Nutrición Hospitalaria

SENPE

Definición de (proto)nutritipos basados en la categorización cualitativa nutricional y un nutrimetro cuantitativo para reflejar el bienestar nutricional relacionado con la calidad de vida

Definition of nutritionally qualitative categorizing (proto)nutritypes and a pilot quantitative nutrimeter for mirroring nutritional well-being based on a quality of life health related questionnaire

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Definition of nutritionally qualitative categorizing (proto)nutritypes and a pilot quantitative nutrimeter for mirroring nutritional well-being based on a quality of life health related questionnaire

Diseño de (proto)nutritipos nutricionales cualitativos de categorización y un nutrimetro cuantitativo piloto para reflejar el bienestar nutricional basado en un cuestionario de calidad de vida relacionado con la salud

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ABSTRACT

Background: there are numerous approaches to assess nutritional status, which are putatively applied to nutritionally classify diseased people, but less information is available to study the role of environmental factors on nutritional well-being. A qualitative (nutritypes) and quantitative (nutrimeter) nutritional categorization based on dietary, lifestyle and disease criteria can be a useful nutritional approach to personalize health interventions and identify at risk individuals.

Methods: cross-sectional study conducted on 102 patients (60 women), evaluating quality of life using the Short-Form 36 questionnaire (SF-36) and lifestyle factors with a general questionnaire, the Mediterranean Diet Adherence Screener (MEDAS) and the Global Physical Activity Questionnaire (GPAQ). A nutrimeter based on physical activity, fat mass, diet and diseases (hypertension, pre-diabetes, obesity and dyslipidemia) data was defined with an equation to quantitatively score the nutritive well-being of the participants, and classify them into two (proto)nutritypes.

Results: participants were categorized into two groups (lower/higher global health) according to quality of life. Significant or marginal statistical differences in physical activity, fat mass, diet and disease were found (all $p < 0.1$). Two (proto)nutritypes were identified based on participant's age, sex, fat mass, physical activity, diet and diseases. Participants classified as high nutritional well-being nutritype showed higher values for physical, mental and global health dimensions. Age, fat mass, physical activity and diet, when categorized by the median, confirm that the designed nutritional well-being nutrimeter identifies two (proto)nutritypes.

Conclusions: the association between phenotypical (fat mass/diseases) and lifestyle factors (diet/physicl activity) with quality of life allowed categorizing individuals with a nutritional quantitative score or nutrimeter according to their nutritional well-being and discriminate two qualitative (proto)nutritypes.

Key words: Nutrimeter. Nutritype. Nutritional well-being. Lifestyle. Quality of life. SF-36.

RESUMEN

Introducción: el estado nutricional puede clasificar metabólicamente a las personas enfermas, pero falta información sobre el papel de distintos factores ambientales relacionados con el bienestar nutricional. Una categorización nutricional cualitativa (nutritipo) y cuantitativa (nutrimetro) basada en la dieta, el estilo de vida y la enfermedad es una herramienta nutricional útil para personalizar las intervenciones de salud e identificar a aquellos individuos en riesgo.

Métodos: estudio transversal en 102 pacientes, en el que se evalúa la calidad de vida mediante el cuestionario Short-Form 36 (SF-36) y los factores del estilo de vida con un cuestionario general, el Mediterranean Diet Adherence Screener (MEDAS) y el Global Physical Activity Questionnaire (GPAQ). Se diseñó una herramienta de evaluación (nutrimetro) de actividad física, masa grasa, dieta y enfermedades a través de una ecuación para calificar cuantitativamente el bienestar nutricional y clasificar a los participantes en (proto)nutritipos.

Resultados: los participantes se clasificaron según la calidad de vida en dos grupos (menor/mayor salud global) y se encontraron diferencias estadísticas ($p < 0,1$) en la masa grasa, la actividad física, la dieta y las enfermedades. Se identificaron dos (proto)nutritipos en función de la edad, el sexo, la masa grasa, la actividad física, la dieta y las enfermedades. Los participantes clasificados en el nutritipo de alto bienestar nutricional mostraron valores significativamente más altos para las dimensiones físicas, mentales y de salud global. La edad, la masa grasa, la actividad física y la dieta confirman que el nutrimetro diseñado puede discriminar dos (proto)nutritipos.

Conclusiones: factores fenotípicos (masa grasa/enfermedades) y del estilo de vida (dieta/actividad física) se han relacionado con la calidad de vida, permitiendo clasificar a individuos con una puntuación

nutricional cuantitativa o nutrimetro según su bienestar nutricional y discriminar dos (proto)nutritipos.

Palabras clave: Nutrimetro. Nutritipo. Bienestar nutricional. Estilo de vida. Calidad de vida. SF-36.

INTRODUCTION

The concept of health has received several definitions because it is a notion that encompasses several factors, which are complex and difficult to integrate (1). The most commonly accepted definition was initially coined in 1948 by the World Health Organization (WHO), which stated that health is a status of complete physical, mental and social well-being and not merely the absence of disease or disability (2). In such WHO declaration, the health of women and girls is recognized to be individually influenced by biology related to sex and other social determinants (3).

In this context, some authors defined “lifestyle” as a general way of living based on the interplay between habitual daily conditions and individual patterns of behavior as determined by sociocultural factors and personal features (4). Several studies have evidenced that certain changes in lifestyle are effective in impacting people’s health and reducing the burden of diseases (5).

The term quality of life (QoL) refers to an “individual’s perception of their position in life in the framework of the culture and value systems, where they live and in relation to their goals, expectations, standards and concerns” (7). While the concept of QoL includes different aspects of human features, such as where people live, job satisfaction, etc., health related to quality of life (HRQoL) covers issues of life that are dominated or significantly affected by personal health and the activities performed to maintain or improve health (8), where important lifestyle factors such as dietary and physical activity patterns with an influential role in such variable are involved. The way in which HRQoL is affected by the nutritional status and the physical activity of a person is a matter of constant interest and demanding debate since food is a basic requirement of daily human life (9).

Due to the difficulty in defining the concepts of health and quality of life, a series of limitations derive from quantifying or measuring them. The Short-Form Health Survey (SF-36) questionnaire is one of the most common ways to measure quality of life due to its reliability and validation (9). The SF-36 provides a profile of the state of health and is one of the most widely used generic scales in the evaluation of subjective clinical outcomes (9). This questionnaire consists of 36 questions, of which 35 are to evaluate health associated with eight different dimensions (10) influenced by nutrition and lifestyle.

Precision nutrition is an apparently novel concept, but for a long time several attempts have been devised for qualitatively categorizing individuals. These classifications have served to distribute individuals according to different characteristics. There is, for example, the classification of obesity based on the distribution of body fat in android or gynoid obesity (11), or the morpho-psychological classification of Kretschmer, which assigns individuals into asthenic, athletic, leptosomatic or dysplastic groups (12). More recently, people with diabetes mellitus have been classified into five "metabotypes": cluster 1 (severe autoimmune diabetes [SAID]), cluster 2 (severe insulin-deficient diabetes [SIDD]), cluster 3 (severe insulin-resistant diabetes [SIRD]), cluster 4 (mild obesity-related diabetes [MOD]) and cluster 5 (mild age-related diabetes [MARD]) (13). Given the importance of quantifying health and nutritional status, there are tools such as the Mini Nutritional Assessment (MNA) that can be implemented as a kind of nutrimeter or nutritional clasifier (14).

