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A Short Screener Is Valid for Assessing Mediterranean Diet Adherence among Older Spanish Men and Women[1–3]

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Abstract

Ensuring the accuracy of dietary assessment instruments is paramount for interpreting diet-disease relationships. The present study assessed the relative and construct validity of the 14-point Mediterranean Diet Adherence Screener (MEDAS) used in the Prevención con Dieta Mediterránea (PREDIMED) study, a primary prevention nutrition-intervention trial. A validated FFQ and the MEDAS were administered to 7146 participants of the PREDIMED study. The MEDAS-derived PREDIMED score correlated significantly with the corresponding FFQ PREDIMED score (r = 0.52; intraclass correlation coefficient = 0.51) and in the anticipated directions with the dietary intakes reported on the FFQ. Using Bland Altman's analysis, the average MEDAS Mediterranean diet score estimate was 105% of the FFQ PREDIMED score estimate. Limits of agreement ranged between 57 and 153%. Multiple linear regression analyses revealed that a higher PREDIMED score related directly ($P < 0.001$) to HDL-cholesterol (HDL-C) and inversely ($P < 0.038$) to BMI, waist circumference, TG, the TG:HDL-C ratio, fasting glucose, and the cholesterol:HDL-C ratio. The 10-y estimated coronary artery disease risk decreased as the PREDIMED score increased ($P < 0.001$). The MEDAS is a valid instrument for rapid estimation of adherence to the Mediterranean diet and may be useful in clinical practice. J. Nutr. 141: 1140–1145, 2011.

Introduction

Estimating overall diet quality and determining its association with health outcomes is a key challenge in nutritional epidemiology. Various indices of diet quality have been proposed (1–3) and there is a consistent body of scientific evidence indicating that increasing adherence to the Mediterranean diet is associated with favorable mental and physical health outcomes (4,5). In epidemiological settings, a composite scale of food items considered characteristic of the Mediterranean diet has been created and a full-length FFQ is the most-used method of estimating an individual's adherence to this healthy eating pattern (6).

However, the full-length FFQ is time consuming for participants and therefore not an optimal choice in time-limited settings. A shorter instrument capable of correctly estimating adherence to the Mediterranean diet would be useful to researchers to control for compliance when this dietary pattern is the intervention goal and even in clinical practice when a rapid estimation of a patient's

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dietary pattern is needed. A 14-point Mediterranean Diet Adherence Screener (MEDAS)[22] was developed to rapidly control for compliance with the dietary intervention of the Prevención con Dieta Mediterránea (PREDIMED) study, a multicentre clinical trial aimed at assessing the effects of the traditional Mediterranean diet on the primary prevention of cardiovascular disease (7). This screener might also be used to assess dietary compliance in large epidemiological settings incorporating a broad spectrum of measurements with limited resources. Of course, evaluating how well the new method measures what it is intended to measure is of paramount importance. The objective of the present study was to determine concurrent and construct validity of the MEDAS instrument in PREDIMED study participants.

Materials and Methods

Study population. The PREDIMED study is a large, multicentre, parallel-group, randomized, controlled, 5-y clinical trial (7,8). The detailed study protocol has been previously published (7–9). The Institutional Review Boards of the participating institutions approved the study protocol and all participants provided informed consent.

From October 2003 to January 2009, 7447 asymptomatic participants at high risk for coronary heart disease (CHD) who were aged 55–80 y were selected in 10 primary care centers in Spain. Inclusion criteria were the presence of type 2 diabetes or at least 3 of the established CHD risk factors: current smoking, systolic blood pressure > 140 mm Hg, diastolic blood pressure > 90 mm Hg, treatment with antihypertensive drugs, HDL-cholesterol (HDL-C) < 40 mg/dL (to convert mg/dL to mmol/L, divide by 38.67) in men or < 50 mg/dL in women, LDL-cholesterol > 160 mg/dL, treatment with hypolipidemia drugs, BMI > 25 kg/m^2, and family history of premature CHD. Exclusion criteria were any history of cardiovascular disease, severe chronic illness, drug or alcohol abuse, allergy or intolerance to olive oil or nuts, or a low predicted likelihood of changing dietary habits according to the stages of change model. The validation study included 7146 (3053 men and 4093 women) participants who completed both dietary questionnaires (the MEDAS and the full-length FFQ). In addition to dietary estimates, cardiovascular risk variables were available from 4675 (65%) participants (1933 men and 2742 women).

