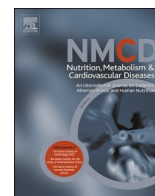




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Food group intake and Mediterranean diet adherence among a representative sample of Spanish middle-aged and older adults. Are we still on track? The HERMEX study

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ABSTRACT

Background and aim: To explore food group intake and adherence to the Mediterranean Diet (MD) in a representative sample of 2833 middle-aged and older adults from the HERMEX study.

Methods and results: This cross-sectional study utilized a food frequency questionnaire to assess food group intake and measured MD adherence using the MD Score. Sociodemographic, anthropometric, and clinical characteristics were also analyzed. Among participants, 74 % were living with overweight or obesity, 69.9 % were non-smokers, and 88 % showed medium-high adherence to the MD. Compared to the national dietary recommendations issued by the Spanish Agency for Food Safety and Nutrition (AESAN), 76 % had carbohydrate intake below recommended levels (average intake: 35.4 %), whereas 73.5 % consumed protein at 16.6 % of total energy intake. Only 2 % of participants adhered to the fat intake recommendation (<35 % of total energy). Consumption of fruits, vegetables, cereals, potatoes, and eggs was below recommendations, while intake of legumes, nuts, fish, seafood, and dairy met or nearly met the recommendations. Meat consumption exceeded recommendations. Macronutrient intake (carbohydrates, protein, fat, and fiber) was similar across BMI groups. However, participants with obesity consumed fewer nuts, whereas those with normal weight had a higher intake of red wine compared to individuals with overweight ($p < 0.05$). MD adherence was similar across BMI groups (34 points on a 0–55 scale).

Conclusions: Prevalence of overweight and obesity was high despite medium-high adherence to the MD. Overall, caloric intake and food consumption patterns were consistent across BMI groups, with notable differences in nut and red wine intake.

1. Introduction

The Mediterranean Diet (MD) is the traditional dietary style of several countries around the Mediterranean Sea [1]. Although the MD varies from one country to another, its key traditional features include an abundance of plant-based foods, such as fruits, vegetables, legumes,

nuts, seeds, potatoes, and whole grains (including breads and other cereal products). Fresh fruit typically serves as the daily dessert, and olive oil is the main source of fat. Dairy products, principally fermented, such as cheese and yogurt, are consumed in moderate amounts. Fish is eaten regularly, while poultry is consumed occasionally. Eggs are generally consumed up to four times per week. Red meat intake is low,

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and wine is typically consumed in low to moderate amounts, usually with meals [2].

The frequency and quantity of food consumption, along with specific dietary practices, have led the MD to be widely praised for its nutritional adequacy, high dietary quality, and positive effects on chronic diseases [3,4]. Specifically, the MD has been associated with several health benefits, including a reduction in total mortality and a lower risk of several diseases, such as certain cancers, cognitive impairment, and the metabolic syndrome and its components, such as obesity, hypertension, hyperglycemia, and hyperlipidemia [5]. Therefore, MD is considered a healthy dietary pattern for humans in terms of primary and secondary prevention of cardiovascular disease (CVD) and other chronic diseases [6].

Spain is one of the representative countries of the MD; however, recent studies suggest that food consumption and the intake of energy and nutrients have changed in recent years, moving away from the traditional and healthy MD pattern [7,8]. This shift is primarily attributed to globalization and socioeconomic changes, which have influenced the Spanish population, especially younger generations, to adopt a more westernized dietary pattern [9]. Notably, the decline in adherence to the MD is not limited to Spain, similar trends have been observed in other Mediterranean and non-Mediterranean countries, as reported in recent systematic reviews and meta-analyses [10,11].

Evidence suggests that the quality of dietary fats specifically, unsaturated fats are preferable to saturated and trans fats [12], and the quality of carbohydrates - prioritizing solid, high-fiber, low-glycemic index sources, such as whole grains [13,14] - play a more significant role in weight management than the quantity of each macronutrient consumed [15]. In line with this fact, findings from the ANIBES study [16] reveal that women with overweight and/or obesity had a less adequate intake of cereals compared to those with normal or under-weight. Notably, women with abdominal adiposity showed the poorest consumption of whole grains. Similarly, men with obesity consumed fewer fruits and vegetables than their lower-weight peers. Men with abdominal adiposity also reported lower intakes of cereals, breakfast cereals, milk and dairy products, and a higher consumption of alcoholic beverages. Overall, men with overweight or obesity with a waist-to-height ratio ≥ 0.5 had notably lower intake levels of cereals, fruits, and vegetables than dietary recommendations.