In this context, the need for developing a tool to qualitatively differentiate (proto)nutritypes, as well as to devise a nutrimeter to equantitatively valuate nutritional well-being, is essential. The aim of the current work was to define nutritypes in an apparently healthy population based on QoL status and to design tools to qualitatively and quantitatively assess the nutritional status. In this context, in an apparently healthy subject, personal, phenotypical and lifestyle factors that are related to nutrition and health in order to define nutritional status based on (proto)nutritypes were examined and contributed to design a nutrimeter to score the nutritional status based on quality of life data.

MATERIAL AND METHODS

From January 2018 to May 2018, a multidisciplinary care group conducted a cross-sectional study that included 102 volunteers, of whom 42 men and 60 were women aged between 21 and 66 years old and working at Clínica Universidad de Navarra (CUN), Universidad de Navarra (UNAV) or Centro de Investigación Médica Aplicada (CIMA). Volunteers were recruited by the Preventive Unit (CUN) physician, who informed them about the study. All participants were specifically asked if they would be willing to take part in a pilot survey as a part of their routine clinical history and follow-up. After ensuring the participants had understood the information, only those who voluntarily accepted were enrolled after they signed an informed consent. The Declaration of Helsinki of the World Medical Association (WMA) guidelines of 1965 and subsequent revisions were taken into account. Following criteria of the local ethical committee (Ref. 2017.034) signing the informed consent is the sufficient condition to perform the current non-invasive survey.

The survey

A nutritionist administered the survey and all the information was collected through a questionnaire, where 52 items categorized into three sections were included in this pilot survey (Supplementary File 1). The first section collected information about socio-demographic variables (sex, age, occupation, smoking status, sleeping hours), dietary habits (number of meals, visual analogue scale, salt intake, alcohol and water consumption, mean meal and number of meals out of home) and clinical variables (medical diagnosis of chronic diseases, family history of diseases, sadness, diagnosis of depression). The second section comprised the Mediterranean Diet Adherence Screener (MEDAS) questionnaire about dietary habits related to the Mediterranean Diet adherence (olive oil, vegetables, fruit, meat, butter, beverages, red wine, legumes, fish, commercial pastries and nuts consumed), which scored from 0 to 14 points as described elsewhere (15). The third section was the GPAQ questionnaire, which inquired about physical activity (at work, during free time, displacement and sitting time) (16). The Spanish version of the SF-36 questionnaire was self-administered (10).

A diet score based on some of the components of the above-mentioned MEDAS was built (Diet Score) to assess the adherence to assumed healthy Mediterranean patterns by measuring the consumption of relevant Mediterranean foods such as olive oil, fruits, vegetables, fish and red wine. Furthermore, physical activity was calculated as minutes per day performing the activity, highlighting in this way the importance of the duration of the exercise and not the frequency of it (17). A disease score (DRS) was also inflected, adding one point with the presence of each of the following conditions: prediabetes, obesity, hypercholesterolemia and hypertriglyceridemia.

Anthropometric and body composition

Waist and hip circumferences were estimated with a measuring tape and the blood pressure with a sphygmomanometer, by trained staff members following standardized protocols (18). Participants were also measured for height (cm), weight (kg), body mass index (BMI: kg/m^2) and also fat mass by bioimpedance using an appropriate manual (TBF-410GS, Tanita®, Tokyo, Japan). The degree of obesity was estimated based on the BMI, which allowed a classification of individuals according to their ponderal status as follows: underweight < 18.5 kg/m^2; normal weight: 18.5 to < 25 kg/m^2; overweight ≥ 25 to < 30 kg/m^2; and obesity ≥ 30 kg/m^2.

Blood and clinical biomarkers

To obtain biochemical data, blood samples were analyzed from each participant following routine protocols at the CUN, which is an international certified laboratory using the routine standard on the CUN. Data of the following variables were collected: total cholesterol, HDL cholesterol, LDL cholesterol, glucose and triglycerides.

The SF-36 questionnaire

The eight scales of the 36-item questionnaire were implemented: physical functioning, physical role limitation, pain, general health, vitality, social functioning, emotional role limitations and general health perception (10). The scales can be summarized into the mental health dimension and physical health dimension based on factor analysis to produce two scores scaled from 0 to 100 (high score indicating good health) as described elsewhere (19). Both dimensions together form a global health dimension. All the dimensions are hypothetically influenced by nutrition and lifestyle, and their measurement may depict the role of such factors in quality of life. In addition to these domains, there is a question, the number 36, about transition of health. For the quantitative analyses of the total score, "global health" was dichotomized into "lower" (52.0 to 84.8 points) *vs* "higher" (84.8 to 99.0 points) global health, according to the median (10).

Statistical analysis

The percentages for categorical variables and mean and standard deviation (SD) for continuous variables were calculated. The initial analyses categorized QoL into two groups (low and high global health) according to the SF-36 median score. The distribution of variables was assessed through the Shapiro-Wilk test. Differences across categories were assessed with the Chi-squared test for categorical variables and the Student's t test or the Mann-Whitney U test for quantitative variables, as appropriate, depending on statistical normality.

Linear regression models were fitted with each of the three dimensions of the SF-36 (physical health, mental health, global health, and their corresponding domains) and the question 36 about the transition of health as dependent variables, and fat mass, leisure time physical activity (measured as minutes of physical activity per day), DRS and the proposed Diet Score as independent variables. Several potential confounders were included as covariates in the multivariable adjusted model: sex, age (years, continuous), family history of hypertension (yes/no), sadness (yes/no), leisure time physical activity (minutes/d, continuous), and adherence to a healthy diet (measured with the created score; continuous) and alcohol consumption (never, weekly and monthly).

We fitted a linear regression model to design a nutrimeter to calculate the predicted score of individuals according to their sex, age, fat mass, physical activity, presence of several diseases (assessed with the DRS) and adherence to a healthy diet (assessed with the built Diet Score). Based on this nutrimeter, we fitted a logistic regression model, using the categorized variable of QoL (higher *vs* lower global health) as dependent variable. We performed an analysis to assess the accuracy of this model using the area under the receiver operating characteristic curve (area under the curve [AUC]; higher values of the AUC meaning better discriminating ability). In addition, we calculated the optimal ROC curve cut-off point using the Youden index (20), which resulted to be 0.46. This approach is used as a criterion for choosing the threshold value for which values of both sensitivity and specificity are maximized (21). We used this optimal cut-off point to classify participants into two nutritypes: mirrored low and high nutritional well-being and to quantitatively score a figure about nutritional status termed as nutrimeter. Additionally, age, fat mass, physical activity and adherence to a healthy dietary pattern was categorized by the median and the differences were studied according to the nutritional well-being score.

All analyses were performed using Stata version 12.1 (StataCorp, College Station, TX) statistical software, whose manual was followed to perform the statistical analyses. All p values presented are two-tailed; $p < 0.05$ was considered as statistically significant.