Dietary assessment. Baseline adherence to the Mediterranean diet was measured by the MEDAS, an adaptation of a previously validated 9-item index (10). The 14-item screener includes 5 additional items that are critical to an assessment of adherence to the traditional Mediterranean diet in the present population. Two of these items (Do you use olive oil as the principal source of fat for cooking? and Do you prefer to eat chicken, turkey or rabbit instead of beef, pork, hamburgers or sausages?) are related to food intake habits and 3 are questions about food consumption frequency (How many times do you consume nuts per week? How many carbonated and/or sugar-sweetened beverages do you consume per day? How many times per week do you consume boiled vegetables, pasta, rice, or other dishes with a sauce of tomato, garlic, onion, or leeks sautéed in olive oil?).

Therefore, the MEDAS consists of 12 questions on food consumption frequency and 2 questions on food intake habits considered characteristic of the Spanish Mediterranean diet. Each question was scored 0 or 1. One point was given for using olive oil as the principal source of fat for cooking, preferring white meat over red meat, or for consuming: *1*) 4 or more tablespoons (1 tablespoon = 13.5 g) of olive oil/d (including that used in frying, salads, meals eaten away from home, etc.); *2*) 2 or more servings of vegetables/d; *3*) 3 or more pieces of fruit/d; *4*) <1 serving of red meat or sausages/d; *5*) <1 serving of animal fat/d; *6*) <1 cup (1 cup = 100 mL) of sugar-sweetened beverages/d; *7*) 7 or more servings of red wine/wk; *8*) 3 or more servings of pulses/wk; *9*) 3 or more servings of fish/wk; *10*) fewer than 2 commercial pastries/wk; *11*) 3 or more servings of nuts/wk; or *12*) 2 or more servings/wk of a dish with a traditional sauce of tomatoes, garlic, onion, or leeks sautéed in olive oil. If the condition was not met, 0 points were recorded for the category. The final PREDIMED score ranged from 0 to 14.

All participants were also asked to complete a 137-item semiquantitative FFQ previously validated in Spain (11). The frequencies were registered in 9 categories that ranged from "never or almost never" to "6 times/d." Food intake data recorded on the FFQ were grouped into the food-based dietary components of the MEDAS for analysis. We validated the dietary assessment data retrieved from the MEDAS by comparing it with the data gathered from the validated full-length FFQ. The FFQ and the screener were administered before intervention.

Anthropometric measurements. We undertook all clinical procedures in accordance with the PREDIMED operations manual. Weight and height were measured with calibrated scales and a wall-mounted stadiometer, respectively. BMI was calculated as weight in kilograms divided by the square of height in meters. Waist circumference (WC) was measured midway between the lowest rib and the iliac crest using an anthropometric tape.

Laboratory measurements. Blood was withdrawn after a 10- to 12-h fast. Sample aliquots were stored at −80C° without freeze/thaw cycles.

Concordance between laboratories was analyzed to homogenize data on glucose, total cholesterol, HDL-C, and TG concentrations with 1439 samples (40% from the total sample) of each variable with the IMIM laboratory as reference. In the reference laboratory, glucose and lipid concentrations were measured using an autoanalyzer (PENTRA-400, ABX-HORIBA Diagnostics). Specifically, glucose, total cholesterol, and TG were analyzed by hexokinase, esterase-oxidase-peroxidase, and glicerol-phosphate oxidase-peroxidase methodology, respectively. HDL-C was measured by direct methodology using accelerator selective detergent. ABX-Horiba (Diagnostics) reagents were used in the analyses. LDL-cholesterol was calculated by the Friedewald equation whenever TG were <3.4 mmol/L (300 mg/dL). An internal and external quality control assessment was followed in all laboratories: Bio-Rad and Spain Chemical and Clinical Society.

CHD risk estimation. CHD risk was estimated using the Registre Gironí del Cor function adapted from the original Framingham function and validated for the Spanish population (12). The variables used were age, sex, diabetes, smoking, systolic and diastolic blood pressure, total cholesterol, and HDL-C.

Other measurements. The baseline examination included administration of the Minnesota Leisure Time Physical Activity questionnaire, validated for use in Spanish men and women (13,14), and a 47-item general questionnaire assessing lifestyle, health conditions, smoking habits, sociodemographic variables, history of illness, and medication use.

