OH)D than the GCa patients ($p = 0.008$) (Table II). After stratification in deficient, insufficient, and sufficient vitamin D levels, the GCo group showed lower number of women with deficient levels and greater number of women with sufficient levels than GCa ($p = 0.014$) (Table II). Besides, an inverse association with breast cancer in the final model (OR = 0.95, 95% CI 0.91-0.99, $p = 0.012$) was observed (Table IV). Therefore, sufficient levels of vitamin D have given protective effect against breast cancer. Similar to our study, Park et al. (43) also dosed the vitamin D levels and stratified the women in groups by the levels of vitamin D, as deficient, insufficient, and sufficient (20 ng/dL, 20-29.9 ng/dL, and 30 ng/dL, respectively). It was assessed the levels of 25(OH)D in Korean women with breast cancer and in the general population, and found a direct association with breast cancer in women with deficient vitamin D serum levels when compared to those with sufficient levels, with no variation of menopausal status.

In Brazil, studies have shown insufficient levels of vitamin D in the elderly. Camargo et al. (2014) found concentration of 25(OH) D of 24.8 ng/mL in patients aged 67.9 ± 8.6 years (44). Arantes et al. (2013) demonstrated deficient levels (< 20 ng /mL) at 17% in women with age between 60 and 85 years old (45). Saraiva et al. (46) also found insufficient levels of 25(OH)D in 43.8% of outpatients and 71.2% of institutionalized elderly patients. Saraiva et al. (2005) found Vitamin D deficiency in 15.4% and insufficiency in 41.9% of patients aged 79.1 ± 5.9 years (47).

According to the *Nurses' Health Study* results, comparing the highest quintile with the lowest quintile of vitamin D in patients, there was a 30% breast cancer reduction risk (48), with even more impact in postmenopausal women aged over 60 years. The vitamin D action in the risk reduction of breast cancer could be explained by the inhibition and control of mammary cell growth demonstrated in animal model (49,50), by the antiproliferative action of 1,25 $(OH)_2D$ in tumor-derived endothelial cells, by modulating the cell cycle, and by affecting tumor cell signaling (51). Vitamin D also has action on the expression of genes involved in growth, differentiation and apoptosis (52). The overexpression of p73 is associated with induction of apoptosis in animals and in humans and can be influenced by calcitriol (52,53). The presence of 25-hydroxyvitamin D3 1-α-hydroxylase (CYP27B1) in mammalian cells indicate that local production of vitamin D would lead to a paracrine or autocrine action in mammary cells protection (54). In the present study, breast cancer patients with low vitamin D levels, would probably have less protection against malignant transformation and tumor growth.

The menopausal *status* seems to influence the association between vitamin D and breast cancer. However, there is no con-

sensus in the literature. In a recent meta-analysis evaluating nine prospective studies, no association of risk reduction was found for breast cancer in pre-menopausal women, however, for post-menopausal women a decrease of risk, especially for 25(OH)D levels between 27 and 35 ng/mL was verified (55). The protective effect of adequate levels of this vitamin in preventing breast cancer among post-menopausal women was demonstrated by Crew et al. (56). Other studies have found benefit in reducing breast cancer risk in pre-menopausal women with normal weight, mainly with an intake of 5 µg/day of vitamin D (57,58). Abbas et al.(59) found an inverse association between breast cancer in pre-menopausal women and vitamin D levels, without interaction with BMI and family history of breast cancer, also demonstrated among Japanese women.

Fedirko et al. (60) also demonstrated an inverse association between circulating levels of vitamin D and breast cancer among pre-and post-menopausal Mexican women in a case-control study. This study had a greater number of menopausal women among the cases. The $25(OH)D_3$ average was 18.6 ng/mL in the cases and 21.9 ng/mL in controls. Furthermore, among the controls, 36% of women had deficient vitamin D levels ($25(OH)D_3 <$ 20 ng/mL) and 9% sufficient levels (> 30 ng/mL). Similarly, in this study, in GCa group, a greater number of menopausal women was observed. Among GCo patients, 14.29% had deficient levels and 34.59% sufficient levels of vitamin D (Table II).

The serum levels of calcium, phosphorus and PTH did not present difference between case and control groups, independent of vitamin D status and despite the vitamin D levels. The calcium and the vitamin D supplement intake may have a role in reduction of breast cancer risk (61-63), but more studies are needed to confirm this association.

The direct association was found in this study between *diabetes mellitus* and breast cancer in univariate analysis, but it did not remain after the final model analysis.

CONCLUSION

This case-control study demonstrated that menopause and family history of breast cancer were considered risk factors for breast cancer in women independent of the women age.

The serum level of vitamin D was considered protective factor for breast cancer. Despite the vitamin D levels found in women with breast cancer being lower than those of the control group, both averages were stratified as sufficient level. The vitamin D status is not yet used for breast cancer screening in women. However, this result suggests that vitamin D may have a positive impact as strategy of breast cancer prevention or reduction. Thus, an interesting strategy would be to screening women with insufficient and deficiency vitamin D status to provide supplementation of this vitamin. Another strategy could be the encouragement of physical activity practice for health improvement, since the practice of moderate to intense physical activity had a protective effect for breast cancer. Thus, our findings will contribute to fill an important gap in the scientific literature.

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REFERENCES

1. WHO. Breast cancer: prevention and control; 2014.
2. Rossi M, McLaughlin J, Lagiou P, Bosetti C, Talamini R, Lipworth L, et al. Vitamin D intake and breast cancer risk: a case-control study in Italy. Ann Oncol 2009;20:374-78.
3. Lacey J, Kreimer A, Buys S, Marcus P, Chang S-C, Leitzmann M, et al. Breast cancer epidemiology according to recognized breast cancer risk factors in the Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Trial Cohort. BMC Cancer 2009;9(1):84.
4. INCA, Instituto Nacional do Câncer José Alencar Gomes da Silva. Coordenação de Prevenção e Vigilância. Estimativa 2014: Incidência de Câncer no Brasil, Ministério da Saúde; 2014.
5. Anderson LN, Cotterchio M, Kirsh VA, Knight JA. Ultraviolet Sunlight Exposure During Adolescence and Adulthood and Breast Cancer Risk: A Population-based Case-Control Study Among Ontario Women. Am. J. Epidemiol 2011;174(3):293-304.
6. Grant W. Update on Evidence that Support a Role of Solar Ultraviolet-B Irradiance in Reducing Cancer Risk. Anticancer Agents Med Chem 2013;13(1):140-6.
7. Knight J, Lesosky M, Barnett H, Raboud J, Veith R. Vitamin D and reduced risk of breast cancer: a population-based case-control study. Cancer Epidemiol Biomarkers Prev 2007;16(3):422-29.
8. Welsh J. Vitamin D metabolism in mammary gland and breast cancer. Mol Cell Endocrinol 2011;347:6.
9. Norman AW. From vitamin D to hormone D: fundamentals of the vitamin D endocrine system essential for good health. Am J Clin Nutr 2008;88(2):491S-99S.
10. Paula FJA. A insuficiência óssea na doença renal crônica: papel do paratormônio. Arq Bras Endocrinol Metabol 2009;53(9):1059.
11. Paula FJ, Lanna CM, Shuhama T, Foss MC. Effect of metabolic control on parathyroid hormone secretion in diabetic patients. Braz J Med Biol Res 2001;34(9):7.
12. Pena GG, Maia YCP, Mendes MCS, Furtado WR, Machado-Coelho GLL, Freitas RN. Physical Activity Is Associated with Malignant and Benign Breast Diseases in Low-Income Brazilian Women. Nutr Cancer 2013;66(4):707-15.
13. Abranches M, Mendes M, Pena G, Maia Y, Ribeiro S, Franceschini S, et al. Antioxidant vitamins and cytokines are altered in breast cancer. Eur J Cancer Prev 2011;20(5):403-10.
14. Eberl MM, Fox CH, Edge SB, Carter CA, Mahoney MC. BI-RADS Classification for Management of Abnormal Mammograms. J Am Board Fam Med 2006;19(2):161-64.
15. WHO. WHO Expert Committee on Physical Status: the Use and Interpretation of Anthropometry(1993: Geneva, Switzerland). Physical status: the use of and interpretation of anthropometry. Geneva, World Health Organization, 1995. Available from: www.who.int/iris/handle/10665/37003.
16. WHO. Global Status report on alcohol-World Health Organization. Geneva; 2004; Available from: http://www.who.int/substance_abuse/publications/global_status_report_2004_overview.pdf
17. CDC. Reducing the Health Cunsequences of Smoking: 25 Years of Progress. A Report of the Surgeon General Rockville, Maryland: Center for Chronic Disease Prevention and Health Promotion. Office on Smoking and Health; 1989. p. 89-8411.
18. CELAFISCS. Centro de Estudos do Laboratório de Aptidão Física de São Caetano do Sul; 2004. Available from: www.celafiscs.com.br.
19. American Cancer Society. What are the risk factors for breast cancer? 2015. Available from: http://www.cancer.org/cancer/breastcancer/detailedguide/breast-cancer-risk-factors.
20. Lippman ME, Krueger KA, Eckert S, Sashegyi A, Walls EL, Jamal S, et al. Indicators of Lifetime Estrogen Exposure: Effect on Breast Cancer Incidence and

Interaction With Raloxifene Therapy in the Multiple Outcomes of Raloxifene Evaluation Study Participants. J Clin Oncol 2001;19(12):3111-16.
21. Cancer CGoHFiB. Menarche, menopause, and breast cancer risk: individual participant meta-analysis, including 118 964 women with breast cancer from 117 epidemiological studies. Lancet Oncol 2012;13(11):1141-51.
22. WHO World Health Organization. Breast cancer: prevention and control. 2014. Available from: http://www.who.int/cancer/detection/breastcancer/en/index3.html [cited 2014 12/31/2014].
23. Howlader N, Noone A, Krapcho M, Neyman N, Aminou R, Waldron W, et al. SEER Cancer Statistics Review, 1975-2009 (Vintage 2009 Populations). Bethesda, MD: National Cancer Institute; 2012 [cited 2015 09/01/2015]; http://seer.cancer.gov/csr/1975_2009_pops09/, based on November 11 SEER data submission, posted to the SEER web site, April 12.].
24. Cutler W, Bürki R, Kolter J, Chambliss C, Friedmann E, Hart K. Invasive Breast Cancer Incidence in 2,305,427 Screened Asymptomatic Women: Estimated Long Term Outcomes during Menopause Using a Systematic Review. PLoS ONE 2015;10(6):e0128895.
25. Phipps AI, Buist DSM, Malone KE, Barlow WE, Porter PL, Kerlikowske K, et al. Family history of breast cancer in first-degree relatives and triple-negative breast cancer risk. Breast Cancer Res Treat 2010;126(3):671-78.
26. Bethea TN, Rosenberg L, Castro-Webb N, Lunetta KL, Sucheston-Campbell LE, Ruiz-Narváez EA, et al. Family History of Cancer in Relation to Breast Cancer Subtypes in African American Women. Cancer Epidemiol Biomarkers Prev 2016;25(2):366-73.
27. Lichtenstein P, Holm NV, Verkasalo PK, Iliadou A, Kaprio J, Koskenvuo M, et al. Environmental and Heritable Factors in the Causation of Cancer - Analyses of Cohorts of Twins from Sweden, Denmark, and Finland. N Engl J Med 2000;343(2):78-85.
28. Fernandes GC, Michelli RAD, Scapulatempo-Neto C, Palmero EI. Association of polymorphisms with a family history of cancer and the presence of germline mutations in the BRCA1/BRCA2 genes. Hered Cancer Clin Pract 2016;14:2.
29. Paiva CE, Ribeiro BS, Godinho AA, Meirelles RdSP, Silva EVGd, Marques GDA, et al. Fatores de Risco para Câncer de Mama em Juiz de Fora (MG): um estudo caso-controle. Rev Bras Cancerol 2002;48(2):231-37.
30. Matos J, Pelloso S, Carvalho M. Prevalence of risk factors for breast neoplasm in the city of Maringá, Paraná state, Brazil. Rev. Latino-Am. Enfermagem 2010;18(3):352-59.
31. Maruti S, Willett W, Feskanich D, Rosner B, Colditz G. A Prospective Study of Age-Specific Physical Activity and Premenopausal Breast Cancer. J Natl Cancer Inst 2008;100(10):728-37.
32. Eliassen A, Hankinson SE, Rosner B, Holmes MD, Willett WC. PHysical activity and risk of breast cancer among postmenopausal women. Arch Intern Med 2010;170(19):1758-64.
33. Suzuki S, Kojima M, Tokudome S, Mori M, Sakauchi F, Fujino Y, et al. Effect of Physical Activity on Breast Cancer Risk: Findings of the Japan Collaborative Cohort Study. Cancer Epidemiol Biomarkers Prev 2008;17(12):3396-401.
34. Parkin DM. Cancers attributable to inadequate physical exercise in the UK in 2010. Br J Cancer 2011;105(Suppl 2):S38-S41.
35. Rundle A. Molecular Epidemiology of Physical Activity and Cancer. Cancer Epidemiol Biomarkers Prev 2005;14(1):227-36.
36. Friedenreich CM, Cust AE. Physical activity and breast cancer risk: impact of timing, type and dose of activity and population subgroup effects. Br J Sports Med 2008;42(8):636-47.
37. Friedenreich CM, Orenstein MR. Physical Activity and Cancer Prevention: Etiologic Evidence and Biological Mechanisms. J Nutr 2002;132(11):3456S-64S.
38. Zhou Y, Zhao H, Peng C. Association of sedentary behavior with the risk of breast cancer in women: update meta-analysis of observational studies. Ann Epidemiol 2015;25(9):687-97.
39. Cohen SS, Matthews CE, Bradshaw PT, Lipworth L, Buchowski MS, Signorello LB, et al. Sedentary behavior, physical activity, and likelihood of breast cancer among black and white women: a report from the Southern Community Cohort Study. Cancer Prev. Res 2013;6(6):566-76.
40. Reeves GK, Pirie K, Beral V, Green J, Spencer E, Bull D. Cancer incidence and mortality in relation to body mass index in the Million Women Study: cohort study. BMJ 2007;335(7630):1134.
41. Keegan THM, Milne RL, Andrulis IL, Chang E, Sangaramoorthy M, Phillips K-A, et al. Past recreational physical activity, body size, and all-cause mortality following breast cancer diagnosis: results from the breast cancer family registry. Breast Cancer Res Treat 2010;123(2):531-42.
42. Friedenreich CM, Neilson HK, O'Reilly R, et al. Effects of a high vs moderate volume of aerobic exercise on adiposity outcomes in postmenopausal women: A randomized clinical trial. JAMA Oncol 2015;1(6):766-76.
43. Park S, Lee D, Jeon J, Ryu J, Kim S, Kim J, et al. Serum 25-hydroxyvitamin D deficiency and increased risk of breast cancer among Korean women: a case–control study. Breast Cancer Res Treat 2015;152(1):147-54.
44. Camargo MBR, Kunii IS, Hayashi LF, Muszkat P, Anelli CG, Marin-Mio RV, et al. Modifiable factors of vitamin D status among a Brazilian osteoporotic population attended a public outpatient clinic. Arq Bras Endocrinol Metabol 2014;58:572-82.
45. Arantes HP, Kulak CAM, Fernandes CE, Zerbini C, Bandeira F, Barbosa IC, et al. Erratum to: Correlation between 25-hydroxyvitamin D levels and latitude in Brazilian postmenopausal women: from the Arzoxifene Generations Trial. Osteoporos Int 2013;24:2.
46. Saraiva GL, Cendoroglo MS, Ramos LR, Araújo LMQ, Vieira JGH, Maeda SS, et al. Prevalência da deficiência, insuficiência de vitamina D e hiperparatiroidismo secundário em idosos institucionalizados e moradores na comunidade da cidade de São Paulo, Brasil. Arq Bras Endocrinol Metabol 2007;51:437-42.
47. Saraiva GL, Cendoroglo MS, Ramos LR, Araújo LMQ, Vieira JGH, Kunii I, et al. Influence of ultraviolet radiation on the production of 25 hydroxyvitamin D in the elderly population in the city of São Paulo (23 o 34'S), Brazil. Osteoporos Int 2005;16(12):1649-54.
48. Giovannucci E. Vitamin D and Cancer Incidence in the Harvard Cohorts. Ann Epidemiol 2009;19(2):84-8.
49. Fleet JC. Molecular actions of vitamin D contributing to cancer prevention. Mol. Aspects Med 2008;29(6):388-96.
50. Gross M, Kost SB, Ennis B, Stumpf W, Kumar R. Effect of 1,25-dihydroxyvitamin D3 on mouse mammary tumor (GR) cells: Evidence for receptors, cellular uptake, inhibition of growth and alteration in morphology at physiologic concentrations of hormone. J. Bone Miner Res.1986;1(5):457-67.
51. Bernardi RJ, Johnson CS, Modzelewski RA, Trump DL. Antiproliferative Effects of 1α, 25-Dihydroxyvitamin D3 and Vitamin D Analogs on Tumor-Derived Endothelial Cells. Endocrinology 2002;143(7):2508-14.
52. Mocellin S. Vitamin D and cancer: Deciphering the truth. Biochim Biophys Acta 2011;1816(2):172-78.
53. Ma Y, Yu W-D, Hershberger PA, Flynn G, Kong R-X, Trump DL, et al. 1α,25-Dihydroxyvitamin D3 potentiates cisplatin antitumor activity by p73 induction in a squamous cell carcinoma model. Mol. Cancer Ther 2008;7(9):3047-55.
54. Welsh J. Vitamin D metabolism in mammary gland and breast cancer. Mol Cell Endocrinol 2011;347(1-2):55-60.
55. Bauer SR, Hankinson SE, Bertone-Johnson ER, Ding EL. Plasma Vitamin D Levels, Menopause, and Risk of Breast Cancer: Dose-Response Meta-Analysis of Prospective Studies. Medicine 2013;92(3):123-31. DOI:10.1097/MD.0b013e3182943bc2.
56. Crew K, Shane E, Cremers S, McMahon D, Irani D, Hershman D. High prevalence of vitamin D deficiency despite supplementation in premenopausal women with breast cancer undergoing adjuvant chemotherapy. J Clin Oncol 2009;27(13):2151-56.
57. Abbas S, Linseisen J, Chang-Claude J. Dietary Vitamin D and Calcium Intake and Premenopausal Breast Cancer Risk in a German Case-Control Study. Nutr Cancer 2007;59(1):54-61.
58. Lee M-S, Huang Y-C, Wahlqvist ML, Wu T-Y, Chou Y-C, Wu M-H, et al. Vitamin D Decreases Risk of Breast Cancer in Premenopausal Women of Normal Weight in Subtropical Taiwan. J Epidemiol 2011;21(2):87-94.
59. Abbas S, Chang-Claude J, Linseisen J. Plasma 25-hydroxyvitamin D and premenopausal breast cancer risk in a German case-control study. Int J Cancer 2009;124(1):250-55.
60. Fedirko V, Torres-Mejía G, Ortega-Olvera C, Biessy C, Ángeles-Llerenas A, Lazcano-Ponce E, et al. Serum 25-hydroxyvitamin D and risk of breast cancer: results of a large population-based case-control study in Mexican women. Cancer Causes Control 2012;23(7):1149-62.
61. Lappe JM, Travers-Gustafson D, Davies KM, Recker RR, Heaney RP. Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial. Am J Clin Nutr 2007;85(6):1586-91.
62. McCullough ML, Rodríguez C, Diver WR, Feigelson HS, Stevens VL, Thun MJ, et al. Dairy, Calcium, and Vitamin D Intake and Postmenopausal Breast Cancer Risk in the Cancer Prevention Study II Nutrition Cohort. Cancer Epidemiol. Biomarkers Prev 2005;14(12):2898-904.
63. Lin J, Manson JE, Lee I, Cook NR, Buring JE, Zhang SM. INtakes of calcium and vitamin d and breast cancer risk in women. Arch Intern Med 2007;167(10):1050-59.

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Nutrición Hospitalaria

Trabajo Original

Otros

Estimación de actividades preventivas en pacientes con enfermedad pulmonar obstructiva crónica. Estudio ADEPOCLE

Estimation of preventive activities in patients with chronic obstructive pulmonary disease. ADEPOCLE study

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Resumen

Objetivos: estimar las actividades preventivas que realizan los pacientes diagnosticados de enfermedad pulmonar obstructiva crónica (EPOC) en la provincia de León.

Métodos: estudio epidemiológico, transversal, multicéntrico (30 centros de salud de la provincia de León). Incluyó pacientes mayores de 35 años diagnosticados y tratados de EPOC. Variables a estudio: edad, sexo, hábitat, datos antropométricos, tabaquismo, estado nutricional, ejercicio físico, vacunación antigripal, vacunación, antineumocócica (VNP23 y VNC13), fenotipo, gravedad, reagudizaciones y hospitalizaciones. Los resultados se expresan con sus IC al 95,5%.

Resultados: se incluyeron 833 pacientes, el 85,8% varones, edad media: 64,69 años (53,66-75,61) y 20,65 años (4,47-36,8) de evolución de la EPOC. El 86,67% (80,30-93,30) tenían antecedentes de tabaquismo (n = 722), de 35,26 años de evolución (17,87-52,64), consumían 28,36 paquetes al año (9,60-46,86), p < 0,001, siendo el 58% fumadores severos. En fumadores activos (n = 288) la intervención más efectiva fue terapia cognitivo-conductual más vareniclina, con abstinencias del 29,86%. En total dejaron de fumar el 51,05% (49,49-52,70) de los pacientes con EPOC, p < 0,001. El 73,67% (71,78-75,65) realizaba ejercicio prescrito, el 88,76% (84,82-90,7) realizaba dieta equilibrada, el 89,7% (87,8-91,8) estaba vacunado frente a la gripe, siendo esta más frecuente en los mayores de 65 años y hospitalizados, p < 0,001. El 9,61% (7,7-11,6) de los no vacunados tuvo reagudizaciones que requirieron ingreso hospitalario, p < 0,001. La tasa de vacunación con VNP23 fue del 52,8% (49,3-56,4) *vs.* 4,97% (3,0-6,61) de VNC13, p < 0,05.

Conclusiones: las actividades preventivas en los pacientes con EPOC se realizan de forma óptima en nuestro entorno, superior a la media nacional, aunque se deben lograr mayores tasas de cobertura de vacunación frente al neumococo.

Palabras clave:

EPOC. Tabaco. Ejercicio. Dieta equilibrada. Vacunación antineumocócica. Vacunación antigripal.

Abstract

Objectives: To estimate the preventive activities carried out by the patients diagnosed with chronic obstructive pulmonary disease (COPD) in the province of Leon.

Methods: Multicenter epidemiological, cross-sectional study (30 health centers in the province of Leon). It included patients older than 35 years diagnosed and treated for COPD. Study variables: age, sex, habitat, anthropometric data, smoking, nutritional status, physical exercise, influenza vaccination, pneumococcal vaccination (PCV13 and VNP23) phenotype, severity, exacerbations and hospitalizations. Results are expressed with their CI 95.5%.

Results: 833 patients were included. 85.8% males; mean age: 64.69 (53.66-75.61) years and 20.65 (4.47-36.8) years of COPD evolution. The 86.67% (80.30-93.30) had previous history of tabaquism (n = 722) with 35.26 (17.87-52.64) years of evolution and an average consumption of 28,36 (9.60-46.86) packs per year p < 0,001, 58% being heavy smokers. In active smokers (n = 288) the most effective intervention was cognitive behavioral therapy combined with varenicline, with an abstinence of 29.86%. A total of 51.05% (49.49-52.70) of the patients with COPD quit smoking, p < 0,001. 73.67% (71.78 to 75.65) performed prescribed exercise, 88.76% (84.82 to 90.7) performed a balanced diet, 89.7% (87.8 to 91.8) were vaccinated against flu, this being more common in patients older than 65 years and hospitalized patients, p < 0.001. 9.61% (7.7 to 11.6) of unvaccinated had exacerbations that required hospitalization, p < 0.001. The VNP23 vaccination rate was 52.8% (49.3 to 56.4) vs. 4.97% (3.0 to 6.61) of PCV13, p < 0.05.

Conclusions: Preventive activities in patients with COPD are performed optimally in our environment, higher than the national average, tough higher coverage rates of vaccination against pneumococcus must be achieved.

Key words:

COPD. Smoking. Physical exercise. Balanced diet. Pneumococical vaccine. Influenza vaccine.

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INTRODUCCIÓN

Las actividades preventivas son esenciales en los pacientes con EPOC; destaca el abandono del tabaco, nutrición adecuada, realización de actividad física regular, vacunación antigripal, vacunación antineumocócica en todos los pacientes y educación sanitaria de los pacientes para favorecer el autocuidado. En muchos pacientes la rehabilitación forma parte de su tratamiento integral.

El abandono del consumo del tabaco es la intervención sanitaria más eficaz para frenar el deterioro progresivo de la EPOC. El profesional sanitario tendrá siempre una actitud empática, comprensiva, a la vez que firme y determinante, para proporcionar intensa ayuda al fumador.

En los pacientes con EPOC es muy importante la valoración del estado nutricional, ya que está bien demostrado que la malnutrición condiciona un peor pronóstico (1,2). Una buena planificación dietética y la práctica de ejercicio físico son esenciales.

La actividad física ha demostrado ser relevante en cuanto a la evolución y pronóstico de la enfermedad. Existen estudios que indican que cuanto mayor es la actividad física menor era la disminución de la función pulmonar, tanto en fumadores activos como en antiguos fumadores. Además, el ejercicio físico reduce el estrés oxidativo, tiene efecto antiinflamatorio, reduce la frecuencia de las infecciones de vías respiratorias (3) (mecanismos atenuadores de los efectos nocivos del tabaco) y facilita a los fumadores dejar de fumar. Aun siendo difícil modificar los hábitos y conseguir que los pacientes que hacían ejercicio comiencen a hacerlo, el consejo individualizado es eficaz para aumentar la actividad física en las personas inactivas (4).

La vacunación antigripal es considerada la medida de prevención primaria más eficaz para prevenir la agudización de la EPOC (5). En algunos estudios la vacunación antigripal se ha asociado a la disminución en el número de ingresos hospitalarios por agudización de la enfermedad (6-8%). El 80% de la mortalidad en estos pacientes se atribuye directamente a complicaciones de la gripe. Sin embargo, en Estados Unidos siguen sin vacunarse entre el 40 y el 50% de las personas de alto riesgo (9), y en el Reino Unido, el 52%. En España, la tasa de vacunación tampoco es la deseada (10). La vacunación antigripal reduce la mortalidad en un 41% en los individuos de alto riesgo. La Guía GesEPOC recomienda la vacunación antigripal a todos los pacientes con EPOC, para evitar las exacerbaciones durante la época epidémica.

La infección neumocócica y en especial la enfermedad neumocócica invasiva (ENI) es una importante causa de morbilidad y mortalidad en el mundo. Los pacientes con EPOC tienen aumentado el riesgo de ENI y su evolución. Un consenso reciente sobre la vacunación antineumocócica en el adulto con patología de base (11) recomienda en los pacientes inmunocompetentes con EPOC la administración de la VNC13 en no vacunados y en los vacunados previamente con VNP23 un año después. La nueva vacuna neumocócica conjugada de 13 serotipos aporta una mayor respuesta inmunológica, incluso en mayores de 70 años que han sido previamente vacunados con la vacuna neumocócica polisacárida (12). Esto es especialmente relevante para la EPOC, ya que confiere un riesgo elevado de enfermedad neumocócica invasiva (13) y la mayoría de pacientes son de edad avanzada, por lo que se debe recomendar la vacunación. También, en consecuencia, el grupo de trabajo del área de tabaquismo de la SEPAR recomienda la vacunación antineumocócica utilizando una sola dosis de VNC13 en todos los fumadores, independientemente de su edad e intensidad y/o carga de consumo, que padecen enfermedades respiratorias como la EPOC (14).

METODOLOGÍA

El estudio ADEPOCLE, es un estudio epidemiológico, transversal, multicéntrico, no controlado en el ámbito de la atención primaria, en el que han participado 30 centros de salud de la provincia de León.

SUJETOS A ESTUDIO

Se incluyeron pacientes ambulatorios mayores de 35 años diagnosticados y tratados de EPOC siguiendo la práctica clínica habitual. La recogida de datos ser realizó en un año, de noviembre de 2013 a noviembre de 2014. El análisis estadístico se realizó durante el primer semestre de 2015. En el estudio se incluyeron un total de 833 pacientes de ambos sexos, mayores de 35 años, que aceptaron participar en el estudio y firmaron el consentimiento informado. Se seleccionaron mediante un muestreo sistemático con arranque aleatorio a los pacientes con número par que acudieron a la consulta de modo consecutivo y que cumplían los criterios de inclusión: pacientes de ambos sexos, mayores de 35 años, con EPOC que tengan realizada espirometría con un índice FEV1/FVC posbroncodilatador $< 0,7\%$, diagnosticados y tratados de EPOC y que firmen el consentimiento informado. Se excluyeron del estudio a los pacientes diagnosticados de EPOC que no tenían realizada una espirometría posboroncodilatadora, a los no tratados y a los pacientes con EPOC correctamente diagnosticados y tratados que no quisieron participar en el estudio.

OBJETIVOS

El objetivo de este estudio fue estimar las actividades preventivas que realizan los pacientes diagnosticados de EPOC en la provincia de León.

VARIABLES A ESTUDIO E INSTRUMENTOS DE MEDIDA

Las variables analizadas fueron: edad, sexo, hábitat (rural, urbano), datos antropométricos (peso, talla e índice de masa corporal), antecedentes personales de tabaquismo, abandono del tabaco, estado nutricional, ejercicio físico, vacunación antigripal, vacunación antineumocócica (VNP23 y VNC13) y rehabilitación. Además, deben de tener caracterizado el fenotipo o

realizar la caracterización en el momento de la visita. Adicionalmente se les evaluará la gravedad de forma multidimensional mediante el índice de BODEX en atención primaria y se registrará el tratamiento adecuado a su fenotipo y nivel de gravedad. Se valorará la calidad de vida mediante el Cuestionario CAT. Se registró el número de reagudizaciones, hospitalizaciones y se registró si habían sido adiestrados en el uso de inhaladores, así como en que nivel de atención y que profesionales sanitarios habían realizado dicho adiestramiento.

ANÁLISIS ESTADÍSTICO

Para el conjunto del total de la muestra en estudio, tras depurar la base de datos de posibles errores, se realizarán las pruebas de estadística descriptiva. Las variables con distribución continua se resumirán mediante medidas de tendencia central y dispersión (media, mediana, desviación estándar y amplitud). Las distribuciones de variables discretas se resumirán mediante tablas de frecuencias.

Las proporciones se estimarán por intervalo de confianza del 95%, utilizando la aproximación normal, o el método exacto de Wilson cuando las prevalencias sean muy extremas y los efectivos disponibles escasos. Para la comparación entre grupos se realizarán de la siguiente manera: las variables categóricas se analizarán mediante tablas de contingencias y aplicación pruebas de Chi-cuadrado para diferencia entre proporciones. Para las variables cuantitativas se utilizarán pruebas paramétricas o pruebas no paramétricas según la naturaleza de las variables. Para la comparación de medias tras la comprobación de normalidad con el Test de Kolgomorov-Smirnov, se utilizó la T de Student si la distribución es normal o el Test de Mann-Whitney cuando la distribución no es normal o el tamaño de la muestra es muy pequeño. La comparación múltiple de medias se realizó por medio de ANOVA o el Test de Kruskal-Wallis como prueba no paramétrica. El nivel de significación estadística mínimo se fijó en todos los casos como $p < 0,05$. Los resultados se expresan con sus IC al 95,5%.

RESULTADOS

En total se incluyeron en el estudio un total de 833 pacientes con EPOC que firmaron el consentimiento informado y cumplieron los criterios de inclusión. Las características de distribución de sexo, edad y hábitat se describen en la tabla I. Existe un predominio de varones con edades comprendidas entre los 55-64 años y del medio rural, con una edad media de 64,69 años (53,66-75,61) y 20,65 (4,47-36,08) años de evolución de la EPOC, $p < 0,001$.

Las actividades preventivas estudiadas y analizadas en los pacientes con EPOC incluyeron, intervención antitabáquica, actividad física regular, alimentación equilibrada, vacunación antigripal y vacunación antineumocócica.

TABACO

El 86,67% (80,30-93,30) de los pacientes con EPOC tenían antecedentes de tabaquismo (n = 722), de 35,26 (17,87-52,64) años de evolución, con consumo medio 28,36 (9,60-46,86) paquetes año, $p < 0,001$, siendo el 58% fumadores severos. El 57,4% (53,90-60,60) son exfumadores. El 39,3% (26,40-32,70) de los pacientes con EPOC fueron fumadores activos declarados *vs.* 35,11% (33,90-37,12) fumadores diagnosticados por cooximetría $p < 0,05$. Los pacientes que seguían siendo fumadores activos (n = 288) presentaban baja motivación (49,80%), alta dependencia (49,5%), actitud negativa (52,60%), bajo estado de ánimo (32,05%), con 2,72 (1,74-3,67) intentos para dejar de fumar, $p < 0,0001$. La terapia conductivo-conductual (TCC) combinado con tratamiento farmacológico se realizó en el 55,8% (52,2-54,9), $p < 0,05$. La intervención más efectiva fue TCC combinada con vareniclina que logra una abstinencia del 29,86%. Con el conjunto de todas las intervenciones dejaron de fumar el 51,05% (49,49-52,70) de los pacientes con EPOC, $p < 0,001$.

EJERCICIO

El 73,67% (71,78-75,65) de los pacientes con EPOC realizaba ejercicio de forma regular según se les había pautado por su médico de familia y/o neumólogo, siendo los fenotipos no reagudizadores los que más ejercicio realizan. Los que menos ejercicio realizan son los fenotipos agudizadores con bronquitis crónica grave, seguidos de los reagudizadores con enfisema, $p < 0,05$. La realización de ejercicio físico se asocia con un menor número de agudizaciones, con una menor gravedad de estas y con un menor número de hospitalizaciones, $p < 0,001$.

Tabla I. Vacunación antigripal

Vacuna de la gripe	Frecuencia	Porcentaje	Bootstrap para porcentaje[a]
			IC 95%
No	80	9,7	7,7-11,6
Sí	743	89,7	87,8-91,8
Total	*828*	*100,0*	

[a] *$p < 0,05$.*

DIETA EQUILIBRADA

El 88,76% (84,82-90,7) de los pacientes sigue una dieta equilibrada según las recomendaciones para pacientes con EPOC descritas en la introducción), siendo los pacientes que peor siguen las recomendaciones dietética los fenotipos mixtos y los fenotipos reagudizadores graves. En menos del 5% se utilizan suplementos dietéticos especialmente en pacientes inmovilizados y caquécticos con EPOC.

VACUNACIÓN ANTIGRIPAL

La vacunación antigripal para prevenir las reagudizaciones de la EPOC se realizó el 89,7% (87,8-91,8) de los pacientes, $p < 0,05$ (Tabla I), siendo los pacientes más vacunados los de gravedad moderada y grave, sin diferencias significativas por fenotipos.

Existen diferencias significativas en cuanto al sexo, edad y el hábitat de los vacunados y son los pacientes más frecuentemente vacunados los varones de ámbito rural, $p < 0,05$. Por grupos de edad, los que más vacunas antigripales recibieron son los de edades comprendidas entre los 65-74 años, los que menos, los de edades entre 35-54 años, $p < 0,001$ (Tabla II), de reciente diagnóstico, con pocos años de evolución de la enfermedad y frecuentemente no reagudizadores.

La tasa de vacunación fue mayor en los pacientes ingresados. El 66,86% (65,30-68,4) no había ingresado o tan solo había tenido un ingreso por reagudización. No se recogieron en este estudio los pacientes con ingresos hospitalarios debidos a la gripe o a sus complicaciones.

La tasa de no vacunados fue más alta en los pacientes reagudizadores, para cualquier número de reagudizaciones producidas en el último año. El 9,61% (7,7-11,6) de los no vacunados tuvo reagudizaciones de su EPOC que requirieron ingreso hospitalario, $p < 0,001$. No existen diferencias significativas en cuanto a la vacunación antigripal por tabaquismo, fenotipos, ni en cuanto a los niveles de gravedad de la EPOC, existiendo un mayor porcentaje con vacunación antigripal en los pacientes con EPOC moderados y graves.

VACUNACIÓN ANTINEUMOCÓCICA

La vacunación antineumocócica para prevenir la aparición de neumonías y enfermedad neumocócica invasiva es muy heterogénea. La tasa de vacunación con la VNP23 fue del 52,8% (49,3-56,4), siendo muy infrecuente la vacunación con VNC13, del 4,97% (3,0-6,61) (Tabla III), $p < 0,05$. Es llamativo el alto porcentaje de pacientes no vacunados frente al neumococo y la baja tasa de vacunación con la VNC13.

Tabla II. Porcentajes de vacunación antigripal por edad, sexo y hábitat

	Frecuencias		% vacunados	IC 95%	p
	Vacunados	No vacunados			
Sexo					
Varones	646	69	77,55	75,95-79,15	0,05
Mujeres	107	11	22,45	20,50-24,35	0,05
Total	753	80	100,00		
Edad					
35-54 años	92	55	12,21	10,36-14,06	0,001
55-64 años	203	21	26,45	24,49-28,41	0,001
65-74 años	296	3	39,30	37,52-41,17	0,001
≥ 75 años	162	1	22,04	20,03-23,81	0,001
Total	753	80	100,00		
Hábitat					
Rural	438	50	58,17	56,12-60,25	0,94
Urbano	315	30	41,83	40,29-43,37	0,94
Total	753	80	100,00		

Tabla III. Tasa de vacunación antineumocócica en pacientes con EPOC

Vacuna antineumocócica	Frecuencia	Porcentaje	IC 95%	p
No vacunados	355	42,61	39,6-46,1	0,05
VNP23	437	52,46	49,5-56,0	0,05
VNC13	6	0,72	0,1-0,91	0,05
VNP23 + VNC13	35	4,21	2,9-5,7	0,05
Total	833	100,0		

VNP23: vacuna antineumococica de polisacáridos capsulares 23 valente; VNC13: vacuna antineumocócica de polisacáridos conjugados 13 valente. IC 95%: intervalo de confianza al 95%. p: significación estadística.

Tabla IV. Vacunación antineumocócica por fenotipos de la EPOC

Vacuna antineumococica	Fenotipo				Total
	Fenotipo no reagudizador	Fenotipo mixto EPOC-asma	Fenotipo reagudizador con enfisema	Fenotipo reagudizador con BC	
No	233	62	29	31	355
VNP23	244	47	52	94	437
VNC13	1	0	0	0	1
VNP23 + VNC13	7	4	9	14	34
Total	485	113	90	139	827

VNP23: vacuna antineumococica de polisacáridos capsulares 23 valente; VNC13: vacuna antineumocócica de polisacáridos conjugados 13 valente. BC: bronquitis crónica. Es de destacar que el fenotipo en que más pacientes se vacunan es no reagudizador, contrariamente a lo deseado.

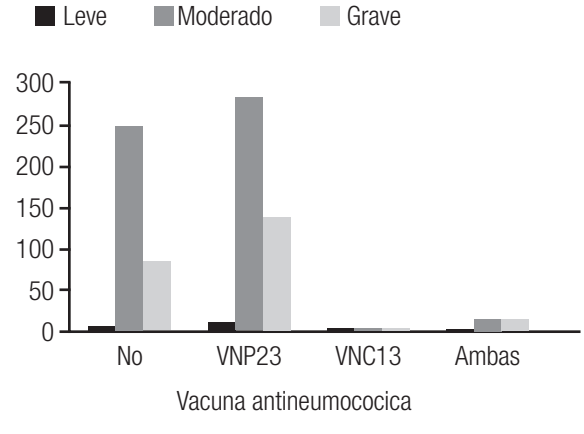
Los vacunados mayoritariamente con VNP23 corresponden al fenotipo no reagudizador, seguidos del fenotipo reagudizador con bronquitis crónica (Tabla IV). Los más vacunados fueron los que no presentaban ninguna reagudización y los que presentaban una. En general, los reagudizadores se vacunaron más con la VNP23. En función del número de ingresos, los más vacunados son los que no han tenido ningún ingreso y los que habían tenido entre 1-3 ingresos hospitalarios. Los pacientes con mayor número de ingresos son los que menor tasa de vacunación antineumocócia presentan con cualquiera de las dos vacunas. No se habían vacunado con la vacuna antineumococica VNP23 los pacientes con EPOC leve, casi la mitad de los pacientes con EPOC Moderado y un tercio de los graves. Se vacunaron mayoritariamente los pacientes con EPOC moderado y grave (Fig. 1). La vacuna VNC13 no se administró prácticamente en ningún estadio de gravedad.

DISCUSIÓN

El nivel de actividad física en la EPOC se asocia consistentemente con la mortalidad y las exacerbaciones, pero hay poca evidencia sobre los determinantes de la actividad física, incluyendo el impacto del tratamiento (15). En este estudio, el 73,67% (71,78-75,65) de los pacientes con EPOC realizaba ejercicio de forma regular. Estos resultados obtenidos en el estudio ADEPOCLE están por encima de la media de los reportados por otros estudios. La implementación de los estilos de vida saludables y la adherencia a los servicios clínicos preventivos recomendados para los pacientes con EPOC está por debajo de los niveles deseables en España. Un programa de entrenamiento muscular de 20 sesiones contribuye a una mejoría en la calidad de vida, la tolerancia al ejercicio y el pronóstico de los pacientes con EPOC con exacerbaciones leves o moderadas (16). Los pacientes con estilos de vida más desfavorables son aquellos que también realizan menor número de las actividades preventivas recomendadas.

La nutrición y metabolismo han sido un tema de la investigación científica extensa en la EPOC, pero en cuanto a la concienciación sobre los hábitos alimentarios, su impacto clínico, el estado nutricional y las intervenciones nutricionales que pueden tener sobre la incidencia y progresión de la EPOC el resultado es limitado. En general, la evidencia indica que una dieta bien equilibrada es beneficiosa para todos los pacientes con EPOC, no solo por sus potenciales beneficios pulmonares, sino también por sus beneficios metabólicos y sobre el riesgo cardiovascular (17). En nuestro entorno, el 88,76% (84,82-90,7) de los pacientes con EPOC sigue una dieta equilibrada. A pesar de ello, la prevalencia de la malnutrición es alta en la EPOC, y es mayor cuanto más grave es la EPOC. En la provincia de León, en menos del 5% de los casos se utilizan suplementos dietéticos, especialmente en pacientes inmovilizados y caquécticos con EPOC.

La prevalencia de vacunación antigripal en diferentes series de pacientes con patología crónica oscila entre el 40 y el 60% (18). En este estudio se determinó que el 89,7% (87,8-91,8) está vacunado de la gripe en la provincia de León, un porcentaje muy superior a la media nacional. En un estudio transversal que incluyó 2.575 pacientes con EPOC en la Encuesta Nacional de Salud de 2006 y en la Encuesta Europea de Salud en España de 2009, se puso de manifiesto que el 63,4% de los pacientes se había vacunado de la gripe en 2006. Estos porcentajes aumentaron



VNP23: vacuna antineumococica de polisacáridos capsulares 23 valente; VNC13: vacuna antineumocócica de polisacáridos conjugados 13 valente.

Figura 1.
Vacunación antineumocócica en función de la gravedad de la EPOC.

en el año 2009, llegando al 72,65% (19). En un estudio realizado en cohortes retrospectivas que incluyó a los 1.323 pacientes diagnosticados de EPOC del Área Básica de Salud del Pla d'Urgell (Lleida), se clasificaron en 2 cohortes: cohorte 1, pacientes vacunados contra la gripe estacional (campaña 2011/2012), y cohorte 2, no vacunados. Se cuantificaron los pacientes que requirieron ingreso hospitalario por exacerbación de la enfermedad entre el 1 de diciembre de 2011 y el 15 de marzo de 2012, el 55,3% había sido vacunado. Los pacientes vacunados eran de mayor edad y presentaban mayor comorbilidad asociada. A la vez, estos ingresaron menos (3,0% *versus* 8,9%, $p < 0,001$). Las efectividades cruda y ajustada de la vacunación antigripal fueron del 68,4% (IC 95%: 47,5-81,0) y del 90,8 (IC 95%: 96,8-88,2), respectivamente (20). Estos datos contrastan con los de otro estudio de cobertura de vacunación antigripal en pacientes con EPOC del 49,4% (46,3-52,5) (21). Algunos autores (22) han señalado que los pacientes con EPOC e IC suelen presentar mejores tasas de vacunación, como es el caso de nuestro estudio. En nuestro trabajo se ha observado que los pacientes con mayor comorbilidad asociada suelen vacunarse más; apreciación también descrita por otros autores. Además, hay que tener en cuenta que únicamente el 18% de los pacientes vacunados lo solicitan directamente a su médico de atención primaria (23). También se debe señalar que los pacientes fumadores se vacunan menos que los no fumadores, tal y como han señalado otros estudios (24), si bien nosotros no hemos encontrado diferencias significativas.