RESULTS

After categorizing (by the median) the participants according to the score obtained in the SF-36 questionnaire in two groups (low *vs* high global health), the participants discriminated as having higher global health (84.8-99.0 points), compared to those with lower global health (52.0-84.8 points), showed a statistically different ($p = 0.046$) percentage of fat mass. No significant differences were found in blood biomarkers or blood pressure between these two groups (Table I).

The higher global health group also reported lower frequency of being sad ($p = 0.005$) while participants in this “healthy” group devoted more hours per week to leisure ($p = 0.035$) and more minutes weekly to napping ($p = 0.002$) as estimation of physical activity and sedentary attitudes. Although there were no statistically significant differences ($p = 0.117$) in terms of sports time and total quality of life, the trends were as expected, where those subjects in the higher global health group status were more active. There were differences ($p = 0.045$) between SF-36 groups in terms of alcohol consumption, being higher in the participants who showed a higher global health score. Significant differences have also been found about when the main food is consumed ($p = 0.031$). In both groups, the main meal was at lunch time, but in the group of putative higher global health there are more participants whose main meal is dinner. Participants classified in the group of higher global health tend more frequently to perceive their health to be better as compared to participants in the low global health group ($p = 0.086$) (Table II).

When nutritional and health factors that influence the QoL were assessed, a negative effect of fat mass on quality of life was found, especially in the domain of physical functioning ($p = 0.003$).

Regarding the relationship between the DRS and QoL, no statistically significant differences were observed, although there were marginally significant trends within the physical functioning domain ($p = 0.075$). Conversely, a positive relationship was found between physical activity and QoL, both with the physical health dimension ($p = 0.013$) and with the global health dimension ($p = 0.013$). Also, marginal statistical relationships were established with some domains such as physical role limitation ($p = 0.095$), pain ($p = 0.059$) and social functioning ($p = 0.061$). Finally, a statistically positive significant association between a better adherence to a healthy diet and general health perception domain was evidenced ($p = 0.029$) as reported and illustrated (Table III). Associations of some SF-36 domains with fat mass (negative), physical activity (positive), a diet score (positive) and disease score (negative) are also depicted (Fig. 1).

The design of a nutrimeter considered participant's age and sex, fat mass, physical activity, DRS and adherence to a healthy diet assessed with the Diet Score. The nutritional well-being score ranged between 74.7 and 95.0 points (mean score: 86.0; SD: 4.5).

Taking into account some determinants of QoL, a logistic regression was performed to define (proto)nutritypes and design the nutrimeter. The analysis to assess the accuracy of the logistic regression model showed an AUC of 0.73, indicating that the model shows a fair accuracy to classify individuals in two new (proto)nutritype groups (Fig. 2).

The optimal cut off point value of the ROC curve, where both sensitivity and specificity values are maximized (73.3% and 68.8%, respectively), was 0.46, which corresponded to below and above 89.6 points of SF-36. Therefore, we classified participants into two (proto)nutritypes: mirrored low and high nutritional well-being. The equation to score the participants based on various factors was: nutritional well-being score = 86.044 – 0.137 * age (years) – 5.730 * sex (men/women) – 0.034 * fat mass (%) + 0.023 * physical activity (minutes/day) + 2.025 * hypertension (yes/no) – 3.689 * pre-diabetes (yes/no) + 1.513 * obesity (yes/no) – 3.694 * dyslipidemia (yes/no) + 1.777 * adherence to a healthy diet assessed with the above-mentioned Diet Score (points).

The two groups across the different QoL dimensions according to their nutritional well-being scores that were classified in the mirrored high nutritional well-being nutritype showed significant higher scores for physical, mental and global health dimensions compared to participants in the mirrored low nutritional well-being nutritype (Fig. 3).

In addition, younger participants showed higher scores compared to older participants, and men had significantly higher scores than women. Also, participants with lower fat mass and higher adherence to a healthy dietary pattern showed higher scores in the nutritional well-being nutrimeter (Fig. 4).

DISCUSSION

According to the WHO criteria, the HRQoL emphasize the need to assess vital estimators on people taking into account the subjective perceptions of the individual and associated capacities to live a useful and full life (22). The objective of this cross-sectional study was to identify the impacts of nutritional/personal inputs in addition to sex/age such as the phenotype and different lifestyle factors, on the QoL on an apparently healthy working population, and to define two nutritypes and design a nutrimeter score. The results revealed that quality of life measured with the SF-36 questionnaire is associated with several lifestyle and personal factors such as physical activity, fat mass, several dietary patterns and several diagnosed disease statuses, which were analyzed to qualitative describe two nutritypes (low nutritional well-being *vs* high nutritional well-being), as well as to design a quantitative nutritional well-being mirror or score which produces a nutrimeter of nutritional well-being.

There are some studies that demonstrate the negative relationship between waist circumference and BMI with quality of life (23).

However, there are fewer investigations that relate the quality of life with the percentage of fat mass. Becerra et al. (2013) evidenced that there is an association between a healthier fat mass profile and more positive assessments of quality of life (24). Higher body fat mass percentage predicted lower quality of life in our study, results that are similar to those obtained by Morrison et al. (2014) in a comparable cross-sectional study (25). Furthermore, Molarius et al. (2006) emphasized the importance of obesity in quality of life, establishing an association between these factors (26), where obesity predicted lower quality of life as Girón (2010) showed in his study (27). In addition, in the Mediterranean SUN cohort, greater adherence to a Mediterranean dietary pattern and lower BMI was found associated with better QoL (28).

Using the SF-36, Barcones Molero et al. (2018) examined the negative impact of obesity in health-related quality of life, which was greater on the physical dimension than on the mental dimension (29). In our analyses, relevant results were observed in the physical health dimension, which suggests that there is greater sensitivity for fat mass as well as for DRS, diet score and physical activity. No significant associations were found between BMI and QoL, albeit a trend was suggested. An inverse statistically significant association between fat mass and QoL was observed. This finding suggest that fat mass may be a better predictor of QoL than BMI.

Furthermore, the reported results suggest that those who self-declared less frequently being sad had a better quality of life, consistent with the results of Gaynes et al. (2002), who demonstrated that depression is associated with decrements to QoL (30). Our study also found a relationship between the main meal eaten and QoL. In 2018, Ferrer-Cascales et al. reported that breakfast can potentially affect mental health in several ways (31). In this line, they established that those participants who make a greater quality breakfast had a better quality of life compared to those who had a poorer breakfast or skipped it. Our results show an inverse trend between the presence of a chronic disease (assessed with the DRS) and the subcategory of physical functioning. When any of the diseases were present, QoL decreased in our analyses, in agreement with other studies (32).

The relation between physical activity and QoL has been consistently described (34-36). Thus, Sánchez-Villegas et al. (2012) found a direct association between them (33), while Piko et al. (2000) evidenced a positive correlation between physical activity and self-perceived health (34). A study by Darviri et al. (2011) reported that poor self-rated health was associated with less physical activity (35). In a clinical trial that studied the influence of physical activity and mental health, Sánchez-Villegas et al. (2008) reported an association between physical activity and sedentary behavior on the incidence of mental disorders (36). In contrast, Brown et al. (2004) suggested that participation in moderate or vigorous physical activity every day of the week or for a extended period is associated with lower HRQoL (37), which affects that physical activity criteria. Our findings showed that longer bouts of physical activity were positively associated with QoL, in agreement with previous evidence. Casals et al. (2017) found a general relation between practicing physical activity and QoL in patients with type 2 diabetes mellitus (38).

