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Adherence to a Mediterranean Dietary Pattern status and associated factors among Portuguese older adults: Results from the Nutrition UP 65 cross-sectional study

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ABSTRACT

Objectives: The aim of this study was to evaluate adherence to the Mediterranean dietary pattern (MDP) and its associated factors in older Portuguese adults.
Methods: A cross-sectional observational study was designed. In the context of the Nutrition UP 65 study, a national cluster sample of 1407 Portuguese individuals ≥65 y of age was analyzed. Adherence to the MDP was evaluated with the Portuguese version of the Prevention with Mediterranean Diet tool. The association between an individual's characteristics and adherence to the MDP was analyzed through hierarchical logistic regression analysis.
Results: In this study, 43% of participants adhered to the MDP (n = 609). Higher educational level (odds ratio [OR], 2.38; 95% confidence interval [CI], 1.54–3.69), living in the center (OR, 1.35; 95% CI, 1.01–1.79), being married or living in a common-law marriage (OR, 1.54; 95% CI, 1.20–1.97), and body mass index ($OR_{preobese}$, 1.52; 95% CI, 1.02–2.25) were related with increased odds of adherence to the MDP. Otherwise, lower adherence to the MDP was found for participants who were ≥80 y of age (OR, 0.70; 95% CI, 0.52–0.94), who lived in Madeira (OR, 0.35; 95% CI, 0.14–0.89) and Azores (OR, 0.28; 95% CI, 0.08–0.99), who rated their health as moderate (OR, 0.65; 95% CI, 0.50–0.84) or as bad or very bad (OR, 0.63; 95% CI, 0.45–0.90), and those who reported six or more comorbidities (OR, 0.62; 95% CI, 0.39–0.97).
Conclusions: Of the sample, 57% did not adhere to the Mediterranean diet. Potentially modifiable factors associated with lower adherence to the MDP were lower educational and health status.

Introduction

The Mediterranean dietary pattern (MDP) has been widely reported to be a model of healthy eating for its contribution to a favorable health status, a better biochemical profile, and an improved quality of life among older adults [1]. It is consensual that the definition of MDP is not universal, partly because this dietary pattern is fairly heterogeneous among Mediterranean countries and also within the countries themselves. However, the traditional MDP is typically based on a high ratio of monounsaturated to saturated dietary lipids (mainly owing to olive oil intake); high consumption of vegetables, fruit, pulses, nuts, non-refined

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cereals (including bread); low consumption of meat and meat products; moderate consumption of milk and dairy products; use of aromatic herbs; water as the main beverage; and moderate consumption of alcohol, especially wine (mostly in main meals). Fish intake is also included in the MDP pattern, but its consumption is dependent on proximity to the sea [2].

The Mediterranean diet has been associated with a number of health benefits, including reduced mortality risk and lower incidence of cardiovascular disease. A remarkable and large body of evidence has proven that the MDP strongly influences health, lowering the risk for developing cardiometabolic diseases such as coronary heart disease, diabetes, dementia (especially Alzheimer's), osteoporosis, and obesity. Additionally, there is a direct association between baseline adherence to an MDP and all dimensions of health-related quality of life [1,3,4].

Examination and monitoring of the dietary characteristics of older adults is important in identifying subgroups at risk for malnutrition and disease [5]. Portugal is a country for which information about the adherence of older adults to the Mediterranean diet is scarce. Due to fact that dietary patterns are potentially modifiable, this data will be of major relevance for guiding public health measures.

Using a nationally representative sample of Portuguese older adults from the Nutrition UP 65 study, the aim of this study was to evaluate adherence to the MDP and its associated factors in older adults.