Statistical analysis. The Pearson product-moment correlation coefficient between the MEDAS-derived PREDIMED score and the FFQ PREDIMED score was calculated to establish relative agreement between methods. General linear modeling procedures (PROC GLM, SAS Institute, version 8.0) were used to estimate general characteristics as well as energy-adjusted food and nutrient intake, derived from the FFQ according to the quintile distribution of the MEDAS-derived PREDIMED score.

In both of these analyses, the linear trend was tested by including the categorized variable (tertile distribution of the dietary indices as continuous in the model). Polynomial contrasts were used to determine *P*-linear trend for continuous variables, with a post hoc Bonferroni correction for multiple comparisons. Chi square tests were used to determine *P*-linear trend for categorical variables.

Kappa statistics (SAS PROC FREQ, SAS Institute, version 8.0) were used to determine agreement in scoring for each of the 14 components

[22] Abbreviations used: CHD, coronary heart disease; HDL-C, HDL-cholesterol; ICC, intraclass correlation coefficient; LOA, limits of agreement; MEDAS, Mediterranean Diet Adherence Screener; PREDIMED, Prevención con Dieta Mediterránea; WC, waist circumference.

derived from the MEDAS and the FFQ. Additionally, absolute agreement between the MEDAS-derived PREDIMED score and the FFQ PREDIMED score was analyzed by the intraclass correlation coefficient (ICC) and limits of agreement (LOA) methods (15), expressed as percentage. A mean agreement (mean difference) of 100% indicates total agreement between the test and reference method.

Multiple linear regression models (PROREG, SAS, version 8.0) were fitted to analyze the association between the PREDIMED score and cardiometabolic risk variables. Differences were considered significant if $P < 0.05$.

Results

The main findings were essentially similar for men and women. Relative and absolute agreements between the MEDAS-derived PREDIMED score and the FFQ PREDIMED score were significant ($P < 0.001$) for men ($r = 0.52$; ICC = 0.52) and women ($r = 0.52$; ICC = 0.51). Therefore, we present unstratified results, adjusted by sex when appropriate.

Higher PREDIMED score ratings were observed among men and PREDIMED score adherence was positively associated with higher education, leisure time physical activity, smoking prevalence, and alcohol consumption. BMI decreased across quintiles of the PREDIMED score (**Table 1**). Absolute agreement of individual component scoring between the MEDAS and the FFQ was determined with κ statistics (**Table 2**). Poor ($\kappa < 0.21$), fair (κ = 0.21–0.40), moderate (κ = 0.41–0.60), good (κ = 0.61–0.80), and excellent (κ = 0.81–1.00) concordance was found for 21.4, 28.6, 28.6, 14.3, and 7.1% of the components of the PREDIMED score, respectively.

In a cross-classification of the PREDIMED score into tertiles, 47.9% of the individuals were grouped into the same tertile on both instruments, whereas 8.6% were grouped in opposite tertiles of the MEDAS and FFQ scores.

The MEDAS had a moderate ability to rank participants by PREDIMED score rating, as shown both by the Pearson correlation coefficient ($r = 0.52$; $P < 0.001$) between the MEDAS-derived PREDIMED score and the FFQ PREDIMED score and by the ICC, an indicator of the degree to which both instruments assigned the same absolute PREDIMED score ratings (ICC = 0.51; $P < 0.001$). The MEDAS significantly overestimated mean scoring for the PREDIMED score compared with the FFQ (8.68 ± 1.90 vs. 8.43 ± 1.73, respectively). LOA ranged from nearly one-half (57%) to fully half (153%) the average of the FFQ estimate.

A smoothed spline regression analysis showed that this correlation was comparable within subgroups of low- and high-adherence participants, and therefore the screener can be used with the population as a whole.

Construct validity of the MEDAS was determined by analyzing the correlations of the MEDAS-derived PREDIMED score with dietary intake reported on the FFQ and with components of the cardiometabolic risk profile. With the exception of vitamin E, all associations between the MEDAS-derived PREDIMED score and nutrient and food intake recorded with the FFQ were in the expected direction (**Table 3**). Furthermore, multivariate linear regression analyses revealed inverse associations of the MEDAS PREDIMED score with baseline serum TG levels, fasting glycemia, and the TG:HDL-C ratio. The opposite association was found for HDL-C (**Table 4**). BMI and WC were negatively associated with the PREDIMED score. Furthermore, the 10-y estimated CHD risk decreased with increasing adherence to the MEDAS-derived PREDIMED score.

