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Validation of an Online Screener, the Mediterranean Eating Pattern for Americans-III in Older Patients with Parkinson's Disease

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ABSTRACT

Mediterranean diet accordance has been associated with slower rates of cognitive decline, a common feature in more advanced Parkinson's disease (PD). Thus, a brief tool was needed to monitor Mediterranean diet accordance of older adults with PD. Relative validity, acceptability, and feasibility of the 21-item online screener, Mediterranean Eating Pattern for Americans (MEPA-III) was assessed. Maximum diet accordance is reflected by a MEPA III score of 21 points. Forty-four adults completed the online reference tool, the VioScreen™ Food Frequency Questionnaire (FFQ), and then the MEPA-III screener three to seven days later. MEPA-III scores averaged 10.7 ± 2.7. When FFQ responses were coded to match those of MEPA-III screener components, agreement for individual components averaged 71.5%, with 8 of 21 component scores with kappas ≥ 0.31 ($p < 0.05$). Total MEPA-III scores were concordant with those from the FFQ ($r = 0.50$, $p < 0.001$). Participants reported that the MEPA-III screener was acceptable (median score 8 out of a possible 10). The screener was feasible because the median completion time was 4.1 min (range 1.6–14.9). The online MEPA-III screener demonstrates good validity, acceptability and feasibility and can be used to characterize a Mediterranean-style diet pattern among participants with PD.

KEYWORDS

Diet assessment; Mediterranean diet; nutrition; Parkinson's disease; screener

1. Introduction

Parkinson's disease (PD) is a neurodegenerative disorder involving loss of the dopaminergic neurons, resulting in both motor and non-motor symptoms.[1] Several motor and non-motor symptoms can impact the nutrition

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status of a person with PD, such as dyskinesias, dysphagia, taste changes, hypo/anosmia, constipation, mood disturbances, and cognitive impairment.[2–7] Cognitive changes may be responsive to dietary and lifestyle changes. Evidence from observational studies suggests that according to a Mediterranean-type diet is inversely related to cognitive decline among older adults.[8–10] Adoption of a Mediterranean diet may also be protective against brain atrophy and maintains neuronal health,[11–13] yet the literature is limited. Mechanistically, the benefits of this dietary pattern may be attributed to some of the same benefits ascribed for cardiovascular disease and obesity;[14–16] these include reduced inflammation and oxidative stress. With respect to the risk of PD, accordance to a Mediterranean diet as measured by a semi-quantitative food frequency questionnaire (FFQ), appears to reduce the odds for developing PD.[16] In another cohort, higher accordance was associated with lower probability of prodromal PD symptoms.[17] Much less is known about the Mediterranean diet accordance in individuals with PD or whether the diet pattern influences disease progression, especially cognitive decline in PD.

Accurate recording of the components of the Mediterranean diet is critical to determining whether a person follows a Mediterranean diet pattern. Most often, Mediterranean diet accordance is assessed by applying a scoring system to FFQ responses in a population cohort. The FFQs are often 120 items or more which can be time consuming for patients to complete, especially in a clinic setting. The 14-point Mediterranean Dietary Adherence Screener (MEDAS) was developed for a Spanish population and specifically assesses intake of those Mediterranean food groups associated with cardioprotection;[15,18] as such, this screener may not be optimally suited for US adults. The Mediterranean Eating Pattern for Americans III (MEPA-III) screener is based on the MEDAS and is the third iteration of the original MEPA (MEPA-I). MEPA-I was validated against a FFQ in healthy US women.[19] MEPA-III screener not only has more food items and terminology familiar to a Midwestern U.S. adult sample but includes food items that capture components of Mediterranean diets. Finally, it is available in a web-based version.

The purpose of this study was to determine the (1) validity of the self-administered online MEPA-III screener and (2) acceptability and feasibility of using this online screener among adults with PD.

2. Methods

2.1. Participants and clinical data

PD participants were recruited from the Rush University Movement Disorders Clinic, a tertiary care U.S. academic medical center. Inclusion

criteria were (1) PD diagnosed by movement disorder specialists, (2) age greater than 40 years, (3) ability to read and speak English, and (4) internet and email account access. Those excluded were those with an advanced stage of PD or with cognitive impairment as judged by the movement disorder specialist.