The results presented in this study suggest a relation between a healthy nutritional dietary pattern and QoL. Participants who reported a greater adherence to a healthy eating pattern (assessed with the built Diet Score) showed better self-perception of their health. These findings are consistent with the study by Henríquez-Sánchez et al. (2011), who reported a significant association between better adherence to the Mediterranean diet and several dimensions of physical and mental QoL (28). Furthermore, Sayón-Orea et al. (2018) evidenced that a higher consumption of fruits, vegetables and fish were associated with better health perception (39), which is in accordance with our findings. Furthermore, Galilea-Zabalza et al. (2018) found a positive association between adherence to the Mediterranean diet and quality of life (40).

In the present study, a valuable outcome was to design an objective tool for qualitatively categorizing subjects on two nutritypes of nutritional well-being based on subjective QoL items. Indeed, this approach allowed to classify our population in two (proto)nutritypes (mirrored low and high nutritional well-being) and study differences in the nutritional status across them. Moreover, this research devised an equation that produces quantitative values to compute the nutritional status through a nutrimeter, which was also used to further discriminate two categories or nutritypes based on age, sex, percentage of fat mass, diseases, adherence to a healthy diet and minutes of physical activity. A cut off point of 0.46 points was considered to discriminate mirrored low/high nutritional well-being.

The main strength of the present study is that most of the questionnaires have been designed and evaluated by the same researcher, who has subsequently administered them and was responsible of creating the database, which reduces bias due to misinterpretation of the questions or confusion. One limitation of the study is the restricted generalizability of our findings. Our study sample consisted of healthy people who were selected based on interest and values. Second, information about diseases, physical activity and dietary habits was retrieved based on self-reported information, and reporting bias should not be discarded, but all values that qualitative of data are used for categorizing individual nutritional status. Third, there may be a social desirability bias as participants may tend to answer in a more socially accepted way, e.g., participants may have reported higher engagement on physical activity. Fourth, the sample size of the study corresponded to a pilot study, and therefore the statistical power is limited. However, despite the small study sample, our findings showed some clear trends although type I (a-risk) or type II (b-risk) errors cannot be discarded. Finally, these exploratory analyses enlightened that higher fat mass had detrimental effects on mirrored nutritional well-being (as a proxy of QoL), whilst increased physical activity levels, better adherence to a healthy dietary pattern and the absence of chronic diseases are related to a better nutritional well-being and higher nutrimeter values. In summary, based on the results of this study, we can conclude that some lifestyle related factors, such as physical activity and adherence to a healthy diet, are associated with better self-reported QoL in addition to body composition and lack of chronic diseases. Moreover, participants classified as high nutritional well-being with the novel (proto)nutritype showed higher scores in a newly designed nutrimeter that considered nutritional and lifestyle factors. These findings remark the importance of these factors in relation to quality of life.

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Table I. Baseline characteristics, body composition and some blood biomarkers of all the participants and classifying them by SF-36 of adults in the study

	All participants	Lower global health* (52.0-84.8 points)	Higher global health† (84.8-99.0 points)	*p-value*
Subjects (n)	102	51	51	
SF-36 points	83.1 ± 9.7	76.2 ± 9.1	90.0 ± 3.6	*< 0.001*
Sex (%)				0.421
Men	41.2	37.2	62.8	
Women	58.8	45.1	54.9	
Age (years)	38.47 ± 12.38	40.80 ± 12.53	36.14 ± 11.88	0.064
Weight (kg)	67.4 ± 13.4	66.7 ± 13.1	68.0 ± 13.8	0.197
Waist circumference (cm)	80.9 ± 11.9	81.8 ± 11.3	80.0 ± 12.4	0.358
Hip circumference (cm)	98.5 ± 6.9	98.2 ± 6.4	98.8 ± 7.4	0.660
Glucose (md/dl)	91.2 ± 8.1	90.6 ± 7.9	91.8 ± 8.3	0.498
Total cholesterol (mg/dl)	180.9 ± 39.6	182.7 ± 38.7	179.1 ± 40.8	0.840
HDL cholesterol (mg/dl)	67.0 ± 16.4	64.9 ± 16.4	69.1 ± 16.4	0.208
LDL cholesterol (mg/dl)	98.9 ± 35.9	99.4 ± 33.9	98.5 ± 37.8	0.771
Triglycerides	74.5 ± 48.7	73.8 ± 41.4	75.2 ± 55.7	0.991
BMI‡ (kg/m^2)	23.74 ± 3.5	23.9 ± 3.7	23.5 ± 3.5	0.367
Degree of obesity (%)				0.688
Low weight	5.9	7.8	3.9	
Normal weight	64.7	60.8	68.6	
Overweight type I	7.8	7.8	7.8	
Overweight type II	14.7	13.7	15.7	
Obese type I	6.9	9.8	3.9	
Fat mass (%)	23.8 ± 7.4	25.2 ± 7.2	22.3 ± 7.3	*0.046*
Pre-diabetes (%)	16.0	20.8	10.9	0.187
Arterial hypertension	4.9	5.9	3.9	0.648

(%)				
Systolic pressure (mm Hg)	117.6 ± 13.1	118.5 ± 14.8	116.6 ± 11.4	0.627
Diastolic pressure (mm Hg)	76 ± 8.7	76.9 ± 8.6	75.1 ± 8.8	0.294
Dyslipidemia (%)	7.84	11.8	3.9	0.141
Hypercholesterolemia (%)	23.5	21.6	25.5	0.641
Hypertriglyceridemia (%)	6.9	7.8	5.9	0.695
DRS§ (points)	0.4 ± 0.7	0.5 ± 0.8	0.4 ± 0.6	0.389

Values are means ± SD. Percentages may not total 100 because of rounding. Significant values are in italics. *Lower global health: the punctuation on the SF-36 that is between 52.0 and 84.8 points (lower than 50th percentile). †Higher global health: SF-36 points that are between 84.8 and 99.0 (higher than 50th percentile). ‡BMI: body mass index. Low weight was defined as a BMI of less than 18.5 kg/m^2. Normal weight was defined as a BMI between 18.5 kg/m^2 and 24.9 kg/m^2. Overweight type I was defined as a BMI between 25 kg/m^2 and 26.9 kg/m^2. Overweight type II was defined as a BMI between 27 kg/m^2 and 29.9 kg/m^2. Obese type I was defined as a BMI between 30 kg/m^2 and 34.9 kg/m^2. § DRS: diseases ratio score. Score that ranges between 0 to 4 depending on the presence (or not) of obesity, hypertension, dyslipidemia or diabetes.