Discussion

The MEDAS adequately ranks individuals according to their PREDIMED score ratings. Furthermore, a reasonable absolute agreement was observed between the PREDIMED score derived from the MEDAS and from the full-length FFQ. Food and nutrient intakes reported on the FFQ followed the direction hypothesized on the basis of the MEDAS-derived PREDIMED score. Importantly, higher PREDIMED score ratings were favorably associated with cardiometabolic risk variables and estimated CHD risk.

The MEDAS was developed within the PREDIMED study group to conveniently determine adherence to the traditional Mediterranean diet and to allow the provision of immediate feedback to the patient. The framework for the construction of this screener was a 9-item index, designed and validated primarily for the study's internal assessment of intervention compliance, which showed a good discrimination capacity between controls and myocardial infarction cases (9). The 5 items added to the original index are critical to an assessment of adherence to the traditional Mediterranean diet in the Spanish population.

The PREDIMED score obtained by the MEDAS is somewhat different from that used in other studies. It specifically addressed

TABLE 1 Characteristics of participants according to quintile distribution of the PREDIMED score derived by the 14-point MEDAS[1]

	Quintile distribution of the PREDIMED SCORE derived from the MEDAS					
	1st	2nd	3rd	4th	5th	*P*-linear trend[2]
n	1875	1383	1380	1315	1193	
Men, *%*	40.4 (38.2, 42.7)	42.7 (40.1, 45.3)	42.7 (40.1, 45.3)	41.9 (38.2, 43.6)	48.4 (43.6, 51.2)	<0.001
Age, *y*	66.8 ± 6.2	67.1 ± 6.2	67.3 ± 6.1	66.9 ± 6.2	66.7 ± 6.1	0.331
BMI, *kg/m²*	30.3 ± 3.9	30.1 ± 3.7	29.9 ± 3.9	29.7 ± 3.8	29.5 ± 3.7	<0.001
Current smokers,[3] *%*	21.4 (19.4, 23.4)	21.1 (18.8, 23.5)	18.1 (15.7, 20.5)	19.7 (17.3, 22.2)	16.9 (14.3, 19.5)	0.039
Educational level,[4] *%*	21.6 (19.7, 23.5)	22.1 (19.9, 24.3)	21.2 (19.0, 23.4)	24.8 (22.5, 27.1)	26.3 (23.9, 28.7)	0.005
LTPA,[5] METs · min/d	210 ± 229	209 ± 211	232 ± 236	252 ± 261	264 ± 265	<0.001
Alcohol consumption, *g/d*	6.6 ± 13.1	8.0 ± 14.9	8.7 ± 14.7	9.3 ± 14.5	11.0 ± 14.3	<0.001

[1] Values are mean ± SD or proportion (95% CI).
[2] The polynomial contrast and chi square test were used to determine *P*-linear trend for continuous and categorical variables, respectively.
[3] Current or ex-smokers (up to 1 y).
[4] More than primary school.
[5] Leisure-time physical activity.

TABLE 2 Absolute agreement between frequency and habits of dietary food intake as measured with the 14-point MEDAS and the FFQ