The number of participants was determined based on a validation study of the MEDAS, the Mediterranean diet screener used in the PREDIMED study.[18] Here, the correlation coefficient between the MEDAS scores and FFQ MEDAS scores was 0.52.[18] A sample size of 42 participants was needed to achieve 80% power with a Pearson's coefficient of 0.52.[20] The study was approved by the Institutional Review Board of Rush University Medical Center, and informed consent was obtained from all participants prior to study participation.

Demographic and PD-related information were obtained from the participant's medical records. These include gender, race-ethnicity, date of birth, marital status as well as PD disease duration, Hoehn & Yahr (HY) stage,[21] and the motor score of the Unified Parkinson's Disease Rating Scale (UPDRS).[22]

2.2. Diet assessment tools and exit questionnaires

All participants completed the following online assessments: (1) the VioScreen™ FFQ at their initial visit, (2) MEPA-III screener three to seven days later, and (3) exit questionnaires in which participants evaluated the FFQ and the screener immediately following MEPA-III.

The VioScreen™ food frequency questionnaire or FFQ (Viocare® Technologies, also known as GraFFS) is a validated, semi-quantitative FFQ with 156 questions on various food items, including pictures of serving sizes of foods.[23] Food and nutrient analyses of VioScreen™ FFQ are based on the nutrient and food composition database provided by Nutrition Data System for Research, version 45 (Minneapolis, MN) which are available to researchers immediately.

The MEPA screener includes questions on the consumption of foods typical of the Mediterranean diet as well as fast food, convenience foods, and sugar-sweetened beverages. The total MEPA-III score ranges from 0 to 21 (higher scores indicate greater intakes of Mediterranean foods); the maximum score of 21 indicates perfect accordance.

Exit questionnaires were used to assess acceptability of the online FFQ and screener to PD participants. They were based on those by Kristal et al.[23] when subjects were evaluating the acceptability of the GraFFS, (the VioScreen™ FFQ), with the second exit questionnaire specifically modified to query about the MEPA-III screener. These questionnaires inquired about the acceptability

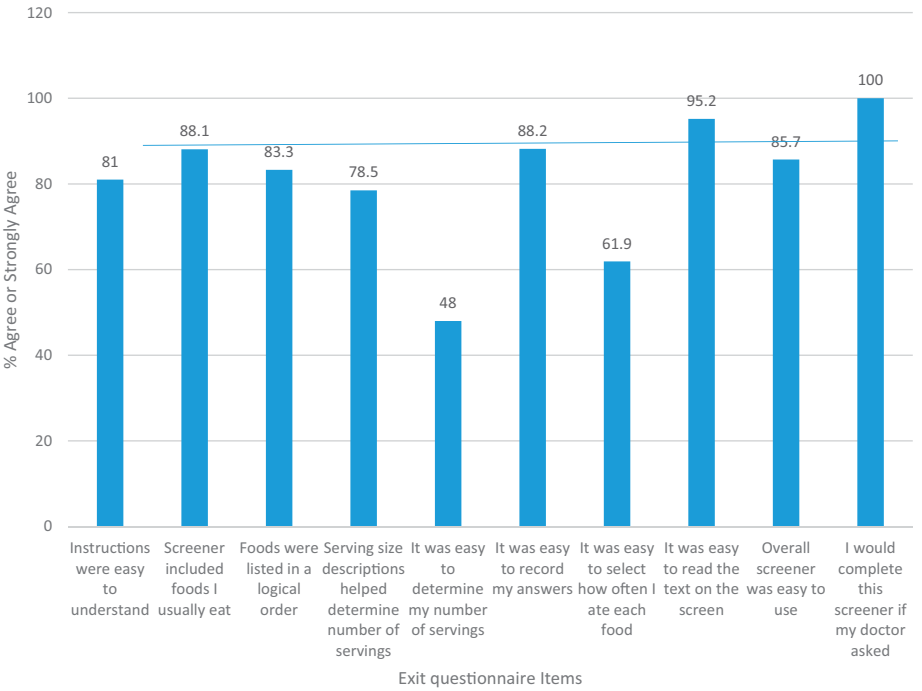

Figure 1. Frequency of PD participants who strongly agree or agree with exit questionnaire items. Representation of proportion of participants who agreed or strongly agreed with statements in the MEPA exit questionnaire. More than 75% of participants agreed with four-fifths of the total number of items in the questionnaire, deeming the screener as acceptable overall.