Table II. Physical activity, dietary habits, lifestyle factors, some blood biomarkers and SF-36 dimensions of all the participants and classifying them by SF-36 of adults in the study

	All participants	Lower global health* (52.0-84.8 points)	Higher global health† (84.8-99.0 points)	*p-value*
Subjects (n)	102	51	51	
Physical activity at work (min)	38.4 ± 104.4	53.3 ± 131.9	19.9 ± 49.9	0.848
Physical activity (min)	81.6 ± 74.1	70.1 ± 64.0	93.1 ± 82.1	0.117
Weekly leisure time (hr)	15.7 ± 11.0	14.7 ± 10.8	16.6 ± 11.1	*0.035*
Sleep time (hr)	7.0 ± 1.3	6.9 ± 1.3	7.0 ± 1.3	0.791
Nap‡ (%)	40.2	29.4	51.0	*0.026*
Nap time (min)	42.6 ± 76.7	23.6 ± 49.1	61.6 ± 93.5	*0.022*
Sitting time (hr)	6.7 ± 3.0	6.9 ± 3.0	6.5 ± 3.0	0.529
Sadness§ (%)	23.5	35.3	11.8	*0.005*
Tobacco (%)				0.757
Smoker	8.0	5.9	9.8	
Former smoker	23.0	23.5	21.6	
Non-smoker	71.0	70.6	68.6	
Health comparison‖ (%)				0.086
Better	24.0	17.7	29.4	
Equal	75.0	76.5	70.6	
Worst	3.0	5.9	0	
Alcohol (%)				*0.045*
Weekly	13.7	5.9	21.6	
Monthly	13.7	11.8	15.7	
Never	72.6	82.4	62.8	
Main meal (%)				*0.031*
Breakfast	6.9	3.9	9.8	
Lunch	82.4	92.2	72.6	
Dinner	10.8	3.9	17.7	
MEDAS¶ (points)	7.4 ± 1.9	7.6 ± 1.6	7.3 ± 2.2	0.515
Vegetables (at least 2 servings/day)	26.5	27.5	25.5	0.822
Fruit (at least 3 units/day)	29.4	23.5	35.3	0.192
Fish (at least 3 servings/week)	20.6	17.6	23.5	0.463

Red wine (at least 7 glasses/week)	10.8	13.7	7.8	0.338
Oil as mean source of fat	97.1	96.1	98.0	0.558
Oil consume (at least 4 spoons/day)	94.1	98.0	90.2	0.092
Legumes (at least 3 serving/week)	17.6	25.5	9.8	*0.038*
Diet Score** (points)	2.6 ± 0.8	2.5 ± 0.8	2.7 ± 0.8	0.148
Physical health dimension	85.4 ± 10.6	76.2 ± 9.1	90.0 ± 3.6	*< 0.001*
Mental health dimension	80.8 ± 13.4	73.6 ± 15.3	88.1 ± 4.5	*< 0.001*
Global health dimension	83.1 ± 9.8	76.2 ± 9.1	90.0 ± 3.6	*< 0.001*
Transition of health	2.9 ± 0.7	3.1 ± 0.1	2.7 ± 0.1	*< 0.001*

Values are means ± SD. Percentages may not total 100 because of rounding. Significant values are in italics. *Lower global health: the punctuation on the SF-36 that is between 52.0 and 84.8 points (lower than 50th percentile). †Higher global health: SF-36 points that are between 84.8 and 99.0 (higher than 50th percentile). ‡Nap: time asleep after lunch, in the afternoon. §Sadness: percentage of people who have recently felt sad or depressed in the questionnaire. ‖How individuals compare their health to the health of individuals in their age range. ¶MEDAS: Mediterranean Diet Adherence Screener. **Diet Score: high consumption of vegetables, fruit and fish, low consumption of red wine and use of olive oil as main source of fat.

Table III. Influence of fat mass, DRS, physical activity and diet score on all the domains and the transition of health question of the SF-36 questionnaire for measuring quality of life

Domains SF-36	*Fat mass*		*DRS**		*Physical activity*		*Diet score*[†]	
	β (95% CI)	*p-value*	*β (95% CI)*	*p-value*	*β (95% CI)*	*p-value*	*β (95% CI)*	*p-value*
Physical health dimension	0.076 (-0.279/0.430)	0.672	0.373 (-2.022/2.768)	2.768	0.034 (0.007/0.061)	*0.013*	1.629 (-0.778/4.036)	0.182
Physical functioning	-0.393 (-0.648/-0.139)	*0.003*	-1.604 (-3.374/0.167)	0.075	0.015 (-0.006/0.035)	0.155	-0.336 (-2.145/1.474)	0.713
Physical role limitation	0.412 (-0.298/1.123)	0.252	1.307 (-3.507/6.122)	0.591	0.046 (-0.008/0.100)	0.095	3.326 (-1.519/8.170)	0.176
Pain	0.330 (-0.446/1.106)	0.400	1.941 (-3.335/7.217)	0.467	0.057 (-0.002/0.117)	0.059	-0.062 (-5.377/5.254)	0.982
General health perception	-0.045 (-0.520/0.429)	0.850	-0.152 (-3.349/3.045)	0.925	0.019 (-0.017/0.055)	0.287	3.586 (0.375/6.798)	*0.029*
Mental health dimension	-0.311 (-0.678/0.056)	0.095	-0.529 (-3.059/2.001)	0.679	0.021 (-0.008/0.049)	0.150	-0.527 (-3.071/2.017)	0.682
Emotional role limitation	-0.437 (-1.326/0.451)	0.331	0.096 (-5.941/6.133)	0.975	0.015 (-0.053/0.083)	0.662	-0.873 (-6.937/5.192)	0.776

Mental health	-0.198 (-0.542/0.145)	0.255	-0.345 (-2.680/1.989)	0.770	0.006 (-0.020/0.032)	0.660	-1.063 (-3.410/1.283)	0.370
Vitality	-0.194 (-0.593/0.205)	0.337	-0.323 (-3.074/2.429)	0.816	0.025 (-0.006/0.056)	0.116	0.533 (-2.232/3.297)	0.703
Social functioning	-0.415 (-0.929/0.098)	0.111	-1.543 (-5.041/1.954)	0.383	0.038 (-0.002/0.077)	0.061	-0.705 (-4.233/2.823)	0.692
Global health dimension	-0.118 (-0.400/0.164)	0.409	-0.078 (-2.000/1.845)	0.936	0.028 (0.006/0.049)	*0.013*	0.551 (-1.381/2.482)	0.573
Transition of health	-0.012 (-0.035/0.010)	0.277	-0.056 (-0.209/0.096)	0.466	-0.001 (-0.003/0.001)	0.305	-0.069 (-0.222/0.085)	0.378

Significant values are in italics. The dependent variables are on the horizontal axis and the independent variables on the vertical axis. All the independent variables are adjusted by sex, age, family history of hypertension, sadness, physical activity, diet score and alcohol consumption. *DRS: score that ranges from 0 to 4 depending on the presence of pre-diabetes, obesity, hypercholesterolemia and hypertriglyceridemia. †Diet Score: score that ranges between 0 to 5. Scores positively the high consumption of vegetables, fruit and fish, low consumption of red wine and use of olive oil as main source of fat.