Sample and methods

Study design and sampling

A cross-sectional observational study was carried out in Portugal with a sample of 1500 Portuguese adults ≥65 y of age. Data from the most recent national census showed that the number of Portuguese residents was 10 562 178 and 2 010 064 older Portuguese were identified, corresponding to 19% of the country's population [6]. Thus, the recruited study sample corresponds to 0.075% of the Portuguese older population. To obtain a representative sample of the Portuguese population, the number of individuals in each strata of region was ascertained, considering the structure of the Portuguese population in terms of sex, age, and education level. After randomizing three or more town councils with >250 inhabitants, in each of the seven country areas, potential community-dwelling participants who fulfilled the inclusion criteria were invited to participate. They were contacted via home approach, telephone, or via institutions, such as town councils and parish centers. Some of these older adults volunteered to participate and were contacted by interviewers. They were recruited until reaching the number of participants with the characteristics in each stratum of this predefined sample [7].

A random, stratified, clustered sampling method was applied using data from Census 2011, regarding sex, age, educational level, and regional area defined in the Nomenclature of Territorial Units for Statistical purposes (NUTS II), to achieve a nationally representative sample of Portuguese older adults. Data were collected between December 2015 and June 2016.

Individuals were considered to be Portuguese if they had Portuguese nationality and if their current tax residence was in Portugal. Individuals were eligible to participate in this study if they were ≥65 y of age. Possible applicants were contacted by the interviewer, who provided information about the study aims and procedures and invited them to participate [7].

Ethics

This research was conducted according to the guidelines established by the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of the Department of Social Sciences and Health from the Faculdade de Medicina da Universidade do Porto (PCEDCSS – FMUP 15/2015) and by the Portuguese National Commission of Data Protection. All participants, or two representatives per participant in case of cognitive decline, were asked to read and sign a duplicated informed consent form.

Data collection

Demographic, lifestyle, and anthropometric measurements and clinical and nutritional status data were collected using a structured questionnaire.

Sociodemographic data included information on sex, date of birth, residence geographical area, residence type, marital status, educational level, and household income. The country regional areas used are defined in NUTS II as Alentejo, Algarve, Azores, Lisbon Metropolitan Area, Centre, Madeira, and North [8]. Educational level was determined by the number of completed school years. Marital status was categorized as single, divorced, widowed, or married or in a common-law marriage. Residence geographical area was defined as living at home or in an institution (e.g., nursing home).

Lifestyle data included information on smoking habits. Participants were asked if they were smokers or non-smokers.

Clinical data included participant's self-perception of health status, cognitive performance, chronic diseases, prescription, and use of over-the-counter (OTC) drugs and nutritional supplements. Participant classified their health status as *very good, good, moderate, bad* or *very bad*. Cognitive performance was assessed by the Portuguese version [9] of the Mini Mental State Examination (MMSE) [10]. Chronic diseases, prescription, and OTC drug and supplement use were collected using questions drawn from the Portuguese National Health Survey 2005–2006. These questions concerned self-reported diagnosis of chronic diseases in the previous 12 months and pharmacologic treatment and use of nutritional supplements, including the name and number of daily doses [6]. Nutritional status was evaluated by the Portuguese version of Mini-Nutritional Assessment-Short Form (MNA-SF) [11,12].

Anthropometric measurements were collected following standard procedures [13]. Standing height was obtained with a calibrated stadiometer (Seca 213, Hamburg, Germany) with 0.1 cm resolution. For participants with visible kyphosis or when it was impossible to measure standing height owing to participant's paralyses or owing to mobility or balance limitations, height was obtained indirectly from non-dominant hand length (in cm), measured with a calibrated paquimeter from Fervi Equipment (Vignola, Italy) with 0.1 cm resolution [14]. Body weight (in kg) was measured with a calibrated portable electronic scale (Seca 803) with 0.1 kg resolution. When it was not possible to weigh a patient, for the same reasons that standing height measurement was not possible, body weight was estimated from mid-upper arm and calf circumferences (CC) [15,16]. Mid-upper arm, waist circumferences (WC), and CC were measured with a metal tape from Lufkin (Sparks, MD, USA), with 0.1 cm resolution. Waist-to-height ratio was calculated using the following formula:

$$\text{WC (cm)}/\text{height (cm)}\ [17].$$

Mid-arm muscle circumference (MAMC) was calculated using the Jelliffe formula [18].