of each tool including the ease of recording answers, and whether the foods that the participant ate were listed on the diet tool. Responses to ten questions (shown on *x*-axis of Figure 1) are on a 5-point Likert scale. The "Agree" or "Strongly agree" response categories were combined and presented as a percent of all possible responses on the *y*-axis (Figure 1). A separate question on the overall acceptability of the tool was rated by the participant on a 10-point Likert scale (1, (poor) to 10, (excellent)).

Participants completed the online MEPA-III screener and exit questionnaires using online Research Electronic Data Capture (REDCap) software, version 2.3 (Nashville, TN).[24] This software allows investigators to collect and manage data from survey respondents; data were available for export and subsequent statistical analysis.

2.3. Scoring of the MEPA-III

Food items on the VioScreen^{TM} FFQ were aligned with the 21 food components on the MEPA-III screener. A score of 1 was assigned to any screener component (food/food group/beverage) for which the intake frequency met the pre-determined cutoff criterion (Table 1). If the frequencies

Table 1. MEPA-III scoring criteria.

Item on MEPA-III screener	Criteria*	Serving size
1. Olive oil in salads or cooking	≥2 servings per day	1 Tbsp
2. Butter or cream	≤5 servings per week	1 Tbsp
3. Peanuts or peanut butter Other nuts, nut butters, or seeds	≥4 servings per week	1/4 cup nuts, 2 Tbsp nut butter
4. Avocado, including guacamole	≥4 servings per week	2 Tbsp guacamole, 1/4 avocado
5. Berries	≥4 servings per week	1/2 cup
6. Other fruit	≥1 serving per day	1 medium fruit, 1/2 cup, 4 oz juice
7. Dark leafy vegetables	≥7 servings per week	1 cup raw, 1/2 cup cooked
8. Other vegetables including Starchy non-fried vegetables	≥2 servings per day	1/2 cup, 4 oz juice
9. Red meat, pork, processed meat	≤3 servings per week	3 oz, 3 strips
10. Poultry	< 3 servings per week	3 oz
11. Fish, not fried	≥1 serving per week	3 oz
12. Milk or yogurt	≥3 servings per week	1 cup
13. Full-fat cheese	≤4 servings per week	1.5 oz cheese, 1 Tbsp cream cheese, 1/4 cup cottage cheese
14. Beans and lentils	≥3 servings per week	1/2 cup cooked
15. Whole grains	≥3 servings per day	1 slice bread, 1/2 cup cooked, 1 cup dry cereal
16. Candy, pastries, frozen desserts	≤4 servings per week	1 medium pastry, 1 regular chocolate bar, 1/2 cup ice cream
17. Fast Food	≤1 meal per week	1 meal
18. Pre-prepared or prepackaged meals, foods	≤4 times per week	1 meal or food item
19. Sugar-sweetened beverages	<1 per day	12 oz
20. Unsweetened beverages	≥6 servings per day	12 oz
21. Alcohol	≤2 servings per day, men; ≤1 serving per day, women	12 oz beer, 5 oz wine, 1.5 oz hard liquor

*To receive a score of 1 for each MEPA item.
MEPA: Mediterranean Diet Pattern for Americans; Tbsp: tablespoon; oz: ounce.

did not met the criterion, then a value of 0 was assigned. For example, if for component 1 (olive oil in salads and cooking), the participant responded that they consumed 3 servings per day (3 tablespoons/day), 1 point would be assigned. If less than 2 tablespoons per day were reported, a 0 would be assigned. Other non-starchy vegetables and non-fried starchy vegetables were combined for a single score for the Mediterranean MEPA-III score. Serving frequencies (e.g., 2 servings of dark leafy vegetables daily or 3 servings of nuts each week, etc.) reported by the participants for each food/beverage item on the FFQ were then totaled for the screener component for each participant. Each of the 21 component scores was summed to provide a total MEPA-III screener score for each participant. Similarly, the scores (1 or 0) for all of the 21 components were summed to provide the total FFQ-derived MEPA-III score.