Los estudios de vigilancia hospitalaria señalan que más del 20% de la enfermedad neumocócica invasiva en España acontece en pacientes con EPOC, siendo estos pacientes uno de los grupos de riesgo donde la letalidad de la enfermedad neumocócica es mayor (25). Estudios epidemiológicos apuntan a una mayor frecuencia de neumonías en los pacientes con EPOC, a lo que contribuiría, además de la toxicidad local producida por el tabaco como causa más frecuente de EPOC, la edad avanzada a la que suele aparecer clínicamente la enfermedad y el excesivo uso de corticoides inhalados en gran número de estos pacientes.

Conscientes de la importancia de las infecciones respiratorias en los pacientes con EPOC, una medida recomendada en las guías de práctica clínica es su prevención. La vacunación antigripal se recomienda desde hace tiempo y en los últimos años se ha añadido a esta recomendación la prevención de la infección neumocócica. Durante muchos años se ha aconsejado la VNP23, y recientemente, la vacuna conjugada de 13 serotipos.

En el presente estudio la tasa de vacunación con la VNP23 fue del el 52,8% (49,3-56,4), datos similares a los obtenidos en otro estudio realizado en España con una cobertura del 50,1% (26). Otro estudio que incluyó un total de 10.711 pacientes en atención primaria reportó una cobertura muy inferior al nuestro, tan solo del 32,5% (31,6-33,4) (27). En otro estudio realizado en Cataluña, el 62,5% de los pacientes con EPOC había recibido la VNP23 y la vacuna antigripal (28). En un estudio publicado recientemente, la cobertura global fue del 65,5% (67,5% de hombres frente a 60,4% de mujeres, $p < 0,001$). En pacientes de 40-59 años, la cobertura fue de 19,5%, llegando a 75,8% en los de ≥ 60 años. Los factores asociados con las mayores tasas de vacunación en ambos sexos eran la edad y el cumplimiento óptimo de la vacunación de la gripe (29). Los datos de coberturas vacunales con VNP23 españoles contrastan con los de otros países como Reino Unido, en el que las tasas de cobertura en mayores de 65 años son del 75% (30).

En España, datos del periodo 2010-2012 indican que la cobertura en la población general para los serotipos de VNC13 es del 63% en adultos inmunocompetentes y del 45% en adultos inmunocomprometidos. En el año 2011, la diferencia de cobertura de serotipos de la VNC13 y la VNP23 era tan solo del 15,5% (31). En nuestro estudio la tasa de vacunación con la VNC13 fue tan solo del 0,73% (0,1-0,91) cuando se administraba sola, llegando al 4,25% (2,9-5,7) cuando se administraba en pacientes que habían recibido la VNP23. Estos pobres porcentajes obtenidos en León son atribuidos a que en Castilla y León, la VNC13 solo está indicada en pacientes con EPOC que hayan tenido ENI y además estén inmunodeprimidos. Las personas con enfermedades respiratorias crónicas con riesgo de ENI, y las fumadoras y exfumadoras con alta carga de consumo de tabaco deben ser vacunadas contra el neumococo y, si es posible, con la nueva vacuna VNC13 (32).

CONCLUSIONES

Los pacientes con EPOC suelen ser físicamente inactivos y con pronóstico negativo. Por lo tanto, la promoción de la actividad física regular es de importancia clave en la reducción de la morbilidad y mortalidad y para mejorar la calidad de vida de esta población. Por sus efectos beneficiosos para estos pacientes y para evitar la desnutrición en las fases avanzadas de la EPOC, estos pacientes deben seguir una dieta equilibrada. Es necesario seguir estrategias adecuadas para conseguir coberturas vacunales frente a la gripe y el neumococo más elevadas en nuestra provincia y a escala nacional para mejorar la calidad de vida de estos pacientes, disminuir el número de reagudizaciones, de hospitalizaciones y mejorar su pronóstico vital.

BIBLIOGRAFÍA

1. Juan Díaz M, Serrano Lázaro A, Mesejo Arizmendi A. Aspectos nutricionales de la patología pulmonar. Nutr Clin Med 2008;2:141-54.
2. Alcolea Batres S, Villamor León J, Álvarez-Sala R. EPOC y estado nutricional. Arch Bronconeumol 2007;43:283-8.
3. Hopkinson N, Polkey M. Does physical inactivity cause chronic obstructive pulmonary disease? Clin Sci 2010;118:565-72.
4. Grandes G, Sánchez A, Sánchez-Pinilla RO, Torcal J, Montoya I, Lizarraga K, et al; PEPAF Group. Effectiveness of physical activity advice and prescription by physicians in routine primary care: a cluster randomized trial. Arch Intern Med 2009;169:694-701.
5. Pesek R, Lockey R. Vaccination of adults with asthma and COPD. Allergy 2011;66:25-31.
6. Menon B, Gurnani M, Aggarwal B. Comparison of outpatient visits and hospitalisations, in patients with chronic obstructive pulmonary disease, before and after influenzae vaccination. Int J Clin Pract 2008;62:593-8.
7. Clancy RL, Dunkley M. A vaccine to prevent exacerbations in COPD. Med J Aust 2011;195:99-100.
8. Karwat KJ, Szpotanska M, Szulc Z, Chazan R. The influence of influenzae vaccination on asthma and chronic obstructive pulmonary disease. Pneumonol Alergol Pol 2006;74:80-3.

9. Poole PJ, Chacko E, Wood-Baker RWB, Cates CJ. Influenzae vaccine for patients with chronic obstructive pulmonary disease. Cochrane Database Syst Rev 2006;25:CD002733.
10. Holm V, Arrazola MP, Szucs TD, de Juanes JR, García de Codes A. Evolución de la cobertura de la vacunación contra la gripe en España. Periodo 2002-2006. Vacunas 2007;2:66-73.
11. Picazo JJ, González-Romo F, García A, Pérez-Trallero E, Gil P, de la Cámara R, et al. Consenso sobre la vacunación anti-neuomcócica en el adulto con patología de base. Rev Esp Quimioter 2013;26(3):232-52.
12. Jackson LA, Gurtman A, Rice K, Pauksens K, Greenberg RN, Jones TR, et al. Immunogenicity and safety of a 13-valent pneumococcal conjugate vaccine in adults 70 years of age and older previously vaccinated with 23-valent pneumococcal po- lysaccharide vaccine. Vaccine 2013;31:3585-93.
13. Inghammar M, Engström G, Kahlmeter G, Ljungberg B, Löfdahl CG, Egesten A. Invasive pneumococcal disease in patients with an underlying pulmonary disorder. Clin Microbiol Infect 2013;19:1148-54.
14. Jiménez Ruiz CA, Solano Reina S, Riesco Miranda JA, Altet Gómez N, Signes-Costa Miñana J, Lorza Blasco JJ, et al. Recomendaciones para la vacunación neumocócica en fumadores. Prev Tab 2012;14:174-7.
15. Jimeno-Santos E, Frei A, Steurer-Stey C, de Batlle J, Rabinovich RA, Raste Y, et al; PROactive consortium. Determinants and outcomes of physical activity in patients with COPD: a systematic review. Thorax 2014;69(8):731-9.
16. López-García A, Souto-Camba S, Aparicio-Blanco M, González-Doniz L, Saleta JL, Verea-Hernando H. Effects of a muscular training program on Chronic Obstructive Pulmonary Disease patients with moderate or severe exacerbation antecedents. Eur J Phys Rehabil Med 2014;5.
17. Schols AM, Ferreira IM, Franssen FM, Gosker HR, Janssens W, Muscaritoli M, et al. Nutritional assessment and therapy in COPD: a European Respiratory Society statement. Eur Respir J 2014;44(6):1504-20.
18. Centers for Disease Control and Prevention. Influenza and pneumococcal vaccination coverage levels among persons aged ≥ 65 years: United States, 1973-1993. MMWR 1995;44:506-67.
19. De Miguel-Díez J, Jiménez-García R, Hernández-Barrera V, Maestu LP, Aparicio IJ, Ramos AO, et al. Clustering of unhealthy lifestyle behaviors is associated with a low adherence to recommended preventive practices among COPD patients in Spain. COPD 2014;11(4):459-67.
20. Montserrat-Capdevila J, Godoy P, Marsal JR, Cruz I, Solanes M. [Effectiveness of influenza vaccination in preventing hospital admission due to exacerbations of chronic obstructive pulmonary disease]. Enferm Infecc Microbiol Clin 2014;32(2):70-5.
21. Santos-Sancho JM, Jiménez-Trujillo I, Hernández-Barrera V, López de Andrés A, Carrasco-Garrido P, Ortega-Molina P, et al. Influenza vaccination coverage and uptake predictors among Spanish adults suffering COPD. Hum Vaccin Immunother 2012;8(7):938-45.
22. Sarrià A, Timoner J. Determinantes de vacunación de la gripe en pacientes mayores de 65 años. Rev Esp Salud Publica 2002;76:17-26.
23. Yip NH, Yuen G, Lazar EJ, Regan BK, Brinson MD, Taylor B, et al. Analysis of hospitalizations for COPD exacerbation: Opportunities for improving care. COPD 2010;7:85-92.
24. Nicholson KG, Kent J, Hammersley V. Influenzae A among community-dwelling elderly persons in Leicestershine during Winter 1993-4; cigarrette smoking as a risk factor and the efficacy of influenzae vaccination. Epidemiol Infect 1999;123:103-8.
25. De Roux A, Cavalcanti M, Marcos MA, García E, Ewig S, Mensa J, et al. Impact of alcohol abuse in the etiology and severity of community-acquired pneumonia. Chest 2006;129:1219-25.
26. Alfageme I, Vázquez R, Reyes N, Muñoz J, Fernández A, Hernandez M, et al. Clinical efficacy of anti-pneumococcal vaccination in patients with COPD. Thorax 2006;61(3):189-95.
27. Briñez-Fernández MC, Carrasco-Garrido P, García-Carballo M, Hernández-Barrera V, de Miguel AG, Jiménez-García R. Determinants of pneumococcal vaccination among patients with chronic obstructive pulmonary disease in Spain. Hum Vaccin 2006;2(3):99-104.
28. Jiménez-García R, Ariñez-Fernández MC, Hernández-Barrera V, García-Carballo MM, de Miguel AG, Carrasco-Garrido P. Compliance with influenza and pneumococcal vaccination among patients with chronic obstructive pulmonary disease consulting their medical practitioners in Catalonia, Spain. J Infect 2007;54(1):65-74.
29. Carreño-Ibáñez LV, Esteban-Vasallo MD, Domínguez-Berjón MF, Astray-Mochales J, González del Yerro C, Iniesta-Fornies D, et al. Coverage of and factors associated with pneumococcal vaccination in chronic obstructive pulmonary disease. Int J Tuberc Lung Dis 2015;19(6):735-41.
30. Andrews NJ, Waight PA, George RC, Slack MP, Miller E. Impact and effectiveness of 23-valent pneumococcal polysaccharide vaccine against invasive pneumococcal disease in the elderly in England and Wales. Vaccine 2012;30:6802-8.
31. Picazo JJ, González-Romo F, García Rojas A, Peréz-Trallero E, Gil Gregorio P, de la Cámara R, et al. Consenso sobre la vacunación anti-neumocócica en el adulto con patología de base. Rev Esp Quimioter 2013; 26:232-52.
32. Casas F, Alfageme I, Barchilón VS, Peis JI, Vargas DA. Recomendación de la vacuna antineumocócica en las enfermedades respiratorias crónicas. Semergen 2014;40(6):313-25.

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Nutrición Hospitalaria

Trabajo Original

Otros

Interventions directed at eating habits and physical activity using the Transtheoretical Model: a systematic review

Intervenciones dirigidas a los hábitos alimenticios y la actividad física mediante el Modelo Transteórico: una revisión sistemática

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Abstract

Introduction: The multi-behavioral Transtheoretical Model (TTM) addresses multiple behaviors and it is a promising strategy to control multifactorial morbidities, such as chronic diseases. The results obtained using the TTM are positive, but are not consistently methodical.

Objectives: The aim of this study was to systematically review the effectiveness of the Transtheoretical Model in multi-behavioral interventions for changing eating habits and levels of physical activity.

Methods: A search on PubMed and SciELO databases was performed with inclusion criteria set for intervention studies before 2016 using the Transtheoretical Model for more than one behavior, including eating habits and/or engaging in physical activity.

Results and conclusion: Eighteen studies were identified; there was a predominance of randomized clinical trials, studies conducted in the United States, and the use of the Internet and/or telephone. The selected studies were aimed at changing eating behaviors; five of the studies did not address physical activity. The main results were reduction of fat consumption, an increase in the consumption of fruit and vegetables, and increases in physical activity, which are progressions in the stages of change and weight loss identified by the Transtheoretical Model. However, the studies showed methodological weaknesses, including high participant loss and the omission of information about randomization and blinding.

Key words:

Theoretical models. Food habits. Exercise. Intervention studies. Review.

Resumen

Introducción: el Modelo Tranteórico multiconductual aborda distintas conductas y es una estrategia prometedora para el abordaje de patologías multifactoriales, sobre todo en las enfermedades crónicas. Los resultados iniciales de su empleo han sido favorables, pero no han sido probados con rigor.

Objetivos: el objetivo de este estudio fue realizar una revisión sistemática de la eficacia del Modelo Transteórico en el cambio de hábitos dietéticos y en el grado de actividad física con intervenciones en varias áreas de la conducta.

Métodos: se realizó una búsqueda en PubMed y SCieLO utilizando como criterios de búsqueda estudios de intervención realizados antes de 2016 y que incluyeran más de un hábito, incluyendo hábitos alimentarios y/o actividad física.

Resultados y conclusión: se identificaron 18 estudios, con un predominio de ensayos clínicos aleatorizados, estudios realizaos en Estados Unidos de Norteamérica, y uso de Internet y/o teléfono. Los estudios seleccionados tenían como meta el cambio en los hábitos dietéticos. En 5 de los estudios no se incluía la actividad física. El principal resultado de la intervención fue la disminución en el consumo de grasa y el aumento en la ingestión de frutas y verduras, así como un aumento en la actividad física. Estos cambios supusieron progresos en la pérdida de peso. Sin embargo, los trabajos eran metodológicamente débiles, incluyendo una alta tasa de abandonos, y falta de información sobre la aleatorización y cómo se realizó el estudio ciego.

Palabras clave:

Modelos Teóricos. Hábitos alimenticios. Ejercicio. Estudios de intervención. Revisión.

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INTRODUCTION

The Transtheoretical Model (TTM) is used in developing and monitoring the effectiveness of health interventions in research and health service contexts. This study focused on the multi-behavioral TTM because it addresses multiple behaviors, which makes it a promising strategy to control multifactorial morbidities, such as chronic diseases (1).

The main pillars of TTM encompass the stages of change (SC), decisional balance, self-efficacy, and processes of change. The SC represents the motivation and promptness of change (2), and progression is mediated by the other components. Decisional balance involves the individual's perception of the advantages and disadvantages of modifying the targeted behaviors and self-efficacy, which is defined as the confidence in the ability to adopt new behaviors. The processes of change comprise cognitive, experimental, and behavioral strategies that encourage the progression across stages (3).

The results obtained using the TTM are positive, but are not consistently methodical. The present work systematically reviewed the effectiveness of the TTM in multi-behavioral interventions for changing eating habits and levels of physical activity.

METHODS

This review was conducted based on the recommendations of the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guide. The following steps were undertaken in this study: The hypothesis and aims of the study were defined, the criteria for inclusion and exclusion of articles was established, bibliographical research was conducted, the material was carefully read, the information to be obtained from the articles was defined, and the methods of analyzing and presenting the results were established.

The bibliographical research was performed with the purpose of answering the following question: *Has the multi –behavioral change-eating habits and physical activity– using the TTM been effective?* The databases of the United States National Library of Medicine (PubMed) and The Scientific Electronic Library Online (SciELO) were used. The keywords used (in Portuguese and in English) included (1) use of the Transtheoretical Model ("stages of change", "stage of change", "transtheoretical model", "transtheoretical model of change"); (2) addressing more than one behavior: Multi-behavioral Transtheoretical Model ("multiple behavior interventions", "multiple behavior changes"); and (3) inclusion of the eating behaviors and/or physical activity in the intervention ("dietary therapy", "eating habits", "physical activity", "diet and exercise").

All articles published before 2016 were identified, followed by an analysis of their titles, and an analysis of abstracts and full texts. When the title and the abstract met the established criteria, the selected articles were read in full (Table I) (4). Moreover, the articles referenced in this work and additional available publications were recovered using the same inclusion criteria.

To verify agreement on the selection of articles to be analyzed in this review, two authors applied the proposed inclusion criteria in an independent and blinded manner. The *kappa* test was used to measure the concordance between the evaluators. In case of discordance, there was a discussion and a consensus was proposed and, when necessary, the other authors of this work were consulted. The articles associated with an unique study were analyzed separately, but referenced in the text according to the first publication.

RESULTS

STUDY SELECTION

The database SciELO did not have any articles containing the multi-behavioral TTM; therefore, only articles found in the PubMed database were analyzed.

The independent evaluators reached an initial consensus over the selection of 78.8% of the articles (kappa test: 0.697). The discordance generated resulted mainly from the incomplete description of the methodology in the abstracts.

Figure 1 presents the flowchart used to select the articles. Eighteen studies met the eligibility criteria and were included in this review. The 18 studies evaluated generated 23 publications: Johnson et al. (5); Cook et al. (6), Prochaska et al. (7-9), Logue et al. (10), Jones et al. (11), Svetkey et al. (12) and Elmer et al. (13) (*Premier* Study), Block et al. (14) and Sternfeld et al. (15) (*Alive!* Study), Clark et al. (1), Greaney et al. (16) and Greene et al. (17) (*SENIOR* study), Riebe et al. (18,19), Steptoe et al. (20,21), Van Wier et al. (22,23) (*ALIFE@ Work* study), Niederhauser et al. (24) (*Building Strong and Ready Families Program*), Mauriello et al. (25), Velicer et al. (26), Armitage et al. (27), Menezes et al. (28) (Table II).

METHODOLOGICAL CHARACTERISTICS OF THE STUDIES

From the 18 analyzed studies, 14 were conducted in the United States of America, two in the United Kingdom (20,27), one in Brazil (28) and one in Canada (11).

The sample size in the studies varied from 71 to 5,407 (average = 1,349) participants, and included male and female participants. The average age ranged from 25, 8 to 75 years, with the exception of two studies which samples were composed by preadolescents (26) and adolescents (25) (Table II).

The main inclusion criterion for the studies was the presence of an aggravating factor, such as overweight (9,10,18,20,22,27), high blood pressure (12), increased risk of cardiovascular diseases (20), and diabetes mellitus (11).

The predominant design was the randomized clinical trial (5-12,14,20,22,26,28), but studies of interventions without a control group (CG) (18,26), an experimental (1) and quasi-experimental (24) group were also identified. Only 8 studies clearly described the randomization method used (10,12,14,20,22,26-28).

Table I. Information extracted from the studies

Methodological characteristics	
Design	– Realization and description of randomization – Presence of a control group – Presence of intervention in the control group
Population	– Statistical comparison of control and intervention groups – Percentage of acceptable abandonment: Acceptable value < 20% in short-term follow-up (≤ 6 months) or < 30% long-term (> 6 months)
Measurement quality	– Realization of blinding in the studies – Comparable time measurements between intervention and control groups – Follow up time acceptable (> 6 months)
Statistical analysis	– Analysis controlled for confounders – Analysis by intention-to-treat
Outcome variables	
Primary outcome	– Consumption and feeding behavior – Physical activity
Other outcomes	– Anthropometric measures: weight, body mass index, waist circumference; and body composition – Pillars of the Transtheoretical Model (TTM)
Other variables extracted	
Participants	– Number – Profile: age, sex, nutritional status and health conditions
Location and year	– Country of conducting the study – Year of publication
Intervention	– Using TTM – Professionals involved – Method of application: Internet, face to face (individual and group) and telephone

From the 16 studies that had a CG, 31 % (n = 5) did not conduct an intervention. The treatment of the CG was generally defined as "usual care" (1,6,7,10-12,20,22, 8), and only five studies (7,10,12,27,28) described the intensity and type of care.

In the majority of the studies, the comparability of the control and intervention groups (IG) was tested on the baseline values (1,6-12,14,20,24,25,27,28) for demographical and socio-economic variables, among others, with the exception of two studies (5,22). In the study of Van Wier et al. (22,23), the groups were not statistically compared before the intervention, although all the analyses were adjusted by baseline values, which created an adjusted follow-up score.

Most of the trials had a follow-up period of six months or longer (4), varying between one (27) and 36 months (26). Some studies presented participant losses considered acceptable over the short- (≤ 6 months) (6,12,27) and long-term (> 6 months) (5,8,11,12,26); one study did not give the loss information. We found losses ranging between 11,1% (27) and 63% (24) in the short-term studies and between 17,3% (26) and 46% (5) in the long-term studies. In general, these losses were lower in the CG.

All studies evaluated the CG and IG (intervention group) at comparable time points, and additional analyses were performed only with the IG; in some studies, this was done for supporting the intervention (8,11).

Seven investigations (39%) did not mention whether the researchers or the participants were blind to status (1,5,7,11,20,22,24), and the reason given was the nature of the interventions (18,20) or the presence of research assistants, who were not blind to the group assignment, during assessments (25,26). The remaining studies explained how blind analyses were performed or the data collection was carried out using self-report questionnaires without the involvement of the researcher (6,8,10,12,14,27,28).

Regarding the statistical analysis of the data, the majority of the studies controlled by potential confounding factors in intention-to-treat analyses (1,5,10-12,14,20,22,25,26). In addition, Prochaska et al. (7,8) used the Generalized Linear Model, a method that allows the evaluation of a changing pattern across time, in addition to performing modeling and evaluation of missing data.

For the evaluation of the main outcomes, the studies used Food Frequency Questionnaires (11,14,17,22), 24 hours Food Records (R24) (10,13,17,18,28) and general questionnaires concerning eating habits and behaviors (6-8,14,25,26,28) to evaluate food consumption. R24 were administered face-to-face, via telephone or computer, two (13) or three (10,17,18,28) times at

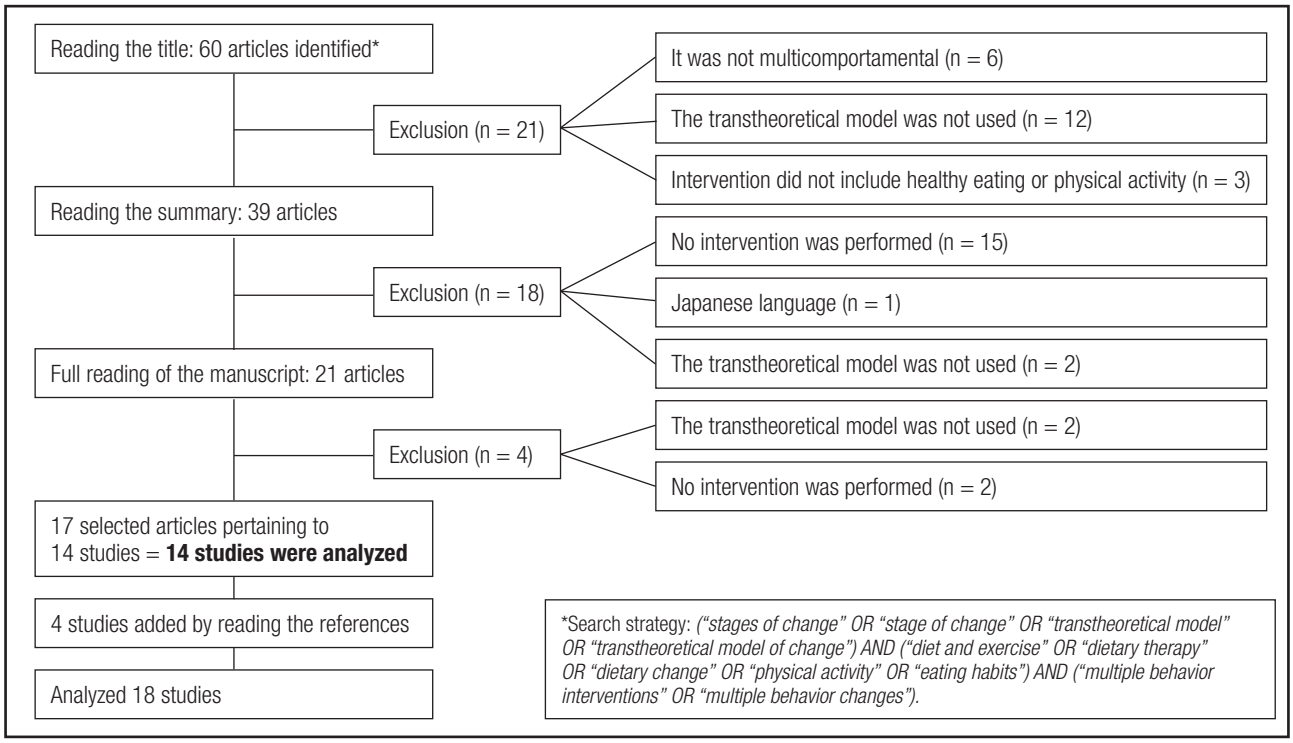

Figure 1.
Flowchart of the study selection process.

each evaluation time-point. However, only one study included the consumption of micronutrients (13), while the others limited the analysis to the consumption of calories, lipids, and food groups, including fruit and vegetables (FV).

Concerning the practice of physical activity (PA), the studies applied distinct questionnaires in which the participants reported the duration and/or frequency of the activity (14,16,19,20,22,24-26). A seven-day PA (physical activity) Recall to estimate the daily energy expenditure (10,13), an ergometric test to evaluate the cardiac frequency or maximum oxygen consumption (13,19), a measure of the functional mobility in the elderly (16), monitoring of PA with a pedometer (23) were among the measures used.

Regarding other outcomes investigated, thirteen studies obtained anthropometric data (10,12,18,20,22,27,28) or used self-reported anthropometric information (5,6,9,11,22,24,25). Weight was the most frequently used measurement, and some studies also included Body Mass Index (BMI) (18,19,24,25,27,28), waist circumference (WC) (10,22,28), and body fat percentage (BF %) (19).

Some studies failed to report which questionnaire was used for evaluating the TTM pillar stages of change (6,14) and only a few described the validation of this tool (5,25,26,28). The remaining TTM pillars (processes of change, decisional balance and self-efficacy) were used to monitor the results in only a few interventions (1,6,14,19,22).

INTERVENTIONS AND THE TRANSTHEORETICAL MODEL

The application methods for the intervention included online platforms, e-mails, phone calls (1,5-11, 14,22,25,26) and group (12,18,28) and individual (9,20) face-to-face meetings.

The professionals engaged in the development and execution of the interventions included nutritionists (10,12,18,22,28), health educators (12,20), health coaches (9), psychologists (10,18,20,28), nurses (20,24), chaplains (24), and physical education teachers (22), or advisors (10,11); seven studies did not report who developed or performed the intervention (1,5,7,8, 25-27). The training of these professionals was mentioned in six of the studies (9,10,12,20,22,28).

The TTM was used as an aid to classify the SC of the participants and assess the intervention (22), as an intervention tool (10,12), or both (1,5-9,11,14,18,20,24-26,28). As an example, in the ALIFE@Work study (22) (performed with overweight workers) the advice related to PA was based on the stages of change, while the advice related to healthy eating habits was based on self-reports of food consumption.

Some interventions were exclusively based on the TTM (1,5,7,8,10,11,18,20,25-28), while others (6,12,14,22) used it in combination with other elements derived from behavioral and cognitive psychology or other theories (9,24).

Table II. Description of the studies included in the review and main results

Studies	Target audience (n) and design	Modality, frequency of intervention, and use of the Transtheoretical Model (TTM)	Intervention	Significant results - eating habits and physical activity
Premier Study (12,13)	– Adults with blood pressure above optimal (n = 810) – A randomized clinical trial (RCT) multicenter	– Modality: Individual and collective intervention – Duration and frequency: 18 months, with 14 weeks: weekly; and for 14 weeks, biweekly; monthly rest – TTM: Construction of action together with other theories	– Control Group (CG): Advice on sodium, alcohol and physical activity - PA (2 visits of 30 minutes)- Intervention Group - IG (1 e 2): CG intervention and behavioral counseling based on social cognitive theory, techniques motivational and TTM – IG 2: DASH diet (↓ total and saturated fat; ↑ fruits and vegetables - FV - and low fat dairy products)	– IG 1 and 2: ↓ Consumption of calories, sodium, total and saturated fat; ↑ cardiorespiratory fitness (6m); ↓ weight – IG 2: ↑ Consumption of cholesterol and calcium, magnesium, fiber and folate; ↑ number of portions of FV and dairy products
Alive! Study (14,15)	– Non medical professionals of business health plan (n = 787) – RCT	– Modality: E-mail – Duration and frequency: 3 months (25 contacts) – TTM: Construction of intervention, together with other theories, and evaluation of effectiveness	– CG: Untreated – IG: Participant chooses a behavior (PA, FV intake, fats and sugar) for sending e-mails tailored to their characteristics, with goals and guidelines for achieving them and overcome barriers, etc.	– IG: ↓ Consumption of saturated and trans fats and ↑ FV; ↑ confidence in the ability to improve diet and PA; ↑ time of moderate PA and total; ↑ chance to advance in stages of change (SC) of FV – Individuals in pre-action and action: ↑ chance to advance in SC (sugar consumption and PA)
SENIOR Study (1,16,17)	– Old-aged people (n = 1,277) – Experimental study	– Modality: E-mail and telephone – Duration and frequency: 12 months (monthly) – TTM: Construction and effectiveness of the intervention	– CG: Prevention materials without description – IG: GI-PE (physical exercise), -IG-FV, IG-PE-FV, to approach the 4 pillars of TTM	– IG -FV: ↑ FV consumption – IG -FV: Maintenance (M) greater use of self-efficacy and processes of change – IG - EP: Higher score for pros to adopt or maintain PE. Individuals in pre-action and action: ↑ progression to higher SC
Cook et al. (6)	– Officials from staffing firm (n = 419) – RCT	– Modality: Internet program – Duration and frequency: 3 months (free use of the program) – TTM: Construction of intervention, together with other theories and assessment of effectiveness	– CG: Printed materials containing topics IG – IG: Interactive program for the workplace, based on social cognitive theory and MT, addressing healthy eating habits (HEH), PA and stress management	– GI and Control Group (CG): ↑ Attitude towards HEH, frequency of healthy eating practices, ↑ motivation to improve diet, intends to practice HEH; improves the SC to PA and HEH; ↑ self-efficacy for diet; ↓ self-reported weight – GI: Improved to SC to weight control – GC: ↑ Self-efficacy for practicing PA
Johnson et al. (5)	– Adults with overweight (Body Mass Index - BMI: 25 to 39.9) (n = 1,277) – RCT	– Modality: E-mail – Duration and frequency: 9 months (quarterly reports) – TTM: Construction and effectiveness of the intervention	– CG: Untreated – IG: 4 sets of reports, tailored by 4 dimensions to the TTM for consumption of calories and fat, moderate PE (minimum of 30 minutes, 5 times/ week) and individual stress management OBS.: Individuals in maintenance without intervention	– IG progressed further stages of action and maintenance (A / M) for PE, HEH and consumption of FV – IG for HEH and PE ↓ self-reported weight

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Table II (Cont.). Description of the studies included in the review and main results

Studies	Target audience (n) and design	Modality, frequency of intervention, and use of the Transtheoretical Model (TTM)	Intervention	Significant results - eating habits and physical activity
DiSC *Study* Jones et al. (11)	– Individuals with diabetes (n = 1029) – RCT	– Modality: E-mail and telephone – Duration and frequency: 12 months (bimonthly) – TTM: Construction and effectiveness of the intervention	– CG: Usual care, with regular visits from family doctor or endocrinologist and/or groups of diabetes education – IG: Individual reports based on stages of change-SC. Individual counseling by phone to answer questions and facilitate achievement of goals for fat intake, smoking, and blood glucose self-monitoring *OBS: Individuals in action/maintenance without intervention*	– IG: ↓ Total fat intake, ↑ FV intake, progression to higher stages of A/M for glucose monitoring and HEH
Logue et al. (10)	– Adults with overweight (BMI > 27 kg/m^2 or waist / hip ratio > 0.95-men and > 0.80-women) from 15 Primary Care Services (PCS) (n = 665) – RCT	– Modality: E-mail and telephone – Duration and frequency: two years (monthly) – TTM: Construction of intervention	– CG: 10 minutes semiannual advice on HEH and PE based on the food pyramid and the American Food Guide – IG: Intervention for fat intake and FV, control food portions, PE and habitual PA, based in SC and calls for weight loss. OBS.: Physicians were trained on use of SC and change processes	– CG and IG: ↓ Calorie intake, ↑ energy expenditure, ↓ weight (6 to 12 m), ↓ waist circumference (WC) – IG: ↑ Minutes of PE weekly
Prochaska et al. (7)	– Parents of teens (n = 2,460) – RCT	– Modality: E-mail – Duration and frequency: 12 months (reports with 0, 6 and 12 months) – TTM: Construction and effectiveness of the intervention	– CG: Received evaluation result of behaviors and SC (with 0, 12 and 24 months) – IG: Reports for each risk behavior – fat intake, sun exposure and smoking, based on TTM	– IG: ↑ FV consumption and behaviors like *replacement* (food with high fat content underneath), *avoid* (reduce frequency and amount of foods high in fat) and *modification* (food preparation) – IG: Progressed further stages of A/M to HEH
Prochaska et al. (8)	– Patients from PCS (n = 5,407) – RCT	– Modality: E-mail – Duration and frequency: 12 months (reports with 0, 6 and 12 months) – TTM: Construction and effectiveness of the intervention	– CG: Received no intervention, but as members of PCS may have participated in actions – IG: Reports for each risk behavior - fat intake, sun exposure, smoking and regular mammograms, based on TTM	– IG: ↑ FV consumption, grains and foods rich in fiber; ↑ modification; progressed further stages of A/M to HEH – GI and GL: ↑ *Replacement* and *avoid*

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Table II (Cont.). Description of the studies included in the review and main results

Studies	Target audience (n) and design	Modality, frequency of intervention, and use of the Transtheoretical Model (TTM)	Intervention	Significant results - eating habits and physical activity
Riebe et al. (18) Riebe et al. (19)	– Participants with BMI between 27-40 kg/m^2 (n = 144) – Intervention without control group (CG)	– Modality: Collective intervention – Duration and frequency: 6 months (4 months: weekly, biweekly rest) – TTM: Construction and effectiveness of the intervention	– CG: Untreated – IG: Counseling based on the four pillars of TTM, supervised biweekly treatment of PE and PE stimulus to practice 2 times / week outside the program. Food records in order to reach goal of fat intake, FV and whole grains; balance, variety and moderation	– IG: ↓ Consumption calories, saturated fat and FV; ↓ total fat and carbohydrates (6 months); ↑ VO2 max (3 months) and PE weekly minutes; ↓ weight, BMI and% body fat; progression stages of A/M for the consumption of fat and PE (6 months) – Individuals who kept feeding behavior (< 25% of caloric intake from fat): less temptation to eat fatty foods and greater use of change processes
Steptoe et al. (20) Steptoe et al. (21)	– Patients with increased risk of cardiovascular disease from 20 PCS (n = 883) – RCT	– Modality: Individual counseling – Duration and frequency: "Brief intervention" (2 or 3 meetings of 20 minutes for those who had 1 or 2 risk factors, respectively) – TTM: Construction and effectiveness of the intervention	– CG: Usual care to promote health – IG: Brief behavioral counseling based on SC, interspersed with 1 or 2 phone calls for consolidation and encouraging behavioral change * Patients with elevated serum cholesterol: reduce dietary fat and increase consumption of FV * Patients with high BMI and no regular PA: PA practice	– IG: ↓ Fat consumption; ↑ regular PE; showed greater chance of switching to A/M to fat intake and PE – GI and CG progressed to A/M to fat intake and PE
ALIFE@ Work Study (22,23)	– Workers of 7 companies with overweight (BMI ≥ 25 kg/m^2) (n = 1,386) – RCT	– Modality: Telephone or internet (e-mail and site) – Duration and frequency: 6 months (10 biweekly counseling sessions) – TTM: Measured at baseline and used for intervention physical activity together with other theories	– CG: Self-help materials – IG PA; consumption of calories, fat, sugar and alcohol – IG-phone: Advice and lessons guided by principles of behavioral therapy – IG -internet: Interactive site with individual pages and lessons; and contacts with a counselor by email	– IG (phone): ↓ Fat intake; ↑ PA (MET / min) and likely to adhere to the guidance of PA – IG (telephone and internet): ↓ Weight and WC
Building Strong and Ready Families Program, Niederhauser et al. (24)	– Active duty infantry soldiers and their spouses (n = 245) – Quasi-experimental study	– Modality: Collective intervention – Duration and frequency: 3 to 6 week (two day-long sessions) – TTM: Construction and effectiveness of the intervention	– CG: Untreated – IG: Building Strong and Ready Families (BSRF) Program (healthy lifestyle promotion and risk behavior elimination – tobacco, nutrition, PE, safety, spirituality, communication skills, and stress)	– IG: > stage progression in PE
Prochaska et al. (9)	– Adults at risk for at least one risk behavior (exercise, stress, BMI, smoking) (n = 1,400) – RCT	– Modality: Face-to-face, telephonically or online – Duration and frequency: 6 months – TTM: Construction and effectiveness of the intervention	– Health Risk Intervention (HRI) group: provide a single step to begin progressing the SC at risk – Motivational Interviewing (MI group): three sessions of health coaching – TTM group: HRI + TTM online with up to four programs (stress, exercise, smoking, and weight management)	– MI and TTM groups: > % of participants in to A/M regarding exercise compared to HRI group

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Table II (Cont.). Description of the studies included in the review and main results

Studies	Target audience (n) and design	Modality, frequency of intervention, and use of the Transtheoretical Model (TTM)	Intervention	Significant results - eating habits and physical activity
Mauriello et al. (25)	– English-speaking high school students between 9th and 11th grade (n = 1,800) – Effectiveness trial	– Modality: Online – Duration and frequency: 14 months – TTM: Construction and effectiveness of the intervention	– CG: Untreated – IG: online TTM-based program including stage-matched and tailored feedback messages aimed at physical activity, FV consumption and TV time	– IG: > number of days doing PA (2 months), more servings of FV (2, 6 and 12 months); progression to A/M for PA (2 months) and FV consumption (2 and 6 months); > stability in A/M for PA (2 months), and FV (6 and 12 months)
Velicer et al. (26)	– English speaking sixth grade students (n = 4,158) – Randomized two-arm comparison trial	– Modality: Online – Duration and frequency: 3 years – TTM: Construction and effectiveness of the intervention	– Substance prevention (SP) intervention: TTM-tailored intervention sessions aimed to reduce tobacco and alcohol use – Energy balance (EB) intervention: TTM-tailored intervention sessions focused on physical activity, TV time and FV consumption	– EB: > relapse prevention and progression to A/M for PA and FV consumption, compared to SP group
Armitage et al. (27)	– People already enrolled on a commercial weight loss program in the north of England (n = 72) – RCT	– Modality: self-administered volitional help sheet – Duration and frequency: 1 month (1 session) – TTM: Construction of the intervention	– CG: Commercial weight loss program and a distracter task – IG: Commercial weight loss program and volitional help sheet linking critical situations (temptations) and appropriate responses (processes of change) related to eat	IG: > weight loss at 1 month compared to CG
Menezes et al. (28)	– Women in primary health care (n = 71) – RCT	– Modality: Collective intervention – Duration and frequency: 6 months (biweekly) – TTM: Construction and effectiveness of the intervention	– CG: Usual care (physical activity and open group-education). – IG: Usual care and TTM-based workshops aimed at changing the anthropometric and dietetic profile of participants	IG: improved body perception, ↓ weight and BMI, ↓ consumption of calories and foods high in fat

Note: Preference was given to the findings in the larger follow up described by the study; Results for those that reached significance in only part of the study, the time at which the change was verified were described in parentheses. ↓ – decrease; ↑ – increase; > greater. Pre-action: Name used for the first three stages of change: pre-contemplation, contemplation and decision; Action: Change the last stages of action and maintenance.

INTERVENTION EVOLUTION: EATING HABITS AND PHYSICAL ACTIVITY

Almost all the studies addressed healthy eating habits (HEH), and thirteen studies included advice on the increasing PA (1,5,6,9,10,12,14,18,20,22,24-26). Interventions focusing on eating habits were particularly aimed at reducing the ingestion of fat and increasing the consumption of FV, which was explicitly addressed in 72% and 38% of the studies, respectively. Others monitored behaviors, including controlling the size of food portions (10), and reducing calories (5,22,28), sodium (13), alcohol (13, 22) and sugar (14, 22) (Table II).

Among the changes in eating habits, significant reductions were observed in the consumption of total fat (11,13,20,22), saturated fat (13,14,19) trans fat (14), calories (10,13,19,28), sodium (13) and cholesterol (12); there was an increase in the ingestion of FV (7,8,11,13,14,17,25,26), vitamins, minerals and fibers (13) (Table II). Positive changes in behavior, such as increased intention, motivation and attitudes to achieve HEH (6), and increased substitution of food with high-fat content for low-fat content, were reported. Reduction in the frequency and quantity of high-fat products and changes in the way the food is prepared (7,8,28) were also observed (Table II).

Some studies documented negative changes in eating habits, such as reduced consumption of FV after 24 months (13) or no alterations after the intervention in the ingestion of sugar (14) and FV (23) (Table II).

The evolution of physical activity was evaluated primarily by the increase in frequency or duration (9,10,14,19,20,22,25,26), whereas the type and intensity of the activities were less explored. The work of Johnson et al. (5) and Cook et al. (6), although including interventions for PA and HEH, did not include the analyses of the evolution in PA frequency and duration (5,6) or in consumption or eating habits (5) (Table II).

As a consequence of alterations in the eating habits and in the practice of physical activity, eight short- and long-term studies showed weight reduction among members of the IG (5,13,19,22,27,28) and CG (6,9, 27), as well as reductions in their WC (10,22), BF % and BMI (19,28) (Table II).

All the studies that evaluated the evolution of the SC reported positive results, and the patients progressed to the stages of action and maintenance (5-8,11,14,16,19,21,24-26) (Table II). Block et al. (14) was the only study that did not find an evolution in the ingestion of fat, despite the positive results for other eating habits.

DISCUSSION

The multi-behavioral TTM is a promising strategy for the promotion of healthy lifestyles, and positive results for multiple behaviors in various scenarios have been reported (1,7,29,30). However, methodological differences among the studies persist, which hinders the demonstration of their effectiveness and their use in theoretical and practical applications.

The positive points of the analyzed studies include the use of randomized clinical trials, which is an appropriate methodology to assess the effects of an intervention; large sample sizes; long-term follow-up; and suitability of the statistical analyses. Consequently, the majority of the studies found a significant evolution in the stages of action and maintenance in the participants, in addition to changes in the behaviors associated with HEH and PA, with significant differences among the intervention and control groups.

Nevertheless, the studies also had methodological weaknesses, such as participant loss and omission of information concerning randomization and blinding. Most of the studies reported the intervention delivered to the CG participants, although the intensity of the intervention was not reported. Logue et al. (10) verified that, at baseline, 83% of the CG participants reported being advised by a physician to lose weight and 48% had previous experience with commercial programs for weight loss. In some studies, individuals of the CG evolved positively in their eating habits, levels of physical activity, and body weight, possibly due to CG group characteristics similar to those found in Logue et al. (6,10).

The positive changes observed for the CG could also result from recruiting highly motivated volunteers or the financial support given to the participants (6,10). The selection processes used may have attracted individuals more likely to undergo lifestyle changes, who, therefore, were not representative of the general population (12).

Similar methodological weaknesses were also identified in a review that aimed to evaluate the effectiveness of TTM-based interventions on sustainable weight reduction. Besides pointing out the insufficient information related to randomization and blinding, the authors indicate others limitations such as wide use of self-reported measures and lack of post-intervention assessments that could allow verifying long-term weight loss sustainability (31).