Understanding the current state of this dietary pattern in Mediterranean countries, such as Spain, is essential for designing effective dietary interventions that address specific observed deviations. Previous studies have indicated a gradual shift away from traditional Mediterranean dietary habits [17,18], not only among younger populations but also among middle-aged and older individuals, including individuals with overweight or obesity. However, there is still a lack of detailed population-based data linking these dietary deviations to specific demographic and health-related factors (e.g., age, weight status). This gap hinders the implementation of targeted public health interventions. Therefore, in a large representative sample of 2833 middle-aged and older adults, we aimed to: i) describe their adherence levels to the MD and food group intake; ii) explore potential differences in adherence levels to the MD and food group intake across various age groups and weight statuses.

2. Methods

2.1. Study design and participants

This cross-sectional study is based on secondary analyses of data obtained from the Harmonizing Equations of Risk in Mediterranean Countries – Extremadura (HERMEX) study [14]. The detailed methodology of the HERMEX project has been published previously [19]. According to data from the National and Extremadura Health Surveys, the population of Extremadura shows a high prevalence of CVD risk factors. Furthermore, data from the Hospital Morbidity Survey and the Mortality

Statistics by Cause, provided by the Spanish National Statistics Institute, indicate that both morbidity and mortality from these diseases exceed the national average. The HERMEX study was initiated to address the need for more comprehensive data regarding this elevated burden.

Participants were selected from the universal health coverage database using a random number generation process to produce a sample that was representative of the target population in terms of age and sex distribution. This initial sample included 75 455 individuals. Exclusion criteria included non-residence at the registered address, pregnancy, inability to attend the study center, institutionalization, terminal illness, and death. Inclusion criteria were residence in the designated municipalities and areas already referred to with a Spanish health insurance card, age between 25 and 79 years, and provision of informed consent.

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the Ethics Committee of the University Hospital Infanta Cristina (Extremadura, Spain), dated June 29, 2005.

2.1.1. Sociodemographic, anthropometric, and clinical characteristics

Sociodemographic data, including age, smoking habits, and educational and occupational status, were collected through personal interviews.

Waist circumference was measured to the nearest millimeter (mm) using a measuring tape at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, directly on the skin. Height was measured in centimeters (cm) using a SECA stadiometer (Model 222, Germany) with a precision of 1 mm; participants were asked to stand barefoot in an upright position with their heels together, arms at their sides, and shoulders relaxed. The Frankfurt horizontal plane was ensured by aligning the orbitale and the external auditory meatus.

Body weight was measured in kilograms (kg) after an overnight fast, with participants wearing only underwear. A SECA electronic scale (Model 888 7021099, Germany) with a precision of 200 grams (g) was used for the measurement. The scale was calibrated daily before use. These variables were used to calculate body mass index (BMI), defined as body weight (in kg) divided by height (in meters) squared (m^2). Internationally accepted cut-off points were used to categorize participants as having normal weight (BMI 18.5–24.99 kg/m^2), overweight (BMI 25–29.99 kg/m^2), or obesity (BMI ≥ 30 kg/m^2) [20].

2.1.2. Dietary assessment

To assess participants' intake of various food groups, a self-administered semi-quantitative food frequency questionnaire (FFQ) comprising 157 items was used [21,22]. The FFQ covered a one-year recall period and included various food groups, such as dairy products, cereals, vegetables, fruits, legumes, eggs, meat and meat derivatives, oils and fats, fast food, canned food, nuts, and beverages. The FFQ recorded consumption levels across nine categories ranging from "Never or less than once a month" to "6 or more times per day". The foods were specified in terms of portions and common household units (such as glasses, teaspoons, and slices). The accuracy of the completed questionnaires was verified by a qualified nutritionist. To calculate the grams consumed for each food item, the reported frequency of consumption was multiplied by the corresponding portion size. The intake of energy (kcal), macronutrients, and micronutrients was quantified using the Spanish Database of Food Composition [23,24]. Fish were classified as fatty (oily) or lean according to the classification established by Spanish dietary guidelines. Fatty fish (e.g., sardines, mackerel, tuna) are characterized by a higher fat content (typically above 5 %) and are rich in omega-3 fatty acids. In contrast, lean fish (e.g., hake, cod, monkfish) have a lower fat content.

2.1.3. National dietary recommendations

For comparison purposes, we used the national dietary recommendations issued by the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) [25]. These guidelines, updated in

2020, offer evidence-based recommendations on the intake of various food groups to promote health and prevent chronic diseases in the general Spanish population. They consider the nutritional needs and the sociocultural context of the Spanish population and are supported by national health authorities. Given their official status and broad scope, these guidelines provide a relevant framework for evaluating dietary intake in Spanish cohorts, as applied in the present study.

