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MEDITERRANEAN DIET

Evaluation of a dietary screener: The Mediterranean Eating Pattern for Americans tool

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Abstract

Background: Evidence exists for an association between accordance with a Mediterranean diet pattern and slower rates of cognitive decline. However, an 'Americanized' version of the Mediterranean diet screener is needed to assess accordance in the USA. Thus, the Mediterranean Eating Pattern for Americans (MEPA) tool was developed to assess accordance with a Mediterranean-like food pattern when time is limited. The present study aimed to determine whether the MEPA screener captured the key elements of the Mediterranean diet compared to the more comprehensive food frequency questionnaire (FFQ).

Methods: The study comprised a cross-sectional study in which 70 women completed both the VioScreen™ FFQ (Viocare, Princeton, NJ, USA) electronically and the 16-item MEPA screener, either electronically or by telephone, aiming to evaluate the inter-method reliability of the proposed screener. The convenience sample included patients ($n = 49$) and healthcare providers ($n = 21$) recruited from a tertiary care medical center.

Results: The overall score from the MEPA screener correlated with corresponding overall MEPA FFQ score ($\rho = 0.365$, $P = 0.002$). Agreement between screener items and FFQ items was moderate-to-good for berries ($\kappa = 0.47$, $P < 0.001$), nuts (κ

= 0.42, $P < 0.001$), fish ($\kappa = 0.62$, $P < 0.001$) and alcohol ($\kappa = 0.64$, $P < 0.001$), whereas those for olive oil ($\kappa = 0.33$, $P = 0.001$) and green leafy vegetables ($\kappa = 0.36$, $P = 0.0021$) were fair. Usual intakes of potassium, magnesium, vitamin C, saturated fat, selected carotenoids, folate and fiber derived from the FFQ varied with MEPA screener scores in the anticipated directions.

Conclusions: The MEPA screener captures several components of the Mediterranean style pattern, although further testing of the MEPA screener is indicated.

Keywords: concordance, dietary assessment, eating patterns.

Introduction

Different versions of the Mediterranean diet exist in various countries, including Greece, Spain and France; however, these diets do possess commonalities. Historically, the various cultures of the different Mediterranean countries have played an important role in determining what foods individuals in these regions consume. Therefore, this agricultural society near the sea has traditionally emphasized the consumption of fresh fruits and vegetables, fish, legumes, nuts, whole grains, olive oil and wine[(1)]. More recently, the Mediterranean diet has gained popularity in the USA because of its health benefits[(2)].

Because there is no single definition of a Mediterranean diet and several Mediterranean diet patterns exist across the Mediterranean countries, the term ‘Mediterranean-like diet’ is used in the present study to describe a pattern incorporating the common features of the Mediterranean diet pattern[(2,3)]. Although accordance with a Mediterranean diet can be an indicator of health, the ‘gold standard’ tools used to measure accordance with such a pattern can be time-consuming to assess in a clinical setting. Lengthy food frequency questionnaires (FFQs) and repeated 24-h recalls are typically used to measure accordance. Because of time-limited settings for dietary assessment, several shorter dietary questionnaires have been developed [(4,5)].

In a 2002 study by Martinez-Gonzalez *et al.*,[(4)] researchers examined Mediterranean diet accordance by quantifying the risk reduction of a first myocardial infarction using an eight-item screener. Further revisions resulted in a nine-item diet screener[(6)] and, subsequently, a more comprehensive 14-point Mediterranean Diet Adherence Screener (MEDAS)[(7)] to measure accordance with the Mediterranean diet. Although these studies have mostly been conducted in the Mediterranean region, few groups have examined the Mediterranean diet and/or the use of tools for American population samples.

The Mediterranean Eating Pattern for Americans (MEPA) tool is a proposed 16-item dietary screener to assess accordance with the Mediterranean-like diet pattern developed by our group. The MEPA screener was adapted from the MEDAS, although it incorporates selected components protective for brain health as previously reported by our group on the basis of FFQ responses of participants in the Chicago Health and Aging Project and the Memory and Aging Project, comprising two prospective cohorts of older adults[8,9] along with additional modifications (i.e. different target frequencies of olive oil, greens, chicken and nuts plus the inclusion of a component specifying fruits other than berries).