It should be highlighted that the use of multi-behavioral TTM is justified considering the complexity of the behaviors associated with people's lifestyles. It is estimated that 15% of the population account for 60% of health care costs due to multiple health-risk behaviors (1). Considering the relevance of maximized cost-effectiveness interventions, multi-behavioral TTM is promising for promoting coaction or paired actions, in which the change on one behavior can have a potential to change another behavior (29,30). The interventions evaluated in this review were included because they were multi-behavioral. However, sometimes the studies did not conduct simultaneous interventions for multiple health risks because some individuals were already at the action and/or maintenance stages for a certain behavior or individuals' choice of a particular type of intervention. Nonetheless, although at advanced stages of change, these individuals could have relapses, which support the multi-behavioral approach.

The interventions used had a heterogeneous set of methods, with different combinations of intensities, follow-up periods, technologies, theoretical models, uses of the TTM, target behaviors, target populations, and variables analyzed. Such heterogeneity makes it difficult to compare or reproduce the studies, in addition to limit the applicability of the discoveries to clinical practice (31).

The use of technological tools was a predominant method of intervention application. This is likely a consequence the complex logis-

tics of face-to-face interventions, which require a large number of professional staff, substantial amounts of time, elevated cost, and other difficulties associated with reaching a large number of participants (6-8,22). On the other hand, the use of technologies may present some difficulties, like assessing the intensity of the intervention, actual participation of the individuals (14), creation of bonds between the educators and the participants, and the sensitization and motivation achieved though virtual communication.

In addition, when evaluated by e-mail, the engagement of the participants was low. In one study, only 30% answered to the evaluation questionnaires sent six and twelve months after the study began (7). The participation in such technological interventions also imposes certain requirements, such as knowing how to read and write and having access to a computer, Internet (1,5-11,14,22), or telephone (1,10,11,22). It also requires that the participants have the basic informatics skills to use interactive platforms, dynamic simulations, and access links (6,14,25,26).

Concerning the use of the TTM, although it comprises four pillars, most of the studies explored solely the stages of change, despite the fact that the authors of the studies highlighted the importance of the other TTM mediators. The importance of evaluating all the pillars is evidenced in the work of Greaney et al. and Greene et al. (The SENIOR study) (16,17), in which the participants that received advice on diet and were at the maintenance stage had higher self-efficacy and use of the processes of change (17), whereas those who received intervention for the promotion of physical activity (PA) had a higher score in starting or maintaining activity (16).

Given the heterogeneous methodology observed, we suggest that CG members do not receive treatment or are exposed to interventions comparable in intensity to those received by IG members in future studies; therefore, the only distinction between the groups is the intervention content. Future studies of interventions should be detailed regarding the nature and magnitude of TTM dimensions that are used and carried out with methods applicable to the population in general.

Potential limitations of this review include those linked to bibliographical research, such as the possible omission of studies related to the theme (32). On the other hand, to minimize this bias, several strategies were employed; these included using a large number of keywords, determining the search strategies in advance, defining inclusion and exclusion criteria, having two independent researchers select the articles, reviewing any additional references in the selected articles, and contacting the authors of the articles when necessary.

The obtained results reveal a growing interest in the international use of interventions based on the TTM for multiple health-related behaviors, especially using technological tools (computer and telephone), which has not yet been seen in Brazil. They provide evidence of the need for national studies and publications.

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REFERENCES

1. Clark PG, Nigg CR, Greene G, et al. The Study of Exercise and Nutrition in Older Rhode Islanders (SENIOR): translating theory into research. Health Educ Res 2002;17(5):552-61.
2. Sutton K, Logue E, Jarjoura D, et al. Assessing dietary and exercise stage of change to optimize weight loss interventions. Obes Res 2003;11(5):641-52.
3. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. Am J Health Promot 1997;12(1):38-48.
4. Van Sluijs EM, Van Poppel MN, Van Mechelen W. Stage-based lifestyle interventions in primary care: are they effective? Am J Prev Med 2004;26(4): 330-43.
5. Johnson SS, Paiva AL, Cummins CO, et al. Transtheoretical model-based multiple behavior intervention for weight management: effectiveness on a population basis. Prev Med 2008;46(3):238-46.
6. Cook RF, Billings DW, Hersch RK, et al. A field test of a web-based workplace health promotion program to improve dietary practices, reduce stress and increase physical activity: randomized controlled trial. J Med Internet Res 2007;9(2):e17.
7. Prochaska JO, Velicer WF, Rossi JS, et al. Multiple risk expert systems interventions: impact of simultaneous stage-matched expert system interventions for smoking, high-fat diet, and sun exposure in a population of parents. Health Psychol 2004;23(5):503-16.
8. Prochaska JO, Velicer WF, Redding C, et al. Stage-based expert systems to guide a population of primary care patients to quit smoking, eat healthier, prevent skin cancer, and receive regular mammograms. Prev Med 2005;41(2):406-16.
9. Prochaska JO, Butterworth S, Redding CA, et al. Initial efficacy of MI, TTM tailoring and HRI's with multiple behaviors for employee health promotion. Preventive Medicine 2008;46:226-31.
10. Logue E, Sutton K, Jarjoura D, et al. Transtheoretical model-chronic disease care for obesity in primary care: a randomized trial. Obes Res 2005;13(5):917-27.
11. Jones H, Edwards L, Vallis TM, et al. Changes in diabetes self-care behaviors make a difference in glycemic control. Diabetes Care 2003;26(3):732-7.
12. Svetkey LP, Harsha DW, Vollmer WM, et al. Premier: a clinical trial of comprehensive lifestyle modification for blood pressure control:rationale, design and baseline characteristics. Ann Epidemiol 2003;13(6):462-71.
13. Elmer PJ, Obarzanek E, Vollmer WM, et al; PREMIER Collaborative Research Group. Effects of comprehensive lifestyle modification on diet, weight, physical fitness, and blood pressure control: 18-month results of a randomized trial. Ann Intern Med 2006;144(7):485-95.
14. Block G, Sternfeld B, Block CH, et al. Development of Alive! (A Lifestyle Intervention Via Email), and its effect on health-related quality of life, presenteeism, and other behavioral outcomes: randomized controlled trial. J Med Internet Res 2008;10(4):e43.
15. Sternfeld B, Block C, Quesenberry CP Jr, et al. Improving diet and physical activity with ALIVE: a worksite randomized trial. Am J Prev Med 2009;36(6):475-83.
16. Greaney ML, Riebe D, Ewing GC, et al. Long-term effects of a stage-based intervention for changing exercise intentions and behavior in older adults. Gerontologist 2008;48(3):358-67.
17. Greene GW, Fey-Yensan N, Padula C, et al. Change in fruit and vegetable intake over 24 months in older adults: results of the SENIOR project intervention. Gerontologist 2008;48(3):378-87.
18. Riebe D, Greene GW, Ruggiero L, et al. Evaluation of a healthy-lifestyle approach to weight management. Prev Med 2003;36(1):45-54.
19. Riebe D, Blissmer B, Greene G, et al. Long-term maintenance of exercise and healthy eating behaviors in overweight adults. Prev. Med 2005;40(6):769-78.
20. Steptoe A, Doherty S, Rink E, et al. Behavioural counselling in general practice for the promotion of healthy behaviour among adults at increased risk of coronary heart disease: randomised trial. BMJ 1999;319(7215):943-7.
21. Steptoe A, Kerry S, Rink E, et al. The impact of behavioral counseling on stage of change in fat intake, physical activity, and cigarette smoking in adults at increased risk of coronary heart disease. Am J Public Health 2001;91(2): 265-9.
22. Van Wier MF, Ariëns GA, Dekkers JC, et al. ALIFE@Work: a randomised controlled trial of a distance counselling lifestyle programme for weight control among an overweight working population. BMC Public Health 2006;6:140.
23. Van Wier MF, Ariëns GA, Dekkers JC, et al. Phone and e-mail counselling are effective for weight management in an overweight working population: a randomized controlled trial. BMC Public Health 2009;9:6.

24. Niederhauser VP, Maddock J, LeDoux F, et al. Building Strong and Ready Army Families: A Multirisk Reduction Health Promotion Pilot Study. Military Medicine 2005;170(3):227.
25. Mauriello LM, Ciavatta MMH, Paiva AL, et al. Results of a multi-media multiple behavior obesity prevention program for adolescents. Preventive Medicine 2010; 51:451-6.
26. Velicer WF, Redding CA, Paiva, AL, et al. Multiple behavior interventions to prevent substance abuse and increase energy balance behaviors in middle school students. TBM 2013;3:82-93.
27. Armitage CJ, Norman P, Noor M, et al. Evidence that a very brief psychological intervention boosts weight loss in a weight loss program. Behavior Therapy 2014;45:700-7.
28. Menezes MC, Mingoti SA, Cardoso CS, et al. Intervention based on Transtheoretical Model promotes anthropometric and nutritional improvements- a randomized controlled trial. Eating Behaviors 2015;17:37-44.
29. Yin HQ, Prochaska JO, Rossi JS, et al. Treatment-enhanced paired action contributes substantially to change across multiple health behaviors: secondary analyses of five randomized trials. Transl Behav Med 2013;3(1): 62-71.
30. Johnson SS, Paiva AL, Mauriello L, et al. Coaction in Multiple Behavior Change Interventions: Consistency Across Multiple Studies on Weight Management and Obesity Prevention. Health Psychol 2014;33(5):475-80.
31. Mastellos N, Gunn LH, Felix LM, et al. Transtheoretical model stages of change for dietary and physical exercise modification in weight loss management for overweight and obese adults. Cochrane Database Syst Rev 2014;2:CD008066.
32. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. PLoS Medic 2009;6(7):1-6.

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ARÁN

Nutrición Hospitalaria

Trabajo Original

Otros

Percepción de embarazadas y matronas acerca de los consejos nutricionales durante la gestación

Pregnant´s and midwives perception about nutrional councils during pregnancy

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Resumen

Introducción: el estado nutricional previo de la embarazada, la adecuada ganancia de peso y la ingesta de ciertos nutrientes pueden tener una influencia importante tanto para la madre como para el recién nacido, a corto y largo plazo. Las recomendaciones de la Organización Mundial de la Salud son transmitidas durante el control del embarazo por la matrona.

Objetivos: analizar los principales estudios sobre la percepción de las embarazadas acerca de los consejos nutricionales recibidos e identificar las estrategias utilizadas por las matronas para su implementación.

Metodología: búsqueda bibliográfica sobre embarazadas de bajo riesgo controladas por matronas y que reciben consejos nutricionales realizada en WOS, CINHAL y PubMed. Se utilizaron los descriptores: *pregnancy, pregnant, midwife, counselling, nutrition* y sus diferentes combinaciones. Los criterios de inclusión fueron artículos originales y revisiones en inglés, español o portugués de los últimos diez años y disponibles en texto completo.

Resultados: se encontraron 184 referencias. Solo 11 tratan el tema abordado. Existen múltiples artículos con consejos nutricionales en el embarazo, pero muy pocos que incluyan estrategias educativas implementadas por las matronas que aborden recomendaciones dietético-nutricionales y su utilidad.

Conclusión: existen escasos estudios que investiguen los conocimientos que las matronas tienen sobre nutrición en el embarazo y los consejos que aportan sobre el tema. Igualmente sucede con los trabajos que estudian la percepción que tienen las gestantes sobre los consejos nutricionales recibidos.

Palabras clave:

Mujeres embarazadas. Matronas. Consejos de salud. Nutrición prenatal.

Abstract

Background: Women's nutritional status, the suitable profit of weight and the ingestion of certain nutrients may have an important influence in health both for the mother and newborn in a short and long term. World Health Organization gives a number of nutritional recommendations which are transmitted during the pregnant women antenatal care by their midwives.

Objectives: To analyze the main studies on the understanding of the pregnant women about the nutritional received councils and to identify the strategies used by the midwives for theirs implementation.

Methodology: Literature review for low risk pregnant's conducted by midwives and receiving nutritional councils in Web of Science (WOS), CINAHL and PubMed. Using descriptors such as: pregnancy, pregnant, midwife, counselling, nutrition and their different combinations. The criteria incorporation was original article and review written in English, Spanish or Portuguese of last ten years and available in complete.

Results: 184 references were found. Finally, only 11 focused on the issue addressed. There are multiple items with nutritional advice in pregnancy but a few that include educational strategies implemented by midwives to address dietary and nutritional recommendations and usefulness.

Conclusion: Only a few studies researchs the midwives' knowledge about nutrition in pregnancy and the councils that they transmit to pregnants. In the same way, not many papers treats the pregnant perception about nutritional councils.

Key words:

Pregnant women. Midwives. Health councils. Prenatal nutrition.

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INTRODUCCIÓN

El embarazo se considera una etapa de vital importancia en la que tienen lugar múltiples procesos hiperplásicos, hipertróficos, de adaptación metabólica y de preparación para la vida extrauterina (1). El estado nutricional de la mujer previo y durante el embarazo, una adecuada ganancia de peso y la ingesta de determinados nutrientes en cantidad y calidad adecuada pueden tener una influencia importante en los resultados para la madre y para el recién nacido, tanto a corto como a largo plazo (2-4). Está demostrado que la capacidad de la gestante para cubrir las necesidades del desarrollo fetal no está relacionada con su alimentación actual o del pasado inmediato, sino que depende más de su salud general (5). Existe un conglomerado de factores como el estrés (ya sea físico o psíquico), las infecciones, o hábitos tóxicos como el consumo de tabaco o de alcohol, que pueden alterar el apetito de la embarazada, así como la disponibilidad y el metabolismo de los nutrientes. Todo estos factores pueden aumentar el riesgo de complicaciones perinatales debido a un estado de malnutrición (1,6,7).

Existen estudios que demuestran que las recomendaciones dietéticas que se entregan en la consulta de la matrona, junto con las modificaciones en el estilo de vida que la embarazada llegue a implementar en el periodo gestacional, son intervenciones efectivas para mejorar el metabolismo materno y prevenir las complicaciones del embarazo, especialmente en mujeres embarazadas con déficit nutricional o con aumento de peso (8,9). Además, a toda gestante se debe le recomendar la práctica diaria de actividad física, siempre que no exista una contraindicación clara para ello. A pesar de estas intervenciones, se ha constatado que mujeres de cada 10 mujeres que acuden a la consulta de control del embarazo de 2 a 3 tienen sobrepeso, y que de 1 a 2 de cada 10 tienen obesidad (10), con el riesgo obstétrico que estos problemas clínicos conllevan (11).

Hasta la fecha, la investigación en relación con la nutrición en mujeres gestantes se ha centrado en el estudio de los nutrientes necesarios (tanto mayoritarios como minoritarios) y el aporte de suplementos nutricionales para suplir posibles déficits. En los países desarrollados el problema no suele ser la escasez de alimentos, sino más bien la calidad y el tipo de dietas lo que influye en la variedad de nutrientes que son consumidos (12). Sin embargo, existen pocos estudios sobre el tipo y contenido de los consejos nutricionales que reciben las embarazadas durante el control del embarazo. Consejos ante los que dichas mujeres verbalizan sentir confusión, miedo y culpabilidad (13).

Actualmente la matrona es el profesional sanitario de referencia para ofrecer recomendaciones nutricionales durante el control del embarazo, pues entre sus competencias se incluyen el asesoramiento y la educación para la salud, no solo para la mujer, sino también en el seno de sus familias y la comunidad (14,15). El gran reto al que se enfrentan las matronas no es tanto dar consejos, sino saber cómo hacerlo para no herir sentimientos en la embarazada, conseguir cambios de comportamiento y no generar frustración, por ejemplo, ante lo que puede y no puede comer. Además, dichas profesionales expresan carecer del tiempo y de los conocimientos necesarios para asesorar a la embarazada, refieren que han recibido poca capacitación durante su formación en temas relacionados con la nutrición a la vez que aseguran tener escasos recursos educativos a la hora de abordar individualmente el caso de gestantes con alteraciones nutricionales (16,17). Cabe considerar que el embarazo es un momento de la vida de las mujeres en el que suelen estar más receptivas ante los consejos nutricionales, de manera que pueden cambiar los estilos de vida y mejorar su calidad de vida (18). Estudios que evalúan las intervenciones dirigidas para mejorar el estilo de vida de las embarazadas evidencian que llevar a cabo distintas actividades educativas y entregar recomendaciones al respecto tienen como resultado un mejor control del peso y una mejora de los resultados perinatales. Las intervenciones estaban enmarcadas en programas de consejo nutricional llevados a cabo por matronas, en los que se recomienda hacer un seguimiento continuo del control de peso y un asesoramiento permanente frente al estilo de vida de la mujer gestante. De esta forma, mejorar los recursos en la educación de las embarazadas ha mostrado tener un resultado positivo en su control nutricional (19,20). Sin embargo, existe escasa literatura especializada que investigue los conocimientos que las matronas tienen sobre la nutrición en las gestantes y las estrategias educativas que las matronas utilizan para tratar esta temática (16,21).

El propósito de este trabajo es analizar los principales estudios sobre las percepciones de las embarazadas acerca de los consejos nutricionales e identificar las estrategias utilizadas por las matronas para su implementación.

MATERIAL Y MÉTODOS

Se ha realizado una búsqueda bibliográfica sistemática en las siguientes bases de datos: Web of Science (WOS), CINHAL y PubMed. La estrategia de búsqueda se formuló a partir de los descriptores de Ciencias de la Salud (DeCS): *"pregnancy", "pregnant", "midwife", "counselling", "nutrition"* y las diferentes ecuaciones de búsqueda como: *[(counselling) AND (nutrition) AND (pregnan*) AND (midwi*] en WOS; [(nutrition) AND (pregnan*) AND (midwi*)] en CINHAL; [(counselling) AND (pregnan*and nutrition) AND (midwi*)]* en PubMed.

Para seleccionar los estudios se establecieron los siguientes criterios de inclusión: artículos originales y revisiones bibliográficas escritos en inglés, español y portugués, en cualquier país, durante los últimos diez años, entre 2005 y 2015. Además, se obtuvieron 6 artículos más por rastreo manual, que correspondían a estudios anteriores al año 2005. Se seleccionaron solo aquellos que estuviesen disponibles en texto completo, cuya población de estudio fuesen embarazadas de bajo riesgo (sin patología añadida) y que acuden a controles de embarazo con matronas de las que reciben consejos sobre alimentación en el embarazo. Como criterios de exclusión: artículos originales y revisiones bibliográficas cuyo objeto de estudio no sea el tema de esta revisión, cuya población de estudio fuesen embarazadas con patología previa al embarazo y artículos no disponibles a texto completo en bases de datos

consultadas. De los artículos seleccionados se realizó un análisis descriptivo.

RESULTADOS

Se incluyeron inicialmente 184 referencias, una vez excluidos los duplicados. De los n = 184 artículos obtenidos, 20 pertenecían a WOS, 49 a CINHAL y 115 a PubMed. Tras la revisión de los títulos y resúmenes se descartaron 106 por no ser pertinentes respecto al tema, no estar disponibles en texto completo, estar en otro idioma diferente a los señalados en los criterios de inclusión y existir una solicitud de pago para conseguirlo.

De los n = 78 resultantes se procedió a la lectura de los textos completos, resultando no elegibles 55, porque en su contenido se evidenció que trataban sobre puntos de vista de profesionales que no eran matronas, estaban referidos principalmente a patologías, eran artículos en prensa, etc. El total de estudios elegibles fue de 23 y de estos solo 5 trataban exclusivamente el tema de estudio. A estos se añadieron 6 por rastreo manual. En la figura 1 se detallan las causas de exclusión de los artículos hasta llegar a los 11 que se revisan en este trabajo.

Son muchos los artículos publicados relacionados con consejos nutricionales sobre yodo, ácido fólico, vitaminas, alimentación saludable o control de peso durante el embarazo, pero muy pocos se centran en las estrategias que deben desarrollar las matronas y en la valoración de su utilidad. Estos últimos son comentados a continuación y han sido incluidos en las tablas I y II para facilitar su visualización. Sus aportaciones se han dividido en dos apartados: el primero sobre las percepciones de las mujeres que han llevado un control de embarazo con una matrona y han recibido sus consejos, y el segundo sobre las perspectivas que las matronas tienen sobre estos consejos nutricionales.

PERCEPCIÓN DE LAS EMBARAZADAS SOBRE LOS CONSEJOS NUTRICIONALES

Szwajcer y cols. (18) en su estudio exploran la influencia que tiene en un evento vital, como lo es el embarazo, la conciencia de su importancia y las motivaciones que tienen las mujeres sobre aspectos relacionados con la nutrición. Para tal fin realizan entrevistas a cinco grupos focales, cada uno conformado por 12 embarazadas; participaron mujeres en distintas fases: algunas que ya

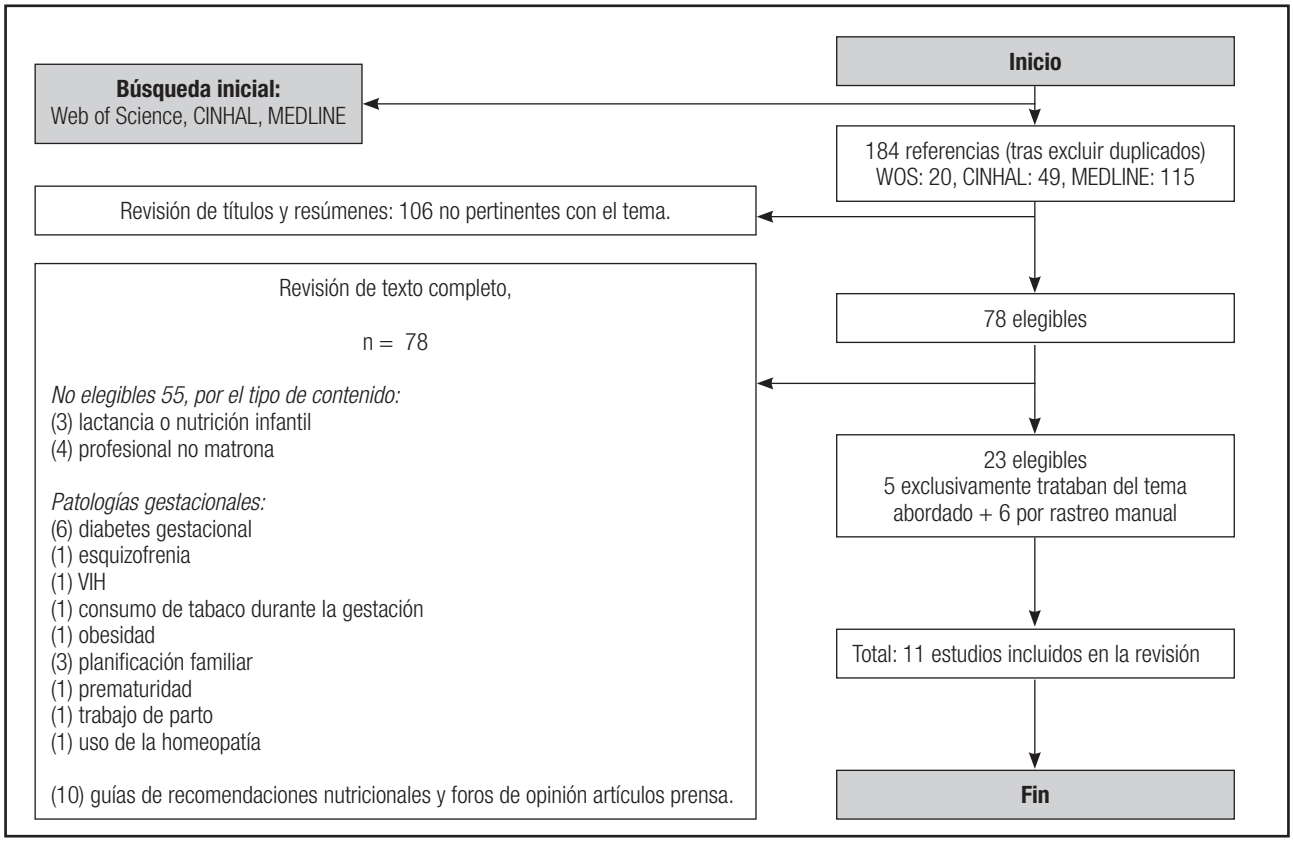

Figura 1.

Diagrama de la búsqueda bibliográfica realizada con los descriptores *pregnancy, pregnant, midwife, counselling, nutrition* y sus diferentes combinaciones en las bases de datos: WOS, CINHAL, PubMed, en el periodo 2005-2015.

Tabla I. Percepción de las embarazadas sobre los consejos nutricionales*

Autor, año (cita)	Objetivo	Población	Métodos	Conclusiones
Szwajcer et al., 2007	Estudiar la influencia de un acontecimiento vital (como el embarazo) en el autocuidado nutricional	60 gestantes	Estudio cualitativo. Entrevistas en profundidad de una hora de duración	La gestación es un momento propicio para que la mujer asuma el protagonismo sobre su estado nutricional, siendo importante la motivación que tenga frente a los consejos nutricionales
Wennberg et al., 2012	Describir experiencias de las mujeres sobre información nutricional	23 gestantes	Estudio cualitativo. Grupos focales y entrevistas. Las entrevistas se analizaron mediante el análisis cualitativo de Graneheim para estudios de enfermería (30)	Las embarazadas gestionan por sí mismas la información dietética, no siendo determinante el papel de la matrona
Garnweidner et al., 2013	Explorar las experiencias en embarazadas, de diferentes etnias, con los consejos nutricionales de sus matronas	15 gestantes	Estudio cualitativo. Entrevistas a 15 mujeres dos veces durante su embarazo (35-60 min) y analizadas siguiendo principios de interpretación fenomenológica de Fade (32)	Los consejos nutricionales recibidos por las gestantes no se adaptaban a sus hábitos alimenticios y eran bastante inespecíficos

**Descripción de los objetivos, población, métodos y conclusiones más relevantes de los artículos encontrados con los descriptores* pregnancy, pregnant, midwife, counselling y nutrition.

concibieron, otras dentro del primer, segundo y tercer trimestre y con diferentes características sociodemográficas. En sus resultados muestran cómo las mujeres indican sus motivaciones para tener más conciencia sobre la importancia de la nutrición. Entre estas se encuentra el interés por el bienestar del niño, el interés personal de la madre y las expectativas que tiene el entorno social frente al cuidado nutricional antes, durante y posterior a la etapa gestacional. Este estudio considera que las indicaciones que reciben las mujeres durante la etapa prenatal y el embarazo, y las motivaciones que tienen para modificar o continuar con sus hábitos nutricionales pueden influir en las conductas futuras adoptadas frente a su alimentación.

El estudio cualitativo realizado por Wennberg y cols. (22), realizado con 23 mujeres embarazadas del norte de Suecia, tenía como objetivo describir sus experiencias en cuanto a la información recibida sobre sus dietas y cambios en la alimentación durante el embarazo. En los resultados surgieron tres temas principales: información nutricional obtenida, reacción ante los consejos nutricionales y utilización de dichos consejos. Aunque las mujeres recibieron información oral y escrita por parte de sus matronas acerca de aspectos generales de la dieta durante el embarazo, la mayoría hacía búsqueda de información por su cuenta. Solo cuando tenían problemas de salud recibieron la orientación de su matrona. Muchas de estas mujeres sintieron confusión, miedo y/o culpabilidad cuando tenían que decidir acerca de algunos aspectos sobre su dieta. Por ejemplo, se sentían inseguras cuando tenían que decidir si comer o no comer determinados alimentos según lo recomendado. En estas decisiones influían sus propias creencias sobre el régimen alimenticio que debían llevar o sus apetencias de consumo de determinados alimentos, ante lo cual muchas comentaron haber usado el sentido común y haber escuchado las señales de su propio cuerpo.

Asimismo, la identificación de las matronas como fuentes fiables de información es confirmada por el trabajo de Garnweidner y cols. (23) que entrevistaron a 15 embarazadas de diferentes grupos étnicos en el área de Oslo (Noruega). Se encontró una diversidad de opiniones respecto a los consejos recibidos, coincidiendo en que la información recibida fue escasa en su contenido. Algunas embarazadas verbalizaron confusión ante qué comer y qué alimentos evitar, considerando que hubo escasas preguntas acerca de sus hábitos de alimentación. Los investigadores encontraron que algunas veces existían incongruencias entre los consejos dados y las creencias culturales culinarias de las participantes. Se constató que las embarazadas consultaban tres fuentes de información (profesionales, Internet y entorno social), y que para temas relacionados con la nutrición, la matrona es considerada una fuente segura de información. Por lo tanto, la atención prenatal puede tener un potencial considerable para promover una dieta saludable. Los hallazgos sugieren que la comunicación sobre nutrición en la atención prenatal debería estar más adaptada a los hábitos alimenticios y los antecedentes culturales de las mujeres, por lo que las matronas deberían mejorar sus niveles de conocimiento sobre nutrición e individualizar los consejos que entregan a las embarazadas.

PERCEPCIÓN DE LAS MATRONAS DE LOS CONSEJOS NUTRICIONALES

El estudio mixto de Mulliner y cols. (24), realizado con una muestra de 77 matronas de Reino Unido, obtuvo una ratio de respuestas del 78% (58 matronas del total de la muestra participaron del estudio); tenía como objetivo explorar el conocimiento y las actitudes de las matronas acerca de la nutrición durante la gestación;

Tabla II. Percepción de las matronas sobre los consejos nutricionales

Autor, año (cita)	Objetivo	Población	Métodos	Conclusiones
Mulliner et al., 1995	Explorar conocimientos en nutrición en las matronas de Reino Unido	77 matronas	Estudio mixto. Entrevistas y encuestas	Percepción de las matronas de falta de conocimientos en temas relacionados con la nutrición para atender las necesidades de asesoramiento nutricional de las gestantes
Elias y Green, 2007	Determinar conocimientos nutricionales en matronas	370 matronas	Encuestas por correo	Percepción de seguridad y de confianza por parte de las matronas respecto al asesoramiento nutricional
Szwajcer et al., 2009	Explorar la práctica de dar información escrita sobre los consejos nutricionales junto con las recomendaciones orales	12 gestantes y 4 matronas	Estudio cualitativo. Se realizaron entrevistas semiestructuradas a matronas	Los consejos nutricionales escritos *(pack* de información), entregados a la embarazadas no eran eficaces como estrategia educativa, no se obtuvo un impacto positivo frente a las recomendaciones y pautas dietético-nutricional demandadas por las gestantes
Lee et al., 2010	Explorar opiniones de las matronas sobre necesidades de entrenamiento en promoción de la salud en el embarazo	13 matronas	Estudio cualitativo. Entrevistas	Las matronas indican que necesitan una mayor formación en temas relacionados con la nutrición, la dieta y el control de peso para ofrecer un adecuado asesoramiento nutricional
Schmied et al., 2010	Explorar las experiencias de los profesionales de la salud al enfrentarse a mujeres obesas en edad reproductiva	34 matronas y otros 3 profesionales sanitarios (2 ginecólogos y 1 anestesista)	Estudio cualitativo. Entrevistas y grupos focales	Las experiencias de las matronas y de otros profesionales (ginecólogos y anestesista) evidencian dificultades en la atención a mujeres obesas y frente al asesoramiento nutricional que requieren durante el embarazo, parto y periodo postnatal
Stotland et al., 2010	Estudiar los conocimientos, actitudes y prácticas de que se dispone para dar consejos sobre prevención de la ganancia de peso excesiva en la embarazada	52 profesionales sanitarios (20 matronas 16 ginecólogos y 16 enfermeras)	7 grupos focales. 6-10 participantes/ grupo, siendo estos homogéneos. Entrevistas semiabiertas dirigidas por el mismo moderador	Percepción de cierta ineficacia en el consejo dietético en gestantes con problemas de peso, destacan la necesidad de mejorar el dominio de técnicas de asesoramiento nutricional que incluyan aspectos desde la alimentación hasta las pautas para la realización de actividad física
Wennberg et al., 2014	Explorar las estrategias de las matronas ante el reto de dar consejos nutricionales	70 matronas	Estudio cualitativo. Entrevistas telefónicas semiestructuradas (20-40 min)	Las matronas tienen desafíos en la consulta relacionados con el asesoramiento que ofrecen a nivel nutricional. Indican la necesidad de mejorar la formación y poseer técnicas específicas para orientar a las mujeres según sus características culturales y condición de salud
Arrish et al., 2014	Explorar el papel de las matronas en nutrición durante el embarazo	Revisión bibliográfica	8 estudios identificados: 4 descriptivos, 2 observacionales, 1 transversal y 1 de intervención	La revisión de la bibliografía ha mostrado la limitada información disponible sobre el papel actual de las matronas en la educación nutricional de la mujer embarazada

para la recolección de datos se emplearon técnicas cualitativas y cuantitativas; se llevaron a cabo encuestas telefónicas y entrevistas semiestructuradas. Este estudio muestra en sus hallazgos que las matronas se sentían poco preparadas para ofrecer asesoramiento dietético a mujeres de grupos étnicos minoritarios, a vegetarianas y a mujeres con patologías médicas preexistentes. Concluye que las matronas requerían mayor educación en nutrición, tanto en su formación básica como en su formación postgraduada.

Lee y cols. (25) realizaron entrevistas a 13 matronas del noroeste de Inglaterra para explorar sus opiniones sobre sus necesidades de capacitación y formación acerca de la promoción de la

salud en el embarazo, en temas como, por ejemplo, consumo de alcohol, tabaquismo, nutrición y alimentación, manejo de la obesidad y su tratamiento. Corroborando los resultados de Mulliner, estos autores encontraron que las matronas no se sentían seguras ante la complejidad de los consejos nutricionales dados a las embarazadas y que consideraban no tener las habilidades de comunicación y los conocimientos necesarios, aunque reconocen su importante papel en la educación y promoción de la salud materna.

La falta de seguridad respecto a los consejos nutricionales aparece también en las conclusiones del trabajo que Szwajcer y cols. (26) realizaron en los Países Bajos con 12 mujeres embarazadas primíparas y 4 matronas, para estudiar la relación entre la comunicación nutricional verbal y la escrita. A las mujeres participantes les entregaron, en la consulta de las matronas, folletos con consejos nutricionales para su lectura, estudio y revisión. Además, se grabaron los encuentros con las matronas donde las embarazadas recibían consejos nutricionales. El estudio concluyó que entregar folletos sobre nutrición como parte de un paquete de información dada en la consulta de la matrona no presentó una utilidad y un impacto real. Las embarazadas manifestaron no sentir que la información suministrada fuera útil, debido a que las orientaciones de las matronas fueron escasas o no lograban el impacto esperado. Se evidenció que las motivaciones para el cambio de comportamiento nutricional no fueron discutidas en la consulta y que la comunicación verbal y el suministro de información escrita no fueron realizadas de manera simultánea.

Las embarazadas apreciaban la oportunidad de discutir el tema de la nutrición con sus matronas, dada su experiencia y el papel que estas desempeñan durante su embarazo, pero coincidían en que los consejos eran muy generales y, por otra parte, se entregaban de forma tardía; es decir, no eran dados en el momento que se precisaban. Finalmente, destacan un uso poco adecuado de la información nutricional por parte de las matronas, debido a que entregaban material informativo sobre consejo dietético por escrito, pero junto a otros materiales variados, y sin reforzar adecuadamente sus contenidos a través de la comunicación verbal.

No concluyó en el mismo sentido el estudio de Elias y Green (17), cuyo estudio tenía como objetivo determinar y evaluar los conocimientos que las matronas neozelandesas tenían sobre nutrición durante la gestación para llevar a cabo su consulta y el asesoramiento nutricional. Para ello enviaron cartas con una encuesta formada por 18 preguntas a 1.340 matronas colegiadas de Nueva Zelanda. La ratio de respuesta fue de un 28% (370). Los resultados indicaron que de las matronas encuestadas, en su gran mayoría, aproximadamente un 75% afirmaron poseer conocimientos en nutrición y se sentían seguras al transmitirlos durante la educación a las embarazadas que acudían a los controles del embarazo.

Por otro lado, un estudio australiano realizado por Schmied y cols. (27), mediante grupos focales y entrevistas a profesionales de la salud, específicamente 34 matronas, dos ginecólogos y un anestesista, recogió datos sobre las experiencias, en especial de las matronas cuando atienden a mujeres obesas en edad reproductiva. La mayoría de estos profesionales expresan preocupación ante el hecho de ofrecer a las embarazadas consejos nutricionales sin que estas mujeres se sientan incómodas o relacionen algún comentario específicamente con su aspecto físico; por ejemplo, las matronas sienten temor a que los comentarios acerca del peso de la mujer embarazada alteren la relación establecida a nivel profesional e indican la necesidad de desarrollar habilidades para atender efectivamente mujeres con problemas de peso.

En este sentido concluye también la investigación cualitativa de Stotland y cols. (28) realizada con ginecólogos, matronas y enfermeros de distintos servicios de salud de San Francisco (USA), que se planteó como objetivo estudiar los conocimientos, actitudes y las prácticas que estos profesionales tienen para dar consejos acerca de cómo prevenir la ganancia excesiva de peso en las embarazadas. Se llevaron a cabo grupos focales, distribuidos de la siguiente manera: tres de ginecólogos, dos de matronas y otros dos de enfermeras. Dentro de sus resultados se describe una necesidad de mejorar el entrenamiento de estos profesionales para ofrecer consejos nutricionales, lo que incluye el aprendizaje de técnicas de comunicación y educativas para tratar temas como ganancia de peso, nutrición y ejercicio físico. También se consideró importante conocer estrategias para no estigmatizar o causar ansiedad a la embarazada, ya que al no tener los profesionales suficiente dominio del tema, las gestantes tenían dudas sobre la efectividad de sus consejos.

Para analizar con más detalle qué estrategias utilizan las matronas en el asesoramiento nutricional, Wennberg y cols. (29) entrevistaron a 70 matronas suecas que realizaban controles en el domicilio a embarazadas, llevando a cabo 8-10 visitas durante la gestación. El principal reto identificado fue aportar consejos nutricionales a mujeres que no cumplían las indicaciones terapéuticas, tenían condiciones especiales o provenían de otros países con hábitos culinarios diferentes. Las matronas expresaron la necesidad de que el tema de la nutrición fuera multidisciplinar, y aumentar sus habilidades para transmitir consejos nutricionales. Se observaron dificultades en las estrategias educativas que empleaban, especialmente con mujeres inmigrantes o de diferentes culturas. Las matronas utilizaban métodos de acercamiento a las embarazadas tales como: repetición del mensaje, establecer acuerdos con las parejas para introducir algún cambio en su comportamiento nutricional y exposición de los riesgos médicos y obstétricos por situaciones relacionadas con la nutrición durante la gestación. En general, como resultado de las intervenciones de las matronas frente a sus pautas nutricionales, las embarazadas se mostraron temerosas y a veces las matronas se veían abocadas, como último recurso, a derivarlas a una consulta especializada.

Arrish y cols. (16) realizaron una revisión de la bibliografía en diferentes bases de datos y diferentes webs gubernamentales australianas para analizar estudios cuyo objetivo fuera explorar los conocimientos, actitudes y estrategias de las matronas sobre los consejos nutricionales en el embarazo. Algunos de los estudios incluidos en esta revisión se han detallado anteriormente.

DISCUSIÓN

Como punto de partida, hay que destacar que coincidimos con Arrish y cols. (16) en que existen pocos estudios disponibles sobre esta cuestión en la literatura especializada internacional.

En cuanto a la percepción de los consejos nutricionales por parte de las embarazadas, se verbalizan dudas, frustración, miedos y ambigüedades ante la información recibida por parte de las matronas (16,17,25,28,29), lo que conlleva que las mujeres recurran a la búsqueda de información por su propia cuenta. Una de las principales carencias percibidas por las gestantes fue recibir consejos escasos y centrados en temas de seguridad alimentaria (24), así como orientaciones poco específicas o aportadas en un momento demasiado avanzado de la gestación (18,26), cuando los intereses de las gestantes están ya más centrados en otros aspectos como la salud del feto (22). A pesar de ello, la figura de la matrona en cuanto a la información nutricional es tenida muy en cuenta por las gestantes, debido a la especial vinculación que mantienen y por la experiencia que se le atribuye (23).

Por otra parte, las matronas son conscientes de la importancia de su labor en el asesoramiento nutricional y de que el embarazo es un momento especialmente favorable para intervenir en esta cuestión (18), pero existen importantes diferencias entre ellas en función de su ámbito geográfico de procedencia. Mientras que las matronas británicas se sienten más inseguras y dudan de la eficacia de sus estrategias concretas de consejo dietético (23,29), las matronas neozelandesas (17) y canadienses (21) sienten que dominan mucho más el asesoramiento nutricional.

En cuanto a las técnicas usadas por las matronas a la hora de aconsejar medidas nutricionales a las gestantes se han identificado: la repetición de mensajes nutricionales, la eliminación de algún producto concreto de la dieta, los acuerdos con las parejas, y la exposición de riesgos médicos y obstétricos de un patrón alimentario inadecuado (23). Varios estudios indican la necesidad de una mayor capacitación en el uso de otras herramientas complementarias (29,30), como, por ejemplo, las intervenciones motivacionales (26). Por otra parte, aunque la combinación del consejo nutricional con otras modificaciones de los estilos de vida (incluyendo ejercicio físico) se han mostrado eficaces para el control del peso durante la gestación (9), solo en algunos de los estudios consultados se refiere el uso combinado de información nutricional y otras intervenciones comportamentales específicas (19). Tampoco queda claro si las matronas usan de forma generalizada las estrategias prácticas, basadas en el manejo de alimentos, a pesar de haber recomendaciones fuertes en este sentido (14).

Por otro lado, a pesar de que algunos estudios apuntan a la posibilidad de que la existencia de ciertos problemas médicos durante el embarazo (como la diabetes gestacional) pueda conllevar una mayor eficacia del consejo dietético (8), las matronas perciben mayores dificultades para abordar el asesoramiento nutricional en pacientes con necesidades especiales (27).

CONCLUSIONES

Tras la revisión de la literatura especializada, se encuentran muy pocos estudios que aborden el modo en que se ofrecen consejos nutricionales en la consulta de las matronas, el grado de comprensión de la información suministrada a las embarazadas y la percepción que estas tienen de este proceso. Esta escasez de investigaciones es especialmente llamativa en los países iberoamericanos.

En cuanto a las percepciones de las embarazadas, destaca la sensación de haber recibido consejos muy generales por parte de las matronas, que no terminan de eliminar sus dudas e inseguridades respecto a la nutrición en el embarazo.

Por otra parte, parece existir una insatisfacción general de las matronas respecto a su propia formación en el uso de las técnicas y estrategias de consejo nutricional, por lo que se aprecia una clara necesidad de mejorar su formación didáctica, específicamente en relación con el tema de la nutrición en el embarazo.

Por todo ello, sería interesante plantear estudios que exploren estas cuestiones con más amplitud y en ámbitos geográficos más variados, utilizando además un enfoque de análisis cualitativo, dadas las características del tema investigado y los aportes encontrados en los estudios de referencia.

BIBLIOGRAFÍA

1. Sánchez-Muñiz FJ, Gesteiro E, Espárrago Rodilla M, Rodríguez Bernal B, Bastida S. La alimentación de la madre durante el embarazo condiciona el desarrollo pancreático, el estatus hormonal del feto y la concentración de biomarcadores al nacimiento de diabetes mellitus y síndrome metabólico. Nutr Hosp 2013;28(2):250-74.
2. Correa LMM, Sosa BEP, Cadavid AD, Mesa SLR, López LPM. Ingesta de hierro y folatos durante el embarazo y su relación con indicadores bioquímicos maternos. Revista latreia 2012;25(3):194-202.
3. Suárez M, Azcona C, Alzina de Aguilar V. Ingesta de yodo durante el embarazo: Efectos en la función tiroidea materna y neonatal. Endocrinol Nutr 2013;60(7):352-7.
4. Pharoah POD, Buttfield IH, Hetzel BS. Neurological damage to the fetus resulting from severe iodine deficiency during pregnancy. Lancet 1971;297(7694):308-10.
5. Organización Mundial de la Salud. Promoción del desarrollo fetal óptimo: informe de una reunión consultiva técnica. Ginebra; 2003. [Internet] Disponible en: http://www.who.int/nutrition/publications/fetal_dev_report_ES.pdf
6. Hale R. Maternal nutrition during pregnancy and folic acid. Br J Midwifery 2007;15(3):167-70.
7. Gillen-Goldstein J, Funai E, Roque H. Nutrition in pregnancy. Waltham: Ciudad del libro; 2009.
8. Piirainen T, Isolauri E, Lagström H, Laitinen K. Impact of dietary counselling on nutrient intake during pregnancy: a prospective cohort study. Br J Nutr 2006;96(06):1095-104.
9. Thangaratinam S, Rogozinska E, Jolly K, Glinkowski S, Roseboom T, Tomlinson JW, et al. Effects of interventions in pregnancy on maternal weight and obstetric outcomes: meta-analysis of randomised evidence. BMJ 2012;344:e2088.
10. Gallo JL. Gestación y obesidad. consecuencias y manejo. XVII Curso Actual en Obstetricia y Ginecologia; 2013.
11. Blincoe AJ. Optimum maternal nutrition for a healthy pregnancy. Br J Midwifery 2006;14(3):151-4.
12. Knudsen V, Orozova-Bekkevold I, Mikkelsen T, Wolff S, Olsen S. Major dietary patterns in pregnancy and fetal growth. Eur J Clin Nutr 2008;62(4):463-70.
13. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Educ Today 2004;24(2):105-12.