	Frequency[1]	MEDAS[2]	FFQ[3]	κ	95%CI[4]
1. Do you use olive oil as the principal source of fat for cooking?	Yes	90.9	84.3	0.55	0.51, 0.58
2. How much olive oil do you consume per day (including that used in frying, salads, meals eaten away from home, etc.)?	≥4 Tbsp[5]	70.9	63.9	0.56	0.54, 0.58
3. How many servings of vegetables do you consume per day? Count garnish and side servings as 1/2 point; a full serving is 200 g.	≥2	42.4	67.6	0.30	0.28, 0.32
4. How many pieces of fruit (including fresh-squeezed juice) do you consume per day?	≥3	52.0	33.4	0.37	0.35, 0.39
5. How many servings of red meat, hamburger, or sausages do you consume per day? A full serving is 100–150 g.	<1	87.3	73.9	0.23	0.19, 0.26
6. How many servings (12 g) of butter, margarine, or cream do you consume per day?	<1	90.6	93.1	0.64	0.61, 0.68
7. How many carbonated and/or sugar-sweetened beverages do you consume per day?	<1	89.4	96.6	0.38	0.33, 0.42
8. Do you drink wine? How much do you consume per week?	≥7 cups[6]	30.1	28.2	0.81	0.79, 0.82
9. How many servings (150 g) of pulses do you consume per week?	≥3	26.9	24.1	0.61	0.59, 0.63
10. How many servings of fish/seafood do you consume per week? (100–150 g of fish, 4–5 pieces or 200 g of seafood)	≥3	56.2	69.3	0.51	0.49, 0.53
11. How many times do you consume commercial (not homemade) pastry such as cookies or cake per week?	<2	67.8	92.1	0.20	0.17, 0.23
12. How many times do you consume nuts per week? (1 serving = 30 g)	≥3	34.0	36.7	0.33	0.31, 0.36
13. Do you prefer to eat chicken, turkey or rabbit instead of beef, pork, hamburgers, or sausages?	Yes	67.0	55.7	0.48	0.46, 0.50
14. How many times per week do you consume boiled vegetables, pasta, rice, or other dishes with a sauce of tomato, garlic, onion, or leeks sautÕed in olive oil?	≥2	62.7	24.8	0.03	0.004, 0.05
Mean	—	62.0	60.3	0.43	

[1] Criterion to score 1 point. Otherwise, 0 recorded.
[2] Percentage of participants scoring 1 on the MEDAS.
[3] Percentage of participants scoring 1 on the full-length FFQ.
[4] 95% CI of κ.
[5] 1 tablespoon = 13.5 g.
[6] 1 cup = 100 mL.

normative or absolute cutoff points for the consumption of food items typical of the Mediterranean diet, such as nuts, legumes, and olive oil, and also inquires about the consumption of foods that do not fit the traditional Mediterranean diet, such as sugary soft drinks and pastries.

The present study aimed to determine the validity of the final composite score derived from the MEDAS screener. Our analysis shows a moderate correlation (r = 0.52) between the MEDAS-derived PREDIMED score and that derived from the full-length FFQ. The magnitude of the correlation is comparable to those reported for food and nutrient intake derived from other short diet screeners and full-length FFQ (16–21). A somewhat higher correlation between the Diet Quality Index Revised, derived from a full-length FFQ, and two 1-wk dietary records has been reported (22). In contrast, Torheim et al. (23) reported lower correlations between 2 of the 3 diet indices obtained by a full-length FFQ and the reference method. Within this context, the MEDAS provides reasonable estimates to adequately rank Mediterranean diet adherence.

Although between-method correlation of variables reflects the strength of their association, a strong correlation does not necessarily imply good absolute agreement between methods. To address this issue, we determined absolute agreement by 2 methods, the ICC for absolute agreement and the LOA proposed by Bland and Altman (15). The ICC (0.51) indicates a moderate agreement between the MEDAS-derived PREDIMED score and the FFQ PREDIMED score. The MEDAS estimations of the PREDIMED score were 5% higher than the FFQ PREDIMED score. However, LOA expressed in percentages were within a reasonable range (24), showing that the MEDAS-derived PREDIMED score ratings were under- and overestimated by 43 and 53%, respectively, compared with the FFQ estimates. We cannot compare these findings with other results, because we are not aware of other studies that have used the LOA method to evaluate agreement between dietary indices.

The well-known favorable health effects of the Mediterranean diet indicate the high quality of this dietary pattern. In this context it is not surprising that adherence to the Mediterranean diet implies a healthy pattern of nutrient intake and a favorable cardiometabolic risk profile (25–27). Hence, if the construct of a composite score such as the MEDAS-derived PREDIMED score is valid, one would expect a positive association between the score and both a healthy nutrient intake and favorable cardiometabolic risk profile. We found that the MEDAS-derived PREDIMED score was positively associated with nutrient and food intakes considered healthy, including vitamin C, β-carotene, folic acid, dietary fiber, unsaturated fatty acids, vegetables, fruits, whole grain cereals, nuts, and fish. There was an inverse relationship between the PREDIMED score and intakes of sodium, saturated fat, sugared beverages, and refined cereals. These findings are in line with data from previous studies comparing dietary indices and nutrient adequacy (28), all of