The present study aimed to establish the inter-method reliability of the screener in an effort to support its use to assess accordance with this dietary pattern in US adult women. The inter-method reliability of the proposed MEPA screener was assessed in relation to a 'criterion' method, the VioScreen™ FFQ (Viocare, Princeton, NJ, USA). Similar to the approach of Schröder *et al.*,[5] a FFQ was selected for comparison to the proposed screener. The FFQ was considered preferable to repeated 24-h recalls because it was important to capture the weekly (not daily) consumption of select foods or food groups. Moreover, at least three to five 24-h recalls would be needed to estimate weekly intakes of key food items (e.g. beans, fish, berries) and, thus, a FFQ would readily capture these frequencies and reflect lower respondent burden. Thus, the objectives of the present study were to: (i) describe accordance with the Mediterranean style diet pattern based on responses from the MEPA tool (and the FFQ); (ii) evaluate the inter-method reliability of scores from the MEPA tool ($MEPA_{screener}$) and those based on FFQ responses ($MEPA_{FFQ}$); (iii) assess the bias of $MEPA_{screener}$ scores against those from the $MEPA_{FFQ}$; and (iv) evaluate FFQ nutrient intakes in relation to $MEPA_{screener}$ score tertiles in a sample of patients and health professionals.

Materials and methods

Study sample

From July 2014 to April 2015, patients between the ages of 24–79 years were recruited from the Rush Heart Center for Women (RHCW) at Rush University Medical Center (RUMC). Women were recruited in-person in the clinic or by e-mail using a list of patient emails provided by the physician. Inclusion criteria were: (i) having daily Internet access; (ii) at least 18 years of age; and (iii) the ability to read and speak English (because tools were only available in English at the time of the study). A total of 70 women completed both the full-length VioScreen™ FFQ followed by the MEPA screener. The Institutional Review Board at RUMC approved the study in November, 2013.

Dietary assessment

All eligible participants completed the 156-item VioScreen™ FFQ[10]. This FFQ has been extensively tested against six 24-h recalls; correlations between nutrients from the two methods exceeded 0.70 and exhibited minimal bias (maximum difference 9%). In addition to queries regarding food intakes, there are also questions regarding height, weight and usual physical activity levels. Criteria to estimate physical activity levels were provided in the initial e-mail (i.e. sedentary, low active, active, very active and extremely active). Nutritional and food group analyses were based on the Nutrition Data System for Research, version 44 (Nutrition Coordinating Center, University of Minnesota). These analyses also include calculation of total and component Healthy Eating Index or HEI 2010 scores. The HEI-2010 scores the nutrient densities (per 1000 kcal) for 11 of 12 key dietary components on a continuous scale based on the Department of Health and Human Services 2010 Dietary Guidelines for Americans[11].

Within 1 week of completing the FFQ, respondents were asked to complete the 16-item MEPA screener. The interval between completion of the FFQ and screener was designed to be small, so that seasonal changes in food availability were minimized. Recall of those items common to the 156-item FFQ and the 16-item screener was of less concern because the FFQ was completed first. All participants were asked if they were "ever counselled or educated with a Mediterranean diet plan"; this question was asked after they completed both FFQ and diet screener. Responses to the MEPA screener were obtained by either telephone interview (n = 31) or via a link (n = 39) to a Research Electronic Data Capture or REDCap (Nashville, TN, USA) survey created by the investigators. For all components, the participant was queried on how often the food item or group was consumed. For all but one component, there were questions addressing how many servings were consumed with serving sizes defined. The full MEPA screener is available upon request.

Scoring the screener and the food frequency questionnaire

A score of '0' or '1' was assigned to each item on the MEPA screener based on reported frequencies. A score of '1' for any given item was indicative of Mediterranean-like diet accordance. One point was given for each of: (i) ≥2 servings of olive oil per day; (ii) ≥7 servings of green leafy vegetables per week; (iii) ≥2 servings of other vegetables per day; (iv) ≥2 servings of berries per week; (v) ≥1 serving of other fruit per day; (vi) ≤3 servings of red meat, hamburger, bacon, or sausage per week; (vii) ≥1 serving of fish per week; (viii) ≤5 servings of chicken per week; (ix) ≤4 servings of full fat or regular cheese or cream cheese per week; (x) ≤5 servings of butter or cream per week; (xi) ≥3 servings of beans per week; (xii) ≥3 servings of whole grains per day; (xiii) ≤4 servings of commercial sweets, candy bars, pastries, cookies or cakes per week; (xiv) ≥4 servings of nuts per week; (xv) ≤1 meal at a fast food restaurant per week; and (xvi) >0 or ≤2 servings of alcohol per day for men and >0 or ≤1 serving of alcohol per day for women. If any condition was not met, a score of '0' was recorded for that item. The total $MEPA_{screener}$ score could range from 0 to 16.