The PREDIMED (Prevención con la Dieta Mediterránea) study is a primary prevention nutrition intervention trial. Baseline adherence to the MDP was measured using a 14-point Mediterranean Diet Adherence Screener scoring 0 to 14. The validation study included 7146 Spanish participants 55 to 80 y of age and showed that this is a valid instrument for rapid estimation of adherence to the Mediterranean diet and may be useful in clinical practice [1,19]. Adherence to the MDP was evaluated with the Portuguese version of the Prevention with Mediterranean Diet tool [20], which consists of 14 questions, each scored with 0 or 1 point. The criteria for assigning 1 point were defined by the tool developers and a final score of ≥10 points indicates good adherence to the MDP [19].

Statistical analysis

Categorical variables were reported as frequencies. The normality of the distribution regarding quantitative variables was evaluated through the Kolmogorov–Smirnov test, and results were described as median and interquartile distance, considering that variables presented non-normal distribution.

Age was categorized into the following groups: 65 to 69, 70 to 74, 75 to 79, and ≥80 y. Educational level was categorized into four categories: no schooling, between 1 and 3 y of schooling, 4 y of schooling (first cycle), and ≥5 y of schooling, which included second cycle (6 y of schooling), third cycle (9 y of schooling), secondary (12 y of schooling), post-secondary (≥12 y of schooling but no higher education), and higher education. Monthly household income was summarized using the following cutoffs: ≤$561, $562 to $1123 and ≥$1124. About half of the participants (50.6%) did not know or preferred not to declare their income, and they were allocated into a separate category. There were three self-perceived health status categories: very good or good, moderate, and bad or very bad. According to the MMSE score, older adults were considered to have cognitive deficit if they were illiterate and scored ≤15 points, if they had 1 to 11 y of schooling and scored ≤11 points, or if they had >11 y of schooling and scored ≤27 points [9].

The number of chronic diseases was categorized into 0 to 1, 2 to 5, and ≥6. Prescription and OTC drug use was categorized into 0, 1 to 4, ≥5, or does not know [21]. Nutritional supplements recognized by the Portuguese Ministry of Health (Infarmed) were categorized into no (do not use), yes, and does not know.

Mini-Nutritional Assessment-Short Form was dichotomized into two categories: not undernourished and at risk for undernutrition. Because of the small number of participants in the "undernourished" category, these were included in the category "at risk for undernutrition." Participants were grouped according to body mass index (BMI) into three categories: normal (18.50–24.99 kg/m^2), preobese (25–29.99 kg/m^2), and obese (≥30 kg/m^2) [22].

Participants were compared regarding MDP adherence in several sociodemographic, lifestyle, clinical, and nutritional characteristics using Mann-Whitney test for continuous variables and χ^2 test or Fisher exact test for categorical variables.

From the original Nutrition UP 65 study sample (N = 1500), 17 participants presenting missing data were not included. From the initial sample, 3 participants who were underweight and 73 with cognitive impairment were not included. Consequently, data from 1407 participants were analyzed. After this, a sensitivity analysis was carried out comparing the studied characteristics between the remaining sample (n = 1407) and those who were excluded (n = 93; Supplementary Table 1).

The inclusion of confounders in the unconditional logistical regression model was based on hierarchical analysis, consisting of a theoretical model that prioritizes the interrelations between several risk factors and death (Fig. 1). This is reflected by assessing the effect of the factor of interest adjusted only for the confounding factors belonging to a higher level. All parameters were included in the hierarchical multivariable logistical regression model to identify the independent factors associated with the adherence to the MDP. Odds ratios (ORs) and respective 95% confidence intervals (CIs) were calculated.

Results were considered significant when $P \leq 0.05$. Statistical analysis was conducted using the SPSS version 23 (IBM, Armonk, NY, USA).

Results

The characteristics of the 1407 participants, with a median age of 74 y, according to adherence to the MDP are presented in Table 1. Within this sample, 43% of the participants adhered to the MDP (n = 609). They were more likely to live in the north, to have completed 4 y of schooling, to be married or in a common-law marriage, to report less than five chronic diseases, to be preobese, to perceive themselves as being in moderate health and not undernourished (Table 1).