TABLE 3 Sex-adjusted nutrient intake recorded on the FFQ according to quintile distribution of the Mediterranean diet score derived by the 14-point MEDAS[1,2]

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile	*P*-linear trend
Foods						
Fruits, *g/4.18MJ*	155 (151, 159)	168 (163, 173)	171 (166, 175)	178 (173, 183)	180 (175, 185)	<0.001
Vegetables, *g/4.18MJ*	139 (136, 143)	153 (149,157)	155 (152, 159)	163 (159, 167)	169 (165, 173)	<0.001
Olive oil, *g/4.18MJ*	15.1 (14.8, 15.5)	17.6 (17.2, 18.0)	18.3 (17.9, 18.7)	19.1 (18.7, 19.5)	19.8 (19.3, 20.2)	<0.001
Refined cereals, *g/4.18MJ*	105 (103, 106)	102 (100, 104)	101 (98.6, 102)	97.3 (95.3, 99.3)	95.0 (92.9, 97.0)	<0.001
Whole grain cereals, *g/4.18MJ*	11.3 (10.2, 12.5)	11.5 (10.2, 12.8)	13.8 (12.5, 15.2)	15.0 (13.7, 16.4)	17.2 (15.8, 18.6)	<0.001
Fish, *g/4.18MJ*	38.3 (37.8, 39.8)	44.2 (43.0, 45.3)	46.2 (45.0, 47.4)	49.5 (48.3, 50.7)	52.0 (50.7, 53.3)	<0.001
Red meat and sausages, *g/4.18MJ*	37.8 (36.9, 38.6)	35.2 (34.3, 36.2)	32.6 (31.7, 33.5)	31.5 (30.5, 32.5)	27.7 (26.7, 28.8)	<0.001
Nuts, *g/4.18MJ*	1.3 (1.1, 1.4)	1.5 (1.3, 1.7)	1.8 (1.6, 2.0)	2.1 (1.9, 2.2)	2.7 (2.5, 2.9)	<0.001
Dairy products, *g/4.18MJ*	178 (173, 182)	179 (174, 184)	174 (169, 180)	176 (171, 181)	164 (159, 170)	<0.001
Sugared beverages, *g/4.18MJ*	11.7 (10.6, 12.9)	8.1 (6.7, 9.4)	6.8 (5.4, 8.1)	5.2 (3.8, 6.6)	4.3 (2.8, 5.7)	<0.001
Nutrients						
Carbohydrates,[3] *%*	43.2 (42.9, 43.6)	41.9 (41.5, 42.3)	41.8 (41.4, 42.1)	41.0 (40.6, 41.3)	40.8 (40.4, 41.2)	<0.001
Proteins,[3] *%*	16.4 (16.3, 16.5)	16.7 (16.5, 16.8)	16.6 (16.4, 16.7)	16.7 (16.6, 16.9)	16.5 (16.3, 16.6)	0.361
Total fat,[3] *%*	38.4 (38.1, 38.7)	39.1 (38.7, 39.4)	39.2 (38.8, 39.5)	39.6 (39.2, 40.0)	39.9 (39.5, 40.3)	<0.001
Saturated fat,[3] *%*	10.4 (10.3, 10.5)	10.2 (10.1, 10.3)	9.9 (9.8, 10.0)	9.8 (9.7, 9.9)	9.4 (9.2, 9.5)	<0.001
Monounsaturated fat,[3] *%*	18.5 (18.3, 18.7)	19.4 (19.2, 19.7)	19.7 (19.4, 19.9)	20.1 (19.8, 20.3)	20.2 (19.9, 20.5)	<0.001
Polyunsaturated fat,[3] *%*	6.1 (6.0, 6.2)	5.9 (5.8, 6.1)	6.1 (5.9, 6.2)	6.2 (6.1, 6.3)	6.6 (6.5, 6.8)	<0.001
Cholesterol, *mg/4.18MJ*	166 (164, 168)	166 (164, 169)	163 (160, 166)	165 (162, 167)	158 (155, 161)	<0.001
Fiber, *g/4.18MJ*	10.8 (10.6, 10.9)	11.2 (11.1, 11.4)	11.5 (11.3, 11.7)	11.9 (11.7, 12.1)	12.2 (12.1, 12.4)	<0.001
Vitamin C, *mg/4.18MJ*	82.8 (81.0, 84.5)	90.2 (88.1, 92.3)	92.3 (90.2, 94.4)	97.4 (95.3, 99.5)	100.0 (97.8, 102.2)	<0.001
Vitamin E, *mg/4.18MJ*	4.7 (4.6, 4.8)	4.4 (4.3, 4.5)	4.4 (4.3, 4.5)	4.5 (4.4, 4.6)	4.62 (4.53, 4.71)	0.662
Folic acid, *μg/4.18MJ*	172 (169, 174)	183 (180, 186)	185 (182, 187)	190 (187, 193)	192 (189, 195)	<0.001
β-Carotene, *mg/4.18MJ*	1.48 (1.45, 1.55)	1.64 (1.58, 1.70)	1.65 (1.59, 1.71)	1.72 (1.65, 1.78)	1.75 (1.68, 1.81)	<0.001