2.4. Statistical analyses

Statistical analyses were performed using SPSS version 22 (Chicago, IL). Descriptive statistics were used to describe the demographics of the study population. Continuous variables such as age, age at PD onset, UPDRS scores, and body mass index (BMI) are expressed as either as

means ± standard deviations, or if variables manifest non-normal distributions, as medians and interquartile ranges (IQR). Frequency distribution was used to describe variables such as race, HY stage, and education.

Concordance between the total MEPA-III screener score and the total score derived from the FFQ was assessed with a Pearson correlation test. The proportion of the study sample who received a score of 1 (and thus, accordant) for each item of the MEPA-III screener and on the FFQ was also described (Table 3). To measure the agreement between food component scores on the self-administered MEPA-III screener score and those of the FFQ, percent agreement and kappa statistics were calculated.

MEPA-III screener scores were stratified into tertiles. Construct validation was evaluated by examining differences in food and nutrient levels as reported on the FFQ across MEPA-III score tertiles using one way ANOVA or Kruskal Wallis tests. For example, it was expected that individuals with MEPA-III scores in the highest tertile would report the most olive oil, green leafy vegetables, nuts, and unsweetened beverages. Similarly, those in the lowest tertile would be expected to report greater amounts of meats, pastries, and prepackaged energy-dense foods.

Acceptability was measured using frequency distribution of Likert scale responses to the exit questionnaires. Higher overall ratings indicated higher acceptability. The MEPA-III screener was assessed as "acceptable" if 75% of the participants chose "agree" or "strongly agree" for 80% of the questions on the exit questionnaire. Meeting this criterion signified that the tool was considered "acceptable". This approach is similar to that was reported by Kristal et al for the evaluation of the online FFQ.[23] Feasibility of the online MEPA screener was determined by examining the length of time for MEPA-III completion. A "feasible" screener would be one that takes less than 10 min to complete.

3. Results

3.1. Participants and characteristics

There were no significant differences in any of the demographic or clinical characteristics of participants across MEPA screener score tertiles (Table 2). Of the 44 PD participants, there were 22 women and 22 men aged (mean ± SD) 62.4 ± 12.1 years (Table 2). Six participants were between 52 and 61 years of age. The sample was primarily non-Hispanic white (85.4%). Average age at diagnosis was 59.6 ± 8.3 years, and the median (IQR) time since PD diagnosis for the sample was 6 (4, 12) years. More than three-quarters of the sample (76%) were documented HY stage 2, and 66% were currently prescribed levodopa as recorded in the electronic medical record.

Table 2. Demographics and clinical attributes of the 44 PD participants stratified by MEPA screener scores tertiles.

Characteristic	MEPA tertile 1 score = 0–9	MEPA tertile 2 score = 10–12	MEPA tertile 3 score = 13–21
	$n = 12$	$n = 21$	$n = 11$
Age, years	63.7 ± 10.6[a]	61.7 ± 12.0	62.3 ± 14.1
Race, *n* (%)			
Non-Hispanic White	9 (81.8)	17 (85.0)	9 (81.8)
Non-Hispanic Black	1 (9.1)	0	0
Other	1 (9.1)	3 (15.0)	2 (18.2)
Age at diagnosis, years	59.7 ± 8.6[a]	57.9 ± 8.6	61.5 ± 8.8
Years since diagnosis, median (IQR)	6 (5, 9)	6 (2, 13)	8 (4, 12)
HY ($n = 31$), *n* (%) stage 2	9 (81.8)	13 (68.4)	9 (81.8)
UPDRS part IV	21.5 ± 6.6[a]	25 (14.5, 29)	28.5 (12, 35.6)
L-Dopa dose, mg, median (IQR)	350 (150, 675)[b]	300 (125, 525)	300 (75, 800)
BMI, kg/m^2	24.7 ± 2.5[a]	24.6 ± 2.0	26.3 ± 2.7
History of DM, *n* (%)	1 (8.3)	1 (4.8)	0 (0)
History of CVD, *n* (%)	1 (9.1)	1 (5.0)	2 (18.2)
HTN or HTN meds, *n* (%)	4 (36.4)	3 (15.0)	5 (45.5)
MMSE	28.2 ± 2.9[a]	29 ± 0.0	29.3 ± 0.6
Education, *n* (%)			
High school	0 (0)	4 (26.7)	0 (0)
GED	1 (9.1)	0 (0)	0 (0)
Some college	3 (27,3)	2 (13.3)	0 (0)
College degree	3 (27.3)	4 (26.7)	4 (36.4)
Post-college	4 (36.4)	5 (33.3)	7 (63.6)
Smoker, *n* (%)			
Never	9 (81.8)	17 (85.0)	8 (72.7)
Former	2 (18.2)	3 (15.0)	3 (27.3)
Current	0 (0)	0 (0)	0 (0)
Marital status, *n* (%)			
Married	8 (72.7)	15 (83.3)	9 (81.8)
Living alone, *n* (%)	2 (18.2)	3 (16.7)	1 (9.1)