2.1.4. Mediterranean diet adherence

Adherence to the MD pattern was assessed using the Mediterranean Diet Score (MedDietScore), developed by Panagiotakos et al. [26]. This score has been recognized as one of the indices with the highest levels of validity and reliability in measuring adherence to the MD, extending beyond the Greek population for which it was originally developed. This index assesses the intake of eleven food groups based on weekly consumption patterns: whole grain cereals, potatoes, fruits, vegetables, legumes, fish, olive oil, red wine, red meat and processed meats, poultry, and full-fat (whole) dairy products. Each food group is scored on a scale from 0 to 5, depending on the frequency of intake and how well it aligns with the traditional MD. For food groups considered beneficial (e.g., fruits, vegetables, legumes, whole grains, fish, and olive oil), higher consumption leads to a higher score (ranging from 0 for rare or no consumption up to 5 for daily consumption). Conversely, food groups considered less aligned with the MD (e.g., red meat, poultry, and full-fat dairy) have a reversed scoring system, where lower consumption receives a higher score. Moderate intake of red wine is rated positively. The total score ranges from 0 (indicating minimal adherence) to 55 (indicating maximum adherence), with higher scores indicating greater adherence to the MD, consequently, better diet quality.

2.2. Statistical analysis

Descriptive statistics (mean \pm standard deviation for quantitative variables and number of female participants (%) for categorical variables) were used to summarize the sociodemographic and clinical characteristics of the study participants.

Participants were divided according to BMI categories (i.e., individuals with normal weight, overweight, or obesity). Subsequently, food group intake and MD adherence were compared across weight status groups by one-way analysis of covariance (ANCOVA) after adjusting for age (as a continuous variable) and sex (as a binary variable (female or male)), whereas occupational status and smoking habit were included as categorical variables. Occupational status comprised the following categories: employed, homemaker, retired, employed but on medical leave, unemployed with benefits, unemployed without benefits, student, and with a permanent disability. Smoking status included: current smoker, ex-smoker for <1 year, ex-smoker for 1–5 years, ex-smoker for >5 years, and never smoker. All analyses were conducted using the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 22.0, Armonk, NY), with a significance level set at $p \leq 0.05$.

3. Results

A total of 4692 participants were selected from an initial pool of 75 455 individuals; 3521 met the eligibility criteria, and 2833 of these agreed to participate, yielding a participation rate of 80.5 %. The final sample for the present analyses comprised these 2833 participants (mean age: 51.2 ± 14.7 years), 46.5 % of whom were male (Fig. 1), all had valid data on the FFQ and sociodemographic, anthropometric, and clinical variables. Table 1 shows the sociodemographic characteristics of the study sample. Most of the participants were individuals with overweight or obesity (74 %), were non-smokers (69.9 %), and had a medium-high MD adherence (88 %).

Table 2 shows the dietary assessment of the participants. The macronutrient intake among participants showed several deviations from the Spanish national dietary recommendations. Carbohydrate intake was low, with 76 % of participants falling below the recommended levels and an average intake of 35.4 % of total energy intake (TEI). This insufficient intake likely contributed to the low adherence to fiber recommendations, particularly among males (30.4 % vs. 59.1 % in females). Protein intake exceeded the recommended levels in 73.5 % of