[1] Values are means or percentages (95% CI).
[2] 1st quintile, *n* = 1875; 2nd quintile, *n* = 1383; 3rd quintile, *n* = 1380; 4th quintile, *n* = 1315; 5th quintile, *n* = 1193.
[3] Percentage energy intake.

which used full-length FFQ to determine the relationship between nutrient intake and dietary ratings.

High adherence to the Mediterranean diet, as estimated with the MEDAS, was associated with lower BMI, WC, and cardiometabolic risk markers. Participants with lower serum concentrations of fasting blood glucose, TG, and the TG:HDL-C ratio scored higher PREDIMED score ratings. The opposite was observed for HDL-C, as expected. These data are in line with previous findings reporting a lower risk of obesity and diabetes prevalence among PREDIMED study participants with high adherence to the MEDAS-derived PREDIMED score (29). Other large prospective studies provided similar results (30,31). Of note, in the present study, participants with high adherence to the Mediterranean diet had a lower 10-y estimated CHD risk than their peers with low adherence to this dietary pattern. Panagiotakos et al. (26) evaluated the performance of a modified PREDIMED score derived from a full-length FFQ to predict cardiovascular risk. They reported lower prevalence of cardiovascular risk variables and a lower 10-y CHD risk among participants with high Mediterranean diet adherence compared with those with low adherence.

TABLE 4 Multiple adjusted regression coefficients and 95% CI of the association between the Mediterranean diet score derived by the 14-point MEDAS with cardiovascular risk variables and 10-y coronary risk (*n* = 4675)[1]

	Mediterranean diet score (1 unit)		
Dependent variable	Regression coefficient	95% CI	*P*
BMI, *kg/m²*	−0.146	−0.191, −0.100	<0.001
WC, *cm*	−0.562	−0.689, −0.435	<0.001
HDL-C,[2] *mmol/L*	0.010	0.005, 0.014	<0.001
TG,[2] *mmol/L*	−0.005	−0.009, −0.002	<0.001
Fasting blood glucose,[2] *mmol/L*	−0.003	−0.005, −0.001	0.004
Total cholesterol:HDL-C[2]	−0.016	−0.031, −0.001	0.038
TG:HDL-C[2]	−0.009	−0.012, −0.005	<0.001
10-y coronary risk[3]	−0.001	−0.002, 0.001	<0.001

[1] Adjusted for sex, age, smoking status, leisure time physical activity, marital status, and educational level.
[2] Log transformed.
[3] Adjusted for sex, age, leisure time physical activity, marital status, and educational level.

A limitation of our study is the similarity in the designs of the reference method and the MEDAS. This may cause an overestimation of validity given the likely correlation in error between both methods. However, no reference method is free of error (32) and it has been shown that the magnitude of correlation coefficients between a long and a short FFQ was comparable to that between a short FFQ and a food record (33). A further limitation is that our findings cannot be extrapolated to the general population due to the fact that our participants were older participants at high risk for CHD.

We concluded that the MEDAS accurately classifies participants with respect to scoring for the PREDIMED score. Additionally, the LOA variations were within a reasonable range. Correlations between the MEDAS-derived PREDIMED SCORE and nutrient intake reported on the FFQ and cardiovascular risk variables indicate a reasonable construct validity of the screener.

This short screener is a valid tool for rapid assessment of adherence to the Mediterranean diet that may also be useful in clinical practice.

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