14. Maternal and child nutrition. NICE Guidelines [PH11]. The National Institute for Health and Care Excellence [Internet]. NICE; 2008 [cited 2015 Nov 14]. Available from: https://www.nice.org.uk/guidance/ph11
15. Ministerio de Sanidad y Política Social. Orden SAS/1349/2009 del 6 de mayo. Boletín del Estado [Internet]. 2009;129:44697–729. Available from: http://www.boe.es/boe/dias/2009/05/28/pdfs/BOE-A-2009-8881.pdf
16. Arrish J, Yeatman H, Williamson M. Midwives and nutrition education during pregnancy: A literature review. Women and Birth 2014;27(1):2-8.
17. Elias S, Green T. Nutrition knowledge and attitudes of New Zealand registered midwives. Nutr Diet 2007;64(4):290-4.
18. Szwajcer EM, Hiddink GJ, Koelen MA, van Woerkum CM. Nutrition awareness and pregnancy: Implications for the life course perspective. Eur. J. Obstet. Gynecol. Reprod Biol 2007;135(1):58-64.
19. Rauh K, Gabriel E, Kerschbaum E, Schuster T, von Kries R, Amann-Gassner U, et al. Safety and efficacy of a lifestyle intervention for pregnant women to prevent excessive maternal weight gain: a cluster-randomized controlled trial. BMC Pregnancy Childbirth 2013;16;13:151.
20. Rauh K, Kunath J, Rosenfeld E, Kick L, Ulm K, Hauner H. Healthy living in pregnancy: a cluster-randomized controlled trial to prevent excessive gestational weight gain - rationale and design of the GeliS study. BMC Pregnancy Childbirth 2014;28;14:119.
21. Ferraro ZM, Boehm K, Gaudet L, Adamo KB. Counselling About Gestational Weight Gain and Healthy Lifestyle During Pregnancy: Canadian Maternity Care Providers' Self-Evaluation. Can J Diabetes 2013(37):S267.
22. Wennberg AL, Lundqvist A, Högberg U, Sandström H, Hamberg K. Women's experiences of dietary advice and dietary changes during pregnancy. Midwifery 2013;29(9):1027-34.
23. Garnweidner LM, Pettersen KS, Mosdøl A. Experiences with nutrition-related information during antenatal care of pregnant women of different ethnic backgrounds residing in the area of Oslo, Norway. Midwifery 2013;29(12):e130-e137.
24. Mulliner CM, Spiby H, Fraser R. A study exploring midwives' education in, knowledge of and attitudes to nutrition in pregnancy. Midwifery 1995;11(1):37-41.
25. Lee D, Haynes C, Garrod D. Exploring health promotion practice within maternity services. National Health Service Foundation Trust. Stockport, UK: National Health Service; 2010.
26. Szwajcer EM, Hiddink GJ, Koelen MA, van Woerkum CM. Written nutrition communication in midwifery practice: What purpose does it serve? Midwifery 2009;25(5):509-17.
27. Schmied VA, Duff M, Dahlen HG, Mills AE, Kolt GS. Not waving but drowning: a study of the experiences and concerns of midwives and other health professionals caring for obese childbearing women. Midwifery 2011;27(4):424-30.
28. Stotland NE, Gilbert P, Bogetz A, Harper CC, Abrams B, Gerbert B. Preventing excessive weight gain in pregnancy: how do prenatal care providers approach counseling? Int J Womens Health 2010;19(4):807-14.
29. Wennberg AL, Hamberg K, Hörnsten Å. Midwives' strategies in challenging dietary and weight counselling situations. Sex Reprod Health 2014;5(3):107-12.
30. Johnson, A, Sandford, J Written and verbal information versus verbal information only for patients being discharged from acute hospital settings to home: systematic review. Health Educ Res 2005;20(4):423-9.

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ARÁN

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Trabajo Original

Otros

Eating attitudes, body image and risk for eating disorders in a group of Spanish dancers

Actitudes alimentarias, imagen corporal y riesgo de trastornos alimentarios en un grupo de bailarines españoles

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Abstract

Introduction: Prevalence of eating disorders (ED) and discrepancies between actual weight and weight perception seem much higher in dancers. The aims analysed in 77 dancers were: risk for ED; relationship between eating attitudes and psychological variables; dieting and self-weighing, and body image distortion.

Method: Weight- and body image-related variables, dieting, self-reported physical fitness, specific ED-related variables and other psychological variables were assessed. The robust Huber's model was applied in order to test the influence of the variables analysed on the Eating Attitudes Test (EAT-40) scores. In case of categorical variables, the Chi-square (χ^2-test) or the Fisher's exact test were applied.

Results: Higher risk of ED was not obtained. Despite the relationship between EAT-40 and BMI, body appreciation and drive for thinness, scores on EAT-40 and BMI do not suggest higher risk in dancers. Dancers had a similar weight perception than other populations and body dissatisfaction seems not to be worse than the reported in other types of participants.

Conclusions: Despite some limitations, our study adds some data in this field of study bearing in mind the use of a cluster of variables previously not taken into account as a whole.

Key words:

Dancers. Eating disorders. Weight misperception. Self-weighing. Body dissatisfaction. Body image distortion. Body appreciation.

Resumen

Introducción: la prevalencia de trastornos de la conducta alimentaria (TCA) y las diferencias entre el peso corporal real y el percibido parecen más elevadas en bailarines. Los objetivos analizados en 77 bailarines fueron: riesgo de TCA; relación entre actitudes alimentarias y variables psicológicas; conducta de dieta y autocontrol de peso, y distorsión de la imagen corporal.

Método: se estudiaron variables relacionadas con el peso y la imagen corporal, conducta de dieta, percepción de la propia forma física, variables específicas relacionadas con los TCA y otras variables psicológicas. El modelo estadístico robusto de Huber fue utilizado para probar la influencia de las variables analizadas en las puntuaciones del Eating Attitudes Test (EAT-40). Para las variables categóricas se usaron la prueba de Chi-cuadrado o el test de Fisher.

Resultados: no se encontró un mayor riesgo de TCA. Aun existiendo correlación entre el EAT-40 y el índice de masa corporal (IMC), aprecio corporal e impulso a adelgazar, las puntuaciones del EAT-40 y el IMC no sugieren un mayor riesgo en este grupo de bailarines. Por otro lado, estos bailarines tienen una percepción del propio peso similar a la de otras poblaciones y su insatisfacción corporal no parece ser peor que la expresada en otros tipos de población.

Conclusiones: a pesar de algunas limitaciones, este estudio añade algunos datos en este campo, teniendo en cuenta el grupo de variables analizadas, previamente no consideradas en conjunto.

Palabras clave:

Bailarines. Trastornos de la conducta alimentaria. Percepción errónea del peso. Autocontrol de peso. Insatisfacción corporal. Distorsión de la imagen corporal. Aprecio corporal.

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INTRODUCTION

The prevalence of eating disorders (ED) seems to be much higher for specific groups such as models, athletes and dancers (1-4). The reasons for these higher rates have been focused (among other elements) on personality factors, specifically some traits such as perfectionism, low self-esteem and high self-standards (2,5-7). Sociocultural influences encourage the development of both body image disorders and ED through two mechanisms: reinforcement –for example comments, which support the maintenance of an ideal of thinness– and modelling –imitation of observed behaviours– (8). The existence of specific personality traits along with sociocultural influences may explain, to some extent, the high prevalence of ED among high-risk occupations (9). Some authors have mentioned that perfectionism and low self-esteem, usually found among dancers, might explain why ED appear to be more prevalent among this group of people (9,10). Nevertheless, this statement remains controversial taking into account the disparity of results, probably due to methodological differences among studies (7). With respect to dancers there are different studies comparing all dancers vs. non-dancers as well as comparing ballet dancers *vs.* non-dancers. The overall prevalence of ED in all dancers was found to be 12%, which was slightly lower than the prevalence found in ballet dancers –16.4%– (7). These studies were mainly based on instruments such as the Eating Attitudes Test (both versions 26 and 40 items), the Eating Disorders Inventory (EDI), the Bulimia Investigation Test Edinburgh (BITE) and several clinical interviews (11-14). When studies have focused on all dancers vs. non-dancers it must be noted that the population of dancers is usually too diverse (ballet, modern dance, jazz, national dance, etc.) to reach clear conclusions. It is generally admitted that general dancers have more than twice the risk of developing an eating disorder and more than three times of developing anorexia nervosa (AN) and eating disorders not otherwise specified (EDNOS) than non-dancers (7).

With respect to body image and weight self-perception, it has been reported that many more dancers and models than control girls, show discrepancies between their actual weight and their weight perception, assessing their weight as normal or above average while actually being underweight (9). This has been explained by the nature of these activities, which imply that less body weight means success. In addition, their professional and cultural surrounding creates an aversion towards gaining weight, and strongly supports the attitude that a skinny body and body image are normal (9).

Generally, body appreciation and body image quality of life seem to be negatively related to body dissatisfaction and drive for thinness, and positively related to self-esteem. In the case of body image quality of life, the relationship with drive for thinness/body dissatisfaction seems to be only clearly significant in women (15,16). On the other hand, body mass index (BMI) is positively correlated to disordered eating attitudes and body dissatisfaction (17,18). In previous studies it has been reported that self-esteem and BMI are related to positive body image (19). In order to detect the risk for ED the Eating Attitudes Test (EAT) has been the most used psychometric instrument. When using the version of 40 items the cut-off point is usually established at 30. With this cut-off point the percentages of people at risk in Spain range between 0.6-8.3 and 7.3-17.3 for males and females, respectively. Recently, some authors have concluded that a cut-off point of 21 yields the best diagnostic prediction with a sensibility and specificity of 88.2% and 62.1% respectively, and positive and negative prediction values of 17.7% and 62.1% respectively (20).

According to the reviewed literature: a) it is expected a positive relationship between dance and higher prevalence of risk for ED; b) it is expected a relationship between eating attitudes and psychological variables such as self-esteem, mental health, specific EDI subscales, body appreciation and body image quality of life; c) considering the dancers group, it is expected a higher prevalence of going on diet and/or more self-weighing frequency and more discrepancies between actual weight and weight perception, assessing weight as normal or above average while actually being underweight; and d) dancers have an increased body image distortion.

METHOD

SAMPLE

The sample comprised 77 dancers from the Centro Andaluz de Danza (CAD; Junta de Andalucía, Seville, Spain) with a mean age of 21.22 (SD = 3.06) and an age range between 18 and 32. 20 were males and 57 were females. The mean BMI was 21.01 (SD = 1.85). All of them voluntarily agreed to participate in the study. The CAD is not a "professional Centre of dance" so the attendants practice dance as a semi-professional activity.

MEASURES AND INSTRUMENTS

According with the main instruments (questionnaires, inventories, scales) used in previous research on this field of study, the following were applied.

Weight- and body image-related factors

Anthropometric measurements: BMI was calculated as the relationship between weight (in kg) and height squared (in m). Weight and height were taken in individual sessions, with the participants in standing position, barefoot, and in light garments. An estadiometer "Añó-Sayol Atlántida S13" model (Barcelona, Spain) was used.

Weight perception: Considering weight perception, participants responded to this question: What do you think of yourself in terms of weight? Possible responses were: "very overweight", "slightly overweight", "about the right weight", "slightly underweight" and "very underweight".

Self-weighing frequency: Participants were asked about their self-weighing frequency: "several times per day", "daily", "several times per week", "weekly", "occasionally".

Body shape: Participants were asked to choose, based on the standard figural stimuli developed by Stunkard and Stellar (21). Which silhouette is closest to your usual appearance? There are 6 silhouettes corresponding (from 1 to 6) to BMI of 17, 19, 21, 23, 25 and 27 approximately.

Dieting

Participants were asked whether they were dieting at the moment or not (yes/no), the reason or reasons for going on that diet (aesthetic reasons, healthy reasons –others than losing weight– or only with the specific objective of losing weight) and the intention of keeping on dieting or being about to do it (yes/no).

Self-reported physical fitness

Participants were asked about their physical fitness perception ("How do you consider your current physical fitness looks like"?) and they were classified as perceiving themselves as possessing a "poor", "fair", "average", "good" or "excellent" physical fitness.

Specific ED-related variables

Eating Attitudes Test-40 (EAT-40) (11,22): The EAT-40 has 40 items related to eating attitudes, which are rated on a six-point Likert scale (from never to always). Of these response options, three are scored with 1, 2 or 3 and the rest with 0. The maximum possible score is therefore 120, and a higher score corresponds to greater severity of disorder. The clinical cut-off point is usually considered to be 30. Factors that group together different items are bulimic behaviours, body image with a tendency toward thinness, laxative use or abuse, induced vomiting, restricted eating, eating in secret and perceived social pressure when weight increases. The EAT is the most widely-used self-report questionnaire for detecting disordered eating behaviours and its test-retest reliability ranges between 77% and 95%, with its positive and negative prediction values being 82% and 93%, respectively.
Eating Disorders Inventory-3 (EDI-3) (23,24): This inventory assesses three risk variables related to ED (in addition to nine psychological variables), and it is applicable in non-clinical samples from ten years on, both individually and collectively. For the present study there were taken those items related to specific ED variables (*i.e.,* drive for thinness –DT–, bulimia –B–, and body dissatisfaction –BD–). The Spanish version of these scales has adequate internal consistency (Cronbach's α coefficients between 0.87 and 0.95).
The Spanish version of Body Image Quality of Life Inventory (BIQLI-SP) (16,25): The BIQLI is a self-reported questionnaire, which comprises 19 items. In order to avoid pathology-oriented biases, those items are evaluated on a 7-point bipolar scale, from +3 (very positive effect) to 0 (no impact) to -3 (very negative effect). The Spanish version (BIQLI-SP) was used for the current study. BIQLI-SP has shown high internal consistency (Cronbach's α coefficient = 0.95) and high stability over a 3-week period (test-retest reliability = 0.84). The validity of the BIQLI-SP has been evidenced by its significant relationships with different variables, both psychological and psychopathological, as well as with eating disorder-related variables.

Other psychological variables

Body Appreciation Scale (BAS) (15,26): This 13-item instrument comprises a single dimension and shows adequate internal consistency (Cronbach's α coefficient = 0.94) and construct validity. It seems to be useful for studying the positive aspects of body image. BAS items are rated along a 5-point scale (*i.e.,* 1 = never, 2 = seldom, 3 = sometimes, 4 = often, 5 = always) and are averaged to obtain an overall body appreciation score. When giving the BAS to men item 12 is revised to: "I do not allow unrealistically muscular images of men presented in the media to affect my attitudes toward my body". Again the Spanish version of the BAS was used here, which has shown adequate psychometric properties (Cronbach's α coefficient = 0.91).
Self-esteem scale (SES) (27,28): The Spanish version of this scale was used. It comprises 10 items that are scored with a Likert format (from strongly agree to strongly disagree; the higher the score, the higher the degree of self-esteem). Reliability in the Spanish population has been shown to be adequate (Cronbach's α coefficient = 0.87), with test-retest correlation of 0.72.
General Health Questionnaire-28 (GHQ-28) (29,30): For this study we used the Spanish version of this screening instrument of general psychopathology which, taking into account a cut-off point of 6-7, shows a sensitivity of 76.9% and a specificity of 90.2%. With a cut-off point of 5-6 the questionnaire shows a sensitivity of 84.6% and a specificity of 82%. Anyhow, it shows an adequate discriminative power (psychiatric case-no case) and it is easy to be administered. The questionnaire was designed to detect the presence of psychiatric cases in community and non-psychiatric clinical settings and comprises four 7-item scales: somatic symptoms, anxiety and insomnia, social dysfunction and depression. Each item is accompanied by four possible responses: *Not at all*, *No more than usual*, *Rather more than usual*, and *Much more than usual. As usual, GHQ-28 was scored with a binary method where Not at all, and No more than usual score 0, and Rather more than usual and Much more than usual score 1.* By means of this scale of 0,0,1,1, the results are utilised to identify psychiatric cases. A higher final score indicates a greater psychopathology. Since there have been handled different cut-off points, only the total score has been considered in the present study. The GHQ has been suggested as a tool for identifying emerging problems as well as to identify chronic problems.

SETTING AND PROCEDURE

All participants attended the CAD regularly and they were practising one of the following three modalities of dance:

Spanish-flamenco dance (40.26%), contemporary dance (32.47%) or neoclassic dance (27.27%). After having obtained the CAD Director's permission and the students' informed consent, participants fulfilled the questionnaires and scales individually and without time limits. Measurements were taken individually. The procedure was supervised by a nutritionist, instructing the participants about how to complete the questionnaires and scales until they were completely sure about their fully understanding of the instructions. That nutritionist was also in charge to resolve any doubts about the tasks when carrying them out. The participants developed their task in a suitable setting. As we noted above, all the participants volunteered to take part in the study, none of them received any kind of reward after fulfilling the task and anonymity was guaranteed. Some nutritionists with experience in this type of studies were in charge to take anthropometric measures (weight and height). None of the participants left the study after inclusion. After the Director's permission and the ethics approval from Junta de Andalucía (Regional Government of Andalusia) were obtained, a timetable was established to collect the data during a week, avoiding evaluation periods in which possible distress could have influenced the study. In order not to alter the classes routine in the CAD, the questionnaires were filled in during the periods assigned by the Director and the anthropometric measures were collected in hours devoted to some other activities different from dancing. All students were invited to participate.

STATISTICAL ANALYSES

Conventional descriptive statistics (M, SD) were used to describe continuous variables and percentages for the categorical ones (n, %). Shapiro-Wilk normality test was used to determine whether the data fitted a normal distribution or not. As result, the robust Huber's model was applied in order to test the influence of the variables analysed (IV) on the EAT scores (DV). In case of categorical variables, the χ^2-test or the Fisher's exact test were applied. All analyses were performed using R software, version 3.2.2.

RESULTS

DESCRIPTIVE STATISTICS

As it was mentioned above, the sample comprised 77 dancers (20 males and 57 females) with a mean age of 21.22 (SD = 3.06) and the mean BMI was 21.01 (SD = 1.85).

Table I shows data considering: the fact of dieting, intention to go on a diet in the future and the aesthetic motivation for that proposal. Weight self-perception, self-reported physical fitness, self-weighing frequency and the reasons for that control are also showed.

Regarding the continuous variables (BAS, GHQ, specific subscales of EDI, BIQLI and SES), descriptives are represented in Table II.

Weight misperception and relations among weight self-perception, self-reported physical fitness and self-weighing

Table I. Descriptive statistics for categorical variables (n, %)

Weight self-perception	
Very underweight	3 (3.94%)
Slightly underweight	6 (7.89%)
On my weight	42 (55.26%)
Slightly overweight	23 (30.26%)
Very overweight	2 (2.63%)
Self-reported physical fitness	
Poor	2 (2.63%)
Fair	14 (18.42%)
Average	21 (27.63%)
Good	33 (43.42%)
Excellent	6 (7.89%)
Dieting	
No	52 (68.42%)
Yes	24 (31.57%)
Planning to go on a diet in the future	
No	43 (56.57%)
Yes	22 (28.94%)
Unknown	11 (14.47%)
Are going on a diet for mere aesthetic reasons?	
No	38 (50%)
Yes	38 (50%)
Self-weighing frequency	
Occasionally	65 (85.52%)
Weekly	8 (10.52%)
Several times per week	3 (3.94%)
Reasons for self-weighing	
Self-control	54 (71.05%)
Weight maintenance/avoid gaining weight	18 (23.67%)
Feeling better	4 (5.26%)

With respect to weight misperception, 8.45% of participants at normal weight perceived themselves as underweight and 33.80% of them perceived themselves as overweight. Among those who were under or overweight there was not any type of weight misperception. Overall 42.25% of participants misperceived their weight.

There seems to be a relationship between weight self-perception and self-reported physical fitness ($\chi^2_{16} = 92.00$; $p < 0.001$).

Table II. Descriptive statistics for continuous dependent variables *(M, Sd)*. Skew

		Skew
BAS	49.29 (7.88)	-0.31
BIQLI	0.98 (0.86)	-0.12
EDI-DT	4.34 (5.34)	1.32
EDI-B	1.19 (2.22)	2.91
EDI-BD	4.75 (5.42)	1.19
SES	32.16 (4.92)	-0.34
GHQ	14.83 (4.41)	0.39

BAS: Body Appreciation Scale; BIQLI: Body Image Quality of Life Inventory; EDI: Eating Disorders Inventory; DT: Drive for thinness; B: Bulimia; BD: Body Dissatisfaction; SES: Self-Esteem Scale; GHQ: General Health Questionnaire.

Most of the participants (95,3%) who reported average, good or excellent physical fitness perceived themselves as on their weight. On the contrary, those participants who reported fair or poor physical fitness considered themselves as being slightly overweight (64.28%) and very overweight (100%) respectively. With respect to the self-weighing frequency, no significant differences were found considering self-reported physical fitness or about the reasons to do it (self control, maintenance/avoid gaining weight, feeling better).

BODY IMAGE

Referring to the actual weight status, 93.24% had a normal BMI (between 18.5 and 24.9). With respect to the silhouettes, the participants chose the numbers 1-5 with the following frequencies: 9 (11.68%), 24 (31.16%), 22 (28.57%), 20 (25.97%) and 2 (2.59%). None of the participants chose the silhouette number 6. The figural stimuli (Stunkard and Stellar, 1990) revealed than among the participants with a normal BMI, 5.79% identified themselves with the silhouette number 1 (which corresponds to a BMI about 17) and 2.89% with the silhouette number 5 (BMI = 25). On the other hand, those participants with an actual BMI < 18 and BMI ≥ 25 chose the silhouettes number 1 (BMI = 17) and 4 (BMI = 23) respectively.

GENDER DIFFERENCES

Considering sex, no significant differences were found with regards to self-reported physical fitness and the fact of dieting. Nevertheless, a significant difference was found with respect to weight self-perception (Fisher's Exact Test, $p < 0.05$). While the proportion of males and females who perceived themselves on their weight was similar (55.55% vs. 54.38%), 38.59% of females considered as being slightly or very overweight vs. 16.66% of males. Finally, 27.77% of males perceived themselves as being slightly or very underweight *vs.* 7.01% of females.

RELATIONS AMONG WEIGHT SELF-PERCEPTION, SELF-REPORTED PHYSICAL FITNESS, SELF-WEIGHING AND DIET

A significant relationship was found between weight self-perception and dieting ($\chi^2_4 = 9.77$; $p < 0.05$) as well as between weight self-perception and going on diet in the future ($\chi^2_4 = 13.94$; $p < 0.01$). All participants who perceived themselves as very underweight or very overweight planned to go on a diet in the future. Among those who described themselves as being on their weight, slightly overweight or slightly underweight, 80%, 50% and 83.33% planned to diet respectively. A similar result was found with regards to the relation between diet for aesthetic reasons and weight self-perception ($\chi^2_4 = 14.48$; $p < 0.01$). None of the participants who perceived themselves as slightly or very underweight planned to go on diet for aesthetic reasons, while all of those who felt to be very overweight and 69.56% among the participants who felt to be slightly overweight planned to do it.
No significant relations were found between self-reported physical fitness and dieting.
With respect to self-weighing, while the percentage of those who self-weighed weekly or several times per week was 29.16% among those who went on diet, this proportion was 7.68% in the case of participants who denied dieting ($\chi^2_2 = 6.13$; $p < 0.05$).

POSITIVE CASES RESPECTING EAT-40

Considering the traditional cut-off point (EAT-40 ≥ 30), 4 positive cases were found (5.19%). After applying the cut-off point of EAT-40 ≥ 21, proposed by Peláez-Fernández, et al. (20), which seems to give the best diagnostic prediction in our context, the number of positive cases was 14 (18.18%).

PREDICTION OF EAT SCORES (DV) BASED ON THE DIFFERENT VARIABLES ANALYZED (IV)

Mean, standard deviation and skew of EDI specific subscales suggested that these variables did not fit a normal distribution (Table II) as it was confirmed by means of the Shapiro-Wilk normality test. This is a trouble to perform a linear regression model so the robust Huber's model was applied in order to test the influence of the variables analysed (IV) on the EAT scores (DV). Linear least-squares estimates can behave badly when the error distribution is not normal, particularly when the errors are heavy-tailed. One remedy is to remove influential observations from the least squares fit. Another approach, robust regression, is to employ a fitting criterion that is not as vulnerable as least squares to unusual data (31). In this case the potential influential observations (outliers) are not data entry errors, neither are they

from a different population than the data. So we had no compelling reasons to exclude them from the analysis. In this regards robust regression is a good strategy since it is a compromise between excluding these influential observations entirely from the analysis and including all the data points and treating all them equally (32). The results of the Huber's M-estimator are shown in table III. BMI, BAS and EDIDT have significant influence on the EAT-40 scores, this influence being no significant for the rest of variables. Despite having observed sex differences, these differences did not reach statistical signification (Figs. 1-3).

Table III. Huber's M-estimation for regression analysis

Coefficients			
	Value	**Std. Error**	**t value**
(Intercept)	14.0777	10.2587	1.3723
BMI	-0.0946	0.3920	-0.2413*
BAS	-0.1162	0.1138	-1.0212*
GHQ	-0.0408	0.1581	-0.2581
EDIDT	1.2037	0.2099	5.7355*
EDIB	-0.6230	0.3180	-1.9593
EDIBD	0.1812	0.2119	0.8550
BIQLI	0.6935	0.7853	0.8831
SES	0.0837	0.1601	0.5226

BAS: Body Appreciation Scale; BMI: Body Mass Index; BIQLI: Body Image Quality of Life Inventory; EDI: Eating Disorders Inventory; DT: Drive for thinness; B: Bulimia; BD: Body Dissatisfaction; SES: Self-Esteem Scale; GHQ: General Health Questionnaire.
** $p < 0.001$.*

DISCUSSION

With respect to our first hypothesis (a positive relationship between dance and higher prevalence of risk for ED), it must be noted that ED in dancers are thought to be common but the exact rates remain to be clarified (7). The dancer group has an overall

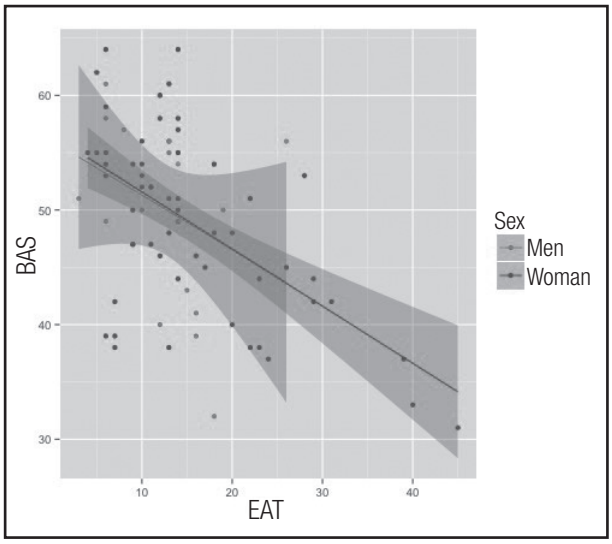

Figure 2.
Relationship between BAS and EAT by sex.

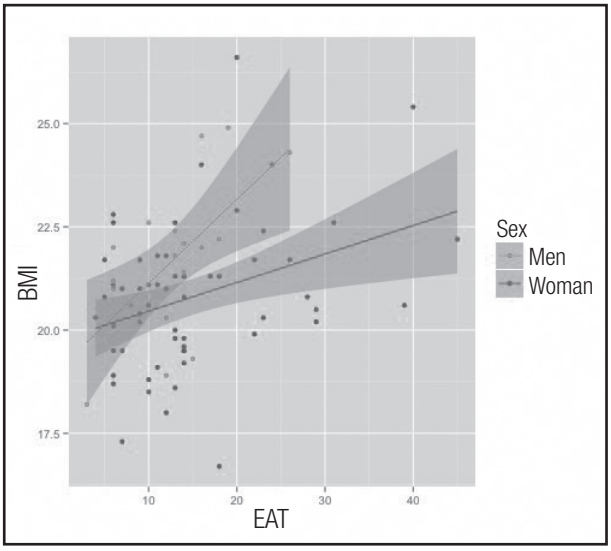

Figure 1.
Relationship between BMI and EAT by sex.

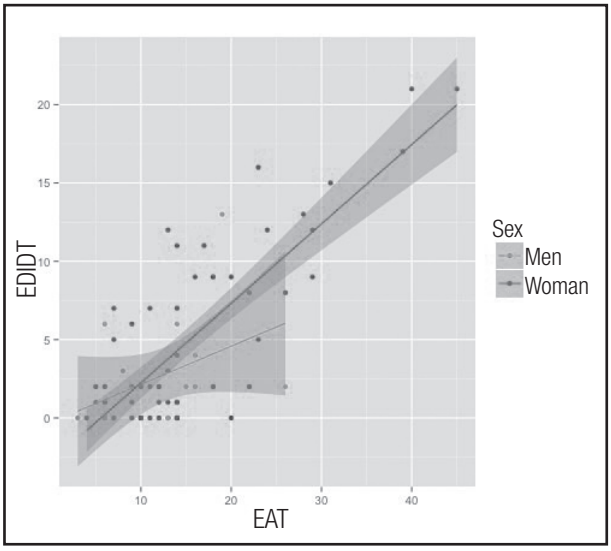

Figure 3.
Relationship between EDIDT and EAT by sex.

prevalence of 16.4% with higher mean scores on the EAT-26 and the EDI subscales, so dancers seem to have a higher risk of suffering from ED as it has been reported recently (7). In the current study it is possible to note that there is a high risk of ED, considering the cut-off point of 21 for the EAT-40 (18.18%). This risk is higher than the one found in students (5.95%-9.43%) but in this case the cut-off point of the EAT-40 was 30 (17,18,33). In the current study, when the cut-off point was 30, the percentage of positive cases was clearly lower (5.19%). Previous studies have shown that the prevalence of AN in ballerinas ranges from 2% to 7% (34). In our study the positive cases were not confirmed by means of a clinical interview, our aim being to study the risk for ED in the specific group of dancers. According to the World Health Organization, the majority of ballerinas have below body weight (a risk factor for ED) (9), which was not found in the current study (only 7.79% of our sample had a BMI $\leq$ 18.5). The prevalence of risk for ED is not clear with our results because it seems to depend directly of the cut-off point applied for the EAT-40. Considering the BMI, the majority of the dancers were at normal weight. In this regards our results do not confirm that dancers are more similar to eating-disordered individuals than to control individuals on measures of eating pathology (2). With respect to the BMI, Wyon et al. (35) have reported that professional dancers had significantly greater BMI than student dancers, so a low BMI as risk factor for ED among dancers seems to remain controversial. Apart from the different cut-off point there is a factor, which could have influenced on our results. As it was noted previously, the CAD is not a "professional Centre of dance" so the attendants practice dance as a semi-professional activity or hobby. In addition, previous research has been focused on ballet dancers while this study includes other very different disciplines. These facts, along with a bit different mean age with respect to the reported in other articles must be taken into account for future studies: in our case 21.22 while other studies report, for example, 13-20 years old (4) or 25 years old (9). In fact, Wyon et al. (35) reported higher EAT-26 scores for female ballet dancers in years 10 and 12. So our first hypothesis was partially confirmed when we used the cut-off point of 21 with respect to the EAT-40.

Our second hypothesis (it is expected a relationship between eating attitudes and psychological variables such as self-esteem, mental health, specific EDI subscales, body appreciation and body image quality of life) was also partially confirmed. In this regard, BMI, body appreciation and EDI-DT (drive for thinness) significantly predicted the scores on the EAT-40. Higher BMI, lower scores on BAS and higher scores on EDI-DT predict higher scores on EAT-40. In other studies with dance students, low self-esteem, high neuroticism, and high psychological distress have proved to be associated with ED as well as teasing for overweight and body image dissatisfaction (36). These results are not specific because the negative relationship between BMI-BAS and BAS-drive for thinness has been reported in previous studies (15). The relationship between EAT-40 and self-esteem and GHQ scores was negative but not significant statistically.

Comparing with other populations the percentage of participants who went on a diet at the moment of this study (31.57%) was significantly higher (33). In the current study there were no significant gender differences with respect to go on a diet and planning to do it for aesthetic reasons, this being different considering other types of participants. In this regard, among students who go on a diet or plan to do it for aesthetic reasons more than 60% has been reported to be females (33). Self-weighing frequency was also different when compared with other studies based on other types of participants. While in the current study 3.94% self-weighed several times per week this percentage was 2.29 in a previous study among secondary school students (37). Considering weight misperception, the percentage of participants who misperceived their weight was significantly higher than the reported in previous studies in our context (23.5%-27.48%) (33,37), and similar to others such as Ruiz-Prieto et al. (41.35%) (38). In some countries, culturally different comparing with Spain *(e.g.,* Ghana), approximately 20-21% of undergraduate students misperceives their weight status (39). The different age ranges and types of participants do not permit to compare these percentages in order to conclude something specific about the weight misperception among dancers. Authors such as Urdapilleta et al. (40) have highlighted that dancers have a more realistic perception of their body weight but bearing in mind the literature, this point remains unclear.

With regards to our third hypothesis (it is expected a more prevalence of going on diet and/or more self-weighing frequency and more discrepancies between the actual weight and the weight perception, assessing the weight as normal or above average while actually being underweight), it has been confirmed. On the one hand dancers seem to diet more frequently than other populations. Considering gender, there is a substantial difference with respect to other people. While generally females diet more frequently than men do, in the case of dancers there are not significant differences between women and men. Another difference must be noted with regards to self-weighing frequency, which in the case of dancers seems to be a bit higher.

Taking into account the silhouettes of Stunkard & Stellar (21), overall 85.13% of dancers chose the silhouettes numbers 2-4, which correspond to normal BMI. The BIQLI showed that the mean was positive, which indicates a positive body image quality of life. In a recent study with students the silhouettes numbers 2-4 were chosen by 75.84% (37) and other study (38) revealed an EDI-BD score of 6.13 among students, which is higher than the one found in the current study (4.75). In this regard body dissatisfaction and body distortion among dancers seem not to be worse than the reported in other populations. In short, our fourth hypothesis was not confirmed.

Summarizing, our results do no confirm that dancers have higher risk of ED at least in this group of participants who attend a specific Centre in Andalusia and when the most strict cut-off point was applied. Scores on EAT-40 and BMI do not suggest higher risk comparing with other populations. The current results show the relationship between EAT-40 scores and variables such as BMI, body appreciation and drive for thinness in this dancers group. A higher BMI, associated to lower body appreciation and higher drive for thinness could be a potential risk cluster for disordered eating attitudes.

There is a point that should be highlighted with respect to the fact of dieting. The concern about weight among dancers might lead to a high frequency of going on a diet as it is observed in our results. Nevertheless, there are not significant gender differences in this regard, which is not the case in other populations in which females are more likely to go on a diet. Dance could be considered as an activity, which implies similar behaviours to control weight in men and women. Something similar occurs when considering self-weighing, a behaviour more frequent among dancers than in other groups. A third element to note, along with dieting and self-weighing, is weight misperception. The probability that dancers have a more realistic perception of their body weight (40) has not been confirmed with our results. While other authors (33,37,38) have been reported a weight misperception ranging between 23.5%-41.35%, in this dancers group the percentage of weight misperception was 42.25%.

Finally, body dissatisfaction and body distortion among dancers are not worse than the reported in other populations taking into account our results referred to the silhouettes of Stunkard and Stellar (21), scores on the body image quality of life and level of body dissatisfaction as measured by the corresponding EDI subscale.

This study has some limitations. First, comparing to other studies this sample would be considered as a small one, so it is difficult to generalize the results. Another trouble to establish comparisons refers to the fact that while in our study the mean age was 21.22 others have reported mean ages from 14.4 (41) to 20.9 (42). Only one study (43) reported a higher mean age (34.4). Third, the characteristics of the CAD must be taken into account. Students at this Centre could be considered as semi-professionals dancers. Other studies have focused on students who practice dance as their main activity (4). In this regard the profile might be considerably different, this being a possible objection to establish comparisons with other studies. Another limitation could be highlighted considering that our work does not have considered a control group. In this regard we have referred to other similar studies focused on non-dancers students. With respect to our first hypothesis, a higher risk for ED could be mentioned provided that the less strict cut-off point of EAT-40 is applied. With the classical cut-off point these results do not support that hypothesis. Despite these limitations, our study adds some data in this field of study bearing in mind the use of a cluster of variables previously not taken into account as a whole.

REFERENCES

1. Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. Clin J Sport Med 2004;14:25-32. Disponible en: http://dx.DOI.org/10.1097/00042752-200401000-00005.
2. Ringham R, Klump K, Kaye W, Stone D, Libman S, Stowe S, et al. Eating disorder symptomatology among ballet dancers. Int J Eat Disord 2006;39:503-8. Disponible en: http://dx.DOI.org/10.1002 /eat.20299.
3. Smethurst W, Wales J, Arcelus J. Puff the magic slimmer? Eur Eat Disord Rev 2010;18:431-3. Disponible en: http://dx.DOI.org/10.1002/erv.1059.
4. Herbrich L, Pfeiffer E, Lehmkuhl U, Schneider N. Anorexia athletica in pre-professional ballet dancers. J Sports Sci 2011;29,1115-23. Disponible en: http://dx.DOI.org/10.1080/02640414.2011.578147.
5. Gunnard K, Krug I, Jiménez-Murcia S et al. Relevance of social and self-standards in eating disorders. Eur Eat Disord Rev 2012;20:271-8. Disponible en: http://dx.DOI.org/10.1002/erv.1148.
6. Penniment KI, Egan SJ. Perfectionism and learning experiences in dance class as risk factors for eating disorders in dancers. Eur Eat Disord Rev 2012;20:13-23. Disponible en: http://dx.DOI.org/10.1002/erv.1089.
7. Arcelus J, Haslam M, Farrow C, Meyer C. The role of interpersonal functioning in the maintenance of eating psychopathology: A systematic review and testable model. Clin Psychol Rev 2013;33:156-67. Disponible en: http://dx.DOI.org/10.1016/j.cpr.2012.10.009.
8. Fairburn CG, Brownell KD. Eating Disorders and Obesity: A Comprehensive Handbook. The Guilford Press: New York; 2002.
9. Zoletić E, Duraković-Belko E. Body image distortion, perfectionism and eating disorder symptoms in risk group of female ballet dancers and models and in control group of female students. Psychiatr Danub 2009;21:302-9.
10. Nordin-Bates SM, Walker IJ, Redding E. Correlates of disordered eating attitudes among male and female Young talented dancers: findings from the UK centres for advanced training. Eat Disord 2011;19:211-33. Disponible en: http://dx.DOI.org/10.1080/10640266.2011.564976.
11. Garner DM, Garfinkel PE. The Eating Attitudes Test: An index of the symptoms of anorexia nervosa. Psychol Med 1979;9:273-9.
12. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The eating attitudes test: psychometric features and clinical correlates. Psychol Med. 1982;12:871-8.
13. Garner DM, Olmstead M, Polivy J. Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. Int J Eat Disord 1983;2:15-34. Disponible en: http://dx.DOI.org/10.1002/1098-108X(198321)2:23.0.CO;2-6.
14. Henderson M, Freeman CP. A self-rating scale forbulimia. The "BITE". Br J Psychiatry. 1987;150:18-24. Disponible en: http://dx.DOI.org/10.1192/bjp.150.1.18.
15. Jáuregui-Lobera I, Bolaños-Ríos P. Spanish version of the Body Appreciation Scale (BAS) for adolescents. Span J Psychol 2011;14:411-20. Disponible en: http://dx.DOI.org/10.5209/rev_SJOP.2011.v14.n1.37.
16. Jáuregui-Lobera I, Bolaños-Ríos P. Body image and quality of life in a Spanish population. Int J Gen Med 2011;4,63-72. Disponible en: http://dx.DOI.org/10.2147/IJGM.S16201.
17. Jáuregui-Lobera I, Romero-Candau J, Bolaños-Ríos P, et al. Eating behaviour and body image in a sample of adolescents from Sevilla. Nutr Hosp 2009;24:568-73. Disponible en: http://dx.DOI.org/10.3305/nh.2009.24.5.4486.
18. Jáuregui-Lobera I, Romero-Candau J, Montaña-González MT, Morales-Millán MT, Vargas-Sánchez N, León-Lozano P. Analysis of eating attitudes in a sample of adolescents from Sevilla. Med Clin (Barc) 2009;132:83-8. Disponible en: http://dx.DOI.org/10.1016/j.medcli.2008.07.001.
19. Jáuregui-Lobera I, Bolaños-Ríos P, Santiago-Fernández MJ, Garrido-Casals O, Sánchez E. Perception of weight and psychological variables in a sample of Spanish adolescents. Diabetes Metab Syndr Obes 2011;4:245-51. Disponible en: http://dx.DOI.org/10.2147/DMSO.S21009.
20. Peláez-Fernández MA, Ruiz-Lázaro PM, Labrador FJ, Raich RM. Validation of the Eating Attitudes Test as a screening instrument for eating disorders in general population. Med Clin (Barc) 2014;142:153-5. Disponible en: http://dx.DOI.org/10.1016/j.medcli.2013.03.018.
21. Stunkard A, Stellar E. Eating and its disorders. In: Cash T, Pruzinsky T, edits. Body Images. New York: Guilford Press; 1990. p. 3-20.
22. Castro J, Toro J, Salamero M, Guimerá E. The Eating Attitudes Test: Validation of the Spanish version. Psychol Assess 1991;7:175-90.
23. Garner DM. Eating Disorder Inventory- 3 Professional manual. Odessa, Fl:-Psychological Assessment Resources; 2004.
24. Elosua P, López-Jáuregui A, Sánchez-Sánchez F. Manual técnico con la adaptación al euskera del Eating Disorder Inventory-3. Madrid: TEA Ediciones; 2010.
25. Cash TF, Fleming EC. The impact of body-image experiences: Development of the Body Image Quality of Life Inventory. Int J Eat Disord 2002;31:455-60. Disponible en: http://dx.DOI.org/10.1002/eat.10033.
26. Avalos L, Tylka TL, Wood-Barcalow N. The Body Appreciation Scale: Development and psychometric evaluation. Body Image 2005;2:285-97. Disponible en: http://dx.DOI.org/10.1016/j.bodyim.2005.06.002.
27. Rosenberg M. Society and the adolescent self-image. Princeton, NJ: Princeton University Press; 1965.
28. Vázquez AJ, Jiménez R, Vázquez-Morejón R. The Rosenberg Self- Esteem Scale: Reliability and validity in clinical samples of Spanish population. Apuntes de Psicología 2004;22:247-55.