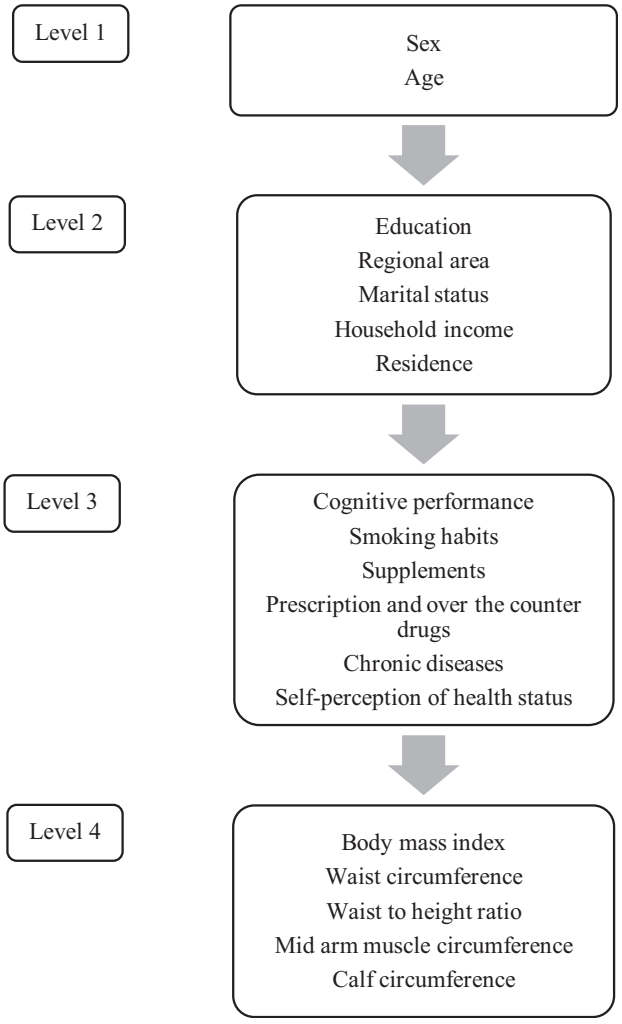

Fig. 1. Hierarchical model of main explanatory variables.

Table 1
Baseline sociodemographic, clinical, and nutritional characteristics of Portuguese adults ≥65 y of age participating in a cross-sectional observational study according to adherence to the MDP (N = 1406)*

	Adherence to MDP (PREDIMED score ≥10 points) n = 609	Nonadherence to MDP (PREDIMED score ≤ 10 points) n = 798	*P*-value
Sex, n (%)			
Women	341 (56)	468 (58.6)	0.328†
Men	268 (44)	330 (41.4)	
Age, y, n (%)			
65–69	184 (30.2)	213 (26.7)	0.078‡
70–74	158 (25.9)	203 (25.4)	
75–79	136 (22.3)	163 (20.4)	
≥80	131 (21.5)	219 (27.4)	
Regional area, n (%)			
North	197 (32.3)	261 (32.7)	0.012‡
Centre	170 (27.9)	189 (23.7)	
Lisbon metropolitan area	148 (24.3)	206 (25.8)	
Alentejo	59 (9.7)	72 (9)	
Algarve	26 (4.3)	29 (3.6)	
Madeira	6 (1)	24 (3)	
Azores	3 (0.5)	17 (2.1)	
Education, y, n (%)			
0	62 (10.2)	132 (16.5)	<0.001‡
1–3	104 (17.1)	154 (19.3)	
4	311 (51.1)	403 (50.5)	
≥5	132 (21.7)	109 (13.7)	
Residence, n (%)			
Home	582 (95.6)	764 (95.7)	0.895†
Institution	27 (4.4)	34 (4.3)	
Marital status, n (%)			
Single, divorced, or widowed	276 (45.3)	456 (57.1)	<0.001†
Married or common-law marriage	333 (54.7)	342 (42.9)	
Household income (US), n (%)			
≤$561	94 (15.4)	136 (17)	0.001‡
$562 to $1123	139 (22.8)	155 (19.4)	
≥$1124	95 (15.6)	76 (9.5)	
Did not know or did not declare	281 (46.1)	431 (54.)	
Cognitive performance (MMSE), n (%)			
Normal	599 (98.4)	782 (98)	0.692‡
Impairment	10 (1.6)	16 (2)	
Self-perception of health status, n (%)			
Very good/Good	235 (38.6)	216 (27.1)	<0.001‡
Moderate	279 (45.8)	419 (52.5)	
Bad/Very bad	95 (15.6)	163 (20.4)	
Smoking habits, n (%)			
No	584 (95.9)	757 (94.9)	0.377†
Yes	25 (4.1)	41 (5.1)	
Chronic diseases, n (%)			
0–1	70 (11.5)	72 (9)	<0.001‡
2–5	413 (67.8)	469 (8.8)	
≥6	126 (20.6)	257 (32.2)	
Supplements, n (%)			
No	459 (75.4)	607 (76.1)	0.938‡
Yes	88 (14.4)	114 (14.3)	
Did not know	62 (10.2)	77 (9.6)	
Prescription and over-the-counter drugs, n (%)			
0	83 (13.6)	107 (13.4)	0.951‡
1–4	347 (57)	455 (57)	
Polypharmacy (≥5)	129 (21.2)	176 (22.1)	
Did not know	50 (8.2)	60 (7.5)	
Nutritional status (MNA-SF), n (%)			
Not undernourished	533 (87.5)	663 (83.1)	0.025‡
At risk for undernutrition	76 (12.5)	135 (16.9)	
Body mass index, kg/m^2, n (%)			
Normal range (18.5–24.99)	94 (15.4)	131 (16.4)	0.018‡