Food intake data reported on the FFQ were grouped into the 16 dietary components defined by the MEPA screener (see Supporting information, Table S1). All FFQ food categories were assessed and categorized into the 16 screener components. Using the same cut-offs as in the MEPA screener, a score of '0' or '1' was assigned to each FFQ-derived item, resulting in total $MEPA_{FFQ}$ scores between 0 and 16. The component $MEPA_{screener}$ scores and total $MEPA_{screener}$ scores were then compared with the component $MEPA_{FFQ}$ scores and total $MEPA_{FFQ}$ scores. In addition to creating scores based on foods defined by the MEPA categories, nutrient intake data reported from the FFQ were compared with the $MEPA_{screener}$ scores. Accordance with a Mediterranean-like diet pattern would reflect nutrient intakes consistent with a Mediterranean pattern: one high in antioxidant nutrients (including b-carotene, folate, vitamin C, lutein and zeaxanthin), potassium, magnesium and fiber. This assumption was based on the fact that foods emphasized in a Mediterranean-style diet (e.g. whole grains, vegetables and fruits) are rich in these nutrients.[2,12,13]

Statistical analysis

All statistics were performed using SPSS, version 22.0 (IBM Corp., Armonk, NY, USA). $P < 0.05$ (*a priori*) was considered statistically significant. Additionally, normality was assessed for all variables by an inspection of histograms and Shapiro–Wilk tests.

Descriptive statistics were used to summarize demographic variables of respondents based on the tertile into which the total MEPA score was classified. Total $MEPA_{screener}$ scores for the first tertile included those less than or equal to 7; for the second tertile, scores included 8 through 10; and, for the third tertile, scores greater than or equal to 11. To determine differences in demographic variables across MEPA screener tertiles, Kruskal–Wallis tests were conducted for continuous variables and chi-squared tests for categorical variables. If the Kruskal–Wallis test was significant, post-hoc Mann–Whitney *U*-tests with Bonferroni correction ($P < 0.017$) were used to identify where the differences existed.

Percentage agreement and kappa statistics were calculated to evaluate agreement between each of the 16 components of the MEPA screener with those on the FFQ. The value of '1' or '0' assigned to the FFQ component was compared with the '1' or '0' for the MEPA screener component. For each item, percentage agreement was calculated and significance was based on chi-squared tests. Kappa's less than 0.21 were considered to indicate poor agreement; those between 0.21 and 0.41, fair agreement; those between 0.41 and 0.60, moderate agreement; those between 0.61 and 0.80, good agreement; and those between 0.81 and 1.00, excellent agreement [(5)]. A Spearman rho correlation test between the total MEPA FFQ score and total MEPA screener score of all individuals was conducted to assess the concordance of total scores between the two methods. To determine whether $MEPA_{screener}$ scores could be used in place of those from the full-length FFQ, a Bland–Altman plot was used to examine the difference, or bias, between the two measurement tools. Limits of agreement (LOA) were set at two SDs above and below the mean difference.

Finally, as a form of 'construct' validity, FFQ food and nutrient intakes were examined for differences and patterns across $MEPA_{screener}$ score tertiles. FFQ food servings and nutrient intakes were compared across tertiles of MEPA scores using Kruskal–Wallis tests. When Kruskal Wallis tests were significant, a post-hoc Mann–Whitney *U*-test with Bonferroni correction ($P < 0.017$) was conducted to assess which tertiles differed from one another.

Results

Demographics

A total of 70% of respondents were RHCW patients, 3% were RHCW health professionals and 27% were registered dietitians with a median [interquartile range (IQR)] age of 58 (39–65) years and a body mass index of 25.7 (22.5–30.3) kg/m^2. The majority of respondents reported the consumption of multivitamins (58.6%) and were not familiar with the Mediterranean diet (61.4%). Half of the participants reported a low activity level, defined as typical daily living activities, in addition to 30–60 min of daily moderate physical activity. Few demographic characteristics differed across MEPA score tertiles (Table 1). More women in the middle and upper MEPA tertiles reported an active lifestyle, whereas a greater number in the first tertile reported either being sedentary or low active. Moreover, HEI 2010 scores of those in the second and third tertiles were significantly higher than those in the first ($P = 0.01$), although there were no differences in HEI scores among those in the second and third tertiles. There were also fewer participants educated or counseled on Mediterranean dietary pattern in the first tertile compared to those in second and third tertiles ($P = 0.003$).