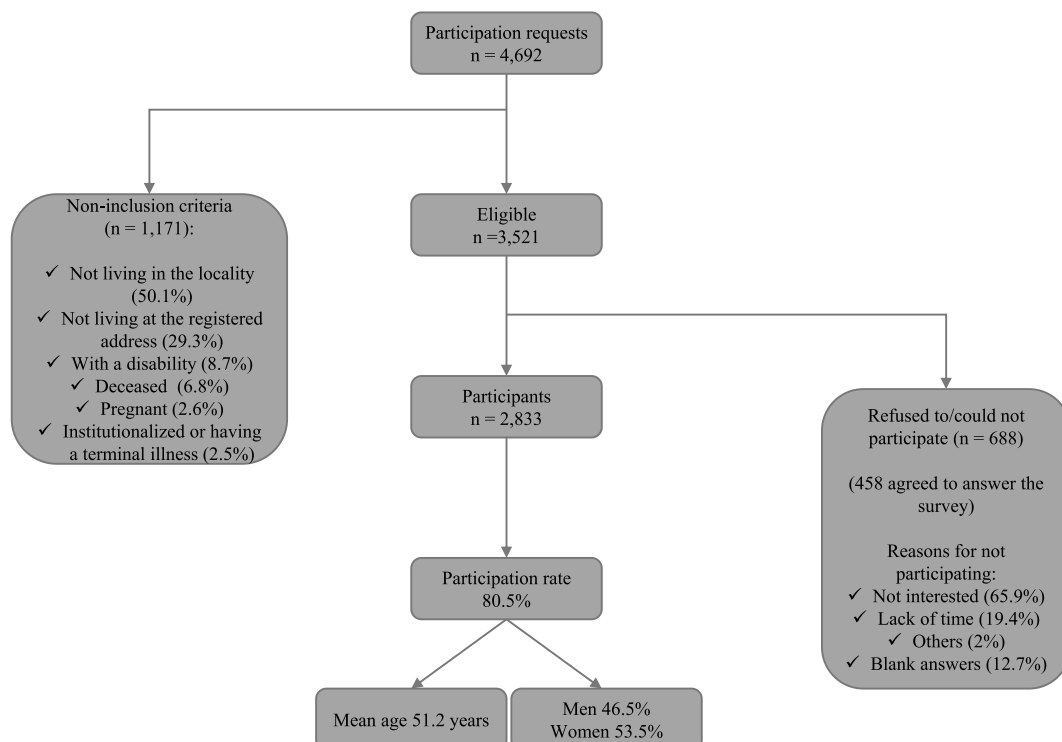


Fig. 1. General flowchart of the study.

Table 1
Sociodemographic and clinical characteristics of the study participants (n = 2824).

| Variable | Mean (SD) |
|--|--------------|
| Age (years) | 51.2 (14.7) |
| Age range (years) | n (%) |
| 25-49 | 1398 (49.5) |
| 50-64 | 795 (28.2) |
| 65-80 | 631 (22.3) |
| Body mass index (kg/m²) | n (%) |
| Normal weight | 731 (25.9) |
| Overweight | 1106 (39.2) |
| Obesity | 987 (35.0) |
| Mediterranean diet adherence (0-55) | n (%) |
| Low MD adherence | 334 (11.8) |
| Medium MD adherence | 824 (29.2) |
| High MD adherence | 1666 (59.0) |
| Sex | |
| Female | 1511 (53.5) |
| Men | 1313 (46.5) |
| Occupational status | |
| Employed | 1340 (47.5) |
| Homemaker | 834 (29.5) |
| Retired | 393 (13.9) |
| Employed but on medical leave | 32 (1.1) |
| Unemployed with benefits | 120 (4.2) |
| Unemployed without benefits | 52 (1.8) |
| Student | 14 (0.5) |
| With a permanent disability | 37 (1.3) |
| Insufficient data | 2 (0.1) |
| Smoking habit | |
| Current smoker | 849 (30.1) |
| Ex-smoker < 1 year | 44 (1.6) |
| Ex-smoker 1-5 years | 134 (4.7) |
| Ex-smoker > 5 years | 495 (17.5) |
| Never smoker | 1302 (46.1) |
| University graduates (yes, n [%]) | 347 (12.3) |

SD, Standard deviation. METS, metabolic equivalents per week; MD, Mediterranean Diet.

Table 2
Dietary assessment of the participants (n = 2824).

| Variable | Mean (SD) | Recommended intake | Participants meeting recommendations n (%) |
|---------------------------------|--|--|--|
| Carbohydrates (% energy) | 35.4 (5.7) | 45-55 (% energy) | 24 (0.8) |
| Protein (% energy) | 16.6 (2.5) | 10-15 (% energy) | 748 (26.5) |
| Fiber (g/day) | Female 26.0 (10.0) Male 26.3 (10.6) | Female > 22-25 g/day Male > 30-35 g/day | Female 893 (59.1) Male 399 (30.4) |
| Alcohol (g/day) | 8.1 (16.4) | <30 g alcohol/day | 2539 (89.9) |
| Fat (% energy) | | | |
| Total fat | 47.7 (6.0) | <35 (% energy) | 56 (2.0) |
| Saturated fat | 13.6 (1.9) | <7-8 (% energy) | 7 (0.2) |
| Monounsaturated fat | 23.9 (4.7) | 20 (% energy) | 662 (23.4) |
| Polyunsaturated fat | 7.21 (1.3) | 5 (% energy) | 48 (1.7) |

Values shown as mean (standard deviation (SD)) unless otherwise indicated. **Recommended intake**, dietary recommendations for the Spanish population provided by the Spanish Agency for Food Safety and Nutrition (AESAN) [25].

participants, with an average intake of 16.6 % of total energy. Fat consumption was notably high, with only 2 % meeting the Spanish national guidelines of less than 35 % of energy from fat. Saturated fat intake was especially excessive, averaging 13.6 %, nearly double the recommended range of 7-8 %, and just 0.2 % of participants were within the advised range. Furthermore, most participants exceeded the recommended intake for monounsaturated fats (MUFA), with 76.6 % going

over the limit, and only 1.7 % met the Spanish dietary recommendations for polyunsaturated fats. The average alcohol intake was recorded at 8.1 g/day.