(*continued*)

Table 1 (*Continued*)

	Adherence to MDP (PREDIMED score ≥10 points) n = 609	Nonadherence to MDP (PREDIMED score ≤ 10 points) n = 798	*P*-value
Preobese (25–29.99)	299 (49.1)	333 (41.7)	
Obese (≥300)	216 (35.5)	334 (41.9)	
Waist circumference, cm, n (%)			
No risk	82 (13.5)	91 (11.4)	0.103‡
High risk (women >80, men >94)	141 (23.2)	158 (19.8)	
Very high risk (women >88, men >102)	386 (63.4)	549 (68.8)	
Waist-to-height ratio, n (%)			
<0.5	9 (1.5)	19 (2.4)	0.253‡
≥0.5	600 (98.5)	779 (97.6)	
Mid arm muscle circumference,cm, median (IQR)	31 (4.3)	31 (4.9)	0.277§
Calf circumference, cm, median (IQR)	35 (4.5)	36 (4.3)	0.003§

IQR, interquartile range; MDP, Mediterranean dietary pattern; MMSE, Mini Mental State Examination; MNA-SF, Mini Nutritional Assessment – Short Form.
*Values may not add up to 100% due to rounding up.
†Fisher exact test.
‡χ^2 test.
§Mann–Whitney test.

Logistic hierarchical regression data are displayed in Table 2. After the hierarchical analysis, having ≥4 y of schooling was associated to adherence to MDP (OR, 1.53; 95% CI, 1.06–2.19 and OR, 2.38; 95% CI, 1.54–3.69). Individuals who were married or were in a common-law marriage had 54% more probability of adherence to the MDP than those who were single, divorced, or widowed (OR, 1.54; 95% CI, 1.20–1.97). Individuals who were preobese had a 52% higher probability of adherence to the MDP than those within normal BMI range (OR, 1.52; 95% CI, 1.02–2.25).

Individuals ≥80 y of age had less probability of adhering to the MDP than those being 65 to 69 y of age (OR, 0.70; 95% CI, 0.52–0.94). Participants living in the central region adhered more to the MDP than those living in the north (OR, 1.35; 95% CI, 1.01–1.79). However, participants living in Madeira and Azores adhered less to MDP than those living in the north (OR, 0.35; 95% CI, 0.14–0.89; OR, 0.28; 95% CI, 0.08–0.99, respectively). Concerning perception of health status, those who rated their health as moderate or bad and very bad had less possibility of adherence to the MDP than those who rated their health as very good and good (35% and 37%, respectively), and those with six or more comorbidities had less odds of adherence to the MDP (OR, 0.62; 95% CI, 0.39–0.97).