[*]No significant differences across tertiles were observed.
[a]Values represent mean ± SD.
[b]Values represent median (IQR).
MEPA: Mediterranean Eating Pattern for Americans; SD: standard deviation; IQR: interquartile range; UPDRS: Unified Parkinson's Disease Rating Scale; BMI: body mass index; DM: diabetes mellitus; CVD: cardiovascular disease; HTN: hypertension; MMSE: mini-mental state exam; GED: general equivalency diploma.

The majority (72.9%) had completed a college degree or higher. Most never had smoked cigarettes and 15% of the sample lived alone.

3.2. MEPA-III screener

Mean MEPA-III screener scores were 10.7 ± 2.7 (range 6–16). No participant received a score of 21 or perfect accordance. The top third of possible MEPA-III scores (13–21) were observed for 11 participants, while the middle tertile of scores (10–12) was comprised of 21 adults, and 12 adults in the lowest tertile had scores less than or equal to 9.

3.3. Validity of the MEPA-III screener

As shown in Table 3, for 15 of the 21 MEPA-III components, the proportion of participants consuming the criterion serving frequency (receiving a

Table 3. Proportion of PD participants who met the criterion for each of the MEPA components on the Screener or the FFQ responses, agreement (%) and kappas (κ) between components on the MEPA-III Screener and the FFQ.

MEPA-III component	MEPA[a]	FFQ[b]	% Agreement	κ	p[c]
1. Olive oil in salads or cooking	18.2	2.3	84.1	**0.19**	**0.03**
2. Butter or cream	72.7	79.5	79.5	**0.44**	**0.003**
3. Peanuts or peanut butter including other nuts, nut butters, or seeds	54.5	27.3	59.1	0.21	0.09
4. Avocado, including guacamole	15.9	11.4	81.8	0.23	0.12
5. Berries	61.4	68.2	79.5	**0.55**	**<0.001**
6. Other fruit	6.8	70.5	27.3	−0.07	0.14
7. Dark green leafy vegetables	11.4	36.4	70.4	**0.25**	**0.03**
8. Other vegetables including starchy non-fried vegetables	31.8	40.9	59.1	0.12	0.40
9. Red meat, pork, or processed meat	56.8	45.5	56.8	0.15	0.32
10. Poultry	56.8	65.9	68.2	**0.34**	**0.02**
11. Fish, not fried	59.1	65.9	65.9	0.28	0.06
12. Milk or yogurt	70.5	70.5	68.2	0.24	0.12
13. Full-fat cheese	75.0	90.6	79.5	**0.31**	**0.01**
14. Beans and lentils	22.7	20.5	69.5	−0.01	0.97
15. Whole grains	22.7	25.0	75.0	**0.31**	**0.04**
16. Candy pastries, cookies, cake, frozen desserts	52.3	38.6	63.6	**0.28**	**0.05**
17. Fast food	97.7	88.6	90.9	**0.31**	**0.005**
18. Pre-prepared or prepackaged meals, foods	86.4	86.4	81.8	0.23	0.13
19. Sugar-sweetened beverages	93.2	72.7	75.0	0.18	0.11
20. Unsweetened beverages	15.9	13.6	84.1	**0.37**	**0.01**
21. Alcohol	93.2	75.0	81.8	**0.36**	**0.002**
Mean	51.2	52.1	71.5	0.25	

MEPA: Mediterranean Eating Pattern for Americans; FFQ: Food Frequency Questionnaire.
[a]Percent accordant (receiving a score of 1) on the MEPA-III Screener.
[b]Percent accordant (receiving a score of 1) on the MEPA-III scored from FFQ data.
[c]p-value for kappa (κ).
Boldfaced values indicate significant agreement.