Accordance

Overall, $MEPA_{screener}$ scores ranged from 3 to 14 with a median (IQR) score of 9 (7–11). $MEPA_{FFQ}$ scores ranged from 3 to 11 and the median (IQR) score was 7 (6–8). There was no difference in median (IQR) $MEPA_{FFQ}$ score for RHCW

Table 1. Participant characteristics according to tertiles of the 16-point Mediterranean Eating Pattern for Americans (MEPA) screener

Demographics	*First tertile (n = 23)* *Total score ≤ 7*	*Second tertile (n = 28)* *Total score ≥ 8 and ≤10*	*Third tertile (n = 19)* *Total score ≥ 11*	*P-values*
Age (years)*	59.0 (37.0–66.0)	51.5 (33.0–63.2)	59.0 (42.0–66.0)	0.36
Body mass index (kg m^{-2})	27.5 (24.3–34.2)	25.4 (21.7–27.6)	24.6 (22.3–30.7)	0.06
Physical activity, n (%)				
Sedentary	4 (20.0)	2 (6.5)	1 (5.3)	
Low active	13 (65)	14 (45.2)	8 (42.1)	0.04
Active to extremely active	3 (15)	15 (48.3)	10 (52.6)	
Estimated energy requirement (kcal)*	2062 (1909–2229)	2159 (1999–2338)	2275 (2023–2373)	0.20
Multivitamin users, n (%)	14 (60.9)	18 (64.3)	9 (47.4)	0.49
HEI 2010 score*	68.6 (61.9–73.5)[a]	75.7 (69.5–82.3)[b]	77.4 (70.6–80.3)[b]	0.004
Hypertensive, n (%)*	8 (42.9)	11 (52.4)	12 (70.6)	0.23
Educated or counselled on the Mediterranean diet, n (%)	3 (13.0)	12 (42.9)	12 (63.2)	0.003
Web-based MEPA screener administration (REDCap), n (%)	9 (39.1)	19 (67.9)	11 (57.9)	0.12

HEI 2010, Healthy Eating Index 2010; REDCap, Research Electronic Data Capture.
* Values reflect median and interquartile range.
a,b. Values bearing different lowercase lettered superscripts in the same row are significantly different from each other..

patients/RHCW health professionals [7 (6–9), *n* = 51] and dietitians [7 (6–8), *n* = 19] (*P* = 0.42), nor did $MEPA_{screener}$ scores for RHCW patients/RHCW health professionals [9 (7–11), *n* = 51] differ from those of dietitians [9 (8–10), *n* = 19] (*P* = 0.47).

Accordance with MEPA screener components (or the number and percentage of individuals who reported consuming foods consistent with the Mediterranean pattern and those assigned a '1' for the component) and those accordant based on FFQ responses are provided in Table 2. Both methods captured accordance with certain foods similarly, including green leafy vegetables, berries and fish. Other components were not accordant (i.e. fast food). For all but three components (other vegetables, other fruit and whole grains), accordance was high with the MEPA screener compared to the FFQ.

Inter-method reliability

Percentage agreement and kappa's between items on the 16-item $MEPA_{screener}$ and the $MEPA_{FFQ}$ are also provided in Table 2. Percentage agreement was highest between the MEPA and FFQ responses for alcohol (85.7%), fish (84.3%), olive oil (82.9%) and whole grains (81.4%) and was lowest for fast food (45.7%). MEPA screener questions regarding other vegetables (κ = 0.19), meat (κ = 0.12), chicken (κ = 0.13), whole grains (κ = –0.10), pastries

Table 2. Accordance with Mediterranean Eating Pattern for Americans (MEPA) components on screener and the food frequency questionnaire (FFQ) and concurrent validity (% agreement and kappa's) between MEPA screener scores and those from the FFQ