Table 3 shows the food consumption of the study participants (n = 2824). The intake of fruits and vegetables was below the Spanish national dietary recommendations, with an average of 2.5 servings/day, while the recommendation is to consume more than 5 servings/day [27]. The consumption of cereals and potatoes was also below the recommendations, with 2.5 servings/day compared to the advised 3-6 servings/day. The consumption of whole grain cereals was remarkably low, with a mean intake of just 0.1 servings per day, highlighting the relevance of promoting the consumption of whole grain cereals [28]. The intake of legumes and nuts was close to the recommendations, with participants consuming an average of 3.3 servings/day of legumes and 2.8 servings/day of nuts, whereas the recommendations are 4 servings/day for legumes and 3 or more servings/day for nuts. Fish and seafood consumption met the recommendations, with an average of 4.1 servings/week, whereas the recommendation is above 3 servings/week. The intake of fatty fish was 1.8 servings/week, lean fish was 0.6 servings/week, and seafood was 1.5 servings/week. Meat consumption significantly exceeded recommendations, with an average of 11.1 servings/week of red meat, meat products, and poultry, while the recommendation is below 3 servings/week. Egg consumption was low at just 0.9 servings/week, likely due to the high meat consumption, which may have displaced other food groups. Dairy consumption was 1.5 servings/day, mainly from whole dairy products (1.3 servings/day),

Table 3
Food frequency consumption of the study participants (n = 2824).

| Variable | Servings consumed | Recommended servings (AESAN 2022) | Participants meeting recommendations n (%) |
|---|-------------------|-----------------------------------|--|
| Fruits and vegetables (servings/day) | | | |
| Fruits | 1.2 (0.9) | ≥2-3 | 401 (14.2) |
| Vegetables | 1.3 (0.6) | ≥3 | 66 (2.7) |
| Cereals and potatoes (servings/day) | | | |
| Total cereals and potatoes | 2.5 (2.8) | 3-6 | 1187 (42.0) |
| Whole grain cereals | 0.1 (0.4) | | |
| Legumes and nuts (servings/week) | | | |
| Legumes | 3.3 (1.3) | 4 | 959 (34.0) |
| Nuts | 2.8 (3.6) | ≥3 | 1183 (41.9) |
| Fish and seafood (servings/week) | | | |
| Total fish consumption | 4.1 (2.1) | ≥3 | 1911 (67.7) |
| Lean fish | 0.6 (0.5) | | |
| Fatty fish | 1.8 (1.1) | 1-2 | |
| Seafood | 1.5 (1.1) | | |
| Meat (servings/week) | | ≤3 | 24 (0.8) |
| Red meat and meat products | 9.8 (11.6) | | |
| Poultry | 1.3 (0.6) | | |
| Dairy products (servings/day) | | | |
| Total dairy products | | 1.5 ≤3 | 2463 (87.2) |
| Skimmed dairy products | | 0.1 (0.5) | |
| Whole dairy products | | 1.3 (1.3) | |
| Eggs (servings/week) | 0.9 (1.7) | ≤4 | 2767 (98.0) |
| Olive oil (servings/day) | 3.1 (1.3) | daily | 2755 (97.6) |
| Red wine (servings/week) | 26.3 (80.5) | | |

Values shown as mean (standard deviation (SD)) unless otherwise indicated. **Recommended servings**, dietary recommendations for the Spanish population provided by the Spanish Agency for Food Safety and Nutrition (AESAN) [25].

meeting the recommendation of up to 3 servings/day. Lastly, olive oil intake was 3.1 servings/day, and red wine consumption was 26.3 servings/week.

Table 4 shows energy intake, food group intake, and MD adherence according to BMI categories. After adjusting for age, sex, occupational status, and smoking habit, pairwise comparisons showed similar values in macronutrient intake (i.e., carbohydrates, protein, total fat, and fiber) across the BMI groups.

We have also observed that the intake of fruits and vegetables was lower than the recommendations for the Spanish population [25] across all BMI categories ($p = 0.090$ and $p = 0.341$, respectively), while all groups adhered to the recommendations for legumes [25].

Participants with obesity had a lower intake of nuts compared with those with overweight ($p = 0.018$). All groups reported a lower intake of lean fish. However, the intake of fatty fish and seafood met the recommendations [25]. Individuals with obesity had a higher intake of red meat and meat products compared with those with overweight and normal weight ($p = 0.842$). Consumption of other protein-rich foods, such as poultry, dairy products, and eggs, was in line with the Spanish national dietary recommendations [25]. Participants with normal weight reported a higher intake of red wine compared with those with overweight ($p = 0.013$). It should be noted that the MD adherence was similar across all groups, averaging around 34 points on a scale from 0 to 55.