Discussion

The aim of this study was to evaluate adherence to the MDP and its associated factors in a national sample of Portuguese older adults. Educational level was the factor most strongly related with adherence to the MDP. Individuals who lived in the central region, who were married or living in a common-law marriage, and who were preobese adhered more to this pattern than those who lived in the north; those who were single, divorced, or widowed; or those with a normal BMI, respectively. On the other hand, participants ≥80 y of age, who lived in Madeira and Azores, who rated their health as moderate and as bad or very bad, or who reported six or more comorbidities, had lower odds of adherence to the MDP than those 65 to 69 y of age who lived in the north, rated their

Table 2
Factors associated with adherence to a Mediterranean dietary pattern according to a hierarchical multivariable logistic regression model for Portuguese adults ≥65 y of age participating in Nutrition UP 65 Study (N = 1407)

		Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
1	Sex				
	Women	1	–	1	–
	Men	1.12 (0.90–1.38)	0.319	1.09 (0.88–1.35)	0.440
	Age, y				
	65–69	1	–	1	–
	70–74	0.90 (0.68–1.20)	0.476	0.90 (0.67–1.20)	0.456
	75–79	0.97 (0.72–1.31)	0.821	0.97 (0.72–1.31)	0.845
	≥80	0.70 (0.52–0.93)	0.014	0.70 (0.52–0.94)	0.018
2*	Regional area				
	North	1	–	1	–
	Center	1.19 (0.90–1.57)	0.216	1.35 (1.01–1.79)	0.043
	Lisbon Metropolitan Area	0.95 (0.72–1.26)	0.730	0.85 (0.63–1.14)	0.267
	Alentejo	1.09 (0.74–1.61)	0.680	1.06 (0.71–1.59)	0.764
	Algarve	1.19 (0.68–2.08)	0.547	1.43 (0.80–2.56)	0.233
	Madeira	0.33 (0.13–0.83)	0.018	0.35 (0.14–0.89)	0.027
	Azores	0.23 (0.07–0.81)	0.022	0.28 (0.08–0.99)	0.049
	Education, y				
	0	1	–	1	–
	1–3	1.44 (0.97–2.13)	0.069	1.38 (0.92–2.08)	0.119
	4	1.64 (1.17–2.30)	0.004	1.53 (1.06–2.19)	0.022
	≥5	2.58 (1.74–3.82)	≤ 0.001	2.38 (1.54–3.69)	< 0.001
	Marital status				
	Single, divorced, or widowed	1	–	1	–
	Married or common-law marriage	1.61 (1.30–1.99)	≤ 0.001	1.54 (1.20–1.97)	0.001
	Household income (US)				
	≤$561,	1	–	1	–
	$562 to $1123	1.30 (0.92–1.84)	0.143	1.07 (0.74–1.55)	0.707
	≥$1124	1.81 (1.21–2.70)	0.004	1.23 (0.79–1.92)	0.360
	Did not know or did not declare	0.94 (0.70–1.28)	0.705	0.83 (0.60–1.14)	0.251
	Residence				
	Home	1	–	1	–
	Institution	1.04 (0.62–1.75)	0.875	1.26 (0.73–2.18)	0.413
3†	Cognitive performance (MMSE)				
	Normal	1	–	1	–
	Impairment	0.82 (0.37–1.81)	0.617	1.00 (0.43–2.32)	0.998
	Smoking habits				
	No	1	–	1	–
	Yes	0.79 (0.48–1.32)	0.365	0.73 (0.42–1.26)	0.256
	Supplements				
	No	1	–	1	–
	Yes	1.02 (0.75–1.38)	0.894	1.02 (0.74–1.41)	0.888
	Did not know	1.07 (0.75–1.52)	0.729	1.26 (0.56–2.82)	0.574
	Prescription and over-the-counter drugs, n				
	0	1	–	1	–
	1–4		0.917		0.438