MEPA screener item	*MEPA (%)**	*FFQ (%)†*	*% Agreement (P-value)*	*Kappa (P-value)*
1. Olive oil	15 (21.4)	5 (7.1)	82.9 (0.006)	0.33 (0.001)
2. Green leafy vegetables	32 (45.7)	30 (42.9)	68.6 (0.002)	0.36 (0.002)
3. Other vegetables	22 (31.4)	40 (57.1)	57.1 (0.07)	0.19 (0.07)
4. Berries	50 (71.4)	46 (65.7)	77.1 (<0.001)	0.47 (<0.001)
5. Other fruit	34 (48.6)	61 (87.1)	61.4 (0.002)	0.25 (0.002)
6. Meat	47 (67.1)	25 (35.7)	51.4 (0.24)	0.12 (0.24)
7. Fish	52 (74.3)	47 (67.1)	84.3 (<0.001)	0.62 (<0.001)
8. Chicken	56 (80.0)	40 (57.1)	60.0 (0.23)	0.13 (0.23)
9. Cheese	47 (67.1)	38 (54.3)	61.4 (0.08)	0.21 (0.08)
10. Butter/cream	42 (60.0)	27 (38.6)	58.6 (0.06)	0.21 (0.06)
11. Beans	24 (34.3)	9 (12.9)	72.9 (0.006)	0.29 (0.003)
12. Whole grains	6 (8.6)	7 (10.0)	81.4 (1.00)	–0.10 (0.39)
13. Pastries	45 (64.3)	32 (45.7)	58.6 (0.09)	0.19 (0.09)
14. Nuts	28 (40.0)	16 (22.9)	74.3 (<0.001)	0.42 (<0.001)
15. Fast food	59 (84.3)	31 (44.3)	45.7 (1.00)	–0.01 (0.93)
16. Alcohol	70 (70.0)	53 (75.7)	85.7 (<0.001)	0.64 (<0.001)

FFQ, food frequency questionnaire.
* Number (%) of participants scoring '1' on the MEPA screener component.
† Number (%) of participants scoring '1' on the FFQ component.

(κ = 0.19) and fast food (κ = –0.01) displayed poor agreement between MEPA and FFQ responses. The MEPA screener questions related to olive oil (κ = 0.33), green leafy vegetables (κ = 0.36), other fruit (κ = 0.25), cheese (κ = 0.21), butter (κ = 0.21) and beans (κ = 0.29) displayed fair agreement with those of FFQ responses. The MEPA screener questions related to berries (κ = 0.47), nuts (κ = 0.42), fish (κ = 0.62) and alcohol (κ = 0.64) displayed moderate to good agreement between MEPA and FFQ responses. Overall agreement, or concordance, between the scores on the $MEPA_{screener}$ and the $MEPA_{FFQ}$ was considered fair, with a mean κ = 0.27.

There was a positive relationship observed between the overall $MEPA_{screener}$ score and $MEPA_{FFQ}$ score (ρ = 0.365, P = 0.002). The effect size of this correlation is considered to be medium.[14] A Bland–Altman plot of the difference between $MEPA_{FFQ}$ score and $MEPA_{screener}$ score against the mean of the two scores is shown in Fig. 1. The bias or mean difference between the two tools was –2.5, suggesting that the MEPA screener over-estimates Mediterranean diet accordance relative to the FFQ. The upper LOA was 5.0, whereas the lower LOA was –5.0.