29. Goldberg P, Hillier VF. A scaled version of the General Health Questionnaire. Psychol Med 1979;9:139-45. Disponible en: http://dx.DOI.org/10.1017/S0033291700021644.
30. Lobo A, Pérez-Echevarría MJ, Artal J. Validity of the scaled version of the General Health Questionnaire (GHQ-28) in a Spanish population. Psychol Med 1986;16:135-40. Disponible en: http://dx.DOI.org/10.1017/S0033291700002579.
31. Fox J, Weisberg S. Robust regression in R. In: Fox J, Weisberg S (eds). An R Companion to Applied Regression. 2.ª ed. Thousand Oaks: Sage publications; 2011.
32. Fox J. Applied regression analysis, linear models, and related models. Thousand Oaks: Sage publications; 1997.
33. Jáuregui-Lobera I, Ezquerra-Cabrera M, Carbonero-Carreño R, Ruiz-Prieto I. Weight misperception, self-reported physical fitness, dieting and some psychological variables as risk factors for eating disorders. Nutrients 2013;5:4486-502. Disponible en: http://dx.DOI.org/10.3390/nu5114486.
34. Szmukler GI, Eisler I, Gillies C, Hayward ME. The implication of anorexia nervosa on a ballet school. J Psychiatr Res 1985;17,177-81. Disponible en: http://dx.DOI.org/10.1016/0022-3956(85)90015-9.
35. Wyon MA, Hutchings KM, Wells A, Nevill AM. Body mass index, nutritional knowledge, and eating behaviors in elite student and professional ballet dancers. Clin J Sport Med 2014;24:390-6. Disponible en: http://dx.DOI.org/10.1097/JSM.0000000000000054.
36. Liu CY, Tseng MC, Chang CH, Fang D, Lee MB. Comorbid psychiatric diagnosis and psychological correlates of eating disorders in dance students. J Formos Med Assoc 2015;115:113-20. Disponible en: http://dx.DOI.org/10.1016/j.jfma.2015.01.019
37. Hernández-Camacho JD, Rodríguez-Lazo M, Bolaños-Ríos P, Ruiz-Prieto I, Jáuregui-Lobera I. Eating habits, excess weight and weight self-perception at school. Nutr Hosp 2015;32:1334-43. Disponible en: http://dx.DOI.org/10.3305/nh.2015.32.3.9351.
38. Ruiz-Prieto I, Carbonero-Carreño R, Jáuregui-Lobera I. Weight misperception and physical fitness perception in relation to the physical activity level, dietary behaviour and psychosocial well-being. Nutr Hosp 2014;31:203-16. Disponible en: http://dx.DOI.org/10.3305/nh.2015.31.1.8119.
39. Mogre V, Aleyira S, Nyaba R. Misperception of weight status and associated factors among undergraduate students. Obes Res Clin Pract 2015;9:466-74. Disponible en: http://dx.DOI.org/ 10.1016/j.orcp.2015.03.002.
40. Urdapilleta I, Cheneau C, Masse L, Blanchet A. Comparative study of body image among dancers and anorexic girls. Eat Weight Disord 2007;12:140-6.
41. Toro J, Guerrero M, Sentis J, Castro J, Puertolas C. Eating disorders in ballet dancing students: problems and risk factors. Eur Eat Disord Rev 2009;17:40-9. Disponible en: http://dx.DOI.org/10.1002/erv.888.
42. Holderness CC, Brooks-Gunn J, Warren MP. Eating disorders and substance use: a dancing vs a nondancing population. Med Sci Sports Exerc 1994;26:297-302. Disponible en: http://dx.DOI.org/10.1249/00005768-199403000-00005.
43. Nascimento AL, Luna JV, Fontenelle LF. Body dysmorphic disorder and eating disorders in elite professional female ballet dancers. Ann Clin Psychiatry 2012;24,191-4.

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Trabajo Original

Otros

Hepatic function and antioxidant activity in diabetic rats subjected to diet supplemented with multimixture

Función hepática y actividad antioxidante en ratas diabéticas con dieta suplementada con multimezcla

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Abstract

Introduction: Food and dietetic components have received considerable attention as auxiliary feeding resources on controlling of chronic non-transmissible diseases, among them diabetes. This study evaluated the effect of supplementary diet with multimixture based on linseed, sesame, oats and sunflower seeds on the hepatic function and antioxidant activity of diabetic rats.

Methods: Male rats were distributed on groups of seven animals: diabetic control (DC), diabetics subject to multimixture diet (DM), diabetic with insulin (DI), and normal control (NC). The treatment was started on the 5th day after diabetes induction with 40 mg/kg i.v. streptozotocin on tampon citrate and kept during 50 days.

Results: The ethereal extract of the supplemented diet showed a higher content of phenolics ($p < 0.05$) compared to other extracts of the supplemented diet and the ethereal extract of the standard diet. There was no difference in antioxidant *in vitro* activity of the utilized diets. Concerning to transaminases, significant bigger ALT levels ($p < 0.05$) were present on diabetic groups compared to NC. The relative liver weight on diabetic groups was significantly higher ($p < 0.001$) compared to NC group. Non-proteic sulfhydryl group levels were significantly higher ($p < 0.05$) on DM and I groups when compared to DM and NC. Only the treatment with insulin resulted in an improvement of antioxidant activity concerning to hepatic catalase. The supplementation with multimixture did not improve the metabolic control of diabetes.

Conclusion: The multimixture treatment showed an isolated improvement on antioxidant activity in the hepatic tissue, evidenced by the increasing on non-proteic sulfhydryl group levels.

Key words:

Diabetes mellitus experiment. Supplementary feeding. Transaminases. Antioxidants.

Resumen

Introducción: alimentos y componentes de la dieta han recibido considerable atención como recursos auxiliares en el control de las enfermedades crónicas, como la diabetes. Este estudio evaluó el efecto de la dieta suplementada con base de linaza multimezcla, sésamo, avena y semillas de girasol en la función hepática y la actividad antioxidante de ratas diabéticas.

Métodos: las ratas macho fueron divididas en grupos de siete animales: control de la diabetes (CD), diabéticos sometidos a dieta multimezcla (DM), diabéticos con insulina (DI), y control normal (CN). El tratamiento se inició en el quinto día después de la inducción de la diabetes con estreptozotocina 40 mg/kg i.v. en tampón citrato y se mantuvo durante 50 días.

Resultados: la dieta extracto etéreo complementado tenía el contenido fenólico más alto ($p < 0,05$) que los otros extractos de la suplementación de la dieta y el extracto de éter de la comida estándar. No hubo diferencia en la actividad antioxidante *in vitro* de la alimentación usada. A medida que las transaminasas, los niveles de ALT significativamente mayor ($p < 0,05$) estuvieron presentes en el grupo de diabéticos en comparación con CN, el peso relativo del hígado en el grupo de diabéticos fue significativamente mayor ($p < 0,001$) en comparación con el grupo CN. Los grupos sulfhidrilo de los niveles de proteína no fueron significativamente mayores ($p < 0,05$) en los grupos F e I comparados con CN y CD. El tratamiento con insulina resultó en una mejora de la actividad antioxidante con respecto a la catalasa hepática.

Conclusión: la suplementación con multimezcla no mejora el control metabólico de la diabetes. El tratamiento con multimezcla aislado mostró una mejora en la actividad antioxidante en el tejido hepático, como se evidencia por el aumento de los niveles de grupos sulfhidrilo no proteicos.

Palabras clave:

Experimento diabetes mellitus. Suplementación alimentaria. Transaminasas. Antioxidantes.

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INTRODUCTION

Diabetes mellitus is a metabolic chronic disease caused by genetic defects or acquired defects on secretion and/or on insulin action, whose natural history is marked by the appearance of acute or chronic complications, such as retinopathy, nephropathy and neuropathy, cerebrovascular accident and coronarian arterial disease (1). Other complications include the non-alcoholic fatty liver disease (NAFLD), a clinical-pathological term that ranges a wide spectrum of diseases that goes from lipid accumulation on hepatocytes to cirrhosis, passing through stages of steatosis with inflammation and fibrosis (2). Its pathogenic mechanisms are little known and results in important alterations on hepatic tests function (3).

Diabetes represent worldwide health problem that threatens to achieve pandemic levels by 2030, considering the predictions that the number of diabetics will be 380 million until 2025 (4). Moreover, the prevalence of NAFLD is above 80% on obese and diabetic individuals (5).

The oxidative stress induced by hyperglycemia plays a key role on the beginning and progression of diabetes complications, in which occur an increase in free radicals production and of reactive oxygen species (ROS) generated mainly by the self-oxidation of glucose and on different oxidant reactions that follows protein, lipids and nucleic acids glycation, plus the reduction of action by the antioxidant defense systems in consequence of the decrease in reduced nicotinamide adenine dinucleotide phosphate (NADP) availability and in the reduced glutathione, and by the oxidative damage of the enzymes involved (6).

The glycemic control on diabetics depends on the treatment based on a pharmacological approach with use of insulin or oral hypoglycemic agents, and non-pharmacological treatment by means of physical exercise and diet. Feeding components have been frequently utilized in combination with the pharmacological treatment because they help on improvement of glucose metabolism control, reducing the risk of complications commonly observed in DM patients. The diet proposed by the specialists must include fiber-rich food, with low standards of saturated fat, salt and simple sugars (7).

In the last years there have been a growing interest for food and feeding components, of conventional use or not, that present claims of functionality to the prevention and control of non-transmissible illnesses and chronic aggravations. Among these foods are linseed, sesame, oats and sunflower seeds, because the linseed (*Linum usitatissimum* L.) is a source of essential fatty acids, fibers and phenolics, known by their antioxidant activity (8); the sesame (*Sesamum indicum)* contains proteins, vitamins and minerals (9); the oats (*Avena sativa L*.) are rich in fibers, proteins and lipids (10); and the sunflower (*Helianthus annuus*) is rich on polyunsaturated fatty acids, with prominence to linoleic acid (11). The present study evaluated the effect of the multimixture-supplemented diet containing oat bran, linseed, sesame and sunflower seed on the hepatic function and antioxidant activity in diabetic rats.

MATERIAL AND METHODS

Male Wistar *Rattus norvegicus,* 60 and 70 days old and weighing from 230 to 270 g, were supplied by the animal house of the Center of Agrarian Studies of the Federal University of Piauí (UFPI). The animals were kept in individual metabolic cages with free access to water and rodent diet (LABINA 5002, EVIALIS do Brasil Nutrição Animal Ltda., São Paulo, Brazil), under controlled conditions (25 ± 2 °C, 12-h dark/light cycle). All experimental protocols were approved by Ethics Committee for Animal Research of the Federal University of Piaui, Brazil, CEEA-UFPI (No. 07/2010). The diabetic animals were randomly distributed in three groups of seven animals treated during 50 days with standard diet (diabetic control - DC), supplementation with multimixture (multimixture diabetics - MD), or standard diet and insulin (insulin diabetics - ID). NPH human insulin 3U/animal was administered on alternated days by subcutaneous administration, being the dose adapted from that used on the study of Pauli et al (12). It was included a non-diabetic control group (NC), composed by normal animals that received standard diet.

To the diabetes induction, after a 12-hour fast with free access to water, the animals received by intravenous administration 40 mg/kg streptozotocin (Sigma Chemical, USA) on citrate buffer 10 mM and pH 4.5. The confirmation of the diabetes was made by determining the fasting capilar glycemia using testing strips accue chek. The animals regarded as diabetics had glycemia ≥ 250 mg/dL (13). On the NC animals, citrate was administered on the moment of the induction of the diabetes.

To the preparation of the multimixture oat bran, linseed, sesame and sunflower seeds were pounded and used to the preparation on a ratio of 4 g of the formulation to each 100 g of the total weight of the diet. Such proportion of the mixture of cereals was chosen based on the study of Almeida et al. (14), which referred to be this one the best proportion of multimixture by comparing the results achieved by them with those achieved in other studies.

The euthanasia was realized with an overdose of sodium thiopental (100 mg/kg) by intraperitoneal injection (15). Samples of venous blood were obtained for biochemical dosages. The weight of the liver was determined, and samples of this organ were processed for evaluation of the antioxidant activity and histological analysis. The histological analysis was realized by optic microscopy (Nikon Eclipse E-600, optic microscope, Tokyo, Japan) on samples dyed with hematoxylin-eosin (HE) and Masson trichrome.

The serum levels of glucose, total proteins, albumin, aspartate aminotransferase (AST) and alanin aminotransferase (ALT) were determined on CENDOMED laboratory (Teresina, Piauí), by enzymatic colorimetric method, using reagents from Labtest Diagnóstica S. A.

The antioxidant activity on the hepatic tissue was determined by the quantification of the activity of catalase and reduced glutathione. The catalase was determined by measuring the decomposition of the hydrogen peroxide through the decreasing of optical density on 230 nm, accompanied by the reduction of the absorbance measured on spectrophotometer Biospectro

SP-220, EQUIPAR Ltda., Curitiba, Brazil (16). The reduced glutathione was evaluated by determining the non-proteic sulfhydryl groups (NPSHG) in homogenate of hepatic tissue at 10% on EDTA 0.02, being the essay realized on Tris 0.4 M, pH 8.9, on the presence of DTNB 0.1 M, with reading of the samples on 412 nm in spectrophotometer Biospectro SP-220, EQUIPAR Ltda., Curitiba, Brazil (16).

The quantification of the total phenolic compounds on the standard and supplemented diet was done based on standard curve of gallic acid according to the method of Swain and Hills (17) on ethereal, alcoholic and aqueous extracts with distilled water and *Folin Denins*. The absorbance was determined on spectrophotometer at 720 nm.

The antioxidant activity of the diets was evaluated according to the Blois method (1958) adapted by Brand-Willians et al. (18), with basis on the reduction of the [2,2 difenil-1-pricril-hidrazil (DPPH·)] radical, which while fixing one H^+ (removed from the antioxidant on study), leads to a decrease on absorbance, allowing the calculation, after establishing the balance of the reaction, the amount of antioxidant spent to reduce 50% of the DPPH radical. To this, it was prepared methanolic solution of DPPH 6 x 10^{-5}M, to which was added to each one of the extracts, on a concentration of 2,800 ppm, and after 30 minutes the absorbance values were measured at 517 nm in spectrophotometer Biospectro SP-220, EQUIPAR Ltda., Curitiba, Brazil (16).

Additionally, the feeding consumption, the water ingestion, the diuresis and the corporal weight were determined each three days.

The statistical analysis was realized through application of the paired t-test to compare the differences within the groups and ANOVA followed by post-test of Tukey to comparison among the groups. The significance level established was $p < 0.05$.

RESULTS AND DISCUSSION

Considering the multiple functions enacted by the liver, the functional tests here realized included glucose evaluation, albumin, total proteins and hepatic cytolysis enzymes, in addition to antioxidant activity and investigation of structural changes on the hepatic tissue. Aspects related to body weight, water and food consumption and diuresis were also evaluated. Additionally, the phenolic content and antioxidant activity of the diet were determined.

On the table I, glycemia and body weight data of the studied groups are presented. It was observed that on the fifth day after streptozotocin administration, the diabetic groups (DC, MD and ID) showed significantly higher glycemia ($p < 0.001$) compared to NC. These were expected results considering that streptozotocin causes β Langerhans islets cells degeneration, leading to the development of diabetic state within three days (19).

At the end of the treatment, the glycemia on diabetic groups remained significantly higher ($p < 0.001$) compared to NC. It was not observed any statistically difference on the group MD when compared to the groups ID and DC (Table I), although MD received treatment in which one of the components is the oat bran, a food rich in soluble fibers, to which it was already demonstrated in some studies a potential benefit on glycemic (20), evidencing a possible absence of hypoglycemic effect of the multimixture when used on the proportions adopted in this study.

The absence of hypoglycemic effect through the administration of insulin on the group I could be related to the type of insulin used, Humulin NPH, which begins to act between 1 and 2 hours after subcutaneous administration, peak between 6-12 hours and whose period of action is up to 18-24 hours (21). Moreover, other limitations on the treatment protocol used are related to the fact that the insulin administration had been realized always on evening, a period in which food consumption is higher; and that the glycemia measurements had been made on situations in which the animals remained without receiving insulin during at least 24 hours to avoid serious hypoglycemia and death during the fast period that precede the glycemia determinations.

Regardind body weight (Table I), at the beginning of the treatment the body weight of the NC group was significantly higher ($p < 0.05$) when compared to DC and I, which can be attributed to the fast weight loss on the period between the induction and confirm-

Table I. Fasting capilar glycemia and body weight on the fifth day after the diabetes induction and at the end of the treatment of *Rattus norvegicus* during 50 days with standard isolated diet (NC and DC), NPH human 3U/animal s.c. insulin administration on alternated days (ID), or with multimixture supplemented diet (MD)

Groups	Glycemia (mg/dL)		Body weigth (g)	
	5th day after diabetes induction	After treatment	5th day after diabetes induction	After treatment
NC	106.25 ± 6.64	105.25 ± 6,82	254.13 ± 5.80	300.63 ± 9.25
DC	427.88 ± 20.85[a]	563.88 ± 47.88[a]	299 ± 6.00[a]	189.50 ± 11.68[a]
MD	429.50 ± 27.43[a]	536.63 ± 60.25[a]	236.56 ± 3.72[a]	192.50 ± 9.96[a]
ID	367.00 ± 13.52[a]	528,63 ± 52.95[a]	233.50 ± 3.86[a]	223.13 ± 11.10[a]

The data represent the media ± EPM. [a]$p < 0.05$ vs. *group NC; [b]$p < 0.05$* vs. *group D. ANOVA one way/Tukey.*

ation of the diabetes. And at the end of the treatment the diabetic groups presented significantly lower body weight ($p < 0.001$) compared to NC, also being observed body weight reduction ($p < 0.05$) on DC and MD groups. The weight loss observed at the end of the experiment on animals of MD can be justified by the fact that the multimixture components, in the proportions they were used, do not present effects on glycemic control, thus the animals kept uncontrolled diabetes with its characteristic manifestations, including weight loss. On the other hand, the animals treated with insulin kept a final weight similar to the initial one, showing a probable effect of the insulin on metabolic control, reducing the weight loss provoked by diabetes, although it was not observed an improvement on the glycemic levels by the reasons already mentioned.

Concerning serum concentration of the aminotransferases (Table II), significantly higher levels ($p < 0.05$) of AST were found on MD group compared to NC, while for ALT significantly higher values ($p < 0.05$) were present in all diabetic groups when compared to NC. The AST and ALT levels express the degree of the lesion on the hepatocyte, being ALT a more sensitive indicator of hepatoxicity than AST, for AST is found in all body tissues, especially on heart, liver, bone muscle, kidney, brain, pancreas, leucocytes, erithrocytes, while ALT is found primarily in the liver and, on small amounts, in kidney and heart (22). The increase in ALT and AST can be also attributed to the leaking of these enzymes on the cytosol of the hepatic cells when there is damage to the hepatocyte membrane, resulting in an increase of permeability (23). And in animals with diabetes induced by streptozotocin such effect could occur as a consequence of the hepatotoxic effect of the drug (24).

The increase observed on both transaminases in groups of diabetic animals is in accordance with other studies. Such elevation could be related to the fact that hyperglycemia resulting of diabetes is responsible for decreasing the non-enzymatic antioxidant defenses, contributing to the occurrence of cellular and tissue damage by the reactive strains of oxygen, which would lead to an increase of the lipid peroxidation on the hepatic tissue, provoking chances on the hepatic function evidenced by the increase of ALT and AST (25). And according to Sorbi et al. (26), the alteration in laboratory exams more frequent in animals with NAFLD are slight to moderate variations on the values of hepatic enzymes like AST and ALT.

Yet, the analysis of the results did not evidence the presence of hypoalbuminemia or reduction of total protein concentrations in the group of diabetic animals (Table II), suggesting that there were no alteration of the hepatic function related to protein synthesis. Similar results were presented by Santos et al. (27) that while evaluating the influence of multimixture upon mineral bioavailability in non-diabetic laboratory animals, demonstrated that the addition of multimixture did not altered the serum values of total protein and albumin. It is pointed out that the serum levels of total proteins constitute themselves in an approximate measurement of the serum proteins (albumins and globulins) that can reveals the nutritional state, presence of kidney and hepatic disease and many other conditions (28).

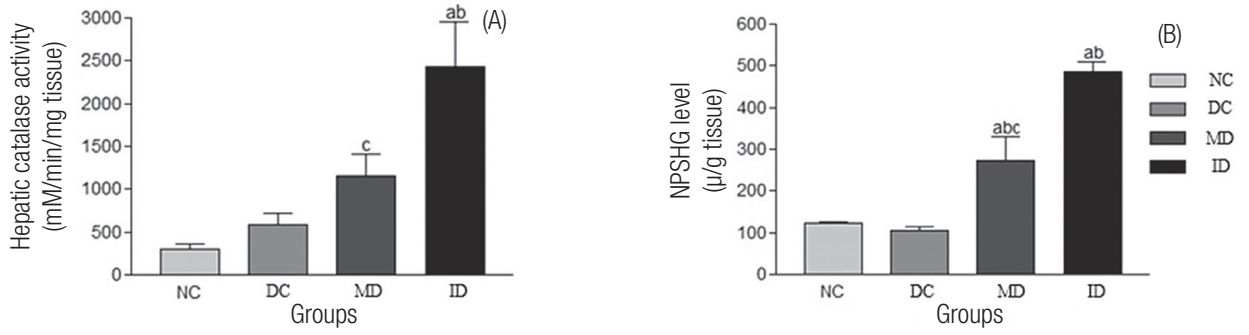
Data relative to the activity levels of the catalase and concentration of NPSHG on hepatic tissue are shown in figure 1. It was observed that the group ID showed significantly higher catalase activity ($p < 0.05$) when compared to the other studied groups. The antioxidant enzymes appear as important constituents of the defense system against oxidative damage, and their activity is highlighted in situations in which the oxidative activity is increased, for example, in diseases like diabetes. The causes of the increase in pro-oxidant activity on diabetes are multifactorial and not completely understood, in which probably the hyperglycemia can lead to the increase in production of free radicals through protein glycation, glucose self-oxidation and fatty acids oxidation. The increased activity of the catalase in group ID in relation to group DC evidence a beneficial effect of the treatment with insulin on the improvement of the antioxidant system, because it would block the action of the free radicals through the reduction of H_2O_2 to H_20 and 0_2 (29).

Concerning the NPSHG on hepatic tissue, the MD and ID groups showed significantly higher levels ($p < 0.05$) of NPSHG compared to NC and DC, being the NPSHG levels of ID higher ($p < 0.001$) than those found on MD. The reduced glutathione plays an important role in protecting the sulfhydryl groups in membranes, in addition to protecting the cell from free radicals and reactive strains of oxygen, exerting an important function against the oxidative stress of the diabetes (30). The NPSHG are compounds that

Table II. Serum levels total proteins, albumin, asparte aminotransferase (ATS), and alanin aminitransferase (ALT) of *Rattus norvegicus* during 50 days with isolated standard diet (NC and DC), NPH human 3U/animal s.c. insulin administration (ID), or with multimixture supplemented diet (MD)

Groups	Total protein (g/dL)	Albumin (g/dL)	AST (U/mL)	ALT (U/mL)
NC	5.9 ± 0.07	3.3 ± 0.04	131.9 ± 9.87	63.3 ± 5.03
DC	5.5 ± 0.24	3.4 ± 0.12	171.6 ± 24.30	215.4 ± 38.13[a]
MD	5.3 ± 0.14	3.5 ±0.09	267.1 ± 28.19[a]	248.9 ± 26.51[a]
ID	5.7 ± 0.22	3.7 ± 0.44	165.4 ± 45.94	200.0 ± 37.67[a]

The data represent the media ± EPM. [a]$p < 0.05$ vs. *NC group. ANOVA one way/Tukey.*



The data represent the ± EPM media. [a]$p < 0.05$ *vs.* NC group; [b]$p < 0.05$ *vs.* D group and $CP < 0.05$ *vs.* I group. ANOVA one way/Tukey.

Figure 1.

Hepatic catalase activity (A) and concentration of non-proteic sulfhydryl groups (NPSHG) (B) at the end of 50 days of treatment of *Rattus norvegicus* with standar isolated diet (NC and DC), NPH human 3U/animal s.c. insulin administration in alternated days (ID) or with multimixture supplement diet (MD).

Table III. Content of phenolic compounds (in equivalents of gallic acid) and antioxidant activity (AA) *in vitro* of extracts of standard diet supplemented or not with multimixture, in mg/100 g of humid sample

Extracts	Phenolic compounds		%AA	
	Standart diet (mg/100 g)	Supplemented diet (mg/100 g)	Standart diet (mg/100 g)	Supplemented diet (mg/100 g)
Ethereal	68.9 ± 6.7	189.2 ± 24.1*	50.8 ± 14.0	64.0 ± 17.1
Alcoholic	62.2 ± 23.2	28.9 ± 6.7[a]	20.5 ± 6.6	13.3 ± 2.6
Aqueous	42.5 ± 0.2	28.9 ± 6.7[a]	41.0 ± 8.7	53.8 ± 13.0

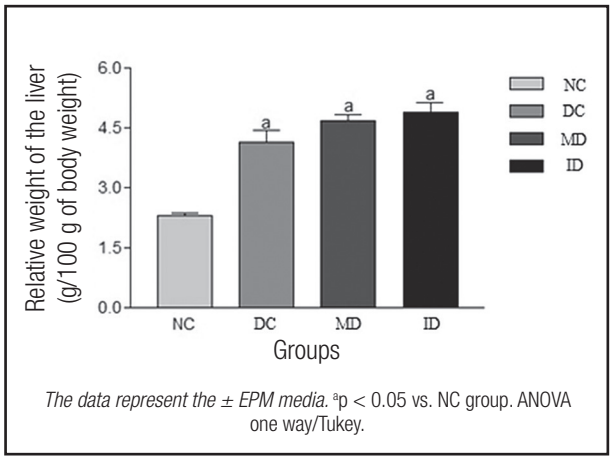
**Non-paired t-test $p < 0.05$ in relation to the same extract of the standard diet. [a]$p < 0.05$ in relation to the ethereal extract of the supplemented diet. ANOVA one way/ Tukey.*

can be modified by the action of free radicals, and therefore considered as oxidative stress measures (31). Therefore, the results found here evidence a beneficial effect of the treatments with insulin and multimixture, being the effect of insulin greater than that of the multimixture. An effect of insulin reducing the effects of diabetes and involving an increase on reduced glutathione levels was already described by Jain and McVie (32).

Regarding the content of phenolic compounds of the diets supplemented or not with multimixture (Table III), it was not find difference between the ethereal, alcoholic and aqueous extracts, but the ethereal extract of the supplemented diet showed significantly higher quantities ($p < 0.05$) of phenolics when compared to the other extracts of the supplemented diet and to the ethereal extract of the standard diet as well.

When considering the antioxidant activity *in vitro* (Table III), all the extracts of the standard and supplemented diet showed antioxidant activity evidenced by the capacity of sequestering the free radical DPPH and, though not statistically significant, the extract that showed the highest percentage of antioxidant activity was the aqueous one of the supplemented diet. However, such antioxidant activity determined on the *in vitro* evaluation seems not to be enough to reduce the oxidant stress indicated as one of the factors involved in the pathogenesis of DM to attenuate the signals and symptoms of the uncontrolled disease found in the groups of diabetic animals in this study.

Concerning the analysis of structural aspects of the liver, it was observed that the relative weight of the organ on the diabetic groups was significantly higher ($p < 0.001$) in relation to NC group (Fig. 2). Such finding could indicate a hepatic burden associated with diabetes as a possible evidence of the development of structural alterations in the liver of diabetic animals through time, among which could be those caused by NAFLD. However, on the histopathological analysis of the liver using coloration with hematoxilin-eosin or Masson trichrome, alterations suggestive of hepatic lesion were not found in any of the experimental groups. The absence of structural alterations in the animals of the group DC can be attributed to the time of exposure to the experimental diabetes to which the groups studied here were exposed, which seems not to be sufficient to provoke cellular damage, or to the fact that the evaluation techniques utilized would not show sensi-



The data represent the ± EPM media. [a]p < 0.05 vs. NC group. ANOVA one way/Tukey.

Figure 2.

Relative weight of the liver of *Rattus norvegicus* treated during 50 days with standard isolated diet (NC and DC), NPH human 3U/animal insulin administration (ID) or with diet supplemented with multimixture (MD).

tivity enough to identify structural alterations in their early stages. Perhaps because of this it was not possible either to verify any possible hepatoprotective effect of the supplemented diet with multimixture.

Analyzing other aspects related to metabolic control, like food consumption, water ingestion and diuresis (Figs. 3 A, B and C), it was observed that the diabetic groups (DC, MD and ID) presented daily medium values of food and water ingestion and diuresis significantly higher ($p < 0.05$) when compared to those found on NC. Such results may be justified by the hyperglycemic and hypercatabolic state, which results in weight loss, polyphagia, polyuria and polydipsia, symptoms of uncontrolled diabetes.

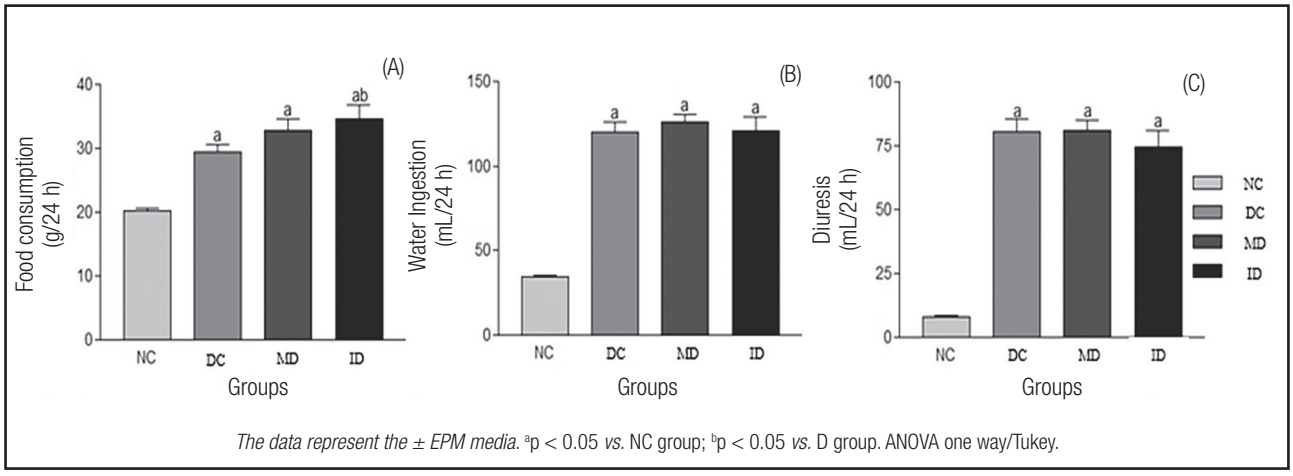
The supplementation of the diet with multimixture based on oat, linseed, sesame and sunflower seeds did not produce alterations that demonstrated hepatoprotective and antioxidant effects with efficient repercussions on improving the metabolic control of the diabetes induced by streptozotocin.

CONCLUSION

The utilization of the diet supplemented with multimixture showed an isolated improvement of the antioxidant activity of the hepatic tissue, evidenced by an increase of the non-proteic sulfhydryl groups. On the other hand, only the treatment with insulin resulted in an improvement of the antioxidant activity concerning the hepatic catalase. Complementary studies are necessary to evaluate the effects of other proportions of the mixture of cereals, as well as their association with medical therapy based on insulin with other doses and treatment regime, also including other markers with greater sensitivity and specificity to the evaluation of the hepatic function and antioxidant activity.

REFERENCES

1. Sacks DB, Arnold M, Bakris GL, Bruns DE, Horvath AR, Kirkman MS, et al. Guidelines and recommendations for laboratory analysis in the diagnosis and management of Diabetes mellitus. Diabetes Care 2011;34:e61-99.
2. Browning DJ, Horton JD. Molecular mediators of hepatic steatosis and liver injury. J Clin Inv 2004;114:147-52.
3. Amarapurkar D, Das HS. Chronic liver disease in diabetes mellitus. Tropic Gastroenterol 2002;23:3-5.
4. Brasil. Ministério da Saúde. Dados Estatísticos de Diabetes Mellitus. Brasília. Disponível em: <http://portal.saude.gov.br/portal/saude/visualizar_texto.cfm?idtxt=29793&janela=1>. Acesso em: 29 de janeiro de 2016, às 11:35 horas.
5. Wieckowska A, McCullough AJ, Feldstein AE. Noninvasive Diagnosis and Monitoring of Nonalcoholic Steatohepatitis: Present and Future. Hepatol 2007;46:582-9.



The data represent the ± EPM media. [a]p < 0.05 *vs.* NC group; [b]p < 0.05 *vs.* D group. ANOVA one way/Tukey.

Figure 3.

Daily medium values of food consumption (A), water ingestion (B), and diuresis (C) of *Rattus norvegicus* trated during 50 days with standard isolated (NC and DC), NPH human 3U/animal/sc insulin administration in alternated days (ID) or with diet supplemented with multimixture (MD).

6. Díaz-Flores M, Baiza-Gutman LA, Ibáñez-Hernández MA, Pascoe-Lira D, Guzmán-Greenfel AM, Kumate-Rodríguez J. Aspectos moleculares del daño tisular inducido por la hiperglucemia crónica. Gac Med Mex 2004;140:437-48.
7. Lindström J, Peltonen M, Eriksson JG, Louheranta A, Fogelholm M, Uusitupa M, et al. High-fibre, low-fat diet predicts long-term weight loss and decreased type 2 diabetes risk: the Finnish Diabetes Prevention Study. Diabetol 2006;49:912-20.
8. Delobel A, Fabry C, Schoonheere N, Istasse L, Hornick JL. Linseed oil supplementation in diet for horses: Effects on palatability and digestibility. Livestock Sci 2008;11615-21.
9. Figueiredo AS, Modesto-Filho J. Efeito do uso da farinha desengordurada do Sesamum indicum L nos níveis glicêmicos em diabéticas tipo 2. Rev Bras Farmacog 2008;18:77-83.
10. Slavin J. Whole grains and human health. Nutr Res Rev 2004;17:1-11.
11. Mandarino JMG. Óleo de Girassol como Alimento Funcional. In: Leite RMVBC, Brighenti AM, Castro C. Girassol no Brasil. Embrapa Soja, Londrina, Paraná [S.l.: s.n.]; 2005. p. 43-8.
12. Pauli JR, Rodrigues Júnior JC, Antunes DFR, Luciano E. Treinamento físico e administração de insulina: efeitos sobre o metabolismo de carboidratos e proteínas. Motriz 2003;9:71-4.
13. Lerco MM, Spadella CT, Machado JLM, Schellini AS, Padovani CR. Caracterização de um modelo experimental de Diabetes mellitus, induzido pela aloxana em ratos. Estudo clínico e laboratorial. Acta Cir Bras 2003;18:132-42.
14. Almeida MEF, Badaró ACL, Magalhães MLN, Oliveira ALG. Efeitos de três misturas regionais como suplemento de dieta padrão para ratos em crescimento. Nutrir Gerais 2008;2:1-14.
15. Brasil. Conselho Federal de Medicina Veterinária. Guia Brasileiro de Boas Práticas em Eutanásia em Animais - Conceitos e Procedimentos Recomendados. Brasília; 2012.
16. Beers RF, Sizer IW. A spectrophotometric method for measuring of the hydrogen peroxide by catalase. J Biol Chem 1951;195:133-40.
17. Swain T, Hills WE. The phenolic constituents of Punnus domestica. The quantitative analysis of phenolic constituents. J Sci Food Agric 1959;19:63-8.
18. Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. Lebenson Wiss Technol 1995;28:25-30.
19. Abeeleh MA, Ismail ZB, Alzaben KR, Abu-Halaweh SA, Al-Essa MK, Abuabeeleh J, et al. Induction of Diabetes Mellitus in Rats Using Intraperitoneal Streptozotocin: A Comparison between 2 Strains of Rats. Eur J Sci Res 2009;32:398-402.
20. Robert EP, Arch GM III, Dana EK, Kit NS. Dietary Fiber for the Treatment of Type 2 Diabetes Mellitus: A Meta-Analysis. J Am Board Fam Med 2012;25:16-23.
21. Evans M, Schumm-Draeger PM, Vora J, King AB. A review of modern insulin analogue pharmacokinetic and pharmacodynamic profiles in type 2 diabetes: improvements and limitations. Diabetes Obes Metab 2011;13:677-84.
22. Teixeira LTA, Júnior LSS, Queiroz FM, Oliveira CN, Schwarz A. Avaliação de efeitos toxicológicos e comportamentais da Hypericum perforatume da Piper methysticum em ratos. Rev Bras Toxicol 2009;22:42-9.
23. Lab Rede. Laboratório de referência em diagnósticos especializados. Disponível em: <http://www.labrede.com.br>. Acesso em 29 de janeiro de 2016.
24. El-Demerdash FM, Yousef MI, El-Naga N I. Biochemical study on the hypoglycemic effects of onion and garlic in alloxan-induced diabetic rats. Food Chem Toxicol 2005;43:57-63.
25. Takaike H, Uchigata Y, Iwasaki N, Iwamoto Y. Transient elevation of liver transaminase after starting insulin therapy for diabetic ketosis or ketoacidosis in newly diagnosed type 1 diabetes mellitus. Diabetes Res Clin Pract 2004;64:27-32.
26. Sorbi D, Boyton J, Lindor KD. The ratio of aspartate aminotransferase to alanine aminotransferase: potential value in differentiating nonalcoholic steatohepatitis from alcoholic liver disease. Am J Gastroenterol 1999;94:1018-22.
27. Santos HB, Madruga MS, Bion FM, Antunes NLM, Mendes K, Àguida L. Estudos bioquímicos e hematológicos em ratos sobre biodisponibilidade de minerais numa dieta enriquecida com multimistura. Ciênc Tecnol Alim 2004;24:613-8.
28. Kataoka A, Santana AE, Seki MC. Alterações do proteinograma sérico em cães naturalmente infectados por Ehrlichia canis. Ars Veterinária 2006;22:98-102.
29. Kono Y, Fridovich I. Superoxide radical inhibits catalase. J Biol Chem 1982;257: 5751-4.
30. Ammon HPT, Klumpp S, Fub A, Verspohl EJ, Jaeschke H, Wendel A, et al. A possible role of plasma glutathione in glucose-mediated insulin secretion: In vitro and in vivo studies in rats. Diabetol 1989;32:797-800.
31. Silva M, Lima WG, Silva ME, Pedrosa ML. Efeito da estreptozotocina sobre os perfis glicêmico e lipídico e o estresse oxidativo em hamsters. Arq Bras Endocrinol & Metabol 2011;55:46-53.
32. Jain SK, McVie R. Effect of glycemic control, race (White versus black) and duration of diabetes on reduced glutathione content in erythrocytes of diabetic patients. Metabol 1994;43:306-9.

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ARÁN

Nutrición Hospitalaria

Revisión

Efectividad de la suplementación de calcio en la dismunición de grasa corporal en personas obesas; un *overview* de revisiones sistemáticas

Effectiveness of calcium supplementation in reducing body fat in obese people; an overview of sistematic reviews

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Resumen

Introducción: actualmente la obesidad es considerada un problema de salud pública, y en la mayor parte de los países ha evolucionado como una pandemia, presentando un incremento en su prevalencia y severidad.

Objetivo: resumir las revisiones sistemáticas Cochrane y no Cochrane que evalúen el efecto de la suplementación de calcio en la disminución de grasa corporal en personas obesas.

Materiales y métodos: se realizó una búsqueda en la base de datos Medline (1980-septiembre 2015), Metabuscador TripDatabase y Epistemonikos (hasta septiembre 2015), Cochrane BVS (hasta septiembre 2015), se buscó de forma manual en revistas relacionadas con el tema de interés, en actas de congresos, se realizó seguimiento de referencias relevantes y se contactó con expertos en el área.

Resultados: la búsqueda preliminar arrojó un total de 7.163 artículos potencialmente elegibles, según los criterios de elegibilidad incluimos 2 revisiones sistemáticas de estudios clínicos aleatorizados.

Conclusión: el suplemento de calcio al parecer sería efectivo en la disminución de grasa corporal, DM -0,51 (-1,27, 0,25); (p = 0,19), presentando "baja evidencia" según la metodología GRADE, esto quiere decir que "es muy probable que investigaciones adicionales tengan un impacto importante en la confianza de la estimación del efecto y es probable que cambie".

Palabras clave:

Obesidad.
Calcio. Factor de coagulación IV.
Peso corporal.
Metaanálisis.

Abstract

Background: Currently obesity is considered a public health problem, and in most countries has evolved as a pandemic, an increase in prevalence and severity.

Objective: To summarize systematic reviews Cochrane and not Cochrane and not evaluating the effect of calcium supplementation in reducing body fat in obese people.

Material and methods: A search was performed in the Medline database (1980-September 2015), Meabuscador Tripdatabase and Epistemonikos (until September 2015), Cochrane BVS (to September 2015), was hand searched journal/issue interest searched conference proceedings, monitoring was conducted relevant references and contacted experts in the field.

Results: The preliminary search yielded a total of 7163 articles potentially eligible, according to the eligibility criteria include two systematic reviews of randomized trials.

Conclusion: Calcium supplementation apparently would be effective in reducing body fat, DM -0.51 (-1.27, 0.25); (p = 0.19), presenting "low evidence," according to the GRADE methodology, this means that "it is very likely that additional research have a significant impact on the confidence of the estimate of effect and is likely to change".

Key words:

Obesity. Calcium.
Coagulation factor IV.
Body weigth. Meta-analysis.

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INTRODUCCIÓN

La obesidad (OB) es una enfermedad crónica, secundaria a la incapacidad del tejido adiposo subcutáneo de adaptarse a un balance energético positivo, que ocurre cuando la ingesta de energía supera el gasto energético (1-5), por lo que se produce un almacenamiento en exceso del tejido adiposo en el organismo (6,7), secundario al aumento significativo de los adipocitos (hipertrofia) o del número de adipocitos (hiperplasia) (6).

Actualmente la OB es considerada un problema de salud pública, y en la mayor parte de los países ha evolucionado como una pandemia, presenta un incremento en su prevalencia y severidad (1,8,9). La causa principal radica en el cambio de estilo de vida de la sociedad moderna (9), convirtiéndose en los últimos años, en uno de los problemas socio-sanitarios de salud más común en los países desarrollados y en vías de desarrollo alrededor del mundo (10,11), lo que está generando extraordinarias implicancias sociales y económicas. La obesidad es por sí misma un factor de riesgo de enfermedades metabólicas y cardiovasculares, que predispone frecuentemente a otros factores de riesgos (1,8,11). Además, produce una reducción significativa de la esperanza de vida, relacionada con el aumento de las tasas de mortalidad (6,8,12,13). Se ha podido identificar una asociación inversa entre el peso, índice de masa corporal, grasa corporal, la ingesta de calcio en la dieta y obesidad (14,15).

La importancia de realizar un *overview* o resúmenes de revisiones sistemáticas, radica principalmente en poder agrupar la evidencia existente frente a distintas revisiones sistemáticas de estudios clínicos aleatorizados, resumir esta información y poder encontrar el equilibrio en los resultados de estas para poder lograr la mejor toma de decisión clínica por parte de los profesionales del área de la salud. Por tal motivo, surge la pregunta de investigación: "en personas adultas obesas, ¿pueden los suplementos de calcio reducir la gasa corporal?".

OBJETIVO

Resumir las revisiones sistemáticas Cochrane y no Cochrane que evalúen el efecto de la suplementación de calcio para la disminución de la grasa corporal en personas obesas.

MATERIALES Y MÉTODOS

MÉTODOS

Criterios para considerar las revisiones sistemáticas en este *overview*.

Tipos de estudios

Sólo se incluirán revisiones sistemáticas de estudios clínicos aleatorizados.

Tipos de participantes

- *Criterios de inclusión*. Solo revisiones sistemáticas de estudios clínicos aleatorizados que involucren a personas adultas con diagnóstico de obesidad. Deben presentar estado nutricional de obesidad, diagnosticada según Índice de masa corporal (IMC), $\geq$ 30 kg/m^2. (Clasificación según Organización Mundial de la Salud) (2,4-7).
- *Criterios de exclusión.* No se incluirán revisiones sistemáticas de otros tipos de estudios con diseño distinto a estudios clínicos aleatorizados. Además serán excluidos deportistas y embarazadas con estado nutricional de obesidad.

Tipos de intervención

Revisiones sistemáticas de estudios clínicos aleatorizados que involucren suplementación oral de calcio.

El calcio suplementado no debe presentar combinaciones de calcio y otros suplementos nutricionales.

Outcome primarios

Revisiones sistemáticas de estudios clínicos aleatorizados, que hayan utilizado una o más de las siguientes medidas de resultado:

- Disminución de la grasa corporal (impedancia bioeléctrica).

Outcome secundarios

- Disminución de la circunferencia de cintura (medición de circunferencia de cintura en centímetros).
- Cualquier efecto adverso.

MÉTODO DE BÚSQUEDA PARA LA IDENTIFICACIÓN DE REVISIONES SISTEMÁTICAS

Se realizó una búsqueda sensible (16) para la identificación de las revisiones sistemáticas en MEDLINE (1980-junio 2015): *((((((“Obesity”[Mesh]) OR “Obesity”)) AND (((Weight Loss) OR “Weight Loss”[Mesh]) OR Weight Reduction)) AND ((((“Calcium”[Mesh]) OR “Calcium”) OR Factor IV, Coagulation))) AND systematic[Title/Abstract]*. En el Metabuscador Epistemonikos se realizó una búsqueda hasta junio de 2015, con los siguientes términos: "obesity"; "weight loss".