(*continued*)

Table 2 (*Continued*)

		Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
		0.98 (0.72–1.35)		1.15 (0.81–1.62)	
	Polypharmacy (≥5)	0.95 (0.66–1.36)	0.761	1.30 (0.86–1.96)	0.208
	Did not know	1.07 (0.67–1.72)	0.766	1.27 (0.50–3.25)	0.617
	Chronic diseases, n				
	0–1	1	–	1	–
	2–5	0.91 (0.64–1.29)	0.584	0.99 (0.67–1.45)	0.947
	≥ 6	0.50 (0.34–0.75)	0.001	0.62 (0.39–0.97)	0.037
	Self-perception of health status				
	Very good/Good	1	–	–	–
	Moderate	0.61 (0.48–0.78)	≤ 0.001	0.65 (0.50–0.84)	0.001
	Bad/Very bad	0.54 (0.39–0.77)	≤ 0.001	0.63 (0.45–0.90)	0.011
4[‡]	Nutritional status (MNA-SF)				
	Not undernourished	1	–	1	–
	At risk for undernutrition	0.70 (0.52–0.95)	0.021	0.80 (0.57–1.12)	0.189
	Body mass index, kg/m^2				
	Normal range (18.5–24.99)	1	–	1	–
	Preobese (25–29.99)	1.25 (0.92–1.70)	0.153	1.52 (1.02–2.25)	0.040
	Obese (≥30)	0.90 (0.66–1.24)	0.518	1.61 (0.97–2.68)	0.065
	Waist circumference, cm				
	No risk	1	–	1	–
	High risk (women >80, men >94)	0.99 (0.68–1.44)	0.960	0.81 (0.52–1.27)	0.258
	Very high risk (women >88, men >102)	0.78 (0.56–1.08)	0.135	0.75 (0.47–1.20)	0.227
	Waist-to-height ratio				
	<0.5	1	–	1	–
	≥0.5	1.63 (0.73–3.62)	0.234	2.26 (0.86–5.40)	0.101
	Mid arm muscle circumference, cm				
		0.98 (0.95–1.00)	0.050	0.99 (0.96–1.02)	0.390
	Calf circumference, cm				
		0.96 (0.93–0.99)	0.003	0.94 (0.90–0.98)	0.006

MMSE, Mini Mental State Examination; MNA-SF, Mini Nutritional Assessment – Short-Form.
*Adjusted for variables of level 1.
†Adjusted for variables of levels 1 and 2.
‡Adjusted for variables of levels 1, 2, and 3.

health as very good or good, or did not have any comorbidities, respectively.

There are prevalence studies in older adult populations that revealed that WC and waist-to-height ratio have a strong inverse association with adherence to the MDP [1,19]. However, this was not observed in the present study. Our interpretation is that the cutoff values used were specified for adult population [17,23] that are not adjust to age-related physiological changes in this older adult population. The use of CC, rather than mid-arm muscle circumference, has been recommended as a more sensitive measure of the loss of total body muscle mass in older adults [24]. In this study, participants with higher CC values had less possibility of adherence to the MDP. This may possibly happen because this pattern is not considerably rich in protein, which is essential to body muscle construction.

Obesity is a growing problem worldwide. Moreover, the prevalence of obesity is higher in Mediterranean countries than in Nordic countries [25]. According to recent Portuguese data, 39.2% of older adults have BMI ≥30 kg/m^2 [26]. A study in Spain that included 351 individuals >60 y of age reported that adherence to the MDP was associated with a higher BMI [27], which is in agreement with the present study. In older adults, low BMI is associated with a decrease in functional abilities and an increase in mortality [28]. A recent study conducted in 4259 individuals of the PREDIMED trial suggests that the effects of dietary energy density on weight change depends on the particular nutrient-dense food consumed, in a context of a specific dietary pattern [29]. According to a recent Portuguese report, although 43.7% of the Portuguese older people have a high adherence to the MDP, it should be noted that foods like biscuits, cakes, pastries, savory snacks and pizzas, soft drinks, and alcoholic drinks, which are not represented in the Portuguese Food Wheel, [30] constitute about 21% of the Portuguese food intake. The average consumption of alcoholic beverages is higher in older adults (298 g/d) than in their younger counterparts (195 g/d) [26], exceeding the recommendations [2]. Therefore, we can say that despite good adherence to this pattern from older adults, there are still several points that can be improved. In our work, the PREDIMED tool allowed the capture of several aspects of the MDP. However, it appears unable to detect the intake of energy-dense foods outside the MDP that may explain the higher likelihood of MDP adherence observed in preobese and obese participants.