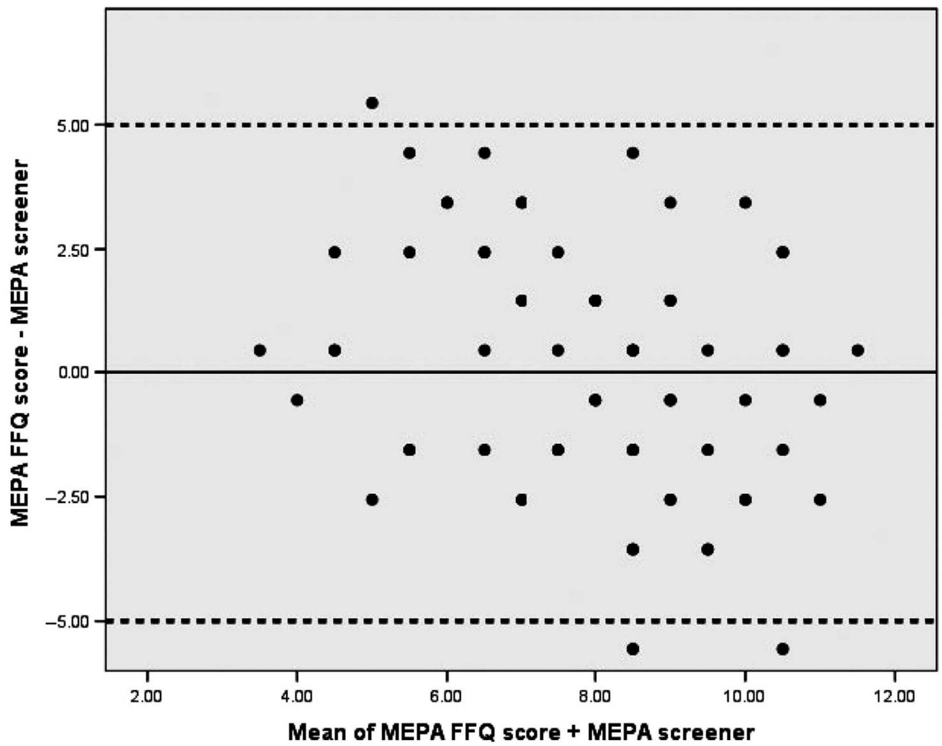

Figure 1. Bland–Altman plot of the difference between Mediterranean Eating Pattern for Americans (MEPA) food frequency questionnaire (FFQ) score and MEPA screener score against the mean of the two scores. The mean difference between the scores was –2.5. The solid line represents the centered mean difference. The upper limit of agreement (LOA) (dotted lines) was set at 1.96 SDs above the mean at 5.0, whereas the lower LOA (dotted lines) was set at 1.96 SDs below the mean at –5.0.

'Construct' validation

With respect to nutrients (Table 3), as the $MEPA_{screener}$ scores increased from first tertile to the second and third tertiles, the reported intake of potassium, magnesium, vitamin C, lutein + zeaxanthin, folate and fiber increased; however, this trend was only significant for potassium ($P = 0.003$), magnesium ($P < 0.0001$), vitamin C ($P = 0.012$), b-carotene ($P = 0.007$), lutein + zeaxanthin ($P < 0.0001$), dietary folate equivalents ($P = 0.009$) and fiber ($P < 0.0001$). Saturated fat (as a percentage of energy) was greater amongst those in the first tertile compared to higher MEPA scores ($P = 0.005$). With respect to foods (data not shown), servings of green leafy vegetables, other vegetables, berries, other fruit, whole grains, nuts and alcohol increased across the MEPA tertile distribution of scores; however, this trend was significant for green leafy vegetables ($P = 0.013$).

Table 3 FFQ nutrient intakes according to tertiles of the 16-point Mediterranean Eating Pattern for Americans (MEPA) screener*

Dietary components or nutrients	*First tertile total score ≤7 (n = 23)*	*Second tertile total score ≥8 and ≤10 (n = 28)*	*Third tertile total score ≥11 (n = 19)*	*P value†*
Energy (kcal)	1678 (1037–2203)	1353 (1211–1816)	1567 (1324–1923)	0.32
Carbohydrate	48.9 (40.5–52.6)	49.4 (40.7–58.9)	48.2 (44.5–52.1)	0.75
Protein	15.8 (13.2–18.4)	17.53 (15.2–18.4)	16.7 (14.7–20.4)	0.25
Total fat	37.1 (34.0–41.5)	31.1 (26.9–38.4)	34.6 (30.4–41.2)	0.056
Saturated fat	11.2 (10.2–13.4)[a]	8.8 (7.0–11.1)[b]	9.3 (7.9–11.8)	**0.005**
Monounsaturated fat	14.2 (12.2–16.2)	12.4 (9.7–16.3)	13.2 (11.2–17.3)	0.33
Polyunsaturated fat	7.5 (6.8–9.5)	7.6 (5.5–8.8)	7.5 (6.1–9.1)	0.56
Cholesterol (mg/1000 kcal)	130.2 (111.3–159.5)	123.4 (85.1–198.6)	118.3 (90.6–136.7)	0.44
β-carotene (μg/1000 kcal)	1749 (1212–5149)[a]	4325 (3453–6973)[b]	4184 (2437–6999)[b]	**0.007**
Potassium (mg/1000 kcal)	1463 (1304– 1825)[a]	1948 (1679– 2261)[b]	1822 (1658– 2274)[b]	**0.001**
Magnesium (mg/1000 kcal)	160.6 (137.3– 175.6)[a]	205.3 (188.5– 229.9)[b]	216.8 (183.6– 245.7)[b]	**<0.0001**
Folate dietary equivalents (μg/1000 kcal)	226.3 (200.1– 261.9)[a]	282.9 (240.9– 384.6)[b]	279.8 (239.9– 328.4)[b]	**0.009**
Vitamin C (mg/1000 kcal)	57.5 (45.1– 77.7)[a]	82.0 (62.6– 115.43)	112.7 (68.3– 137.7)[b]	**0.002**
Lutein + Zeaxanthin (μg/1000 kcal)	1303 (856– 1812)[a]	2919 (1652– 5079)	4226 (1721– 7049)[b]	**<0.0001**
Fiber (g/1000 kcal)	10.7 (8.9– 12.0)a	14.9 (11.9– 17.5)[b]	14.5 (12.1– 17.3)[b]	**<0.0001**
Omega-3 fatty acids (g/1000 kcal)	0.98 (0.82– 1.17)	0.88 (0.74– 1.11)	0.88 (0.65–1.16)	0.48