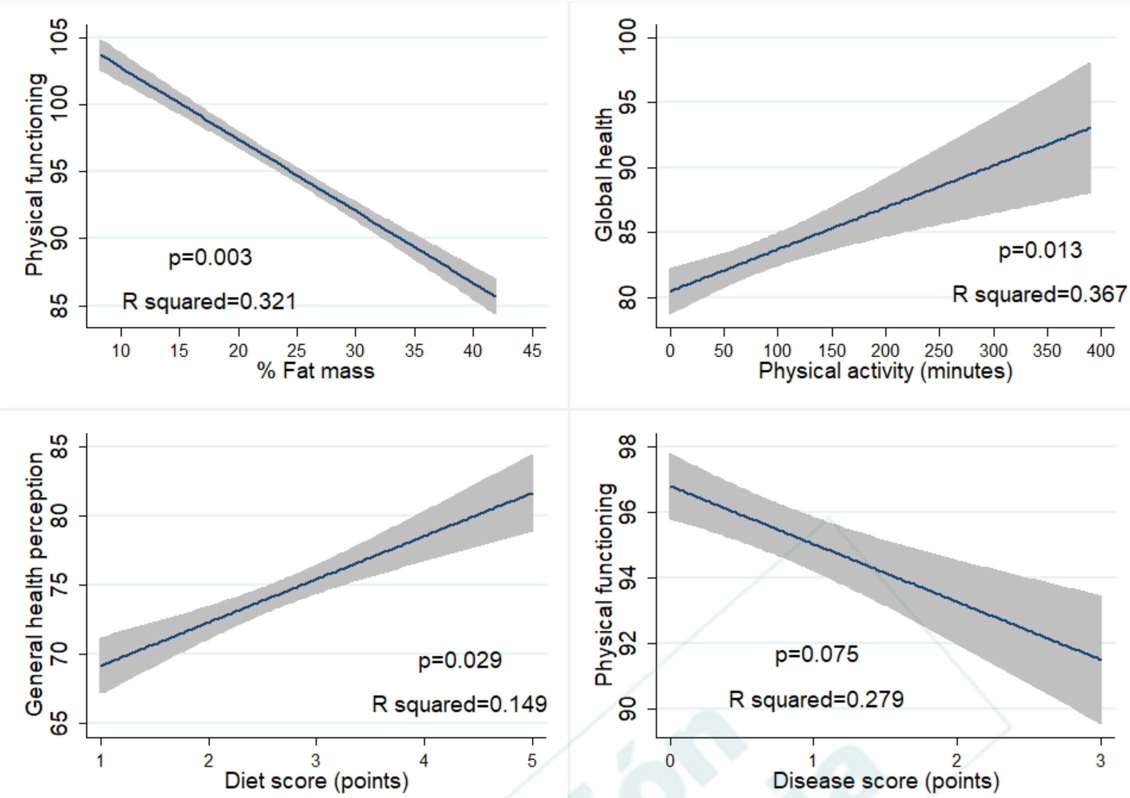

Fig. 1. Linear regression between quality of life dimensions and fat mass, physical activity, adherence to a healthy dietary pattern and DRS once adjusted by sex, age, family history of hypertension, sadness, physical activity, diet score and alcohol consumption.

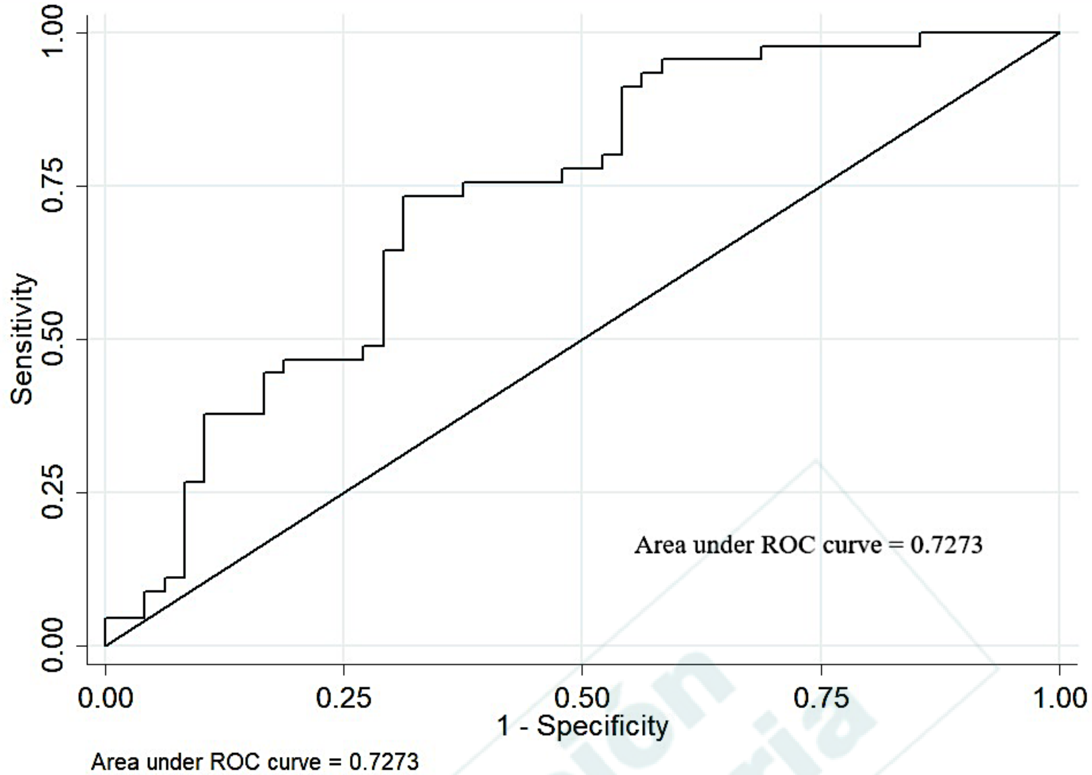

Fig. 2. Logistic regression model ROC curve.