1 for that component) was similar whether one uses the MEPA-III screener or MEPA scores derived from FFQ responses. The proportion of PD participants who met criterion targets for butter or cream (component 2) on the MEPA-III was 72.7%, while this was 79.5% of adults responding to the online FFQ several days before. On both instruments, avocado (component 4) consumption was low, while the proportions who reported consuming berries (component 5) at target frequencies were relatively high (61.4% and 68.2% on MEPA and FFQ, respectively) and similar (79.5% agreement). Fish, milk or yogurt or whole grains are other examples of consistent reporting on the two different tools. Percent agreement ranged from 90.9% for fast foods (component 7) to a nadir of 27.3% for other fruit (component 6). In terms of the more conservative parameter, kappa—there were several components in which notable agreement between the MEPA-III screener and the FFQ MEPA was observed. The responses for berries (component 5) and butter and cream (component 2) were among the highest ($\kappa = 0.55$; 0.44, respectively). The mean kappa was 0.25 with 71.5% mean agreement.

For the relative validity of the MEPA III screener, concordance between total MEPA scores derived from the screener and the FFQ was

Table 4. Food and nutrient intakes of PD participants as reported on the VioScreen™ FFQ and stratified by MEPA tertile.

MEPA score	MEPA Tertile 1 0–9 $n = 12$	MEPA Tertile 2 10–12 $n = 21$	MEPA Tertile 3 13–21 $n = 11$
Foods (servings per week)			
Green leafy vegetables[a]	**3.0 (1.0, 4.9)**	**3.5 (1.1, 6.1)**	**7.0 (3.5, 12.4)**
Non-starchy vegetables	5.3 (2.5, 8.3)	8.5 (4.4, 11.9)	16.0 (6.9, 22.0)
Nuts	1.9 (1.1, 3.5)	1.9 (0.4, 3.8)	2.0 (0, 7.0)
Meats	6.9 (3.3, 8.3)	3.7(0.7, 5.8)	2.6 (0.6, 6.6)
Milk and yogurt	5.1 (2.1, 7.4)	6.7 (3.6, 10.5)	7.5 (4.4, 13.2)
Fast Foods	1.0 (0.3, 1.0)	0.6 (0.6, 1.0)	0.6 (0.2, 0.6)
Unsweetened beverages	**18.2 ± 9.8**	**21.3 ± 15.9**	**38.7 ± 28.3**
Olive Oil	0.7 (0.0, 4.2)	1.3 (0.5, 9.0)	3.3 (0.5, 9.6)
Fish	**0.5 (0, 1.2)**	**1.4 (0.7, 2.2)**	**3.0 (0.9, 3.8)**
Prepackaged foods	**2.8 (0.5, 6.1)**	**1.3 (0.6, 2.5)**	**0.2 (0.0,2.0)**
Alcohol	**0.9 ± 1.4**	**2.3 ± 3.5**	**4.7 ± 4.9**
HEI 2010	**61.5 ± 8.6**	**74.8 ± 8.5**	**76.5 ± 10.4**
Nutrients (unit per 1000 kcal, unless noted)			
Total Energy (kcal)	2054 (1516, 2264)	1468 (1218, 1837)	1827 (1726, 2627)
Fat[b]	**37.1 ± 6.8**	**35.9 ± 9.2**	**32.5 ± 11.1**
Saturated fat[b]	**12.4 ± 2.1**	**11.0 ± 2.9**	**9.0 ± 2.5**
Omega-3 fatty acids[b]	0.9 ± 0.2	0.9 ± 0.3	0.9 ± 0.4
Monounsaturated fatty acids[b]	13.0 ± 2.7	14.0 ± 5.7	13.2 ± 6.2
Fiber (g)/1000 kcal	**10.3 ± 2.3**	**11.4 ± 2.6**	**13.3 ± 2.9**
Folate (mcg)	**307.4 ± 115.8**	**336.2 ± 181.4**	**396.7 ± 186.2**
Calcium (mg)	1007 (741,1299)	751 (684,1147)	1388 (555, 1783)
Potassium (mg)	**2735 ± 848**	**2607 ± 1000**	**3789 ± 1196**
Vitamin A (RE)	**860 (560, 1083)**	**716 (520, 1026)**	**1319 (1157, 1634)**
Beta carotene	**3871 ± 2355**	**3968 ± 2477**	**7728 ± 4209**
Vitamin B6 (mg)	**1.9 ± 0.8**	**1.7 ± 0.7**	**2.8 ± 1.7**
Vitamin B12 (mcg)	5.3 ± 3.0	4.7 ± 2.5	7.4 ± 15.0
Vitamin C (mg)	**71 (48, 120)**	**79 (54, 141)**	**190 (73, 211)**
Vitamin K (mcg)	**114 ± 39**	**128 ± 78**	**229 ± 154**
Vitamin E (IU)	**13 (8, 23)**	**12 (10, 18)**	**17 (12, 33)**
Water (g)	**2408 ± 941**	**2340 ± 914**	**3298 ± 943**