FFQ, food frequency questionnaire.
*Dietary components presented as a percentage of energy unless otherwise indicated; data presented as the median (IQR).
†Differences across tertiles were assessed by Kruskal–Wallis tests, significant p values are bold-faced in the last column and Bonferroni-adjusted Mann–Whitney post-hoc comparisons. Different superscript lowercase letters indicate statistical differences (P < 0.017).

Discussion

The present study was designed to assess the intermethod reliability and bias of a newly developed MEPA screener. Fair concordance between scores of the MEPA screener and the FFQ was observed, although this was not as strong as that reported for the MEDAS tool and the Spanish FFQ ($r = 0.52$, $P < 0.001$)[5]. Because correlation does not necessarily imply good agreement, this measure was also determined. Overall mean agreement between the $MEPA_{screener}$ components and the $MEPA_{FFQ}$ components was fair ($\kappa = 0.27$) and not as good as that reported for the MEDAS tool and FFQ ($\kappa = 0.43$)[5], although it was better than that reported between the MEDFICTS screener and the Block FFQ ($\kappa = 0.08$)[15]. Agreement between the MEPA screener and the VioScreen™ FFQ varied from item to item; the alcohol and fish components exhibited good agreement ($\kappa = 0.64$, and 0.62, respectively). Percentage agreement between scores also varied, with the two components having the highest percentage agreement (85.7% and 84.3%, respectively) between the MEPA screener and FFQ methods.

We found that the MEPA score was positively associated with healthy nutrient intakes, including carotenoids, potassium, magnesium, vitamin C, folate and fiber. There was an inverse relationship between MEPA scores and saturated fat intake. Fruits and vegetables are major components of the Mediterranean diet pattern, and they contain carotenoids, potassium, magnesium, vitamin C and fiber. Therefore, the positive trend in these nutrients is expected with Mediterranean diet accordance increase. No significant differences were observed across tertiles with regard to monounsaturated fat and polyunsaturated fat. Although we expected to see a positive trend, the lack of relationship is most likely related to the fact that a large proportion of monounsaturated fat is derived from grain-based desserts if olive oil is not the primary fat consumed.

Several similarities exist between the report by Schröder *et al.*[(5)] in which the validity of the MEDAS tool was evaluated and the present study. MEDAS was a 14-item screening tool, whereas the MEPA is a 16-item screener. Schröder *et al.*[(5)] reported MEDAS scores of 8.6 (1.9) [mean (SD)] and an FFQ score of 8.4 (1.7). Similarly, in the present study, our $\text{MEPA}_{\text{screener}}$ scores [9 (7–11)] [median (IQR)] were greater than those based on the FFQ [7 (6–8)]. Schröder *et al.*[(5)] reported a higher correlation coefficient (r = 0.52, P < 0.001), intraclass correlation (ICC) (ICC = 0.51, P < 0.001) and a higher mean kappa (κ = 0.43) than those values reported in the present study (r = 0.395, P = 0.001; ICC = 0.38, P = 0.001; κ = 0.27), respectively. On the other hand, their group also reported wider limits of agreement than those reported in the present study (57–153% and 59–120%, respectively).

Because the MEDAS was the screener on which the MEPA screener was derived, several items/components were identical. For example, both screeners ask questions regarding olive oil, vegetable, fruit, red meat, fish, butter/cream, beans, pastries, nuts and wine/alcohol intake. The MEDAS screener included a frequency question on sugar-sweetened beverage intake and a preference question related to intake of chicken, turkey or rabbit over the intake of beef, pork, hamburgers or sausages; no such questions are included in the MEPA screener. The MEPA screener differentiated between the intake of berries versus those of other fruits and the intake of green, leafy vegetables versus those of other vegetables; no such components are found on the MEDAS screener. [Berries constitute a component apart from other fruits in MEPA because of the preliminary evidence for a protective cognitive impact observed in animal studies[(16)] and at least one cohort study.[(17)]] In addition, the MEPA screener has a component for fast food intake. Kappa's reported by Schröder *et al.*[(5)] are higher for all the common components, with the exception of fish and nuts. For the fish item, we report a kappa of 0.62, whereas Schröder *et al.*[(5)] reported a kappa of 0.51. Additionally, the kappa reported for nuts in the present study is slightly higher than that reported by Schröder *et al.*[(5)] (κ = 0.42 and κ = 0.33, respectively). The lower kappa's for the present effort may be a result of how each screener was developed. The MEDAS FFQ was designed specifically to assess the Mediterranean diet pattern of Spanish participants in the Prevención Dieta Mediterránea (PREDIMED) study before the intervention; similarly, the MEDAS screener was developed by the same researchers. By contrast, the VioScreen™ FFQ used in the present study was not designed specifically to assess accordance with a Mediterranean pattern; thus, some food items did not directly correspond to those in the MEPA screener.