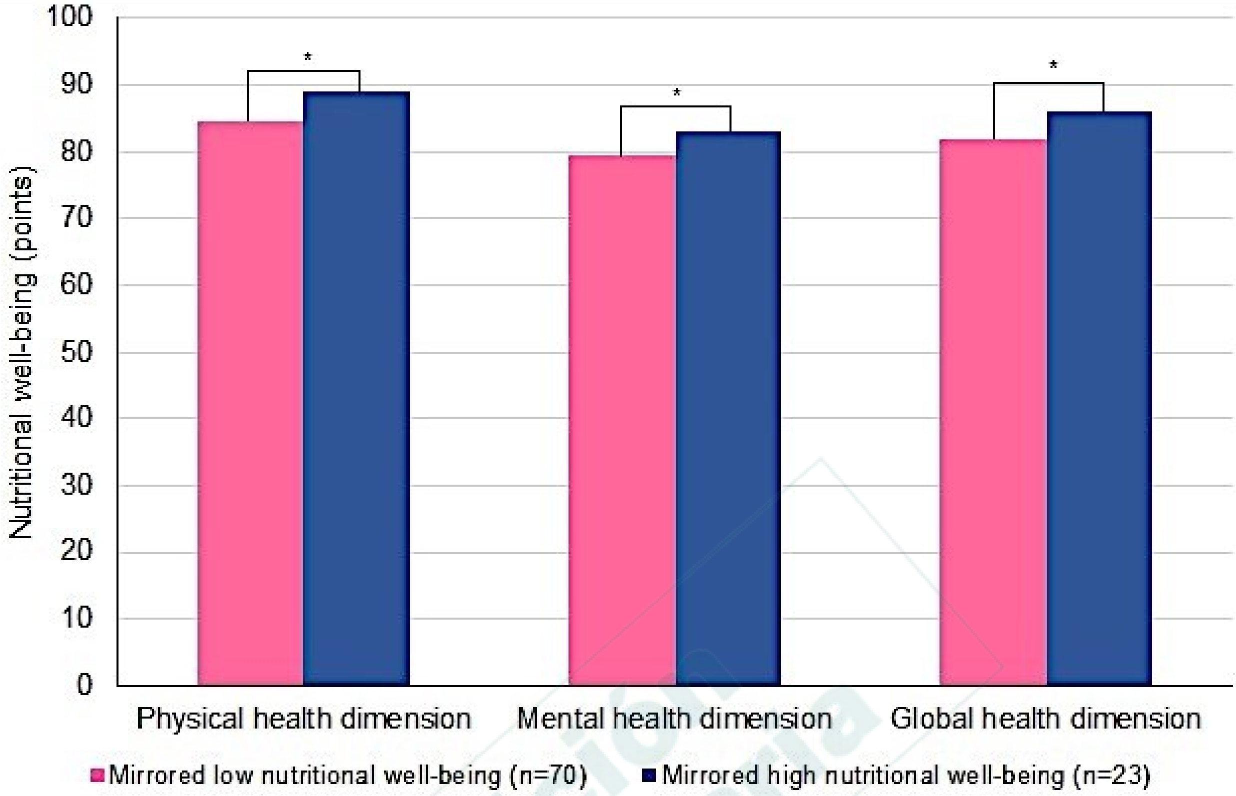

Fig. 3. Differences between mirror low and high nutritional well-being (categorized according to the optimal ROC curve cut off point, which corresponded to below and above 89.6 points) across quality of life dimensions. *p < 0.01.

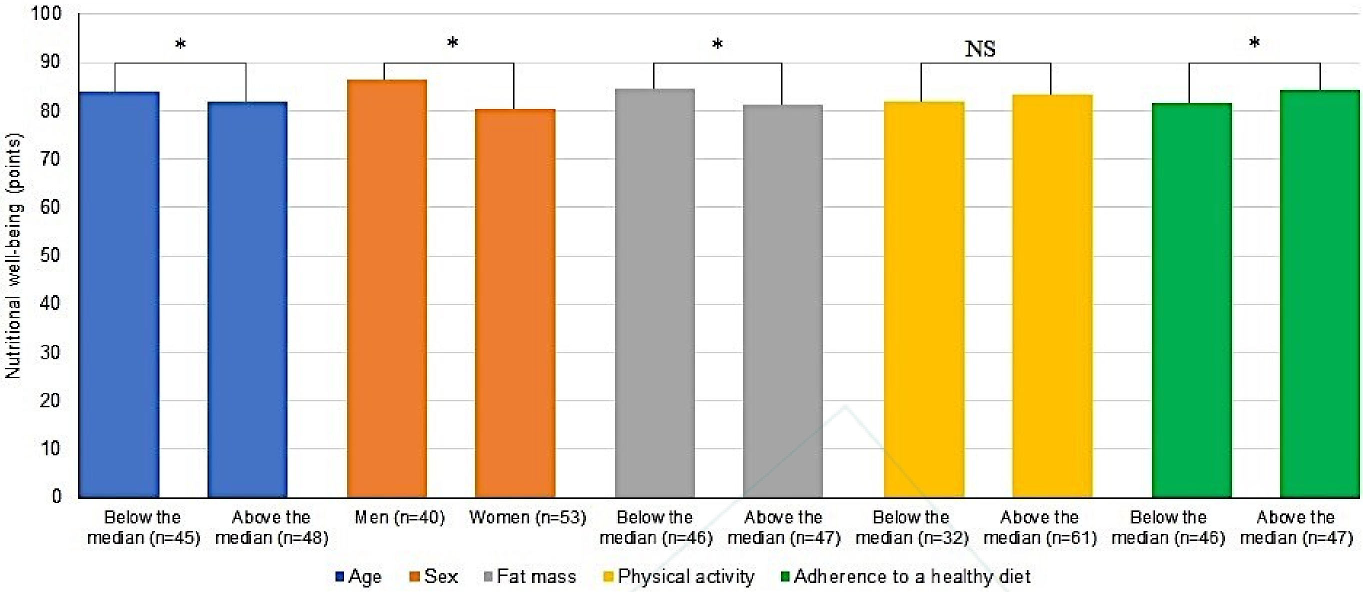

Fig. 4. Differences in age, sex, fat mass, physical activity and adherence to a healthy dietary pattern according to the nutritional well-being score. *p < 0.01. NS: non-significant.

Supplementary File 1

CUESTIONARIO DE ESTILO DE VIDA

Nombre y apellidos: ______________________	
☐ **Sexo**: ☐ Hombre Mujer	**Fecha de nacimiento**: ____/____/______
Edad: _______	**Número historia clínica:** ______________

PREGUNTAS GENERALES			
¿Cómo consideraría su salud en comparación con la gente de su edad?	Mejor ☐	Igual ☐	Peor ☐
¿Ha sido diagnosticado o actualmente está en tratamiento de diabetes?	☐ Sí	☐ No	
¿Ha sido diagnosticado o actualmente está en tratamiento de hipertensión arterial?	☐ Sí	☐ No	
¿Ha sido diagnosticado o actualmente está en tratamiento de dislipemia?	☐ Sí	☐ No	
¿Algún miembro de su familia ha sido diagnosticado de alguna de las siguientes enfermedades? ☐ ☐ ☐	Diabetes Hipertensión arterial Dislipemia Obesidad		
Últimamente, ¿se ha sentido triste, desanimado, bajo de ánimo o deprimido?	Sí	No	
¿Ha sido diagnosticado de depresión?	Sí	No	
¿Cuántas horas semanales realiza su actividad profesional?	horas		
¿Cuántas horas considera que dedica semanalmente al ocio?	horas		
¿Duerme usted la siesta?	Sí	No	
	horas		
¿Cuántas horas calcula que duerme diariamente por las noches?	horas		
¿Consume alcohol en forma de bebidas de alta graduación? (excluidos vino, sidra y cerveza)	Sí	No	
	Copas/vasos		

PREGUNTAS GENERALES (Continuación)		
¿Es usted fumador?	☐ Sí	☐ No
	☐ Exfumador	
En caso afirmativo, ¿cuántos años hace que fuma? En caso de exfumador, ¿cuántos años estuvo fumando?	años	
En caso afirmativo o de ser exfumador, ¿cuántos cigarrillos consume/consumía al día?	cigarrillos	
¿Qué número de comidas realiza al día?	comidas	
De todas las comidas que realiza, ¿cuál es la principal?		
¿Qué número de comidas (almuerzo) realiza fuera de casa semanalmente? (excluyendo las cenas)	comidas	
En caso afirmativo, ¿se trae la comida de casa?	☐ Sí	☐ No
¿Suele picotear o realizar consumo de algún alimento entre horas?	☐ Sí	☐ No
¿Cuántos vasos de agua consume al día?	vasos	
¿Consume sal en la mesa?	☐ Sí	☐ No