4. Discussion

The main findings of the present study show that the participants had medium-high adherence to the MD. No differences were found among

Table 4
Energy intake, food group intake, and Mediterranean diet adherence according to body mass index categories.

| | Normal weight n = 731 | Overweight n = 1106 | Obesity n = 987 | P |
|-------------------------------------|-------------------------|-------------------------|------------------------|-------|
| Energy intake (Kcal/day) | 2840 (35.2) | 2861 (27.1) | 2804 (29.3) | 0.358 |
| Carbohydrates (g/day) | 255.6 (3.8) | 256.8 (2.9) | 249.0 (3.2) | 0.175 |
| Protein (g/day) | 116.7 (1.7) | 120.0 (1.3) | 118.2 (1.4) | 0.296 |
| Fiber (g/day) | 25.8 (0.4) | 26.5 (0.3) | 25.9 (0.3) | 0.292 |
| Total fat (g/day) | 148.7 (1.8) | 150.0 (1.4) | 147.1 (1.4) | 0.339 |
| Fruits (s/day) | 1.2 (0.03) | 1.2 (0.02) | 1.3 (0.03) | 0.090 |
| Vegetables (s/day) | 1.3 (0.02) | 1.3 (0.02) | 1.3 (0.02) | 0.341 |
| Cereals and potatoes (s/day) | 2.5 (0.05) | 2.6 (0.04) | 2.5 (0.04) | 0.482 |
| Whole grain cereals (s/week) | 0.07 (0.01) | 0.08 (0.01) | 0.1 (0.01) | 0.057 |
| Legumes (s/week) | 3.3 (0.05) | 3.3 (0.04) | 3.2 (0.04) | 0.267 |
| Nuts (s/week) | 2.7 (0.1) | 3.1 (0.1) ^a | 2.7 (0.1) ^a | 0.018 |
| Lean fish (s/week) | 0.7 (0.02) | 0.7 (0.01) | 0.7 (0.01) | 0.848 |
| Fatty fish (s/week) | 1.8 (0.04) | 1.9 (0.03) | 1.9 (0.03) | 0.098 |
| Seafood (s/week) | 1.5 (0.04) | 1.6 (0.03) | 1.5 (0.03) | 0.244 |
| Red meat and meat products (s/week) | 9.8 (0.4) | 9.8 (0.3) | 10.0 (0.4) | 0.842 |
| Poultry (s/week) | 1.3 (0.02) | 1.4 (0.02) | 1.4 (0.02) | 0.555 |
| Skimmed dairy (s/day) | 0.1 (0.01) | 0.1 (0.01) | 0.2 (0.01) | 0.105 |
| Whole dairy (s/day) | 1.3 (0.05) | 1.4 (0.04) | 1.3 (0.04) | 0.419 |
| Eggs (s/week) | 0.9 (0.06) | 0.9 (0.05) | 1.0 (0.05) | 0.676 |
| Olive oil (s/day) | 3.2 (0.05) | 3.1 (0.04) | 3.1 (0.04) | 0.551 |
| Red wine (s/week) | 33.1 (2.9) ^a | 21.8 (2.3) ^a | 26.2 (2.5) | 0.013 |
| MD Adherence (0–55) | 34.2 (0.1) | 34.4 (0.1) | 34.0 (0.1) | 0.072 |

Model adjusted for age, sex, occupational status, and smoking habit. Values shown as mean (standard error). Upper case ^{a,b} letters in the same row indicate a significant pairwise difference ($p < 0.05$) between groups with the same letter. The Bonferroni correction for multiple comparisons was applied to analyze pairwise differences. s, servings.

the three groups categorized by BMI.

In the present study, representative of the Spanish population, the consumption of various food groups was according to the Spanish national dietary recommendations (i.e., cereals and potatoes, legumes, nuts, fatty fish, seafood, dairy products, eggs, poultry, and olive oil) [25]. However, we observed underconsumption of other food groups, such as fruits and vegetables, and an excessive intake of red meat and meat products, particularly among individuals with obesity. The mean intake of fruits and vegetables was 2.5 servings/day, substantially below the widely recommended threshold of at least 5 servings/day [27]. These findings are consistent with other Spanish population-based studies, such as the ENRICA study and the ANIBES study, which also reported insufficient fruit and vegetable consumption across various age groups [29,30]. These results are concerning because low intake of fruits and vegetables has been consistently linked to higher risks of CVD, cancer, and all-cause mortality [31,32].