The limitations of the present study include the changes in MEPA screener administration (by telephone interview, then self-administered electronically) during data collection. The MEPA screener was originally designed to be administered via telephone. In an effort to allow participants more flexibility, this screener was adapted to the electronic REDCap version. Another limitation is that the findings from the present study may be generalized to adult women only and the sample size was small (n = 70). It is critical that the FFQ instrument contain items that are directly parallel to those on the MEPA screener. For example, the VioScreen™ FFQ had a question that addressed the intake of olive oil and the MEPA screener also asked about olive oil intake. However, in future versions of this screener, if participants were asked about extra virgin olive oil intake, a new FFQ question related to extra virgin olive oil would be necessary. Additional validity testing using the more open-ended 24-h diet recall may be performed, although several 24-h recalls over a long time interval will be needed to capture less frequently (not daily) food items; this was the value afforded by the FFQ. Comparison with nutrient and/or food biomarkers would be another important way to ascertain the measurement characteristics of the proposed screener.

In conclusion, further testing of the MEPA screener is indicated to determine whether it is a valid tool for assessing accordance with this Americanized Mediterranean diet pattern. Additional validation studies in more diverse samples using either the FFQ, repeated 24-h diet recalls and food biomarkers are warranted.

Supporting information follows References: Table S1. Food frequency questionnaire items included in and excluded from analysis according to 16 Mediterranean Eating Pattern for Americans (MEPA) screener components.

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the manuscript. CCT, HER and LAC revised the MEPA tool. CCT created the study design, ran analyses and interpreted these analyses with LAC. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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Supplemental Materials

Table S1. Food frequency questionnaire items included in and excluded from analysis according to 16 Mediterranean Eating Pattern for Americans (MEPA) screener components.

Olive Oil
- Oil, olive (cereals and breads)
- Oil, olive (fat used in cooking)
- Oil, olive (fats on potatoes, rice, noodles and beans)
- Oil, olive (fats used on vegetables)

Leafy Green Vegetables
- Cooked greens, such as kale, mustard greens and collards
- Green salad (lettuce or spinach)
- Cooked greens, such as spinach, Swiss chard and beet greens

Other Vegetables
- Broccoli
- Carrots-cooked
- Carrots-raw
- Cauliflower, cabbage and Brussels sprouts
- Fresh tomatoes
- Green or string beans
- Green peas
- Green peppers and green chilies, cooked
- Green peppers and green chilies, raw
- Onions and leeks
- Potatoes (boiled, baked or mashed)
- Red peppers and red chilies, cooked
- Red peppers and red chilies, raw
- Salsa (as dip or on foods)
- Corn and hominy
- Summer squash and zucchini
- Tomato juice, V-8 and other vegetable juice
- Winter squash such as acorn, butternut and pumpkin
- Yams and sweet potatoes
- Fresh garlic, including in cooking

Berries
- Berries such as strawberries and blueberries

Other Fruits
- All other fruits
- Apples, applesauce and pears
- Apricots-dried
- Apricots-fresh or canned
- Avocado and guacamole
- Bananas
- Cantaloupe, melon and mango (in season)
- Cherries, fresh
- Dried fruit (other than apricots) such as raisins and prunes
- Grapes, fresh
- Orange and grapefruit juice with calcium
- Orange and grapefruit juice with vitamins A, E and C
- Orange juice and grapefruit juice
- Oranges, grapefruit and tangerines (not juice)
- Other 100% fruit juice such as apple, grape, and cranberry
- Peaches, nectarines and plums
- Pineapple, fresh and canned
- Watermelon and red melon

Meat
- Bacon and breakfast sausage
- Beef, pork, ham and lamb-with fat
- Beef, pork, ham and lamb-without fat
- Ground meat, extra lean
- Ground meat, lean