En TripDatabase (hasta septiembre de 2015), utilizando la siguiente estrategia de búsqueda: *((((“Obesity”[Mesh] OR “Obesity”[All Fields]) AND ((((“weight loss”[MeSH Terms] OR (“weight”[All Fields] AND “loss”[All Fields]) OR “weight loss”[All Fields]) OR “Weight Loss”[Mesh]) OR (“weight loss”[MeSH Terms] OR (“weight”[All Fields] AND “loss”[All Fields]) OR “weight loss”[All Fields] OR*

("weight"[All Fields] AND "reduction"[All Fields]) OR "weight reduction"[All Fields]))) AND (("Calcium"[Mesh] OR "Calcium"[All Fields]) OR ("calcium"[MeSH Terms] OR "calcium"[All Fields] OR ("factor"[All Fields] AND "iv"[All Fields] AND "coagulation"[All Fields])))) AND systematic[Title/Abstract]. No hubo restricción de idioma. Las búsquedas en las bases de datos fueron realizadas por dos investigadores de forma independiente (JP-SP). En caso de existir alguna discrepancia, un tercer autor actuaba como árbitro (RA).

Se realizó una búsqueda manual desde el año 1999 a septiembre de 2015, en las siguientes revistas electrónicas: *Nutrición Clínica y Dietética Hospitalaria, Revista Salud Pública y Nutrición, Revista Colombiana de Metabolismo y Nutrición Clínica, Jornada de Nutrición Nutriguía, Nutriguía para Todos, Revistas Académicas, Revista Cubana de Alimentación y Nutrición, Nutrición 21, Revista Chilena de Nutrición, Revista Médica Clínica las Condes, PULEVA Salud, Revista Española de Nutrición Humana y Dietética, Revista Salud Pública y Nutrición, Revista Nutricion Clínica, Revista de Endocrinología y Nutrición, Nutrición Clínica y Dietética Hospitalaria, Revistas Académicas, Revista Cubana de Alimentación y Nutrición, Nutrición y Vida, Revista Chilena de Nutrición, ReNut, Saber Alternativo y Nutricion Clínica en Medicina.*

Se buscó en actas de los siguientes congresos: I Jornada Nacional de Formación y Educación para la Salud (2007), XIX Congreso Argentino de Nutrición (2013), VIII Congreso Internacional Nutrición, Alimentación y Dietética (2013), V Congreso nacional de Nutrición Clínica y Metabolismo (2009), VI Congreso Nacional de Nutrición Clínica y Metabolismo (2011), VII Congreso Nacional de Nutrición Clínica y Metabolismo (2013). Además buscamos en Cochrane BVS (hasta septiembre de 2015), en Google Académico (hasta septiembre de 2015) y en tesis electrónicos (hasta septiembre de 2015) http://www.tesis.uchile.cl/.

ANÁLISIS Y RECOLECCIÓN DE DATOS

Dos autores (PJ y CS) de forma independiente, extrajeron los datos, valoraron la calidad metodológica y evaluaron la calidad global de la evidencia. En caso de existir discrepancias, un tercer autor (RA) actuaba como árbitro.

La calidad metodológica de las revisiones sistemáticas de estudios clínicos aleatorizados incluidas, fueron analizadas con la herramienta de AMSTAR (18) (Tabla I). AMSTAR es una herramienta válida, fiable y fácil de usar. Consta de 11 ítems y tiene la validez de contenido para medir la calidad metodológica, además de la fiabilidad de las revisiones sistemáticas; a cada uno de los 11 ítems, se le asigna una puntuación de 1 si cumple el criterio específico, o una puntuación de 0 si no cumple el criterio, no es clara, o no es aplicable. La interpretación de la valoración crítica, se divide en tres niveles: 8 a 11 puntos es de alta calidad, de 4 a 7 puntos es de mediana calidad, y de 0 a 3 puntos es de baja calidad. La calidad global de la evidencia fue evaluada utilizando la metodología GRADE (18).

RESULTADOS

De acuerdo con los criterios para realizar el *overview* de revisiones sistemáticas de estudios clínicos aleatorizados, la búsqueda preliminar identificó 7.163 revisiones sistemáticas potencialmente elegibles (Fig. 1). Al aplicar los límites de búsqueda de los criterios de selección, quedaron incluidas 2 revisiones sistemáticas de estudios clínicos aleatorizados (14,19).

Se valoró la calidad metodológica mediante la herramienta de AMSTAR (Tabla II), según la evaluación realizada por los autores (PJ-CJ) el artículo de Schrager (14) presentó baja calidad metodológica; la investigación realizada por Onakpoya (19) presentó alta calidad metodológica (bajo riesgo de sesgo).

DISCUSIÓN

Realizamos una síntesis de la evidencia actual, donde se intentó resumir toda la evidencia existente en las revisiones sistemáticas Cochrane y no Cochrane, buscando la efectividad y beneficios asociados al consumo de suplementos de calcio en la disminución de grasa corporal en personas obesas.

Debido a la gran cantidad de estudios primarios incluidos en las revisiones sistemáticas existentes, la disparidad en sus intervenciones estudiadas, las medidas de resultado o desenlace de interés utilizadas *(outcome),* seguimiento de los participantes y el tratamiento estadistico de las variables, hicieron bastante compleja la extracción de los datos de interés. Por tal motivo, se decidió acotar la investigación según los criterios de inclusión como la valoración de los resultados de interés (primarios y secundarios). Según los criterios de elegibilidad, solo incluimos 2 revisiones sistemáticas de estudios clínicos aleatorizados. En el momento de evaluar la heterogeneidad de los estudios que analizaban nuestra comparación de interés: suplemento de calcio *versus* placebo, resultado de interés Índice de masa corporal; $I^2 = 44\%$ (heterogeneidad moderada). Se consideró razonable su metaanalización.

En base a la evaluación del riesgo de sesgo de las revisiones sistemáticas incluidas (riesgo de sobreestimar o subestimar los resultados) realizada por los autores de la presente revisión, presentan bajo riesgo de sesgo Onakpoya (19), mientras que la RS de Schrager (14) fue calificada de alto riesgo de sesgo (Tabla II).

En la actualidad no existe ningún *overview* de revisiones sistemáticas que evalúe la efectividad de la suplementación de calcio para la reducción de grasa corporal en personas con obesidad, considerando la existencia de RS de ECA que presentan contradicciones en relación a su efectividad.

La evidencia actual basada en revisiones sistemáticas de estudios clínicos aleatorizados han establecido que el suplemento de calcio podría ser superior que el placebo en la reducción de grasa corporal presentando una diferencia de medias DM -0,51 (-1,27, 0,25); ($p = 0,19$) y al parecer no presentaría eventos adversos, por tal motivo, se podría recomendar como un complemento a un tratamiento y no como una intervención de primera línea.

Los objetivos de las RS incluidas estaban orientados a ver la efectividad del suplemento de calcio *versus* otras intervenciones,

Tabla I. AMSTAR herramienta de medición para evaluar revisiones sistemáticas

1. ¿Se brindó un diseño "a priori"? La pregunta de la investigación y los criterios de inclusión deberían establecerse antes de llevar a cabo la revisión	Sí No No responde No corresponde
2. ¿Hubo duplicación en la selección de estudios y extracción de datos? Debería haber al menos dos personas independientes a cargo de la extracción de datos, y debería existir un procedimiento consensuado para los desacuerdos	Sí No No responde No corresponde
3. ¿Se realizó una búsqueda exhaustiva de literatura? Deberían consultarse al menos dos fuentes electrónicas. El informe debe incluir los años y las bases de datos utilizadas (p. ej. Central, EMBASE y MEDLINE). Deben especificarse las palabras clave y/o los términos MESH y, de ser posible, debe proveerse la estrategia de búsqueda. Todas las búsquedas deberían ser complementadas con consultas a contenidos actuales, revisiones, libros de textos, registros especializados, o expertos en el campo particular de estudio, y mediante la revisión de las referencias en los estudios encontrados	Sí No No responde No corresponde
4. ¿Se utilizó el estado de publicación (es decir, literatura gris) como criterio de inclusión? Los autores deberían especificar que buscaron informes sin tener en cuenta el tipo de publicación. Los autores deberían especificar si excluyeron o no algún informe (de la revisión sistemática), en función del estado de publicación, idioma, etc.	Sí No No responde No corresponde
5. ¿Se brindó una lista de estudios (incluidos y excluidos)? Debería proveerse una lista de estudios incluidos y excluidos	Sí No No responde No corresponde
6. ¿Se brindaron las características de los estudios incluidos? De manera adjunta, como una tabla, deberían proveerse los datos de los estudios originales sobre los participantes, las intervenciones y los resultados. Deberían informarse los rangos de las características en todos los estudios analizados, por ejemplo, la edad, la raza, el sexo, los datos socioeconómicos relevantes, el estado de enfermedad, la duración, la severidad, o cualquier otra enfermedad	Sí No No responde No corresponde
7. ¿Se evaluó y documentó la calidad científica de los estudios incluidos? Deberían proveerse métodos "a priori" (por ejemplo, para estudios de efectividad si el autor o los autores eligen incluir solo estudios aleatorizados, de doble ciego, controlados con placebo, u ocultamiento de las asignaciones como criterios de inclusión). Para otros tipos de estudios, serán relevantes los ítems alternativos	Sí No No responde No corresponde
8. ¿Se utilizó de manera adecuada la calidad científica de los estudios incluidos al formular las conclusiones? El rigor metodológico y la calidad científica de los estudios deberían considerarse en el análisis y las conclusiones de la revisión, y plantearse explícitamente al formular las recomendaciones	Sí No No responde No corresponde
9. ¿Fueron adecuados los métodos utilizados para combinar los hallazgos de los estudios? Para los resultados conjuntos, debería hacerse una prueba para garantizar que los estudios pudieron combinarse y para evaluar sus homogeneidad (es decir, la prueba chi-cuadrado para la homogeneidad, I^2). Si existe heterogeneidad debería utilizarse un modelo de efectos aleatorios y/o debería considerarse lo adecuado de la combinación (es decir, ¿fue adecuado combinar los resultados?)	Sí No No responde No corresponde
10. ¿Se valoró la probabilidad de sesgo de publicación? Una evaluación de sesgo de publicación debería incluir una combinación de ayudas gráficas (p. ej. un gráfico en embudo –*funnel plot*– , otras pruebas disponibles) y/o pruebas estadísticas (p. ej. prueba de regresión de Egger)	Sí No No responde No corresponde
11. ¿Se planteó el conflicto de intereses? Deberían reconocerse claramente las fuentes posibles de apoyo tanto en la revisión sistemática como en los estudios incluidos	Sí No No responde No corresponde

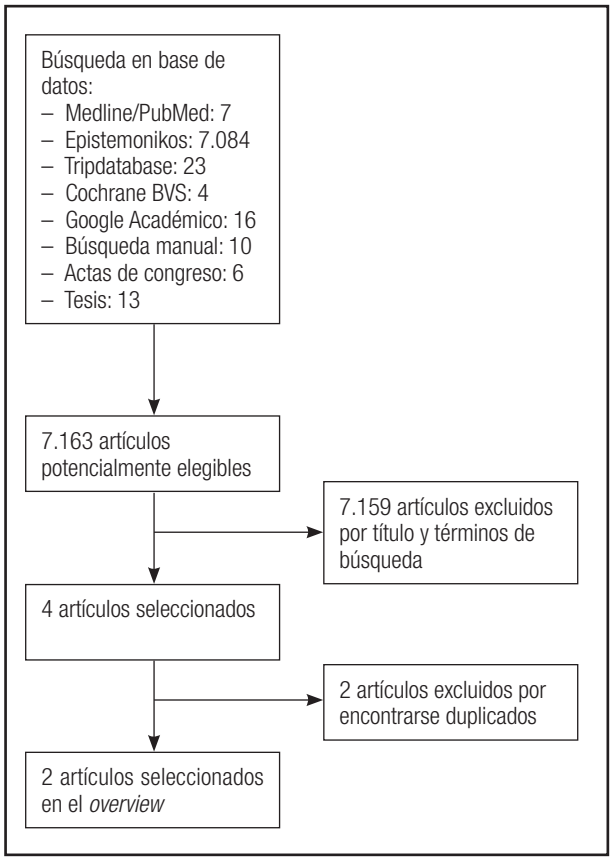


Figura 1.
Algoritmo de búsqueda.

presentando criterios de elegibilidad bastante acotados, estrategias y límites de búsqueda, siendo totalmente diferentes a los de nuestro trabajo (Tabla III). Esto es debido a que un *overview* trata de ser lo más extenso posible dentro de sus criterios y búsqueda, tratando de abarcar la mayor cantidad de trabajos posibles para luego entregar la información resumida y de fácil comprensión.

CONCLUSIÓN

Al comparar el suplemento de calcio comparado con placebo en la reducción de grasa corporal, presentó una DM -0,51 (-1,27, 0,25); (p = 0,19), siendo no estadísticamente significativo. Según los niveles de evidencia del grupo de trabajo GRADE, el resultado de interés fue categorizado como "baja evidencia", esto quiere decir que "es muy probable que investigaciones adicionales tengan un impacto importante en la confianza de la estimación del efecto y es probable que cambie". Creemos que los resultados expuestos en nuestro *overview* (resumen de revisiones sistemáticas) no deberían ser fundamento para que los clínicos basen su decisión en la aplicación o en la no utilización de este suplemento en personas con obesidad. Pese a lo extenso de nuestros criterios en la búsqueda de literatura científica, siempre existe la posibilidad de que no se haya podido identificar algún estudio. Aún así, siempre se debe considerar la probabilidad de que existan estudios con dificultad en su indexación que hayan quedado fuera de nuestro *overview*.

Tabla II. Evaluación y valoración de AMSTAR

Suplementación de calcio para la disminución de peso en personas con obesidad												
Autor	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*Puntaje*
Sarina Schrager, 2005 (22)	N	N	N	N	N	S	N	N	N	N	N	1
Igho J Onakpoya, 2011 (27)	S	S	S	S	N	S	S	S	S	S	S	10

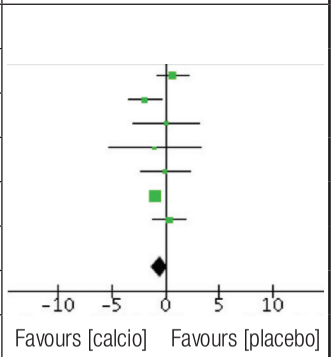
La puntación máxima en AMSTAR es de 11, de 0-4 indica que el examen es de baja calidad, 5-8 de calidad moderada y 9-11 de alta calidad.
S: sí; N: no; NR: no responde; NC: no corresponde.

Resumen de las revisiones sistemáticas incluidas en el *overview*

Autor	Objetivo	Conclusión
Schrager (22)	Revisar los datos epidemiológicos que apoyan una relación entre la ingesta de calcio en la dieta y la obesidad, explicar la base fisiopatológica para tal relación y presentar algunos datos recientes de apoyo en los seres humanos	El calcio de los productos lácteos parece tener un mayor impacto que el calcio de los suplementos dietéticos. Proveedores de atención primaria deberían incluir recomendaciones sobre la ingesta adecuada de calcio en el asesoramiento dietético estándar sobre el control de peso
Onakpoya (27)	Evaluar críticamente la evidencia de los ensayos clínicos aleatorios (ECA), sobre la eficacia de los suplementos de calcio para la reducción de peso corporal en los individuos con sobrepeso y obesidad	La evidencia de los ensayos clínicos aleatorios, sugiere que la administración de suplementos de calcio genera la perdida pequeña de peso, estadísticamente significativo, en los individuos con sobrepeso y obesidad, pero la relevancia clínica de este hallazgo es incierta

Tabla III. *Forest plot* de comparación: suplemento de calcio *versus* placebo, *outcome:* grasa corporal

	Experimental			Control				Mean Difference	Mean Difference
Study or subgroup	*Mean*	*SD*	*Total*	*Mean*	*SD*	*Total*	*Weight*	*IV, Random, 95% CI*	*IV, Random, 95% CI*
Reidt 2005	-4.8	2.3	23	-5.5	2.7	24	16.3%	0.70 [-0.73, 2.13]	
Reidt 2007	-5.1	2.5	14	-3.2	1.7	17	14.9%	-1.90 [-3.44, -0.36]	
Ricci 1998	-7.2	4.4	15	-7.3	4.3	16	5.3%	0.10 [-2.97, 3.17]	
Shalileh 2010	-3.3	7.2	20	-2.3	6.7	20	2.9%	-1.00 [-5.31, 3.31]	
Shapses 2001	-4.8	3.4	14	-4.8	2.9	14	8.3%	0.00 [2.34, 2.34]	
Shapses 2004	-5.5	0.6	46	-4.5	0.6	54	37.3%	-1.00 [-1.24, -0.76]	
Yanovski 2009	0.4	6.7	168	0.01	7.6	167	15.0%	0.39 [-1.14, 1.92]	
Total (95% CI)			*300*			*312*	*100.0%*	*-0.51 [-1.27, 0.25]*	
Heterogeneity. $Tau^2 = 0.39$; $Chi^2 = 10.73$, df = 6 (p = 0.10); $I^2 = 44\%$									
Test for overall effect: Z = 1.31 (p = 0.19)									



Resumen de la evidencia según GRADE

Evaluación de la calidad							Nº de pacientes		Efecto		Calidad	Importancia
Nº de estudios	**Diseño**	**Riesgo de sesgo**	**Inconsistencia**	**Evidencia indirecta**	**Imprecisión**	**Otras consideraciones**	**Suplemento de calcio**	**Placebo**	**Relativo (95% CI)**	**Absoluto**		
Grasa corporal (seguimiento por 6 meses: medido con: - mejor indicado con valores más bajos												
7	Ensayos clínicos aleatorios	Serio	Inconsistencia no grave	Evidencia indirecta no grave	Serio	Ninguna	300	312	-	MD 0,39 superior (1,4 inferior a 1,92 superior)	⊕⊕ o o BAJA	CRÍTICA
Circunferencia de cintura – No informada												
0	-	-	-	-	-	Ninguna	-	-	-	-		IMPORTANTE
								0%				
Cualquier evento adverso – No informado												
0	-	-	-	-	-	Ninguna	-	-	-	-		IMPORTANTE
								0%				

BIBLIOGRAFÍA

1. Moreno M. Definición y clasificación de la obesidad. Rev Med Clin Condes 2012;23(2):124-8.
2. Wong-On M, Murillo-Cuzza G. Fundamentos fisiopatológicos de la obesidad y su relación con el ejercicio. Acta Méd Costarric 2004;46 (1).
3. Hall V, Quesada M, Rocha M. Obesidad fisiopatología y abordaje terapéutico, CIMED Centro de Información de Medicamentos, Universidad de Costa Rica [Internet] 2002. Disponible desde: http://sibdi.ucr.ac.cr/boletinespdf/cimed24.pdf
4. Errandonea M. Obesidad y trastornos de alimentación. Rev Med Clin Conde. 2012;23(2):165-71.
5. Arteaga A. El sobrepeso y la obesidad como un problema de salud. Rev Med Clin Condes 2012;23(2):145-53.
6. Zemel M. Role of calcium and dairy products in energy partitioning and weight management. The American Journal of Clinical Nutrition 2014.
7. Reyes M, Díaz E, Lera L, Burrows R. Ingesta y metabolismo energético en una muestra de adolescentes chilenos con sobrepeso y obesidad. Rev Med Chile 2011;139:425-31.
8. González A, Campos-Nonato I, Hernández-Barrera L, Flores-Aldana M. Asociación entre la ingesta de calcio dietético y el índice de masa corporal elevado en adultos mexicanos de 20 a 59 años de edad: estudio de corte transversal. Medwave 2013;13(2):e5635. DOI: 10.5867/medwave.2013.02.5635.
9. Papapietro K. Cirugía para la obesidad: efectos generales, beneficios y riesgos. Rev Med Clin Condes 2012;23(2):189-95.
10. Ministerio de Salud, Argentina. Guía de práctica clínica nacional sobre diagnóstico y tratamiento de la obesidad en adultos para todos los niveles de atención [Internet]. Disponible en: http://www.msal.gov.ar/images/stories/bes/graficos/0000000302cnt-2013-11_gpc_obesidad-2013.pdf
11. Barahona M. Lácteos en la prevención y tratamiento de la obesidad [Internet]. Disponible en: http://www.produccion-animal.com.ar/produccion_bovina_de_leche/leche_subproductos/06-mauricio_barahona.pdf
12. Atalah E. Epidemiología de la obesidad en chile. Rev Med Clin Condes 2012;23(2):117-23.
13. Holecki M, Zahorska-Markiewicz B, Wiecek A, Mizia-Stec K, Nieszporek T, Zak-Golab A. Influence of calcium and vitamin D supplementation on weight and fat loss in obese women. Obes Facts 2008;1(5):274-9.
14. Schrager S. Dietary calcium intake and obesity, evidence-based clinical practice. J Am Board Fam Pract 2005;18:205-10.
15. Parikh SJ, Yanovski JA. Calcium intake and adiposity, The American Journal of Clinical Nutrition 2014.
16. Montori VM, Wilczynski NL, Morgan D, Haynes RB; for the Hedges Team. Optimal search strategies for retrieving systematic reviews from MEDLINE. An analytical survey. BMJ 2005;(7482):68.
17. Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol. [Internet] 2007;7:10. Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1810543/
18. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ 2008;336:924-6.
19. Onakpoya IJ, Perry R, Zhang J, Ernst E. Efficacy of calcium supplementation for management of overweight and obesity: systematic review of randomized clinical trials. Nutr Rev 2011;69(6):335-43. doi: 10.1111/j.1753-4887.2011.00397.x.

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Nutrición Hospitalaria

Revisión

Factores nutricionales y no nutricionales pueden afectar la fertilidad masculina mediante mecanismos epigenéticos

Nutritional and non-nutritional factors may affect male infertility through epigenetic mechanisms

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Resumen

Introducción: la infertilidad es un problema global en aumento. Se estima que aproximadamente un 15% de las parejas en edad reproductiva tiene dificultades a la hora de concebir. De estas, alrededor de la mitad presentan uno o varios factores masculinos asociados a infertilidad o subfertilidad, aislados o en combinación con problemas de origen femenino. Durante la última década se ha empezado a estudiar la infertilidad desde una perspectiva multifactorial, considerando las interacciones y conexiones entre diferentes situaciones genéticas, epigenéticas, bioquímicas y fisiológicas del paciente.

Objetivo: la presente revisión pretende describir mecanismos epigenéticos que pueden ser modulados mediante aspectos nutricionales y que están relacionados con la etiología de la infertilidad masculina y con la herencia transgeneracional de este fenotipo.

Material y métodos: se ha realizado una extensa búsqueda de publicaciones científicas en las principales bases de datos electrónicas especializadas: NBCI, Elsevier, Scielo, Scirus y Science Direct.

Resultados y conclusión: varios trabajos que muestran la importancia del estado nutricional en la fertilidad del hombre y, más específicamente, la capacidad de los componentes de la dieta para modificar los perfiles epigenéticos que no únicamente pueden afectar a su fertilidad, sino que también pueden ser transmitidos a la descendencia mediante lo que se ha denominado herencia transgeneracional, ocasionándoles problemas de salud diversos entre los que también se hallan problemas en la fertilidad.

Palabras clave:

Infertilidad masculina.
Epigenética.
Nutrición.

Abstract

Introduction: Infertility rate is globally increasing. It is estimated that approximately 15% of couples in reproductive age have troubles conceiving. Half of these couples present with problems related to male infertility or subfertility, alone or in combination with female problems. During the last decade, infertility has been studied from a multifactorial perspective, which includes interactions between different genetics, epigenetics, biochemical and physiological situations of the patients.

Objective: The present review aims to describe epigenetic mechanisms that can be modulated by nutritional aspects and which are related to the aetiology of male infertility and transgenerational inheritance.

Materials and method: Extensive search of scientific publications was performed in specialized electronic databases: NBCI, Elsevier, Scielo, Scirus and Science Direct.

Results and conclusion: Several published works have shown the importance of nutritional status in man's fertility, and more specifically, the ability of diet components to modify the epigenetic profiles, affecting not only their fertility, but also increasing the possibility to be transmitted to the offspring. This mechanism has been called transgenerational inheritance.

Key words:

Male infertility.
Epigenetics. Nutrition.

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INTRODUCCIÓN

La infertilidad es una condición multifactorial y patológica que afecta aproximadamente al 15% de las parejas en edad reproductiva (1). Se define como la incapacidad de una pareja de conseguir o completar un embarazo de forma espontánea tras un periodo de un año manteniendo relaciones sexuales sin medidas anticonceptivas (2). Aproximadamente en el 40-50% de los casos la causa de la infertilidad es atribuible, total o parcialmente, al varón (3). La infertilidad masculina es un trastorno multifactorial y poligénico, donde interaccionan factores genéticos y epigenéticos con factores ambientales (Tabla I). Una revisión del año 2007 (4) indicaba que la infertilidad asociada a causas genéticas se presenta aproximadamente en un 15% de los varones infértiles. Hasta el presente, se conocen más de 139 variantes genéticas asociadas con infertilidad masculina, aunque estas solo representan una fracción muy pequeña de los 2.300 genes asociados con la espermatogénesis (5). Sin embargo, estos estudios con marcadores genéticos no pueden dar cuenta completamente de la heredabilidad de la infertilidad masculina. Esto puede ser, en parte, debido a la naturaleza poligenética de la infertilidad masculina, en donde diferentes variantes de la secuencia de ADN ejercen un pequeño efecto y por las cuales se necesita una población de análisis muy amplia para detectarla o debido a las modificaciones y alteraciones epigenéticas (Fig. 1). Se puede definir epigenética como la herencia de la actividad del ADN que no depende de la secuencia *per se* sino de las modificaciones químicas del ADN y de las proteínas reguladoras adyacentes (6). Las marcas epigenéticas más conocidas son la adición de un grupo metilo al ADN en la citosina del dinucleótido CpG en sentido 5'-3' (6). En el varón, las metilaciones del ADN son especialmente importantes durante la espermatogénesis, la cual consiste en una serie coordinada de

Tabla I. Causas de la infertilidad masculina

Causas	Descripción	Ejemplos
Genéticas	Anomalías genéticas asociadas con alteraciones de la fertilidad	Aneuploidías de los cromosomas sexuales; mutaciones en genes implicados en espermatogénesis *(SYCP3, TEX11, AZFc, NR5A1...)*
Epigenéticas	Anomalías en el epigenoma, asociadas a exposición a factores ambientales, que causan infertilidad o subfertilidad	Exposición durante la etapa adulta a hábitos de vida o tóxicos ambientales que producen alteraciones en el epigenoma
Epigenética: herencia transgeneracional	Fenotipos alterados en la descendencia debida a epimutaciones en la línea germinal del progenitor	Exposición durante el desarrollo o la etapa adulta a tóxicos ambientales (vinclozina, BPA, DTT, metoxiclorina) que pueden provocar alteraciones en el epigenoma del espermatozoide
Hábitos de vida/exposición ocupacional	Hábitos o exposiciones que causan alteraciones en la fertilidad del individuo, potencialmente reversibles	Incremento constante de la temperatura escrotal (sauna, uso de ropa interior ajustada…); obesidad; tabaquismo; uso de drogas; exposición a insecticidas, pesticidas o contaminantes orgánicos

Adaptada de la referencia 58.

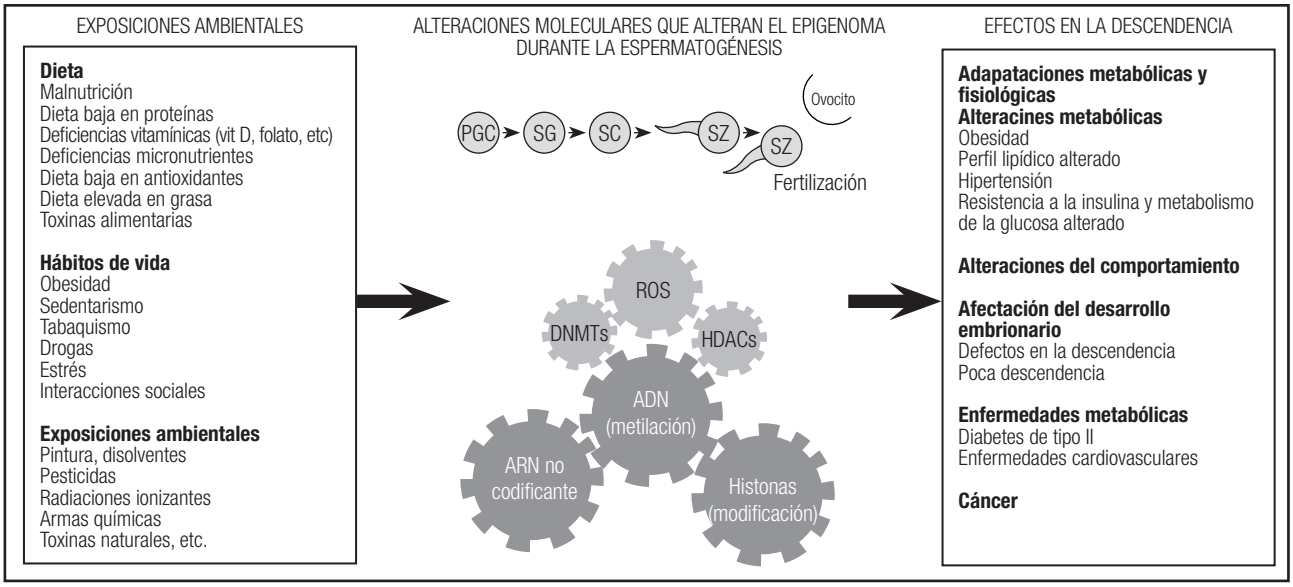

Figura 1.

Epigenoma del espermatozoide: el mensajero de experiencias y exposiciones ancestrales (55).

eventos que empiezan con la división por meiosis de la espermatogonia, la cual produce espermátidas haploides, seguida, de un proceso de diferenciación de las espermátidas a espermatozoides maduros (7). Por ejemplo, patrones aberrantes de metilación en los genes de las células germinales masculinas *(e.g.* gen *MTHFR,* del inglés *Methylene tetrahydrofolate reductase)* resultan en procesos de embriogénesis alteradas y en alteraciones en la capacidad fertilizante de los individuos afectados (8). Otra marca epigenética estudiada es la modificación de las proteínas llamadas histonas. En general, las modificaciones que pueden padecer las histonas incluyen acetilaciones, metilaciones, ubicuitinizaciones, sumolaciones y fosforilaciones. Aunque la presencia de histonas en el espermatozoide maduro es muy inferior a la de las células somáticas (9), su metilación temporal es esencial para la progresión de la espermatogénesis. Así por ejemplo, una reducción en la actividad de la enzima H3K4 metiltransferasa en la histona H3 provoca una disminución muy importante del número de espermatocitos, mediada por procesos de apoptosis, que culmina en una interrupción de la espermatogénesis (10). Recientemente se ha descubierto que la actividad anormal de los pequeños ARN no codificantes (ARN de ~22 nucleótidos, sncARN), así como los ARN no codificantes de cadena larga, y los ARN antisentido, entre otros, pueden alterar la espermatogénesis o producir retrasos importantes en el desarrollo embrionario (11).

Los cambios epigenéticos presentan una gran plasticidad y responden a las señales ambientales, incluyendo la dieta. Se ha demostrado que la ingestión de grasa saturada en varones ejerce no solamente una actividad lipémica y aterogénica mediante la regulación de la expresión de diferentes genes asociados con el sistema inmunológico y el metabolismo energético, sino también mediante la inducción de cambios en el patrón de metilación de islas CpG del ADN de genes como *IGF2* (12), y la modulación de la expresión de algunos microARN (por ejemplo, miR-122) en adultos (microARN que, a su vez, están asociados con la gametogénesis masculina) (13). Además, se sabe también que los componentes de la dieta pueden modular la disponibilidad de grupos metil para las reacciones de metilación (7). Hasta el momento, son pocos los estudios que describen el efecto de la ingestión de diferentes tipos de nutrientes sobre las modificaciones epigenéticas y la expresión de los genes asociados con la fertilidad masculina. Existe, pues, la necesidad de contrastar los datos públicos e ilustrar la relación entre la ingestión de ciertos nutrientes, especialmente micronutrientes y grasas saturadas, y las modificaciones epigenéticas asociadas con la fertilidad masculina. Así, el objetivo del presente estudio es realizar una revisión de los estudios más recientes para describir mecanismos epigenéticos, especialmente la metilación del ADN, modificación de las histonas y rol de los ARN no codificantes, que pueden ser modulados mediante aspectos nutricionales y que están relacionados con la etiología de la infertilidad masculina y con la herencia transgeneracional de este fenotipo.

MÉTODOS

Para la realización de esta revisión se seleccionaron artículos publicados antes del 1 de julio de 2015 y que se encontraron al realizar diversas búsquedas en PubMed (http://www.ncbi.nlm.nih.gov/pubmed). Los datos utilizados se extrajeron de los artículos seleccionados, así como artículos secundarios identificados durante la lectura de estos. Las palabras clave utilizadas durante las diferentes búsquedas realizadas fueron: "male infertility", "male infertility and genetics", "male infertility and obesity", "male infertility and diet", "epigenetics" "male infertility and epigenetics" y "obesity and epigenetics".

RESULTADOS Y DISCUSIÓN

El epigenoma puede alterarse dependiendo de las condiciones ambientales a las que esté expuesto el individuo. Esto puede provocar alteraciones en la fertilidad del individuo, y es posible que la descendencia de estos individuos pueda desarrollar patologías que vendrán determinadas por el epigenoma heredado (14). En la tabla II se presentan los genes más importantes en los que se han detectado alteraciones epigenéticas en individuos infértiles, mientras que en la tabla III se precisan las funciones de las principales enzimas modificadoras del epigenoma durante

Tabla II. Lista de modificaciones epigenéticas encontradas en varones infértiles

Gen/proteína	Alteración e infertilidad masculina
MTHFR	Hipermetilación resulta en baja calidad espermática e infertilidad
PAX8, NTF3, SFN, HRAS	Hipermetilación se asocia a baja concentración espermática, movilidad y morfologías anormales
JHM2DA	*Knockouts* resultan en un mal empaquetamiento del ADN y pueden ocasionar infertilidad
IGF2, H19**	Hipometilación se asocia a baja concentración espermática
*RASGRF1**	Hipermetilación de la región imprintada se asocia a parámetros seminales alterados
*GTL2**	Hipermetilación de la región imprintada se asocia a parámetros seminales alterados
PLAG1, D1RAS3*, MEST **	Hipermetilación de la región imprintada se asocia a parámetros seminales alterados
KCNQ1, LIT1*, SNRPN**	Hipermetilación de la región imprintada se asocia a parámetros seminales alterados

**Genes con impronta genética. Adaptada de la referencia 59.*

Tabla III. Funciones de las principales enzimas modificadoras del epigenoma durante la espermatogénesis y efecto fenotípico de su disfunción en modelo animal

Gen / proteína	Función	Fenotipo (referencia)
MTHFR	Mantenimiento del *pool* de los donantes de grupo metilo	Infertilidad
DNMT1	Mantenimiento de la metilación del ADN	Esterilidad
DNMT3L	Cofactor *DNMT3a*	Esterilidad
SWI/SNF, ISWI	Remodelación de la cromatina	Infertilidad
JHDM2A	Remodelación de la cromatina	Infertilidad
G9a	Metilación de las histonas	Esterilidad
Mll2 (HMT)	Metilación de las histonas	Esterilidad
LSD1/KDM1	Desmetilación de las histonas	Infertilidad
HATs	Acetilación de las histonas	Subfertilidad y posible azoospermia en humanos
MYST	Acetilación de las histonas	Infertilidad
HDAC	Deacetilación de las histonas	Esterilidad
SIRT1	Deacetilación de las histonas	Infertilidad

Adaptada de las referencias 11 y 60.

la espermatogénesis y las consecuencias fenotípicas de su desregulación. Los resultados detallados de estos experimentos se exponen en tres diferentes subsecciones y en función del tipo de marca epigenética, desde las metilaciones, pasando por les acetilaciones y el rol de los ARN no codantes. En el varón, estos cambios epigenéticos pueden producirse en tres niveles diferentes: a) testículos; b) epidídimo; y c) espermatozoide. A nivel testicular, los cambios epigenéticos pueden alterar los procesos de protaminación y en la cantidad y expresión de genes y ARN no codantes durante la espermiogénesis. Paralelamente, a nivel epididimal, los cambios epigenéticos pueden afectar la capacidad fecundante del individuo a través de cambios en el microambiente en el cual los espermatozoides realizan el proceso de maduración. Finalmente, estudios recientes demuestran que el espermatozoide puede transmitir también información epigenética a las generaciones siguientes (revisado en la cita bibliográfica 15 (15).

LA ALTERACIÓN DE LOS PATRONES DE METILACIÓN DURANTE LA ESPERMATOGÉNESIS PUEDE AFECTAR LA FERTILIDAD MASCULINA

Las marcas epigenéticas más estudiadas son la adición de un grupo metilo al ADN. Según definición de Takai y Jones (16), las islas CpG son regiones de ADN con más de 500 pares de bases, en donde el contenido de nucleótidos G+C es igual o superior al 55% y donde el ratio entre dinucleótidos CpG observados y los dinucleótidos CpG esperados es superior a 0,65. En mamíferos, estas islas CpG se encuentran en las regiones promotoras de aproximadamente el 40% de los genes. El proceso de metilación del ADN es consecuencia de la acción de las enzimas DNMT (*DNA methyltransferase*, en inglés). Esta familia de proteínas incluye tanto miembros catalíticos, responsables de la metilación *de novo*, como proteínas encargadas del mantenimiento de estas marcas epigenéticas. Las enzimas DNMT3a, DNMT3b y DNMT3L (*DNA methyltranferase* 3a, 3b y 3L, respectivamente) son las encargadas de la metilación *de novo* en los espermatozoides de mamíferos. Las dos primeras catalizan la reacción de metilación, mientras que DNMT3L facilita la acción de DNMT3a y DNMT3b y coordina el correcto emplazamiento de las marcas de metilación (17). La importancia de la metilación para la fertilidad del individuo se demuestra en estudios realizados en ratones *knockout* para alguno de estos genes. En estos estudios, la disrupción del gene *DNMT3L* ocasiona infertilidad en el individuo portador (18) (Tabla III). Además, aunque la fertilización puede ocurrir en ausencia del correcto establecimiento y mantenimiento de la metilación del ADN, el embrión resultante es incapaz de desarrollarse adecuadamente (19). En otra serie de estudios, también realizados en modelo ratón, se analizó la función de la enzima histona demetilasa JHMD2A(20), la cual juega un papel importante tanto en infertilidad masculina como en obesidad (20). En particular, los autores de este estudio describieron cómo JHDM2A se une directamente a las regiones promotoras de dos genes vitales para el correcto empaquetamiento del ADN en el núcleo del espermatozoide: el gen *Tnp1* (proteína de transición nuclear) y el gen *Prm1* (protamina 1). La unión de JHDM2A induce su activación transcripcional al desmetilar los residuos en H3K9 (21). Si el empaquetamiento no se realiza correctamente, se altera la fertilidad (9). Además, esta enzima regula también la transcripción de genes implicados en el metabolismo de los lípidos, de manera que ratones *knockout* para esta proteína exhibían obesidad e hiperlipidemia (20). Entre los genes regulados por JHDM2A se halla PPARα (del inglés *Peroxisome proliferator-activated receptor alpha)*. Finalmente, estudios realizados en humanos han demostrado que estados de hipermetilación aberrantes en determinados *loci* se relacionan con parámetros seminales alterados: baja o nula concentración espermática (oligospermia y azoospermia) y movilidad y morfología alterada (8,22) (Tabla II). Entre los genes en los que se detectó esta hipermetilación se encuentran *MEST* (21), *LIT1* (23), *KCNQ1* (23,24), *PAX8* (22), *NTF3* (22), *SFN* (22), *HRAS (22)* y *MTHFR* (8,25,26). En otro estudio, realizado en varones humanos infértiles, se demostró que niveles anormalmente elevados de metilación del promotor del gen *MTHFR* en testículo (niveles que no se correspondían con los hallados en sangre) se asocian a una mayor probabilidad de presentar infertilidad (25).

Los patrones de hipometilación en ciertos genes también pueden provocar desequilibrios en el proceso de la maduración del espermatozoide. Durante la espermatogénesis, existen procesos epigenéticos que incluyen una masiva y activa desmetilación del genoma para asegurar una reiniciación específica de sexo combi-

nando la metilación del ADN y las modificaciones de las histonas (7). Estudios realizados en ratón han demostrado que la desregulación del patrón de metilación en las células germinales puede resultar en la ausencia del vaso deferente o en azoospermia (27).

Relacionado con el nivel de metilación del ADN, encontramos el concepto de la "impronta genética" (28). El concepto describe la herencia de la información epigenética específica de uno de los progenitores. Esta impronta genética nos lleva al concepto de herencia epigenética transgeneracional. *Grosso modo,* los estudios publicados hasta la fecha indican que la herencia transgeneracional se basa en una memoria epigenética, que tal vez tenga un papel de adaptación evolutiva para la descendencia frente a condiciones ambientales adversas (15). Los padres pueden estar expuestos a cambios epigenéticos tanto en el tejido somático como en la línea germinal en respuesta a factores ambientales (p. ej., factores nutricionales o no nutricionales, tabaco, estrés, enfermedades). Estos cambios se transmiten a la descendencia y determinan un estado metabólico mejor o peor adaptado al ambiente en el cual ha vivido el padre o la madre. Si el ambiente en el que se desarrolla la descendencia es diferente a la de sus padres, el estado metabólico heredado ya no estará adaptado a las condiciones ambientales, lo que podría derivar en enfermedades metabólicas. Esta idea contrasta con la hipótesis extendida de que el patrón de metilación es completamente eliminado en las células primordiales germinales y durante las primeras etapas embrionarias, como paso necesario para su totipotenciación. Si la eliminación de la metilación fuese completa, entonces la herencia epigenética a través de las marcas de metilación sería imposible. Y, sin embargo, las evidencias encontradas en animales nos hablan de una persistencia de los cambios en el patrón de la metilación del ADN adquiridos, de una herencia transgeneracional que se perpetúa y que consigue transmitir cambios epigenéticos que se manifiestan en el fenotipo de la descendencia, y que pueden mantenerse generación tras generación. Por todo ello, se empieza a aceptar que la pérdida de la metilación en las células primordiales germinales y en el embrión no es completa. De hecho, ya se ha demostrado que algunas secuencias repetitivas, como los elementos IAP (*Intracisternal A particle*, en inglés) y algunos genes con impronta no son desmetilados (29). Posiblemente, otras secuencias genómicas puedan también escaparse de este borrado epigenético y tengan un papel como transmisores transgeneracionales del epigenoma (15). En la tabla II se pueden encontrar algunos ejemplos de genes con impronta y los efectos de su desregulación sobre la fertilidad.

LAS MODIFICACIONES DE LAS HISTONAS PUEDEN AFECTAR A LA FERTILIDAD MASCULINA

Las histonas, además de empaquetar el ADN, juegan un rol muy importante en las modificaciones post-traduccionales de sus aminoácidos (p. ej., acetilación de la lisina, metilación de la arginina, fosforilación de la serina) (30). Generalmente, las acetilaciones se asocian a regiones activas desde el punto de vista transcripcional. A su vez, las metilaciones de las histonas se asocian tanto a regiones activas como a regiones inactivas, dependiendo principalmente de qué residuo es el que padece la metilación: la metilación de la lisina 9 de la histona H3 (H3K9), por ejemplo, se asocia a un silenciamiento de la transcripción; en cambio, la metilación de la lisina 4 (H3K4) de esta misma histona se asocia a una activación de la transcripción. Existen varios enzimas encargados de las modificaciones post-transcripcionales de las histonas. Algunas, como la proteína PRDM9, encargada de la tri-metilación en los residuos H3K4 y H3K36, son específicas de la línea germinal (31). La presencia de histonas en el espermatozoide maduro es muy inferior a la de las células somáticas (9). Esto es debido a cambios en la estructura de la cromatina, cambios que implican la sustitución de las histonas por protaminas. El resultado final es un estado de compactación tan elevado del ADN del espermatozoide que imposibilita la transcripción, a la vez que ejerce un efecto protector contra daños en el genoma. Se cree que las histonas que no son reemplazadas por protaminas (aproximadamente un 10% de ellas) (24), tienen un papel fundamental en la transmisión de la epigenética a la descendencia. De hecho, en las regiones del núcleo del espermatozoide maduro en las que se mantienen las histonas se encuentran promotores del desarrollo, agrupaciones de microARN y genes con impronta genética (24).