¿Cómo de hambriento se encuentra ahora mismo? Nada ____________________ Extremadamente	Hora:
¿Cómo de saciado se encuentra ahora mismo? Nada ____________________ Extremadamente	
¿Cómo de grande es su deseo de comer ahora mismo? Nada ____________________ Extremadamente	

DIETA		
1. ¿Usa usted el aceite de oliva como principal grasa para cocinar?	Sí = 1 punto	
2. ¿Cuánto aceite de oliva consume en total al día (incluyendo el usado para freír, comidas fuera de casa, ensaladas, etc.)	4 o más cucharadas = 1 punto	
3. ¿Cuántas raciones de verdura u hortaliza consume al día? (las guarniciones o acompañamientos = ½ ración) 1 ración = 200 g	2 o más (al menos una de ellas en ensalada o crudas) = 1 punto	
4. ¿Cuántas piezas de fruta (incluyendo zumo natural) consume al día?	3 o más al día = 1 punto	
5. ¿Cuántas raciones de carnes rojas, hamburguesas, salchichas o embutidos consume al día? (ración: 100-150 g)	Menos de 1 al día = 1 punto	
6. ¿Cuántas raciones de mantequilla, margarina o nata consume al día? (porción individual: 12 g)	Menos de 1 al día = 1 punto	
7. ¿Cuántas bebidas carbonatadas y/o azucaradas (refrescos, colas, tónicas, *bitter*) consume al día?	Menos de 1 al día = 1 punto	
8. ¿Bebe usted vino? ¿Cuánto consume a la semana?	7 o más vasos a la semana = 1 punto	
9. ¿Cuántas raciones de legumbres consume a la semana? (1 plato o ración de 150 g)	3 o más a la semana = 1 punto	
10. ¿Cuántas raciones de pescado-marisco consume a la semana? (1 plato, pieza o ración: 100-150 g de pescado o 4-5 piezas o 200 g de marisco)	3 o más a la semana = 1 punto	
11. ¿Cuántas veces consume repostería comercial (no casera) como galletas, flanes, dulce o pasteles a la semana? (ración 30 g)	Menos de 2 a la semana = 1 punto	
12. ¿Cuántas veces consume frutos secos a la semana? (ración 30 g)	3 o más a la semana = 1 punto	
13. ¿Consume usted preferentemente	Sí = 1 punto	

carne de pollo, pavo o conejo en vez de ternera, cerdo, hamburguesas o salchichas? (carne de pollo: 1 pieza o ración de 100-150 g)		
14. ¿Cuántas veces a la semana consume los vegetales cocinados, pasta, arroz u otros platos aderezados con salsa de tomate, ajo, cebolla o puerro elaborada a fuego lento con aceite de oliva (sofrito)?	2 o más a la semana = 1 punto	

EJERCICIO FÍSICO	
En el trabajo	
1. ¿Exige su trabajo una actividad física intensa que implica una aceleración importante de la respiración o del ritmo cardiaco (como levantar pesos, cavar o trabajos de construcción) durante al menos 10 minutos consecutivos?	☐ Sí ☐ No (saltar a la 4)
2. En una semana típica, ¿cuántos días realiza usted actividades físicas intensas en su trabajo?	☐ días
3. En uno de esos días en los que realiza actividades físicas intensas, ¿cuánto tiempo suele dedicar a esas actividades?	Horas: minutos ☐☐ ☐☐
4. ¿Exige su trabajo una actividad de intensidad moderada que implica una ligera aceleración de la respiración o del ritmo cardiaco, como caminar deprisa (o transportar pesos ligeros) durante al menos 10 minutos consecutivos?	☐ Sí ☐ No (saltar a la 7)
6. En una semana típica, ¿cuántos días realiza usted actividades físicas intensas en su trabajo?	☐ días
7. En uno de esos días en los que realiza actividades físicas intensas, ¿cuánto tiempo	Horas: minutos ☐☐ ☐☐

suele dedicar a esas actividades?	
Para desplazarse	
8. ¿Camina usted o usa usted una bicicleta al menos 10 minutos consecutivos en sus desplazamientos?	☐ Sí ☐ No (saltar a la 10)
10. En una semana típica, ¿cuántos días camina o va en bicicleta al menos 10 minutos consecutivos en sus desplazamientos?	☐ días
11. En un día típico, ¿cuánto tiempo pasa caminando o yendo en bicicleta para desplazarse?	Horas: minutos ☐☐ ☐☐
En el tiempo libre	
12. En su tiempo libre, ¿practica usted deportes/fitness intensos que implican una aceleración importante de la respiración o del ritmo cardiaco (como correr, footing, aerobic, natación rápida, jugar al fútbol o baloncesto, desplazamiento de cargas pesadas, GAP, esgrima, volleyball, surf, etc.) durante al menos 10 minutos consecutivos?	☐ Sí ☐ No (saltar a la 13)
14. En una semana típica, ¿cuántos días practica usted deportes/fitness intensos en su tiempo libre?	☐ días
15. En uno de esos días en los que practica deportes/fitness intensos, ¿cuánto tiempo suele dedicar a esas actividades?	Horas: minutos ☐☐ ☐☐

En el tiempo libre (continuación)	
16. En su tiempo libre, ¿practica usted alguna actividad de intensidad moderada que implica una ligera aceleración de la respiración o del ritmo cardiaco (como caminar deprisa, ir en bicicleta, caminar a paso rápido, bailar, caza, tareas domésticas, jardinería, patinaje, pesca, etc.) durante al menos 10 minutos	☐ Sí ☐ No (saltar a la 16)

consecutivos?	
14. En una semana típica, ¿cuántos días practica usted actividades físicas de intensidad moderada en su tiempo libre?	días
15. En uno de esos días en los que practica actividades físicas de intensidad moderada, ¿cuánto tiempo suele dedicar a esas actividades?	Horas: minutos
Comportamiento sedentario	
16. ¿Cuánto tiempo suele pasar sentado o recostado en un día típico?	Horas: minutos

A rellenar por el personal sanitario:

Peso (kg):

Altura (cm):	% Grasa corporal (%):	Agua corporal (kg):
Perímetro cintura (cm):	Masa grasa (kg):	% Agua corporal (%):
Perímetro cadera (cm):	% Grasa visceral (%):	Edad metabólica (años):
IMC (kg/m^2):	Músculo (kg):	Presión arterial (mm Hg):
Grado de obesidad:	Masa ósea (kg):	

Glucosa (mg/dl):	Eritrocitos (mil./mm^3):
HDL colesterol (mg/dl):	Hematocrito (%):
LDL colesterol (mg/dl):	Hemoglobina (g/dl):
Triglicéridos (mg/dl):	Leucocitos (mil./mm^3):
PCR (mg/dl):	Neutrófilos (%):
GOT (UI/l):	Eosinófilos (%):
GPT (UI/l):	Basófilos (%):
Creatinina (mg/dl):	Linfocitos (%):
Ácido úrico (mg/dl):	Monocitos (%):
Plaquetas (mil./mm^3)	