Living in Madeira and Azores reduced the odds of adherence to the MDP. Indeed, similar findings have been obtained showing that individuals living in Azores had the lowest adherence to the MDP in Portugal [26]. Nevertheless, our results could be misrepresented by the small sample size (only 6.6% of the sample are from islands) in relation to the reference region in our adjusted model (north: 65% of the sample).

Considering the educational level, it has been demonstrated that education is the strongest determinant of socioeconomic differences in food habits [31]. In the present study, having ≥5 y of schooling was the strongest predictor of adherence to the MDP. Many studies have obtained similar findings—adherence to the MDP directly associated with higher educational levels [19,32].

Regarding marital status, in the present study individuals who were married or were in a common-law marriage were more likely to adhere to the MDP than those who were single, divorced, or widowed. This association may be explained by the fact that psychosocial factors, such as the loss of a spouse and social isolation, may lead to qualitative and quantitative changes in food ingestion through loss of appetite, refusal to eat, or lack of motivation to prepare food, thus reducing the consumption of energy and consequently leading to a higher risk for poor nutritional status [32,33].

According to household income, in the adjusted model, this variable did not have statistical significance. This is probably explained by the fact that 50.6% of the participants did not report their income, which could have misrepresented the results.

Regarding perception of health status, in Portugal the prevalence of adherence to the MDP is significantly higher in individuals who perceive their health as being good, particularly in older adults (49.3%) [26]. Indeed, similar findings have been obtained in this study. In the present study, undernutrition status did not have statistical significance in the adjusted model. Knowing that inadequate nutritional intake is one of the main causes of undernutrition in old age [28], our interpretation of these results is that there are many undernourished older people who did not have access to the questionnaire owing to their conditions, which may have resulted in better-than-average health and nutrition among the selected sample. In addition, the severely undernourished are easier to identify than those who are mildly or moderately undernourished because the latter do not manifest overt signs of undernutrition.

Therefore, subclinical and marginal nutritional deficits might go unnoticed or undocumented [28].

The present study had several limitations that must be acknowledged. According to the sensitivity analyses (Supplementary Table 1), we cannot extrapolate these results to the general older adult population. One likely limitation is the strict inclusion and exclusion criteria, which may possibly have resulted in the selection of a sample with better-than-average health and nutritional status. Furthermore, the Mediterranean diet score is based on a traditional Mediterranean reference pattern defined a priori, which does not consider the overall correlation between foods. On top of that, the PREDIMED score is not validated specifically for the Portuguese population, which can be a source of error. In addition, causality relationships remain often controversial. For this, studies assessing dose-response effects, midlife exposure, and with appropriate follow-up need to be designed.

The main strengths of this study were the large number of individuals studied and the population-based recruitment of a nationally representative sample of Portuguese older adults. Furthermore, to our knowledge this is the first work to describe adherence to the MDP and its associated factors in a nationally representative sample of older adults in Portugal.

Conclusion

The present study illustrates the importance of a lifestyle approach in which the MDP is included. High educational levels are strongly associated with better adherence to the MDP. However, individuals who are ≥80 y of age, live in Madeira or Azores, rate their health as moderate and bad or very bad, have six or more comorbidities, or have higher values of CC, were less likely to adhere to the MDP. Consequently, in these groups it is necessary to reinforce the promotion of older adults' health, well-being, and quality of life through healthy patterns.

Inadequate diet might represent a relevant, modifiable risk factor for functional decline and the transition to disability. The findings of this research will have significant relevance to public health in Portugal.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi: 10.1016/j.nut.2019.03.005.

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