La evolución temporal de los niveles de modificación en H3K4, H3K9 y H3K27 son esenciales para la progresión de la espermatogénesis (32). Los niveles de metilación en H3K4 en el ADN de las espermatogonias, por ejemplo, necesitan alcanzar su máximo para empezar su diferenciación e iniciar meiosis. En cambio, los niveles de H3K9 y H3K27 son mínimos al inicio de meiosis y van incrementando a medida que se suceden los diferentes estadios de esta división celular. Finalmente, para iniciar la espermiogénesis, se requiere la eliminación la metilación en H3K9. Todos estos cambios están orquestados por enzimas específicas. Si alguna de ellas no funciona correctamente, el resultado es una alteración importante en la fertilidad del individuo. Por ejemplo, una reducción en la actividad de la enzima H3K4 metiltransferasa provoca una disminución muy importante del número de espermatocitos, mediada por procesos de apoptosis, que culmina en una interrupción de la espermatogénesis (33). Otro ejemplo es el control de la acetilación de las histonas al final de la espermatogénesis. Esta acetilación permite que la cromatina adopte una configuración más relajada, de manera que facilita la eliminación de las histonas y su substitución por protaminas. Si este proceso es alterado y la acetilación ocurre antes de lo pautado, se incrementa la fragmentación del ADN del espermatozoide y se compromete la capacidad fecundante del espermatozoide.

LOS sncARN DESEMPEÑAN UN ROL IMPORTANTE EN EL CONTROL DE LA FERTILIDAD MASCULINA

El espermatozoide se considera una célula inactiva desde el punto de vista transcripcional. No obstante, se sabe desde hace varias décadas que contiene ARN (9). La mayor parte de este ARN

son fragmentos de transcritos largos. El primer ARN mensajero específico identificado en espermatozoides humanos fue el c-MYC mARN (34). Además de transcritos o fragmentos de transcritos que codifican proteínas, el transcriptoma del espermatozoide también contiene una gran variedad de sncARN.

Aunque cuando se compara con el transcriptoma del ovocito la contribución de sncARN del espermatozoide parezca insignificante, al menos dos estudios han demostrado que la inhibición en el zigoto de los sncARN provenientes del espermatozoide conduce a retrasos importantes en el desarrollo embrionario. Los sncARN se diferencian, entre otras características, por los mecanismos de su biogénesis y sus mecanismos de acción. Entre los tipos de sncARN destacan los microRNA (ARN ~22 nc que regulan post-transcripcionalmente la expresión génica mediante su emparejamiento con la región no traducible 3´ del ARN mensajero (3' UTR); los siARN (con complementariedad perfecta y con una representación del 17%) y los piARN (especializados en controlar la transcripción de transposones en las células germinales y de particular interés debido a su papel en la herencia epigenética transgeneracional) (35). Es interesante notar que algunos microARN se expresan de manera exclusiva o preferencial a nivel testicular y, en algunos casos, en tipos celulares específicos. A modo de ejemplo, existen microRNA que se expresan durante el período de diferenciación de la espermátida, como por ejemplo miR-18, encargado de la regulación del gen Hsf2; miR-469, regulador de los genes *Tp2* (en inglés, *transition protein-2)* y *Prm2* (en inglés, *protamine 2)* y miR-122, encargado también de la regulación del de Tp2 (36). En cuanto a la importancia de los sncARN durante la espermatogénesis, varios estudios realizados en ratones *knockout* para la proteína Dicer 1 (una endonucleasa ARNasa III con funciones importantes en la biogénesis de los microARN) sugieren que la falta de actividad de Dicer provoca una desaparición gradual pero completa de microARN en las células de Sertoli (células mitóticas presentes en el testículo que ofrecen soporte vital a las células germinales y meióticas). Esta desaparición provoca una gran desregulación del transcriptoma, proceso que provoca una interrupción de la espermatogénesis y una progresiva degeneración testicular (37). Hoy día se conoce la implicación de los ARN no codificantes de cadena larga (lncRNA) en la espermatogénesis (p. ej. *Tsx*, *HongrES2*, *Mrhl* y *Spga-lncRNA*) (38), aunque Luk y cols. (38) concluyen que los lncRNA están infrarepresentados en las bases de datos de anotación actuales, resultando en una predicción errónea de los lncRNA y su funcionalidad en las células especializadas durante el desarrollo germinal de los hombres. Recientemente, se ha sugerido que el concepto de herencia transgeneracional no solamente está ligado a los patrones de metilación sino también a los sncARN. Se ha demostrado, por ejemplo, que el estrés traumático sufrido durante las primeras semanas de vida altera la expresión de microARN y piARN en espermatozoides y esto, a su vez, modifica respuestas conductuales en la descendencia (39). Así pues, lo que propone este trabajo es una explicación biológica, unas bases moleculares que explican la naturaleza transgeneracional de la conducta innata, donde los sncARN del espermatozoide actúan cómo *bits* de información que moldean el *hardware* genético de la descendencia, provocando modificaciones en el comportamiento de las generaciones futuras.

LA NUTRICIÓN PUEDE INFLUENCIAR LA FERTILIDAD MASCULINA MEDIANTE LA REGULACIÓN DE MECANISMOS EPIGENÉTICOS. LA EPIGENÉTICA NOS EXPLICA POR QUÉ NO TODOS LOS PACIENTES OBESOS SON INFÉRTILES

La relación entre la obesidad y la disminución de la fertilidad no ha sido establecida con claridad. Diferentes estudios muestran el impacto negativo del sobrepeso y la obesidad sobre la calidad del ADN de los espermatozoides y, consecuentemente, sobre la salud de la descendencia (13,40). Varios estudios han vinculado el síndrome metabólico con una función espermática alterada (41) (Fig. 2). Así, los resultados sugieren que la relación entre obesidad e infertilidad es más compleja que la simple interacción entre el peso y la función reproductiva, y que la epigenética puede tener un rol importante (Figs. 3 y 4). Como se representa en la figura 3, diferentes factores ambientales (entre ellos la dieta) actuarían sobre la maquinaria epigenética, provocando alteraciones en el epigenoma del individuo. De manera más precisa, un estudio realizado con ratones que recibieron dietas ricas en grasa durante 9 semanas detectó alteraciones importantes a nivel de calidad espermática: los espermatozoides presentaron un incremento en la fragmentación del ADN, una disminución de la motilidad, problemas en la capacitación y menores tasas de fecundación (13). Además, se detectó también una elevada presencia de especies reactivas de oxigeno (ROS) (42). Con estos resultados, los autores concluyeron que la obesidad inducía estrés oxidativo y fragmentación del ADN, dos factores relacionados con una mala capacidad reproductiva. No obstante, tal y como se ha comentado anteriormente, es posible que no sea la obesidad o la adiposidad *per se* la que contribuya al incremento de ROS y a la elevada fragmentación del ADN, sino que estos factores sean consecuencia de alteraciones en el metabolismo (Fig. 2). Los cambios que se observan en la expresión de microARN (p. ej. miR-122) debido al consumo elevado de grasas se han relacionado con la patogénesis de estas enfermedades y oligoastenozoospérmicos (36). Este tipo de dietas no únicamente afecta a la función de los sncARN, puesto que también se han observado modificaciones en el patrón de metilación de algunas regiones del ADN que provocan la alteración en la expresión de algunos genes, como por ejemplo *IGF2* (43). Cuando la dieta, además de ser rica en grasas, contiene también niveles elevados de colesterol, los microARN que presentan una reducción de su expresión (p. ej. miR-16, miR-103, miR-107 y miR-451), o un aumento (p. ej. miR-351 y miR-669c) son varios. Paralelamente, la disminución del miR-107 implica el incremento de la expresión del gen *FASN (fatty acid synthetase*, en inglés) en ratones obesos (44) y un incremento de la sensibilidad a la insulina y la tolerancia a la glucosa, mientras que su sobre expresión conducía a alteraciones en la homeostasis de la glucosa (45). Finalmente, en otro estudio se encontró

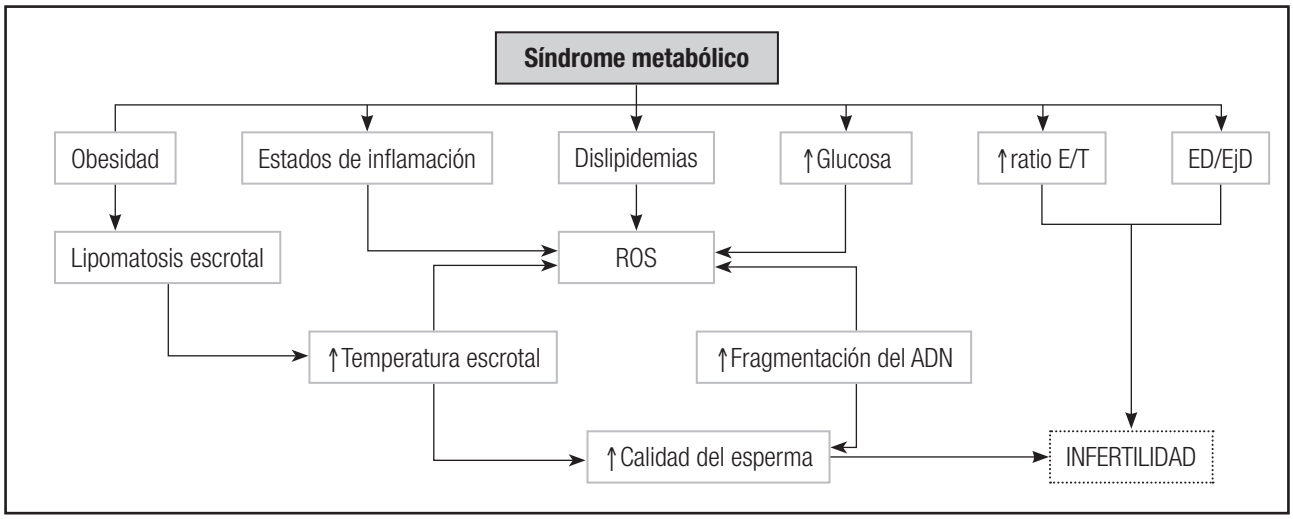

Figura 2.

Relación entre nutrición y obesidad, entre nutrición e infertilidad y entre obesidad y nutrición (adaptada de la referencia 41).

expresión elevada de miR-143 y miR-145 en ratones alimentados con dietas ricas en grasa (46). La desregulación de la expresión de miR-143 se asoció a niveles incrementados de insulina basal en plasma, alteraciones en la homeostasis de la glucosa e intolerancia a la insulina. Todos estos mecanismos son importantes en la fertilidad masculina, pues el metabolismo de la glucosa tiene una función muy importante durante la espermatogénesis (47). Diferentes trabajos confirman el efecto deletéreo de la diabetes en los parámetros seminales del individuo, la fragmentación del ADN del espermatozoide y la calidad de la cromatina y la resultante capacidad fecundante del individuo (48). En otro estudio, los autores concluyeron que los espermatozoides de individuos infértiles presentaban contenidos de ácidos grasos muy elevados (independientemente de su peso), lo cual promueve la generación de ROS por parte de la mitocondria del espermatozoide y una pérdida de competencia funcional (49).

Al analizar el efecto de los micronutrientes sobre la fertilidad del individuo; en general, los resultados demuestran que la suplementación con vitaminas específicas (como la vitamina E o la vitamina C) y minerales (como el zinc) se relaciona con un incremento en la calidad seminal y en el éxito reproductivo (50). Aunque no se ha demostrado todavía a nivel testicular, es probable que los mecanismos de acción de los micronutrientes sobre la fertilidad tengan también una base epigenética moduladora basada en la regulación de algunos microARN. Como se ha indicado precedentemente, las vitaminas del grupo B (especialmente la vitamina B6 y la B12) sirven como coenzimas del metabolismo de 1 carbono (C1), el cual determina los niveles de la S-adenosil-

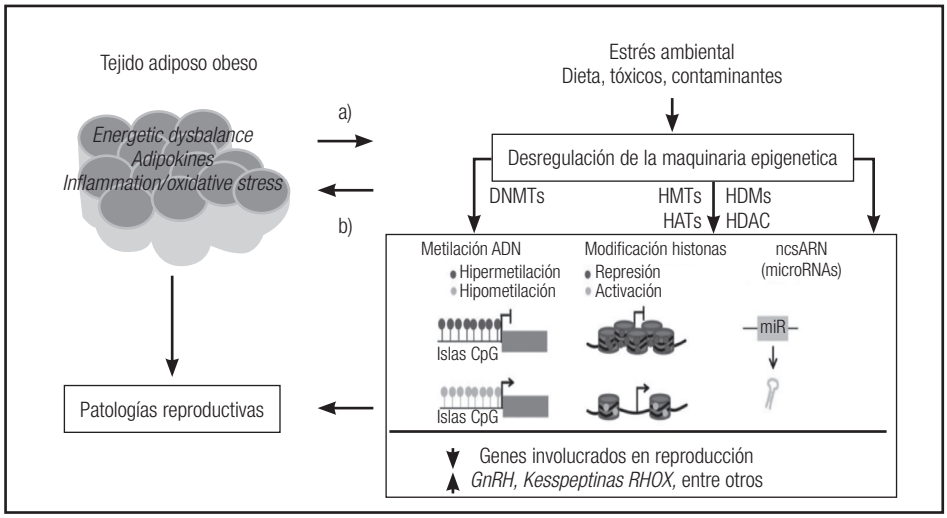

Figura 3.

Representación de las alteraciones metabólicas relacionadas con el síndrome metabólico y su asociación con la infertilidad masculina. La modificación del epigenoma provocada por factores ambientales (como por ejemplo la dieta) participaría en el desarrollo de estas alteraciones metabólicas (imagen adaptada de la referencia 56).

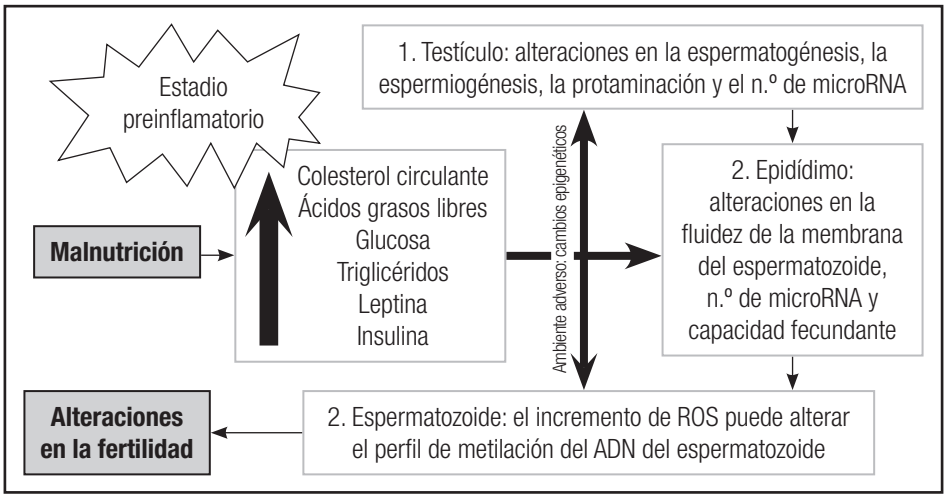

Figura 4.

Hipótesis de cómo la malnutrición puede afectar a la fertilidad del individuo, a través de cambios epigenéticos provocados por desequilibrios metabólicos (adaptado de referencia 57).

metionina (SAM), una molécula que participa en numerosas reacciones celulares cómo la metilación del ADN o las modificaciones postraduccionales de las histonas (51). Por lo tanto, los niveles de folato en la dieta pueden influenciar los niveles de metilación del ADN a nivel celular y consecuentemente afectar la expresión de genes importantes para el desarrollo y la homeostasis de un organismo (7). De hecho, Lambrot y cols. (7) alimentaron ratones con dietas deficientes en folato (0,3 mg ácido fólico por kg) o suficientes en folato (2 mg ácido fólico por kg) durante toda su vida para evaluar el papel de los folatos en los mecanismos de transmisión de la información ambiental vía el epigenoma del espermatozoide. En sus resultados destacaron que la deficiencia de folato alimentario resulta en la metilación de las histonas H3 de los espermatozoides o la metilación del ADN, lo que significa una inadecuada salud de los hijos. En mamíferos, se sabe que el butirato, que es un ácido de cadena corto resultante de la fermentación bacteriana de carbohidratos complejos y compuestos organsulfurados, es un inhibidor de la deacetilasa de las histonas (HDACs, en inglés *histone deacetylases)* (52). Se necesitan experimentos para revelar si los alimentos que inducen el aumento de ácido butírico pueden modificar las histonas y afectar la fertilidad masculina. Curiosamente, se ha demostrado que el gen *SIRT1* (del inglés *sirtuin* 1) puede desacetilar la proteína DNMT1 y consecuentemente alterar su actividad. Este resultado sugiere que las sirtuins pueden modificar los patrones epigenéticos. La acción de la proteína sirtuin es potenciada por el resveratrol (53), un polifenol natural que se encuentra de manera abundante en las plantas, frutos y vino, y que ha ganado mucho interés debido a su potencial efecto antienvejecimiento. Se necesitan estudios para elucidar si las sirtuins están involucradas en cambios epigenéticos mediados por la nutrición. Finalmente, en hombres, la ingestión de factores no nutricionales como las toxinas o drogas también puede producir modificaciones epigenéticas que afectan a la generación siguiente. Así, por ejemplo, la ingestión de 5-aza-2'-deoxycytidina, un agente anticancerígeno, causa una disminución de la metilación global del ADN y una morfología alterada de los espermatozoides (54), con un impacto en la disminución de la motilidad, de la capacidad de fertilización o la capacidad del embrión para sobrevivir.

CONCLUSIÓN

La infertilidad masculina es un trastorno multifactorial donde interaccionan factores genéticos y epigenéticos con factores ambientales como el sobrepeso o la obesidad. Las modificaciones epigenéticas observadas con más frecuencia corresponden a la hipermetilación de genes relacionados con la espermatogénesis o las modificaiones enzimáticas asociadas con la regulación postranscripcional de las histonas durante la espermatogénesis. Finalmente, también se presentan resultados que muestran cómo la espermatogénesis puede desregularse mediante las modificaciones de expresión de ciertos ARN no codificantes de cadena corta y larga.

Las primeras observaciones indican que la exposición a dietas ricas o deficientes en determinados nutrientes (especialmente grasas saturadas o donadores de grupos metilo) durante largos periodos de tiempo, inducen cambios epigenéticos con consecuencias para la fertilidad masculina del paciente y la fertilidad de su descendencia (herencia transgeneracional). Además, es necesario subrayar que el impacto de los nutrientes y de los factores no nutricionales durante la programación epigenética de las células germinales es importante pues puede modificar la regulación de la espermatogénesis. Cabe remarcar que aunque la afectación del epigenoma acontece en periodos puntuales, primeros estadios de la embriogénesis y de la infancia, existe también la posibilidad de intervenir durante la edad adulta.

BIBLIOGRAFÍA

1. De Kretser DM. Male infertility. Lancet 1997; 349(9054):787-90.
2. Zegers-Hochschild F, Adamson GD, de Mouzon J, Ishihara O, Mansour R, Nygren K, et al. The International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) Revised Glossary on ART Terminology, 2009. Hum Reprod 2009;24(11):2683-7.

3. Wong WY, Thomas CM, Merkus JM, Zielhuis GA, Steegers-Theunissen RP. Male factor subfertility: possible causes and the impact of nutritional factors. Fertil Steril 2000;73(3):435-42.
4. Ferlin A, Raicu F, Gatta V, Zuccarello D, Palka G, Foresta C. Male infertility: role of genetic background. Reprod Biomed Online 2007;14(6):734-45.
5. Ying HQ, Pu XY, Liu SR, A ZC. Genetic variants of eNOS gene may modify the susceptibility to idiopathic male infertility. Biomarkers 2013;18(5):412-7.
6. Dada R, Kumar M, Jesudasan R, Fernandez JL, Gosalvez J, Agarwal A. Epigenetics and its role in male infertility. J Assist Reprod Genet 2012;29(3):213-23.
7. Lambrot R, Xu C, Saint-Phar S, Chountalos G, Cohen T, Paquet M, et al. Low paternal dietary folate alters the mouse sperm epigenome and is associated with negative pregnancy outcomes. Nat Commun 2013;4:2889.
8. Khazamipour N, Noruzinia M, Fatehmanesh P, Keyhanee M, Pujol P. MTHFR promoter hypermethylation in testicular biopsies of patients with non-obstructive azoospermia: the role of epigenetics in male infertility. Hum Reprod 2009;24(9):2361-4.
9. Miller D, Brinkworth M, Iles D. Paternal DNA packaging in spermatozoa: more than the sum of its parts? DNA, histones, protamines and epigenetics. Reproduction 2010;139(2):287-301.
10. Glaser S, Lubitz S, Loveland KL, Ohbo K, Robb L, Schwenk F, et al. The histone 3 lysine 4 methyltransferase, Mll2, is only required briefly in development and spermatogenesis. Epigenetics & Chromatin 2009;2.
11. Rajender S, Meador C, Agarwal A. Small RNA in spermatogenesis and male infertility. Front Biosci (Schol Ed) 2012;4:1266-74.
12. Soubry A, Hoyo C, Jirtle RL, Murphy SK. A paternal environmental legacy: Evidence for epigenetic inheritance through the male germ line. Bioessays 2014;36(4):359-71.
13. Bakos HW, Mitchell M, Setchell BP, Lane M. The effect of paternal diet-induced obesity on sperm function and fertilization in a mouse model. Inter J Androl 2011;34(5):402-10.
14. Flintoft L. Epigenetics: Dad's diet lives on. Nat Rev Genet 2011;12(2):80.
15. Szyf M. Nongenetic inheritance and transgenerational epigenetics. Trends Mol Med 2015;21(2):134-44.
16. Takai D, Jones PA. Comprehensive analysis of CpG islands in human chromosomes 21 and 22. Proc Natl Acad Sci USA 2002;99(6):3740-5.
17. Okano M, Xie S, Li E. Cloning and characterization of a family of novel mammalian DNA (cytosine-5) methyltransferases. Nat Genet 1998;19(3):219-20.
18. La Salle S, Oakes CC, Neaga OR, Bourc'his D, Bestor TH, Trasler JM. Loss of spermatogonia and wide-spread DNA methylation defects in newborn male mice deficient in DNMT3L. BMC Dev Biol 2007;7:104.
19. Li E, Bestor TH, Jaenisch R. Targeted mutation of the DNA methyltransferase gene results in embryonic lethality. Cell 1992;69(6):915-26.
20. Okada Y, Tateishi K, Zhang Y. Histone demethylase JHDM2A Is involved in male infertility and obesity. J Andro. 2010;31(1):75-8.
21. Houshdaran S, Cortessis VK, Siegmund K, Yang A, Laird PW, Sokol RZ. Widespread Epigenetic Abnormalities suggest a broad DNA methylation erasure defect in abnormal human sperm. PloS one 2007;2(12).
22. Houshdaran S, Cortessis VK, Siegmund K, Yang A, Laird PW, Sokol RZ. Widespread epigenetic abnormalities suggest a broad DNA methylation erasure defect in abnormal human sperm. PloS one 2007;2(12):e1289.
23. Hammoud SS, Purwar J, Pflueger C, Cairns BR, Carrell DT. Alterations in sperm DNA methylation patterns at imprinted loci in two classes of infertility. Fertil Steril 2010;94(5):1728-33.
24. Hammoud SS, Nix DA, Zhang H, Purwar J, Carrell DT, Cairns BR. Distinctive chromatin in human sperm packages genes for embryo development. Nature 2009;460(7254):473-8.
25. Wu W, Shen O, Qin Y, Niu X, Lu C, Xia Y, et al. Idiopathic male infertility is strongly associated with aberrant promoter methylation of methylenetetrahydrofolate reductase (MTHFR). PloS one 2010;5(11):e13884.
26. Chan D, Cushnie DW, Neaga OR, Lawrance AK, Rozen R, Trasler JM. Strain-specific defects in testicular development and sperm epigenetic patterns in 5,10-methylenetetrahydrofolate reductase-deficient mice. Endocrinology 2010;151(7):3363-73.
27. Doerksen T, Benoit G, Trasler JM. Deoxyribonucleic acid hypomethylation of male germ cells by mitotic and meiotic exposure to 5-azacytidine is associated with altered testicular histology. Endocrinology 2000;141(9):3235-44.
28. Sapienza C, Paquette J, Tran TH, Peterson A. Epigenetic and genetic factors affect transgene methylation imprinting. Development 1989;107(1):165-8.
29. Seisenberger S, Andrews S, Krueger F, Arand J, Walter J, Santos F, et al. The dynamics of genome-wide DNA methylation reprogramming in mouse primordial germ cells. Mol Cell 2012;48(6):849-62.
30. Holbert MA, Marmorstein R. Structure and activity of enzymes that remove histone modifications. Cur Opinion Struct Biol 2005;15(6):673-80.
31. Eram MS, Bustos SP, Lima-Fernandes E, Siarheyeva A, Senisterra G, Hajian T, et al. Trimethylation of histone H3 lysine 36 by human methyltransferase PRDM9 protein. J Biol Chem 2014;289(17):12177-88.
32. Godmann M, Auger V, Ferraroni-Aguiar V, Di Sauro A, Sette C, Behr R. Dynamic regulation of histone H3 methylation at lysine 4 in mammalian spermatogenesis. Biol Reprod 2007;77(5):754-64.
33. Glaser S, Lubitz S, Loveland KL, Ohbo K, Robb L, Schwenk F, et al. The histone 3 lysine 4 methyltransferase, Mll2, is only required briefly in development and spermatogenesis. Epigenetics Chromatin 2009;2(1):5.
34. Kumar G, Patel D, Naz RK. c-MYC mRNA is present in human sperm cells. Cell Mol Biol Res 1993;39(2):111-7.
35. McManus MT, Sharp PA. Gene silencing in mammals by small interfering RNAs. Nat Rev Genet 2002;3(10):737-47.
36. Kotaja N. MicroRNAs and spermatogenesis. Fertil Steril 2014;101(6):1552-62.
37. Papaioannou MD, Nef S. microRNAs in the testis: building up male fertility. J Androl 2010;31(1):26-33.
38. Luk AC, Gao H, Xiao S, Liao J, Wang D, Tu J, et al. GermlncRNA: a unique catalogue of long non-coding RNAs and associated regulations in male germ cell development. Database (Oxford) 2015. 2015:bav044.
39. Gapp K, Jawaid A, Sarkies P, Bohacek J, Pelczar P, Prados J, et al. Implication of sperm RNAs in transgenerational inheritance of the effects of early trauma in mice. Nat Neurosci 2014;17(5):667-9.
40. Fejes I, Koloszar S, Zavaczki Z, Daru J, Szollosi J, Pal A. Effect of body weight on testosterone/estradiol ratio in oligozoospermic patients. Arch Androl 2006;52(2):97-102.
41. Crujeiras AB, Casanueva FF. Obesity and the reproductive system disorders: epigenetics as a potential bridge. Hum Reprod Update 2015;21(2):249-61.
42. Bakos HW, Mitchell M, Setchell BP, Lane M. The effect of paternal diet-induced obesity on sperm function and fertilization in a mouse model. Int J Androl 2011;34(5 Pt 1):402-10.
43. Susiarjo M, Bartolomei MS. EPIGENETICS You are what you eat, but what about your DNA? Science 2014;345(6198):733-4.
44. Park JH, Ahn J, Kim S, Kwon DY, Ha TY. Murine hepatic miRNAs expression and regulation of gene expression in diet-induced obese mice. Mol Cells 2011;31(1):33-8.
45. Trajkovski M, Hausser J, Soutschek J, Bhat B, Akin A, Zavolan M, et al. MicroRNAs 103 and 107 regulate insulin sensitivity. Nature 2011;474(7353):649-53.
46. Jordan SD, Kruger M, Willmes DM, Redemann N, Wunderlich FT, Bronneke HS, et al. Obesity-induced overexpression of miRNA-143 inhibits insulin-stimulated AKT activation and impairs glucose metabolism. Nat Cell Biol 2011;13(4):434-46.
47. Ding GL, Liu Y, Liu ME, Pan JX, Guo MX, Sheng JZ, et al. The effects of diabetes on male fertility and epigenetic regulation during spermatogenesis. Asian J Androl 2015;17(6):948-53.
48. Kilarkaje N, Al-Hussaini H, Al-Bader MM. Diabetes-induced DNA damage and apoptosis are associated with poly (ADP ribose) polymerase 1 inhibition in the rat testis. Eur J Pharmacol 2014;737:29-40.
49. Koppers AJ, Garg ML, Aitken RJ. Stimulation of mitochondrial reactive oxygen species production by unesterified, unsaturated fatty acids in defective human spermatozoa. Free Radic Biol Med 2010;48(1):112-9.
50. Buhling KJ, Laakmann E. The effect of micronutrient supplements on male fertility. Curr Opin Obstet Gynecol 2014;26(3):199-209.
51. Kelly TL, Neaga OR, Schwahn BC, Rozen R, Trasler JM. Infertility in 5,10-methylenetetrahydrofolate reductase (MTHFR)-deficient male mice is partially alleviated by lifetime dietary betaine supplementation. Biol Reprod 2005;72(3):667-77.
52. Dashwood RH, Ho E. Dietary agents as histone deacetylase inhibitors: sulforaphane and structurally related isothiocyanates. Nutr Rev 2008;66(Suppl. 1):S36-38.
53. Kaeberlein M, McDonagh T, Heltweg B, Hixon J, Westman EA, Caldwell SD, et al. Substrate-specific activation of sirtuins by resveratrol. J Biol Chem 2005;280(17):17038-45.
54. Kelly TL, Li E, Trasler JM. 5-aza-2'-deoxycytidine induces alterations in murine spermatogenesis and pregnancy outcome. J Androl 2003;24(6):822-30.
55. Soubry A. Epigenetic inheritance and evolution: A paternal perspective on dietary influences. Prog Biophys Mol Biol 2015;118(1-2):79-85.
56. Gorbachinsky I, Akpinar H, Assimos DG. Metabolic syndrome and urologic diseases. Rev Urol 2010;12(4):e157-180.
57. McPherson NO, Lane M. Male obesity and subfertility, is it really about increased adiposity? Asian J Androl 2015;17(3):450-8.
58. Guerrero-Bosagna C, Savenkova M, Haque MM, Nilsson E, Skinner MK. Environmentally induced epigenetic transgenerational inheritance of altered Sertoli cell transcriptome and epigenome: molecular etiology of male infertility. PloS one 2013;8(3):e59922.
59. Rajender S, Avery K, Agarwal A. Epigenetics, spermatogenesis and male infertility. Mutat Res 2011;727(3):62-71.
60. Boissonnas CC, Jouannet P, Jammes H. Epigenetic disorders and male subfertility. Fertil Steril 2013;99(3):624-31.

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Revisión

Association between sarcopenic obesity and cardiovascular risk: where are we?

Asociación entre obesidad sarcopénica y riesgo cardiovascular: ¿dónde estamos?

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Abstract

Introduction: The main changes in the body composition refer to the increase of adipose tissue and/or the decrease of muscular mass, and these changes have effect in many clinical outcomes. Sarcopenic obesity (SO) consists of the presence of excessive adipose tissue and deficit of muscular mass simultaneously. People with SO may have synergistic effect due to obesity and sarcopenia, with increases cardiovascular risk more than obesity itself.

Objective: To describe the findings in the literature about the association between SO and risk factors and/or cardiometabolic disease (CMD) or cardiovascular disease (CVD).

Methods: An electronic search was done on the following databases: MEDLINE, Scopus, SciELO, LILACS and Web of Science, using the matching expressions and Boolean operators: "obesity sarcopenic" OR "sarcopenic obesity", in the titles of the studies, AND "cardiometabolic disease" OR "cardiovascular disease" OR "metabolic syndrome" OR "insulin resistance", in the abstract.

Results: Most of studies are cross-sectional and present many different diagnosis criteria for SO. It was possible to verify the association of the SO and the risk factors and/or CMD or CVD.

Conclusion: SO is associated with risk factors and/or CMD or CVD. The lack of a consensus about this definition jeopardizes the effective clinical practice and the research about the subject.

Key words:

Obesity. Sarcopenia. Sarcopenic obesity. Cardiometabolic disease. Cardiovascular disease.

Resumen

Introducción: los principales cambios en la composición del cuerpo refieren el incremento de tejido adiposo y/o la disminución de masa muscular, y estos cambios tienen efecto en varios resultados clínicos. La obesidad sarcopénica (OS) consiste en la presencia simultánea del exceso de tejido adiposo y el déficit de masa muscular. Las personas con OS pueden tener un efecto sinérgico debido a la obesidad y la sarcopenia, lo que incrementa el riesgo de enfermedad cardiovascular, más que la obesidad en sí.

Objetivo: describir los hallazgos en la literatura científica sobre la asociación de la SO y los factores de riesgo y/o ECM (enfermedad cardiometabólica) o enfermedad cardiovascular (ECV).

Métodos: se realizó una búsqueda electrónica en las siguientes bases de datos: MEDLINE, Scopus, SciELO, LILACS y Web of Science, usando las expresiones coincidentes y los operadores booleanos: "obesidad sarcopénica" o " sarcopénica obesidad ", en los títulos de los estudios, y "enfermedad cardiometabólica" o "enfermedad cardiovascular" o "síndrome metabólico" o "resistencia a la insulina", en el *abstract*.

Resultados: la mayoría de los estudios son de corte transversales y presentan diferentes criterios de diagnóstico para la OS. Fue posible verificar la asociación de la OS y los factores de riesgo y/o ECM o ECV.

Conclusión: la OS está asociada con los factores de riesgo y/o ECM o ECV. La falta de un consenso sobre esta definición pone en peligro la efectividad de la práctica clínica y la investigación sobre el tema.

Palabras clave:

Obesidad. Sarcopenia. Obesidad sarcopénica. Enfermedad cardiometabólica. Enfermedad cardiovascular.

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INTRODUCTION

The assessment of body composition (BC) allows the measuring of larger body compartments such as fat-free mass which also includes the bone mineral tissue, body fat mass and total body water (1). The use of this evaluation has grown due to the increase in the prevalence of chronic diseases, overweight and obesity worldwide and it has been used to assess adverse health outcomes in conditions of BC changes (1,2).

The main changes of BC are related to excess of adipose tissue (AT) and/or the deficit of muscular mass (MM), defined as obesity, sarcopenia or sarcopenic obesity (SO), when both conditions appear simultaneously (1). The prevalence of SO has increased in industrialized countries due to the high number of cases of obesity and sarcopenia in obese people, ranging from 4.4% to 42.9%, depending on the diagnostic methods and on the studied population (3-21). There is not a consensus between the definition and classification of SO, and this gap contributes to the inconsistent findings in its association with clinical outcomes (22-24).

Knowledge about the consequences of the SO to health were initially limited to functional outcomes. Recently, the associations between this condition and cardiometabilic disease (CMD), cardiovascular disease (CVD) and mortality has been the target of growing attention (12,22,25), justifying the study of these relationship since SO can be prevented or treated.

OBJECTIVE

The objective of this review is to describe the findings in literature about the association between SO and the risk factors and/or CMD or CVD.

METHOD

Review of the literature in English, Spanish and Portuguese, indexed in MEDLINE, Scopus, SciELO, LILACS and Web of Science. No filter of date were used. Combinations of Boolean operators and descriptors used were: "obesity sarcopenic" OR "sarcopenic obesity" in the title of the work AND "cardiometabolic disease" OR "cardiovascular disease" OR "metabolic syndrome" OR "insulin resistance" in the abstract. The last search was held on September, 2015. The articles were selected by their titles and abstracts and a detailed analysis was done with the full articles. Search included cross-sectional, prospective or retrospective studies with adults (> 18 years) and elderlies.

RESULTS

Although described in the literature for a long time, the first studies linking SO to CMD and/or CVD and their risk factors (Fig. 1) date from 2004 and the number of publications is growing every year including those that discuss the association of SO with risk factors and/or CMD and CVD in people with different clinical conditions (Fig. 2).

Thirty-nine articles were identified, but only 33 were related to the objective of this study. It is noteworthy that most studies are cross sectional. Table I shows the studies found on the association between OS and risk factors and/or CMD and CVD. In addition 24 references were included because of its relevance in the theoretical basis of this study.

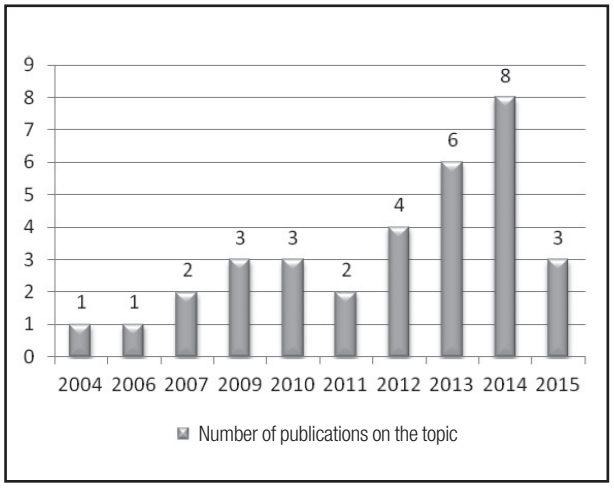

Figure 1.

Evolution of the number of publications on the topic; association between sarcopenic obesity and risk factors and/or CMD or CVD.

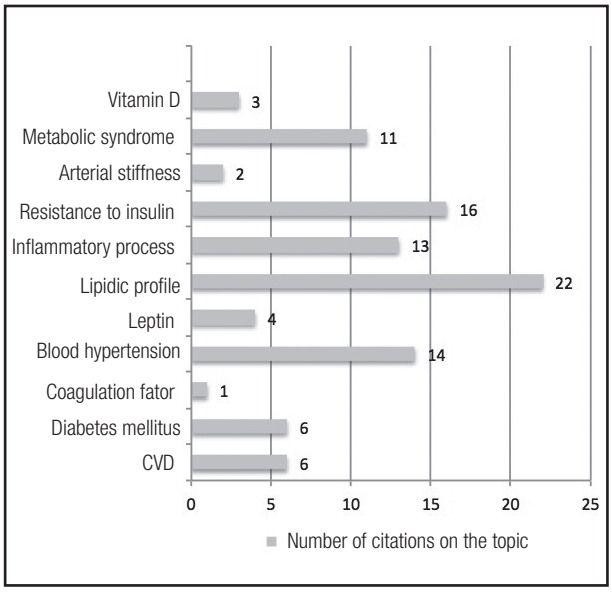

Figure 2.

Review of risk factors and/or CMD and CVD that had been evaluated in the cited publications.