Regarding red meat and processed meat consumption, our findings reveal intake levels above the recommendations, especially in individuals with obesity. Similar patterns have been reported in other Mediterranean cohorts, including the European Prospective Investigation into Cancer and Nutrition (EPIC)-Spain study, which identified excessive red meat consumption associated with higher CVD and cancer risk [33,34]. Evidence from international meta-analyses further supports these associations, emphasizing the importance of limiting red and processed meat in favor of plant-based alternatives [35].

We found an overall medium-high adherence to the Mediterranean dietary pattern in our sample, which is inconsistent with other epidemiological studies conducted in Spain. For instance, in a representative sample of 4302 Spanish adults, Baladia et al. [36] found low adherence to the MD even among older adults—an age group traditionally considered more likely to adhere to this pattern. As previously stated, the reported decline in MD adherence is not limited to Spain; similar patterns have been documented across Mediterranean and non-Mediterranean countries [10,11]. This suggests a widespread nutritional transition away from traditional dietary models, further emphasizing the importance of monitoring and promoting the MD in diverse populations.

In our representative sample, we found that energy consumption was similar across the three BMI categories. The consumption of different food groups also showed similar patterns across these categories, maintaining comparable deviations from dietary recommendations. Notably, significant differences among BMI categories were only found in the consumption of nuts and red wine. In the case of nuts, participants with overweight consumed a higher number of servings than individuals in the other groups. Regarding wine consumption, individuals with normal weight reported the highest intake (33.1 servings/week), followed by those with obesity (26.2 servings/week), while the participants with overweight had the lowest intake (21.8 servings/week). These differences highlight the complex role of wine consumption, which remains controversial due to its potential health risks and benefits. Concerning alcohol consumption, we found a mean intake of 8.1 g/day in our sample. This level of consumption is consistent with that reported in other Mediterranean cohorts, such as the PREDIMED study [37], which reported moderate alcohol intake, particularly wine. However, the health effects of alcohol remain controversial. While some epidemiological studies and meta-analyses have suggested a potential cardioprotective effect of low-to-moderate alcohol consumption, especially in the context of a Mediterranean dietary pattern [38,39], recent large-scale analyses and systematic reviews challenge this perspective, highlighting that even low levels of alcohol intake may increase the risk of certain cancers and all-cause mortality [40]. Thus, understanding alcohol's role in health remains a complex issue.

Our findings regarding the lack of significant differences in overall MD adherence across different BMI categories are inconsistent with previous studies. For instance, the recent ATTICA cohort study, which assessed the association between MedDietScore and BMI over a 20-year

follow-up in a Greek population, found that higher adherence to the MD was associated with a significantly lower BMI and a reduced risk of maintaining overweight or obesity over time [41]. This is inconsistent with our data, where MD adherence was relatively homogeneous across BMI categories. These inconsistencies may be partly explained by the differences in the study designs (cross-sectional vs. longitudinal), population characteristics, and the range of MD adherence observed. Our cross-sectional results reflect dietary habits at a single point in time. In contrast, long-term dietary patterns, as shown in the ATTICA study, may have a higher influence on BMI than short-term habits. This highlights the importance of promoting sustained adherence to healthy diets, such as the MD, over extended periods.

4.1. Dietary quality and quantity

In this large sample of middle-aged and older adults, we found that adherence to the MD patterns was mainly medium or high (i.e., 29.2 % and 59 % of participants, respectively), indicating a generally favorable dietary behavior. This level of adherence to the MD appears to be higher than the adherence reported in previous studies conducted in other regions of Spain. For example, the DIMERICA study [42], which included participants from different Spanish provinces, found predominantly low to moderate adherence levels. Similarly, the EVA study [43] conducted in a Spanish population sample from Salamanca, and free of CVD, reported lower proportions of high adherence across age and sex groups. These inconsistencies may be due to regional cultural differences, dietary traditions, socioeconomic status, or the impact of local public health initiatives promoting the MD. Moreover, our sample consisted of middle-aged and older adults, a demographic group that may be more health-conscious and motivated to follow dietary recommendations, and whose traditional gastronomic preferences may also align more closely with the MD pattern, potentially contributing to the higher adherence observed.

There is consensus in the literature that society is currently undergoing a nutritional transition, which highlights the need for accurate and updated information on dietary intake patterns [16]. We found that protein intake exceeded the upper recommended limit (<15 % of TEI) by approximately 17 % compared with the Spanish dietary recommendations for energy and nutrient intake [44,45]. However, our data were consistent with findings from the ANIBES study, which also reported an average protein intake of 17 % of macronutrients in a representative sample of the Spanish population [16]. Similarly, total fat intake was high in the study population, reaching 48 % of TEI, being significantly higher than the dietary recommendations (<35 % TEI) [25]. However, it is important to interpret this finding in the context of the Mediterranean dietary pattern, which is traditionally high in fat (typically ranging from 35 % to 45 % of TEI) due to the prominent use of olive oil, nuts, and fatty fish. These sources contribute predominantly unsaturated fatty acids, particularly MUFA, which have been associated with favorable cardiometabolic outcomes. Therefore, a higher proportion of dietary fat does not necessarily reflect poor diet quality, especially when the quality of the fat is predominantly unsaturated. This is consistent with previous observations in Mediterranean populations [37,46,47] and reinforces the idea that fat quality may be a more relevant indicator than total fat quantity in assessing the healthfulness of the diet.