Table I. Review of the studies that investigate the association between sarcopenic obesity and risk factors and/or cardiometabolic and cardiovascular diseases in adults and elderlies

Author, year study design	Characteristics of the population	Mensuration of SO	Risk or cardiometabolic / cardiovascular diseases	Main findings
Baumgartner et al., 2004 (4) Cross-sectional	n = 451 (M/W) Age ≥ 60 y	DXA (SC = ASM/height^2; OB = %FM)	MetS	The prevalence of MetS was higher in patients with OS (19.2%) compared to healthy and sarcopenic groups
Aubertin et al., 2006 (35) Cross-sectional	n = 22 (W) Age: 55-75 y	DXA (SC = SMI/height (m^2); OB = %FM)	Lipid profile; glycemia; HOMA-IR; CRP	Obesity without sarcopenia, is associated with changes in lipid profile, even after adjusting the variable visceral fat
Schrager et al., 2007 (38) Cross-sectional	n = 871 (M/W) Age ≥ 65 y	SC = HS ≤ 19 kg (W) and ≤ 33 kg (M); Anthropometry (OB = BMI ≥ 30 kg/m^2 or WC ≥ 98 cm)	Inflammatory markers (CRP; IL-6; soluble receptor IL6, TNF-alpha, IL-18 and antagonist receptor of IL-1)	SO (WC ≥ 98 cm), was associated with elevated levels of IL-6 (F = 4:58, p = 0.033) and IL-6 soluble receptor (F = 6.24, p = 0.013)
Honda et al., 2007 (55) Prospective cohort	n = 328 (M/W) Age: 53 ± 12 y	SC = Global subjective assessment; Anthropometry (OB = BMI > 25 kg/m^2)	Inflammatory markers (CRP; IL-6; TNF-alpha); Leptin	Individuals with SO showed higher prevalence of diabetes and higher levels of leptin CRP and IL-6
Stephen & Janssen, 2009 (5) Prospective cohort	n = 3,366 (M/W) Age ≥ 65 y	BIA (SC = muscle mass adjusted by height); HS (SC = HS adjusted by height); Anthropometry (OB = WC)	Coronary cardiac disease; congestive cardiac failure; cerebrovascular accident	The rate of coronary events in sarcopenic obese increased 23% (BIA) and in 33% (HS). The risk of congestive cardiac failure in individuals with SO, considering BIA was 42% higher
Messier et al., 2009 (46) Cross-sectional	n = 136 women in post menopause	DXA (SC = ASM/height); Anthropometry OB = BMI)	Lipid profile; inflammatory markers; insulin sensitivity	Individuals with SO did not show unfavorable metabolic profile when compared to obese individuals
Kim et al., 2009 Cross-sectional (6)	n = 526 (M/W) Age ≥ 20 y	DXA (SC = SMI; OB = %FM)	MetS	Individuals with SO had a higher prevalence of MetS (55.6%) and higher number of risk factors for MetS
Lim et al., 2010 (33) Cross-sectional	n = 264 (M/W) Age: 20-88 y	CT (SO = reason area of visceral fat / muscle area of quadriceps (VMR)	MetS	Individuals with higher VMR had a higher prevalence of MetS. The VMR was positively correlated with the number of components of MetS
Lim et al., 2010 (7) Cross-sectional	n = 565 (M/W) Age ≥ 65 y	DXA (SC = ASM/ height^2 e ASM/body mass in kg); CT (OB = VFA > 100 cm^2)	MetS (WC ≥ 90 cm in men ≥ 80 cm in women); HOMA-IR	SO (ASM/ Ht^2) was associated with higher (HOMA-IR) and higher levels of TGL. The SO group had 8.2 times higher risk of MetS than normal individuals
Srikanthan et al., 2010 (40) Cross-sectional	n = 14,528 (M/W) Age > 20 y	BIA (SC = SMI); anthropometry (OB = BMI > 30 kg/m^2)	Insulin resistance (HOMA-IR); dysglycemia (HbA1Cg); pre-diabetes (HbA1Cg and fasting glucose); diabetes (HbA1Cg and fasting glucose	Individuals with SO had the stronger associations with insulin resistance, dysglycemia, pre-diabetes and diabetes

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Table I. Review of the studies that investigate the association between sarcopenic obesity and risk factors and/or cardiometabolic and cardiovascular diseases in adults and elderlies

Author, year study design	Characteristics of the population	Mensuration of SO	Risk or cardiometabolic / cardiovascular diseases	Main findings
Kohara et al., 2011 (3) Cross-sectional	n = 782 (M/W) elderlies	CT (SC = sectional area of the muscle of thigh adjusted by body mass; OB = VFA >100 cm^2)	Leptin; lipid profile; BP; fastening glucose; serum level of insulin; HbA1Cg; HOMA-IR	Individuals with SO have higher levels of leptin, fasting plasma glucose, serum insulin, HbA1C, HOMA-IR and total lymphocytes count
Kim et al., 2011 (23) Cross-sectional	n = 526 (M/W) Age: 53.6 ± 15.6 y	DXA; TC SO = Index ASM/$height^2$ /VFA	MetS; arterial stiffness	The lowest tertile of the index presented OR of 5.43 95% IC 2.56-13.34) for MetS. As the index is an independent determinant of arterial stiffness
Kohara et al., 2012 (50) Cross-sectional	n = 1,024 (M/W) Adults and elderlies	CT (SC = transversal area of femoral muscle/weight in kg; OB = VFA > 100 cm^2	Arterial stiffness = velocity of pulse branchial ankle	Individuals with SO had higher arterial stiffness values than the control, only in men
Levine & Crimmins, 2012 (8) Cross-sectional	n = 1,127 (M/W) Age ≥ 60 y	DEXA (SC = Skeletal muscle mass); anthropometry (OB = WC)	HOMA-IR; CRP	The group of individuals with SO have higher levels of CRP
Levine & Crimmins, 2012 (9) Cross-sectional	n = 2,287 (M/W) Age ≥ 60 y	DEXA (SC = ASM/body mass in kg x 100); anthropometry (OB = WC)	HOMA-IR; CRP	Sarcopenic obese individuals had higher insulin resistance index
Hwang et al., 2012 (10) Cross-sectional	n = 2,221 (M/W) Age ≥ 60 y	DXA (SC = ASM/body mass in kg x 100); anthropometry (OB = WC)	HbA1C; fasting glucose; insulin; lipid profile; PTH; serum vitamin D	Serum insulin levels and vitamin D were associated with SO in both sexes. Serum glucose and TGL levels were associated SO in women and PTH levels increased the risk of SO in men
Park et al., 2013 (49) Cross-sectional	n = 6,832 (M/W) Adults	DEXA (SC = ASM/body mass in kg); anthropometry OB = WC)	BP	Compared with healthy subjects, patients with SO have 6 times more likely to have BP
Chin et al., 2013 (43) Cross-sectional	n =1,578 (M/W) Age ≥ 65 y	DEXA (SC = ASM/body mass in kg); anthropometry (OB = BMI)	Lipid profile; HOMA-IR; prevalence of DM; prevalence of CVD	Individuals with SO had higher levels of TGL and HOMA-IR. SO not associated with CVD
Kim et al., 2013 (11) Cross-sectional	n = 493 (M/W) Age ≥ 20 y	DXA (SC = SMI); CT (SO = VFA > 100 cm^2	HOMA-IR; CRP; vitamin D; MetS	SO was associated with HOMA-IR in both sexes, vitamin D in men and CRP in women
Kim et al., 2013 (12) Cross-sectional	n = 298 (M/W) Age: 20-70 y	DXA (SC = ASM/body mass in kg x 100); CT (OB = VFA > 100 cm^2)	Serum levels of A-FABP; systolic and diastolic BP; lipid profile; fasting glucose; levels of insulin; HOMA-IR; serum leptin; CRP; IL- 6; TNF-α	The group with SO showed higher BP, total cholesterol, TGL, HOMA-IR, levels of CRP, IL-6, leptin and A-FABP levels, in both sexes. Women with SO had higher BP systolic and TGL and lower HDL levels

(Continue in the next page)

Table I. Review of the studies that investigate the association between sarcopenic obesity and risk factors and/or cardiometabolic and cardiovascular diseases in adults and elderlies

Author, year study design	Characteristics of the population	Mensuration of SO	Risk or cardiometabolic / cardiovascular diseases	Main findings
Lu et al., 2013 (13) Cross-sectional	n = 600 (M/W) Age: 63.6 ± 10.1 y	BIA (SC = SMI); anthropometry (OB = BMI)	MetS	The group of individuals with SO demonstrated higher odds ratio for MetS (OR 11.59, 95%IC 6.72-19.98)
Chung et al., 2013 (14) Cross-sectional	n = 2,943 (M/W) Age ≥ 60 y	DXA (SC = ASM adjusted by body mass); anthropometry (OB = BMI > 25 kg/m^2)	BP; HOMA-IR; lipid profile; inflammatory markers; levels of vitamin D; hepatic function; renal function; ferritin; leukocytes ; MetS	The prevalence of MetS and Vitamin D deficiency was higher in patients with SO. HOMA-IR, levels of TGL, ferritin and leukocytes were higher in the group with the SO, as well as vitamin D levels were lower in this group
Baek et al., 2014 (15) Cross-sectional	n = 3,483 (M/W) Age ≥ 65 y	DXA (SC = ASM adjusted by the body mass and height); anthropometry (OB = BMI ≥ 25 kg/m^2)	Lipid profiles; MetS; HOMA-IR	Men with SO have higher OR for dyslipidemia and rising of TC, TGL, LDL and relative TGL/HDL and decreased HDL
Liu et al., 2014 (16) Prospective cohort	n = 680 (M) Age ≥ 75 y old	HS (SC = HS < 22.5 kg); anthropometry (OB = WC ≥ 90 cm)	BP; lipid profile; fasting glucose; MetS; risk of mortality	The group of individuals with SO have a higher prevalence of diabetes mellitus and lower HDL levels
Dos santos et al., 2014 (17) Cross-sectional	n = 149 (W) Average age: 67.1 ± 6.12 y	DXA (SC = ASM; OB = FM SO = residual value of equation that predicts ASM based on the height and fat mass)	BP; lipid profile; HOMA-IR; CRP	There was no significant difference in blood pressure, blood glucose, HOMA-IR, lipid profile and inflammatory pattern between the group with SO and other groups
Atkins et al., 2014 (47) Prospective cohort	n = 4,252 (M) Age: 60-79 y	Anthropometry (SC = mid-arm circumference; OB = WC > 102 cm)	Mortality in general and because of cardiovascular disease; Cardiovascular events; Events of coronary disease	There was not an association between body composition and other evaluated factors. Individuals with OS had higher levels of PCR
Ohara et al., 2014 (51) Cross-sectional	n = 1,470 (M/W) Adults and elderlies	CT (SC = transversal sectional area of the thigh; OB = VFA > 100 cm^2)	Arterial stiffness: speed of branchial pulse ankle	SO was significantly associated with arterial stiffness
Han et al., 2014 (44) Cross-sectional	n = 4,846 (M/W) Age ≥ 60 y	DXA (SC = ASM/ body mass in kg) and anthropometry (OB = BMI ≥ 25 kg/m^2)	BP; lipid profile; insulin resistance; evaluation of previous CVD	Individuals with SO presented 3 times more chances of showing high blood pressure. The group with SO showed higher percentage of individuals with previous high BP, using anti-hypertensive and with previous CVD and higher levels of TGL and HOMA-IR
Park et al., 2014 (45) Cross-sectional	n = 6,832(M/W) Age ≥ 19 y	DXA (SC = ASM/ body mass in kg); anthropometry (OB = WC)	MetS	SO was associated to the increase for MetS in men and women
Kim et al., 2014 (19) Cross-sectional	n = 298 (M/W) Age: 20-70 y	DXA (SC = SMI); CT (OB = VFA ≥ 100 cm^2)	Cardiorespiratory fitness; BP; lipid profile; HOMA-IR; leptin; IL-6; CRP	The group SO presented lower cardiorespiratory fitness, higher levels of TGL, leptin and BP and lower HDL levels

(Continue in the next page)

Table I. Review of the studies that investigate the association between sarcopenic obesity and risk factors and/or cardiometabolic and cardiovascular diseases in adults and elderlies

Author, year study design	Characteristics of the population	Mensuration of SO	Risk or cardiometabolic / cardiovascular diseases	Main findings
Yang et al., 2015 (20) Cross-sectional	n = 844 (M/W) Age ≥ 65 y	DXA (SC = SMI; OB = % FM)	Inflammatory process: CRP, IL-6 and TNF-α	SO is associated with the increase of CRP levels, in men
Kim et al., 2015 (21) Cross-sectional	n = 3,320 (M/W) Age ≥ 40 y	DXA (SC = ASM/body mass kg); anthropometry (OB = BMI ≥ 25 kg/m^2)	Framingham Risk Score	The prevalence of risk ≥ 20% for risk of CVD in 10 years was higher in the group of sarcopenic obese, reaching 26.8%
Choudhary et al., 2015 (54) Prospective cohort	n = 82 (M/W) Average age: 50.5 ± 10.65 y	BIA (SC = muscle mass); Anthropometry (OB = BMI > 25 km/m^2)	MetS	SO individuals with MetS had higher percentages as well as greater number of positive components syndrome

A-FABP: adipocyte fatty acid-binding protein; ASM: appendicular skeletal muscle mass; AT: adipose tissue; BIA: bioelectric impedance analysis; BMI: body mass index; BM: body mass; BP: blood pressure; CRP: C-reactive protein; CT: computerized tomography; CVD: cardiovascular disease; DM: diabetes mellitus; DXA: dual energy X-ray absorptiometry; FM: fat mass; HbA1C: glycosylated hemoglobin level; HDL: high-density lipoprotein; HOMA-IR: homeostatic model assessment insulin resistance; HS: handgrip strength; IL-6: interleukin 6; LDL: low-density lipoprotein; M: man; MetS: metabolic syndrome; OB: obesity; PTH: parathyroid hormone; SC: sarcopenia; SMI: skeletal muscle mass index; SO: sarcopenic obesity; TC: total cholesterol; TGL: triglycerides;VFA: visceral fat area; W: woman; WC: waist circumference; y: year.

These papers were presented and discussed in four sessions:

1. SO (definition, diagnosis and physiopathology);
2. OS and risk factors for cardiometabolic and cardiovascular disease;
3. SO, cardiometabolic and cardiovascular disease.
4. SO, CVD and CMD in special clinical situations.

Session 2, 3 and 4 shows the 33 selected works. Six articles were excluded due to language or do not meet the objectives of this study.

SARCOPENIC OBESITY (DEFINITION, DIAGNOSIS AND PHYSIOPATHOLOGY)

The term SO was first described by Baumgartner et al., and was defined by the combination of sarcopenia and obesity (25,26). The heterogeneity of the definitions of SO in the studies may interfere in the results and can be categorized in seven aspects that involve: the method of analysis of BC used, the cutoff point for sarcopenia and obesity classification, the adjustment of MM by body mass or height of the individual, the compliance of the method, the study design, the biologic validity and the predictive risk (2). All these categories are important for a standard definition of SO, but the adjustment of the amount of MM seems to have a higher impact in the discrepancies found in the associations between SO and CMD or CVD (22).

Measurement methods as computed tomography (CT), DEXA (dual X-ray absorptiometry) and the BIA (Bioelectrical Impedance Analysis) have been used to assess the total or skeletal MM (25). Many definitions of sarcopenia have been proposed, but so far none has been universally adopted. Baumgartner et al., 1998 (27) defined sarcopenia as the condition of an individual which the appendicular skeletal muscle mass (ASM) divided by the square of height (ASM/h^2) is two standard deviations (SD) below of the average of young population of reference. However, this index is highly correlated with body mass index (BMI) and it classifies individuals with low BMI as sarcopenic and could subestimate the sarcopenia in individuals who are overweight and obese (28). Janssen et al. (29), in turn, in 2002 proposed a definition of sarcopenia with the skeletal mass index (SMI) by the skeletal MM divided by body mass of the subject, both in kilograms and multiplied by 100 [(MM/body mass)x100], so that individuals were considered to have a normal SMI if their SMI was greater than one SD above the sex-specific mean for young adults (aged 18-39). ASM adjusted by the body mass has been described as the most appropriate index to identify sarcopenia (5,7,15). A definition of sarcopenia was proposed by The European Working Group on Sarcopenia in Older People, in 2010, and suggests consider for diagnosing sarcopenia, not only the amount of MM but the presence of both changes, deficit of MM and low muscle function (25,30), but this criterion was not used in the studies found.

Independently of the BC analysis, a complex etiology is associated with the development of SO. It can occur in elderly, in sedentary adults with body weight gain or in obese adults with chronic comorbidities with active inflammatory process (2,31).

Many explanations for SO have been proposed and evidences suggest that a vicious cycle between the accumulation of AT and the deficit of MM is responsible for keeping the development of the phenotype (22).

The increase of AT, especially visceral fat, as well as the excess of free fatty acids may induce chronic inflammation by increased secretion of pro-inflammatory cytokines such as TNF-α and interleukin-6 (15,22). The inflammatory process, in turn, not only causes degradation of MM but also promotes insulin resistance (15) that contributes to the changes in the morphology, size and muscle function, leading to the onset and progression of sarcoepnia (22,32).

The skeletal muscle is an important tissue to capture glycose and its decrease may promote insulin resistance and its consequences (31,33,34). Sarcopenia increases insulin resistance, reduces energy expenditure and physical activity, which in turn may lead to an increase of AT, particularly of visceral fat, perpetuating the process (6,22).

Histologically, the SO presents itself as type II muscle fiber atrophy and an infiltration by adipocytes and lipids deposition on the muscular tissue, limiting its metabolic and endocrine action (22,35). To explain this characteristic, it has been suggested that muscle satellite cells *in vitro* have the ability to form adipocytes and myocytes. In human, in some pathologic situations as obesity, hyperglycemia, in the presence of high plasmatic concentrations of fatty acids, as well as the presence of physical inactivity, these satellite cells can acquire adipocytes characteristics, which would explain the presence of mature adipocytes in the muscle tissue (22). They have suggested that intramyocellular triglycerides (IMTG) are an important factor associated with inflammatory process and insulin resistance in the skeletal muscle as long chain fatty acids, diacylglycerol, and ceramides (22).

A metabolic pathway that plays a key role in regulating energy metabolism in muscle tissue is the AMP-activated protein kinase pathway. The activation of this pathway leads to the reduction of IMTG and decreases the syntheses of other factors which may induce the inflammatory process and insulin resistance. The dysregulation of this pathway occurs in certain circumstances as aging or some illnesses as obesity, metabolic syndrome (MetS) and CVD and it can contribute to fat accumulation, inflammation and insulin resistance. These facts contribute to maintain the phenotype (22) and that is why some studies indicate insulin resistance as a path for the understanding the SO (36) as in the study MrOS which administration of an insulin sensitizer in diabetic patients significantly reduced the decline in free fat mass when compared to healthy controls (37).

Inflammation also plays a central role in the pathogenesis of insulin resistance and its presence in both changes in BC: obesity and sarcopenia (38,39). In obesity, the accumulation of intramyocellular lipids results in a bioactive lipid intermediates and lipids peroxides that activate the inflammatory cascade (32,40). Furthermore, similar to the AT, muscle tissue has recently been considered an endocrine organ secreting hormones that modulate systemic metabolism. Analogs adipokines, myokines are responsible for inhibiting and preventing inflammation and insulin resistance. In individuals with SO the relative scarcity of myokines comparedto adipokines increase the risk of CVD and CMD (32,40).

A new adipokine, A-FABP (adipocyte fatty acid-binding protein), has been described as a link between obesity, inflammatoty process and insulin resistance and may be involved in the pathogenesis of SO (12). It is predominantly expressed in the adipocyte and macrophage and a significant portion is released in the bloodstream. It binds to fatty acids with high affinity, and acts in the transportation of intracellular fatty acids, in the regulation of the lipid metabolism and in the modulation of gene expression. It is possible that A-FABP works as a lipid hormone transporter or in an hormone-like fashion to modulate the systemic insulin sensibility and the energy metabolism. Some studies show that A-FABP are positively associated to body fat and negatively to MM and in human, it is associated with severity of insulin resistance and its consequences (12).

Besides the inflammatory process and insulin resistance, leptin is highlighted in the physiopathology of SO. It is secreted by adipocytes and has physiologic and physiopathologic actions in several organs, including skeletal muscle where it acts stimulating lipolysis and insulin sensitivity (3,32). The leptin receptors have been shown to be negatively regulated by leptin itself and by insulin resistance. In obese subjects, serum leptin levels increase with fat deposition diminishing its beneficial effect in skeletal muscle (3). Studies show that individuals with SO have higher serum leptin levels when compared to obese, sarcopenic or control groups (3,12,19). Serum leptin levels also correlated negatively with the MM indicators and positively with the AT indicators (3,19).

The vicious cycle between the accumulation of AT and the loss of MM can be associated with CMD and/or CVD via a large network of factors including mainly pro inflammatory cytokines and insulin resistance, but also oxidative stress, mitochondrial dysfunction, energy intake, physical inactivity and other factors which are identified (22,41,42).

SO AND RISK FACTORS FOR CARDIOMETABOLIC AND CARDIOVASCULAR DISEASES

The studies that investigated the association of OS with known cardiometabolic and/orcardiovascular risk factors, descrebed controversial results depending on the assessed population and the method used for diagnosing OS.

The association between SO and lipid profile was the issue most studied in this review, being present in 22 citations, but it was not the main objetive of these studies which limits the conclusions about their results. Only Baek et al. (15), in 2014, investigated the association between SO and dyslipidemia as the principal aim of the study in 3,483 Korean elderly. They defined sarcopenia by ASM adjusted for body mass and obesity by BMI $\geq$ 25 kg/m^2. After adjusting for confounding factors the group with SO showed a higher chance of dyslipidemia (OR, 2.82; 95% CI, 1.76-4.51) regardless of sex (15).

Many cross-sectional studies in the Korean population, especially in elderly subjects (7,10,14,43,44), but also in adults (11,12,45), showed that SO was associated with changes in the lipid profile characterized by elevated levels of triglycerides (TGL) (7,10,14,22,43-45), total cholesterol (TC) (22) and reduction of the high density lipoprotein (HDL) (10,11). They used as criterion for diagnosis of sarcopenia, ASM adjusted for body mass and for obesity, BMI > 25 kg/m^2, the visceral fat area (VFA) by computed tomography (CT) or waist circumference (WC).

When ASM/height (2) was used for evaluation of sarcopenia in this population, an association was identified between SO and increased on the low density lipoprotein (LDL) ($p = 0.032$) (6). Other methods for SO defining how the SMI by DEXA associated with VFA (11,19) and MM Index (SMI) by BIA and BMI (≥ 25 kg/m^2) (13) also demonstrated associations between SO and increase of TC (13) and TGL (11,13,19) and reduced HDL (11,19). The use of *handgrip strength* (HS) (16) for defining sarcopenia and visceral fat rate/MM thigh relationships (33) or regard MM skeletal/visceral fat also demonstrated an association between SO and elevation of TGL (23,33), TC (23), LDL (23) and low HDL (16,23,33). Only few studies did not highlighted the association between SO with some changes in lipid profile, but they did not focus on the Korean population, and mostly showed changes in lipid profile related only to obese individuals (3,17,20,21,35,46). It is noteworthy that the studies in Asian populations, mostly Koreans, used as criterion for obesity BMI ≥ 25 kg/m^2, following the cutoff of World Health Organization (WHO). The use of this cutoff is recommended for international classification, but for public health actions, a lower cutoff BMI is recommended, ≥ 23 kg/m^2 representing increased risk and ≥ 27.5 kg/m^2 representing high risk (47). Asians generally have a higher percentage of body fat than white individuals of the same age, sex and BMI represeting risk factor for type 2 diabetes and CVD (47,48). This observation lead WHO to debate the proposed methods by which countries could make decisions about the definitions of increased risk for their population (47).

The association between SO and insulin resistance has also been well described in the literature, being cited in 16 of the studies included. Srikanthan et al., 2010 (40), investigated 14,528 healthy individuals aged ≥ 20 years, using BMI > 30 kg/m^2 for obesity definition and SMI by BIA. Consistent with their hypothesis, the authors showed that the group of individuals with SO had the highest OR for insulin resistance (OR, 2.13; 95% CI, 2.02 to 2.23, $p < 0.0001$), even if excluded diabetic subjects from the analysis (OR, 1.99; 95% CI, 1.89-2.08; $p < 0.0001$). It was also observed that this association was stronger in adults than in elderly (OR, 2.39; 95% CI, 2.24-2.55; $p < 0.0001$ in adults and OR, 1.86; 95% CI, 1.73-2.00; $p < 0.0001$ in ederly) what can be explained by sarcopenia associated with an inflammatory process in these patients, suggesting that inflammation may play a role in the development of metabolic complications of sarcopenia (40).

The association between SO and insulin resistance was described, only in women (11), male (12) or in the both sexes (3,7,9,14,15,43,44). All these studies used HOMA-IR (homeostatic model assessment insulin resistance) to investigated insulin resistance, but different methodologies were used to evaluate sarcopenia: ASM adjusted for body mass (7,11,12,14,15,43,44) or height (9), muscular area in the thigh/visceral fat (3) and the MM index (DEXA) (11) and BMI (12,14,15,43,44), VFA (3,7,11) and WC (9) for evaluate obesity. Individuals with SO showed a higher HOMA-IR when compared to others who were obese, sarcopenic or normal individuals (3,7,9,11,12,14,15,43,44).

Even the HOMA-IR showed a negative correlation with the storage of MM and positive correlation with the AT reserve (19), some studies found higher HOMA-IRvalues in the group of obese individuals with sarcopenia when compared with those OS, sarcopenic and normal subjects (8,19). Only one study (35) showed no difference between sarcopenic obese group and obese, but it used an equation to estimated visceral fat from body fat, which may limit the defining criterion.

Studies intend to evaluate the association of the SO with inflammatory process, using the ASM adjusted by body mass (12), SMI (8,11,20), HS (38) and arm muscle circumference (49), as markers of sarcopenia and VFA (11), WC (8,38,49), the percentage of body fat by DEXA (20) and BMI (12) to identify obesity, showed that individuals with SO had higher ultra-sensitive C-reactive protein levels (CRP US) in women (8,11,12,20,38,49) and men (8,12,20,38,49) andhigher IL-6 (12,38) when compared with obese, sarcopenic or normal individuals; but no association with TNF-α (20) e adiponectin (12). So that individuals with SO has 1.4 more likely to have elevation in CRP levels compared to the standard group (OR, 1.438; 95% CI, 1.139-1.815, $p = 0.002$), even after adjusting for other clinical variables that have influence on the inflammatory process (11).

Schrager et al. in 2007 (38) also highlighted that the distribution of fat mass is an important aspect and central obesity is more pro-inflammatory than global obesity. It was also demonstrated a strong effect of muscle strength in predictive model CRP US and IL-6. With these findings, the group provides evidence that central obesity can adversely affect muscle strength by stimulating the production of pro-inflammatory cytokines and IL-6 pathway stimulation.

CRP US also relate to MM assessed by SMI (DEXA) and the VFA, in isolation, of both sexes (11,19). Studies using a regression equation with appendicular skeletal MM and fat mass (17), overweight and sarcopenic individuals (46), the VFA estimated by formula and SMI (35) and the VFA and the area the cross sectional thigh muscle (3), respectively, for the diagnosis of SO did not show any differences between the inflammatory parameters evaluated in the presence and/or absence of obesity and sarcopenia (3,17,35,46). Already Levine & Crimmins, 2012 (9) showed higher CRP levels in non-obese sarcopenic individuals, and attributed this finding by using an indicator of the amount of MM and not functionality.

Vitamin D deficiency is another risk factor for CMD and CVD.It has been associated with insulin resistance and type 2 diabetes as well as obesity. Moreover, vitamin D levels, assessed by serum 25 [OH] D, may have an effect on mass and muscle function (11). A high intake of vitamin D and calcium in rats resulted in reduced accumulation of body fat and increase in lean mass, with a commensurate increase in expression of insulin receptors (50).

Studies using the ASM adjusted for body mass and SMI assessed by DEXA as sarcopenia indicator (10,11,14) and BMI (14), the WC (10) and VFA (11) as obesity indicators showed that individuals with OS have lower levels of 25 [OH] D, compared with sarcopenic, obese or normal individuals (11,14), or when compared with those without sarcopenic obesity (10). Although the levels of 25 [OH] D were positively correlated with the amount of lean body mass in both sexes and negatively correlated with visceral fat in men (11), patients with SO of both sexes had higher levels of vitamin D deficit, compared to the other groups (14). Subjects in the highest quartile of distribution of levels of 25 [OH] D showed protection to SO in both sexes (10).

Among other risk factors studied in literature, Atkins et al., in 2014 (49), evaluated the association between SO and homeostasis indicators, such as the plasma levels of D-dimer and thevon Willebrand Factor, showing that patients with SO had higher plasma levels of the two indicators.

SO, CARDIOMETABOLIC AND CARDIOVASCULAR DISEASES

Despite evidence, the association between SO and CMD and CVD itself has been less studied (25). There are few prospective studies to examine this association. Five publications with this design were identified, all the others were cross-sectional studies.

The association with hypertension is the most studied. Studies evaluating sarcopenia by ASM adjusted for body mass (12,14,21,44,45,51) and SMI (19) and obesity by BMI (12,14,21,44), the WC (45,51) andVFA (19) showed that both men and women with SO had higher blood pressure values compared with sarcopenic, obese or normal individuals (12,14,19,21). Individuals with SO also had higher prevalence of (44,45) and a higher odds ratio of developing hypertension compared to normal subjects (44,51). The sarcopenic obese group also had the highest percentage of individuals using antihypertensive drugs (44).

Studies using the SMI (13,20) to define sarcopenia and BMI (13) and the fat mass (FM) percentage (20) for definition of obesity, identified the association with hypertension only for the obese group (1,20). Others that used HS (16), regression equations (17) or the SMI adjusted for height (6) to define sarcopenia, showed no difference among the groups (obese, sarcopenic, sarcopenic obesity and normals individuals) (6,16,17).

It is known that blood pressure is directly related to body size in the general population. The association between SO and hypertension, can be traced to sarcopenia being independently associated with hypertension, adding to the risk factors of AT accumulation. The loss of MM represents a decrease in insulin responsive mass, promoting insulin resistance and hypertension (44). The arterial stiffness, a risk factor also evaluated, is an important determinant of high blood pressure and predictor of adverse cardiovascular events (36). Studies using cross-sectional area of the thigh muscle and VFA, measured by CT, for diagnosing SO found that the it is associated with increased arterial stiffness (52,53). Resistance training could be recommended to increase the MM and to improve the protection against hypertension and arterial stiffness in this population (21).

MetS is also evaluated in several studies. The strong relationship between SO and MetS has been little explored, but it is known that the inflammatory process plays a key role in this respect because it is associated with increased AT and MM deficit and insulin resistance, favoring the altered metabolism (13). Studies using diagnostic sarcopenia ASM adjusted for body mass (7,11,14,45) or the height (4,6) and the SMI by BIA (13) and by DEXA (11), and the obesity diagnosis by percentage of FM (4,6), VFA (7,11), BMI (13,14) and WC (45), showed that individuals with SO had higher prevalence of MetS compared to groups regardless of sex (4,11,14,45) and only when compared to normal subjects (6). The SO also showed an association with components of MetS (13) and the amount of components (6) presented by subjects with the syndrome. The OR for MetS was also higher in the group of subjects with SO than in the other groups (OR, 11.59; 95% CI, 6.72-19.98) suggesting that it also can be considered a major risk factor for MetS in addition to sarcopenia and isolated obesity (6,7). The number of components in MetS was also correlated negatively with SMI and positively with VFA, in both sexes (11).

Studies evaluating the SO through the relationship skeletal MM/visceral fat (23) and the rate visceral fat /thigh muscle (33), also found that individuals with SO had higher prevalence of MetS (33), higher reason to chance to MetS (23,33) and is associated with the components of MetS (33). It was observed that MetS components had a negative correlation with the rate ASM/visceral fat (23) and a positive correlation with the rate of visceral fat/thigh muscle (33). But when the SO was evaluated by handgrip strength associated with WC the higher prevalence of MetS was only in the obese group (16).

The CMD studies also show the association between SO and diabetes mellitus. Studies using the HS and the SMI to define sarcopenia and WC and BMI for definition of obesity, showed that there was a higher prevalence of diabetes mellitus among individuals with SO than among others. In the SO group, there was a higher odds ratio of having pre diabetes (OR, 1.46; 95% CI, 1.12-1.75) expressed by a glycated hemoglobin $\geq 6\%$ and $< 6.5\%$ or a fasting glucose ≥ 100 mg/dL and < 126 mg/dL and diabetes (OR, 2.81; 95% CI, 2.30-3.43), expressed by a glycated hemoglobin $\geq$ 6,5% or a fasting glucose ≥ 126 mg/dL (16,40).

Because of the aforementioned associations and the importance of risk factors, it is necessary to investigate the relationship between SO and the presence of CVD installed. Study using the ASM adjusted for body mass and BMI to define SO, found that older individuals with this phenotype had higher prevalence of coronary heart disease and higher cardiovascular risk in ≥ 10 years (21). The odds ratio for this risk, even after adjusting for confounding variables such as food intake, exercise and alcohol consumption was greater in sarcopenic obese group for both men (OR, 2.49; 95% CI, 1.53- 4.06) and women (OR, 1; 87; 95% CI, 1.02-3.41) (21).

When evaluating sarcopenia through muscle strength, it was also found that compared to normal body composition, the risk of congestive heart failure has increased to 42% ($p = 0.002$) and

the risk for CVD was increased by 23% (p = 0.006) in subjects with SO (5).

Chin et al. in 2013 (43) even using the ASM adjusted for body mass and BMI to define SO in elderly Koreans did not identify difference in the proportion of individuals with CVD. As Atkins et al. in 2014 (49) using for diagnosis of SO, the arm muscle circumference and the WC in a cohort of 11 years, also did not identify any association between SO and coronary heart disease and cardiovascular events. Therefore the difference of methods and study designs may contribute to differences in the results of the associations.

Several mechanisms may explain the relationship between SO and the increase of risk for CVD. Based on all described metabolic changes that the MM deficit promotes is the possibility that the skeletal MM acts as a protective agent against CVD, however it is known that the loss of MM does not occur in isolation but is strongly associated with the parallel increase of AT and this mechanism leads to a vicious cycle that works synergistically may also increase the risk for CVD (21).

SO, CVD AND CMD IN SPECIAL CLINICAL SITUATIONS

The ability to stabilize chronic diseases is a great advance in modern medicine, leading to extended life expectancy in the population. However chronic diseases is associated with metabolic abnormalities and changes in body composition can affect your outcome and increase the demand and the cost of the health system. There is a close relationship between the loss of MM and chronic diseases, so that the term sarcopenia which was originally introduced to define the decline in MM associated with age is now used to indicate loss mass or function muscle related to chronic diseases or low-protein and energy intake (31). The causes of sarcopenia in chronic diseases and cancer include inflammation, physical inactivity, sub-optimal protein intake as well as factors related to age.

The sarcopenia with normal or excess AT can be observed in cancer patients undergoing adjuvant chemotherapy (54) and even more so in patients with chronic kidney disease and chronic obstructive pulmonary disease (55). The SO on these clinical situations can be caused mainly by the high prevalence of obesity in the population in general and the presence of the inflammatory system activation in these clinical conditions (31).

The clinical outcomes of patients with chronic diseases and SO are worse than the obese patients with normal MM (31) and in these situations, the SO can also be associated with CVD and CMD. The evaluation of patients after liver transplantation, has identified a prevalence of 88% of SO and these patients had a higher frequency of MetS compared to transplanted without SO (57% *vs.* 20%, p = 0.041) (56). The evaluation of 328 patients with chronic kidney disease in final stages, using BMI and subjective global assessment for diagnosis of SO, found that this group had higher percentage of diabetic patients, as well as higher serum levels of leptin, CRP US and IL-6 (57).

DISCUSSION

The most important problem in clinical practice and research in SO is the lack of a definition. OS is not only the junction of two pathological conditions, but the additive effect of both. Most of the selected studies are cross-sectional and show great discrepancy in methods, but they indicate the association of the SO with cardiovascular risk factors and/or CVD and CMD. The better understanding about this association is important to prevent these effects in the general population and in those individuals with associated diseases.

REFERENCES

1. Thibault R, Pichard C. The evaluation of body composition: a useful tool for clinical practice. Ann Nutr Metab 2012;60(1):6-16.
2. Prado CM, Wells JC, Smith SR, Stephan BC, Siervo M. Sarcopenic obesity: a critical appraisal of the current evidence. Clin Nutr 2012;31(5):583-601.
3. Kohara K, Ochi M, Tabara Y, Nagai T, Igase M, Miki T. Leptin in sarcopenic visceral obesity: possible link between adipocytes and myocytes. Plos One 2011;6(9):E24633.
4. Baumgartner RN, Wayne SJ, Waters DL, Janssen I, Gallagher D, Morley JE. Sarcopenic obesity predicts instrumental activities of daily living disability in the elderly. Obes Res 2004;12(12):1995-2004.
5. Stephen Wc, Janssen I. Sarcopenic-obesity and cardiovascular disease risk in the elderly. J Nutr Health Aging 2009;13(5):460-6.
6. Kim TN, Yang SJ, Yoo HJ, Lim KI, Kang HJ, Song W, et al. Prevalence of sarcopenia and sarcopenic obesity in Korean adults: The Korean Sarcopenic Obesity Study. Int J Obes (Lond) 2009;33(8):885-92.
7. Lim S, Kim JH, Yoon JW, Kang SM, Choi SH, Park YJ, et al. Sarcopenic obesity: prevalence and association with metabolic syndrome in the Korean Longitudinal Study On Health And Aging (Klosha). Diabetes Care 2010;33(7):1652-4.
8. Levine ME, Crimmins EM. Sarcopenic Obesity and cognitive functioning: the mediating roles of insulin resistance and inflammation? Curr Gerontol Geriatr Res 2012;2012:826398.
9. Levine ME, Crimmins EM. The Impact of insulin resistance and inflammation on the association between sarcopenic obesity and physical functioning. Obesity (Silver Spring) 2012;20(10):2101-6.
10. Hwang B, Lim JY, Lee J, Choi NK, Ahn YO, Park BJ. Prevalence rate and associated factors of sarcopenic obesity in korean elderly population. J Korean Med Sci 2012;27(7):748-55.
11. Kim TN, Park MS, Lim KI, Choi HY, Yang SjJ, Yoo HJ, et al. Relationships between sarcopenic obesity and insulin resistance, inflammation, and vitamin D status: The Korean Sarcopenic Obesity Study. Clin Endocrinol (Oxf) 2013;78(4):525-32.
12. Kim TN, Won JC, Kim YJ, Lee EJ, Kim MK, Park MS, et al. Serum Adipocyte fatty acid-binding protein levels are independently associated with sarcopenic obesity. Diabetes Res Clin Pract 2013;101(2):210-7.
13. Lu CW, Yang KC, Chang HH, Lee LT, Chen CY, Huang KC. Sarcopenic obesity is closely associated with metabolic syndrome. Obes Res Clin Pract 2013;7(4):E301-E307.
14. Chung JY, Kang HT, Lee DC, Lee HR, Lee YJ. Body composition and its association with cardiometabolic risk factors in the elderly: a focus on sarcopenic obesity. Arch Gerontol Geriatr 2013;56(1):270-8.
15. Baek SJ, Nam GE, Han KD, Choi SW, Jung SW, Bok AR, et al. Sarcopenia and sarcopenic obesity and their association with dyslipidemia in korean elderly men: The 2008-2010 Korea National Health And Nutrition Examination Survey. J Endocrinol Invest 2014;37(3):247-60.
16. Liu L, Chen L, Yeh K, Llin M, Hwang A, Peng L, et al. Sarcopenia, but not sarcopenic obesity, predicts mortality for older old men: a 3-year prospective cohort study. Journal Of Clinical Gerontology & Geriatrics 2014;5:42-6.
17. Dos Santos EP, Gadelha AB, Safons MP, Nobrega OT, Oliveira RJ, Lima RM. Sarcopenia and sarcopenic obesity classifications and cardiometabolic risks in older women. Arch Gerontol Geriatr 2014;59(1):56-61.
18. Batsis JA, Mackenzie TA, Barre LK, Lopez-Jimenez F, Bartels SJ. Sarcopenia, sarcopenic obesity and mortality in older adults: results from the National Health and Nutrition Examination Survey III. Eur J Clin Nutr 2014;68(9):1001-7.

19. Kim TN, Park M, Ksim YJ, Lee EJ, Kim MK, Kim JM, et al. Association of low muscle mass and combined low muscle mass and visceral obesity with low cardiorespiratory fitness. Plos One 2014;9(6):E100118.
20. Yang CW, Li CI, Li TC, Liu CS, Lin CH, Lin WY, et al. Association of sarcopenic obesity with higher serum high-sensitivity c-reactive protein levels in chinese older males - a community-based study (Taichung Community Health Study-Elderly, TCHS-E). Plos One 2015;10(7):E0132908.
21. Kim JH, Cho JJ, Park YS. Relationship between sarcopenic obesity and cardiovascular disease risk as estimated by the Framingham Risk Score. J Korean Med Sci 2015;30(3):264-71.
22. Kim TN, Choi KM. The implications of sarcopenia and sarcopenic obesity on cardiometabolic disease. J Cell Biochem 2015;116(7):1171-8.
23. Kim TN, Park MS, Lim KI, Yang SJ, Yoo HJ, Kang HJ, et al. Skeletal muscle mass to visceral fat area ratio is associated with metabolic syndrome and arterial stiffness: The Korean Sarcopenic Obesity Study (Ksos). Diabetes Res Clin Pract 2011;93(2):285-91.
24. Cauley JA. An Overview of sarcopenic obesity. J Clin Densitom 2015;30.
25. Atkins JL, Wannamethee SG. The effect of sarcopenic obesity in cardiovascular disease and all-cause mortality in older people. Reviews In Clinical Gerontology 2015;25:86-97.
26. Baumgartner RN. Body Composition In Healthy Aging. Ann N Y Acad Sci 2000;904:437-48.
27. Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, et al. Epidemiology of sarcopenia among the elderly in New Mexico. Am J Epidemiol 1998;147(8):755-63.
28. Newman AB, Kupelian V, Visser M, Simonsick E, Goodpaster B, Nevitt M, et al. Sarcopenia: alternative definitions and associations with lower extremity function. J Am Geriatr Soc 2003;51(11):1602-9.
29. Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. J Am Geriatr Soc 2002;50(5):889-96.
30. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European Consensus On Definition And Diagnosis: Report of the European Working Group On Sarcopenia In Older People. Age Ageing 2010;39(4):412-23.
31. Biolo G, Cederholm T, Muscaritoli M. Muscle contractile and metabolic dysfunction is a common feature of sarcopenia of aging and chronic diseases: from sarcopenic obesity to cachexia. Clin Nutr 2014;33(5):737-48.
32. Kob R, Bollheimer LC, Bertsch T, Fellner C, Djukic M, Sieber CC, et al. Sarcopenic obesity: molecular clues to a better understanding of its pathogenesis? Biogerontology 2015;16(1):15-29.
33. Lim Ki, Yang SJ, Kim TN, Yoo HJ, Kang HJ, Song W, et al. The association between the ratio of visceral fat to thigh muscle area and metabolic syndrome: the Korean Sarcopenic Obesity Study (KSOS). Clin Endocrinol (Oxf) 2010;73(5):588-94.
34. Juby AG. A Healthy body habitus is more than just a normal BMI: implications of sarcopenia and sarcopenic obesity. Maturitas 2014;78(4):243-4.
35. Aubertin-Leheudre M, Lord C, Goulet ED, Khalil A, Dionne IJ. Effect of sarcopenia on cardiovascular disease risk factors in obese postmenopausal women. Obesity (Silver Spring) 2006;14(12):2277-83.
36. Kohara K. Sarcopenic obesity in aging population: current status and future directions for research. Endocrine 2014;45(1):15-25.
37. Lee CG, Boyko EJ, Barrett-Connor E, Miljkovic I, Hoffman AR, Everson-Rose SA, et al. Insulin sensitizers may attenuate lean mass loss in older men with diabetes. Diabetes Care 2011;34(11):2381-6.
38. Schrager MA, Metter EJ, Simonsick E, Ble A, Bandinelli S, Lauretani F, et al. Sarcopenic obesity and inflammation in the Inchianti Study. J Appl Physiol (1985) 2007;102(3):919-25.
39. Dominguez LJ, Barbagallo M. The cardiometabolic syndrome and sarcopenic obesity in older persons. J Cardiometab Syndr 2007;2(3):183-9.
40. Srikanthan P, Hevener Al, Karlamangla AS. Sarcopenia exacerbates obesity-Associated insulin resistance and dysglycemia: findings from the National Health and Nutrition Examination Survey III. Plos One 2010;5(5):E10805.
41. Despres JP, Lemieux I. Abdominal obesity and metabolic syndrome. Nature 2006;444(7121):881-7.
42. Kim TN, Choi KM. Sarcopenia: definition, epidemiology, and pathophysiology. J Bone Metab 2013;20(1):1-10.
43. Chin SO, Rhee SY, Chon S, Hwang YC, Jeong IK, Oh S, et al. Sarcopenia is independently associated with cardiovascular disease in older Korean adults: the Korea National Health and Nutrition Examination Survey (KNHANES) From 2009. Plos One 2013;8(3):E60119.
44. Han K, Park YM, Kwon HS, Ko SH, Lee SH, Yim HW, et al. Sarcopenia as a determinant of blood pressure in older Koreans: Findings from the Korea National Health and Nutrition Examination Surveys (KNHANES) 2008-2010. Plos One 2014;9(1):E86902.
45. Park SH, Park JH, Park HY, Jang HJ, Kim HK, Park J, et al. Additional role of sarcopenia to waist circumference in predicting the odds of metabolic syndrome. Clin Nutr 2014;33(4):668-72.
46. Messier V, Karelis AD, Lavoie ME, Brochu M, Faraj M, Strychar I, et al. Metabolic profile and quality of life in class i sarcopenic overweight and obese postmenopausal women: a Monet Study. Appl Physiol Nutr Metab 2009;34(1):18-24.
47. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363(9403):157-63.
48. Gupta M, Singh N, Verma S. South Asian and cardiovascular risk. Circulation 2006;113:E924-29.
49. Atkins JL, Whincup PH, Morris RW, Lennon LT, Papacosta O, Wannamethee SG. Sarcopenic obesity and risk of cardiovascular disease and mortality: a population-based cohort study of older men. J Am Geriatr Soc 2014;62(2):253-60.
50. Siddiqui SM, Chang E, Li J, Burlage C, Zou M, Buhman KK, et al. Dietary intervention with vitamin D, calcium, and whey protein reduced fat mass and increased lean mass in rats. Nutr Res 2008;28(11):783-90.
51. Park SH, Park JH, Song PS, Kim DK, Kim KH, Seol SH, et al. Sarcopenic obesity as an independent risk factor of hypertension. J Am Soc Hypertens 2013;7(6):420-5.
52. Kohara K, Ochi M, Tabara Y, Nagai T, Igase M, Miki T. Arterial stiffness in sarcopenic visceral obesity in the elderly: J-Shipp Study. Int J Cardiol 2012;158(1):146-8.
53. Ohara M, Kohara K, Tabara Y, Ochi M, Nagai T, Igase M, et al. Sarcopenic obesity and arterial stiffness, pressure wave reflection and central pulse pressure: the J-Shipp Study. Int J Cardiol 2014;174(1):214-7.
54. Freedman RJ, Aziz N, Albanes D, Hartman T, Danforth D, Hill S, et al. Weight and body composition changes during and after adjuvant chemotherapy in women with breast cancer. J Clin Endocrinol Metab 2004;89(5):2248-53.
55. Vermeeren MA, Creutzberg EC, Schols AM, Postma DS, Pieters WR, Roldaan AC, et al. Prevalence of nutritional depletion in a large out-patient population of patients with COPD. Respir Med 2006;100(8):1349-55.
56. Choudhary NS, Saigal S, Saraf N, Mohanka R, Rastogi A, Goja S, et al. Sarcopenic obesity with metabolic syndrome: a newly recognized entity following living donor liver transplantation. Clin Transplant 2015;29(3):211-5.
57. Honda H, Qureshi AR, Axelsson J, Heimburger O, Suliman ME, Barany P, et al. Obese sarcopenia in patients with end-stage renal disease is associated with inflammation and increased mortality. Am J Clin Nutr 2007;86(3):633-8.

Fe de erratas

En Nutrición Hospitalaria 2016;33(Suppl. 3):1-3, aparece el artículo "Conclusions of the II International and IV Spanish Hydration Congress. Toledo, Spain, 2nd-4th December, 2015". Como autores de este figuran Aranceta-Bartrina J, Gil A, Marcos A, Pérez-Rodrigo C, Serra-Majem LL, Varela-Moreiras G, cuando lo correcto es que aparezca la cita de la siguiente manera:

Aranceta-Bartrina J, Gil A, Marcos A, Pérez-Rodrigo C, Serra-Majem LL, Varela-Moreiras G, on behalf of the Scientific Committee, Scientific Secretary and Speakers: Drewnowski A, Palou A, Anadón A, Murray B, Gómez-Candela C, Maffeis C, Ramón D, Benton D, Corella D, Alonso-Aperte E, Martínez de Victoria E, O'Neal E, Pfeffer F, Braun H, Lukaski H, Polanco I, Bernal J, González-Alonso J, Ordovás JM, del Coso J, Kenney L, Sardinha LB, Díaz-Rubio M, González-Gross M, Kapsokefalou M, Sawka MN, Millard-Stafford M, Palacios N, Watson P, Riobó P, Urrialde R, Mora-Rodríguez R, Maughan RJ, Ortega RM, Gellert R, Oliver S, Trangmar S and Partearroyo T. Conclusions of the II International and IV Spanish Hydration Congress. Toledo, Spain, 2nd-4th December, 2015. Nutr Hosp 2016;33(Suppl. 3):1-3.

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