It is important to note that high-fat diets may decrease insulin sensitivity and are positively associated with increased CVD risk [48–50]. However, a precise dose-response relationship has not yet been defined. Evidence suggests that moderate fat intake (<35 % TEI) is linked with reduced energy intake, which can contribute to moderate weight loss and/or prevention of weight gain [16]. Our data showed a polyunsaturated fat (PUFA) intake of around 7 %, and a saturated fat (SFA) intake of 14 %. These values exceed the global averages reported in a systematic assessment by the Global Burden of Disease Nutrition and Chronic Diseases Expert Group, which estimated average PUFA and SFA intakes at 6 % and 10 % of TEI, respectively [51]. In comparison, the

EPIC cohort study found that the mean total fat intake was ≥ 35 % of TEI, with ≥ 14 % accounted for SFA, 10–13 % MUFA, and 4–8 % PUFA intake [52]. In our sample, MUFA intake was notably higher, reaching 24 %, nearly twice the levels observed in the EPIC study. However, systematic reviews of prospective cohort studies, which often compare the highest versus lowest intake categories, do not describe associations between MUFA, PUFA, and SFA intake and the risk of chronic diseases, including CVD [53,54]. Notwithstanding, randomized controlled trials have indicated that replacing SFA with PUFA and/or MUFA can improve blood lipid profiles and glycemic control, with PUFA replacements showing a more pronounced effect. Regarding the carbohydrate intake, we observed a mean intake of 35.4 % of TEI, which is also below general recommendations [25]. This is important because current evidence suggests that dietary patterns high in fat (>35 % TEI) and low in carbohydrates (<50 % TEI) may have adverse effects on weight management in the short and long term [55].

4.2. Limitations and strengths

Our results should be interpreted taking into account some limitations. The cross-sectional design of the study prevents us from establishing causality, and reverse causation cannot be eliminated. We categorized participants based on their BMI, despite being aware that BMI is not always a good marker of adiposity [56]. However, BMI cut points remain the most internationally accepted standards for categorizing individuals according to their obesity grade [57]. Despite these limitations, our study has several strengths. Firstly, it is based on a large, population-based sample of middle-aged and older adults from a region of Spain with a particularly high CVD risk profile, which enhances the representativeness and relevance of the findings. Secondly, food group intake was assessed using a validated FFQ, and adherence to the MD was measured with the MedDietScore, allowing for comparability with other national and international cohorts. Importantly, this study provides novel data by examining adherence to the MD and its relation to BMI categories in a population group that is often underrepresented in nutritional surveillance studies. For instance, national dietary surveys frequently focus on younger or working-age adults, overlooking older individuals who may have different dietary needs and patterns. These results also update existing data for Spain and contribute to understanding how adherence to healthy dietary patterns varies with weight status in aging populations.

5. Conclusion

This study reveals that, despite a medium-to-high adherence to the MD among middle-aged and older Spanish adults, the consumption of certain food groups was below the recommended range for Spanish populations. Notably, an insufficient intake of fruits, vegetables, whole grains, and dietary fiber was found. In contrast, an excessive consumption of red meat and saturated fats was found. These nutritional shortcomings, particularly among males, are concerning given the high prevalence of overweight, obesity, and related chronic diseases in the region. From a public health perspective, reinforcing adherence to MD patterns through targeted dietary interventions, especially those focused on reducing red meat intake and increasing the consumption of plant-based foods, could play a crucial role in improving diet quality. This, in turn, may help decrease the burden of cardiovascular and metabolic diseases in this population.

Author contributions

ENV: validation, writing-original draft preparation, writing-review, and editing. VAA: conceptualization, methodology, validation, data curation, writing-review, and editing. LJM: conceptualization, validation, writing-original draft preparation, writing-review, and editing. MFA: conceptualization, formal analysis, methodology, validation, data

curation, writing-review and editing. DFB: resources, data curation, writing-review and editing, project administration, funding acquisition. TN: validation, writing-review, and editing. FJFR: conceptualization, validation, resources, data curation, writing-review and editing, project administration, funding acquisition.

Disclosure of interests

The authors declare no conflict of interests.

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