[a]Values represent either median (25, 75th) or mean ± SD.
[b]Components are expressed as a percent of energy.
Boldfaced values are significantly different across tertiles ($p < 0.05$) by either Kruskal Wallis or one-way ANOVA tests.

assessed ($r = 0.50$, $p < 0.001$, Supplemental Figure 1). This relationship mirrors the observed agreements of individual components (Table 3).

To examine construct validity, food and nutrient intakes were compared across MEPA score tertiles (Table 4). In terms of foods, differences were observed across tertiles in consumption of dark green leafy green vegetables ($p = 0.03$); however post-hoc tests did not identify which groups differed from one another. Similarly, servings of unsweetened beverages, fish, pre-packaged foods and alcohol per week increase significantly with increasing MEPA-III scores. Other components exhibit non-significant trends in the anticipated direction. For example, meat servings are highest in the lowest tertile, are lower in the middle tertile, and still lowest in the highest MEPA-III tertile. Differences in intakes across tertiles were also observed for saturated fat, fiber, potassium, vitamin A and other micronutrients.

3.4. Acceptability and feasibility of the screener

As shown in Figure 1, at least 75% of participants agreed or strongly agreed with 8 out of 10 of the statements on the exit questionnaire for the MEPA-III screener, meeting the acceptability criteria and deeming the screener acceptable overall. Two items were not deemed acceptable. Only 48% and 61.9% of participants agreed or strongly agreed with the following statements, respectively: "it was easy to determine my number of servings," and "it was easy to select how often I ate each food" (Figure 1). As shown in Supplemental Table 1, a larger proportion of participants selected a "neutral" response for these two items on the exit survey. In terms of the overall rating of the MEPA-III screener (10 is best possible), participants gave the MEPA-III screener a median (IQR) score of 8.0 (6.7, 8.0).

The screener was deemed feasible in terms of length of time by 66.7% of participants; in terms of actual completion time, median (IQR) was 4.1 min (3.0, 4.8). One participant took as little as 2 min to complete the screener, while another took much more, 14.9 min. Nine of the participants reported receiving help completing the screener. Two received help from researchers (because of computer issues), six received help from a spouse or other family member, and one received help from a friend.

4. Discussion

Based on the present study of the MEPA-III screener, the online screener is acceptable for use by adults with PD. Participants reported that recording their answers was relatively easy and all would complete the screener if asked by their doctor. The median completion time was 4.1 min. Moreover, food components key to a Mediterranean diet pattern were captured by the 21-item screener when compared to the lengthier 156-item FFQ.

The screener in its original form as a 16-item screener[19] was based on that of the MEDAS, a screener created for the PREDIMED studies.[10,17] In the PREDIMED study, responses to a short screener were compared to responses to a 137–question FFQ in 7,447 adults with a reported concordance between MEDAS scores and FFQ MEDAS scores of $r = 0.52$. In validation assessments of earlier versions of the MEPA (both version I and II had fewer items), our team observed correlations of $r = 0.32$ and 0.37.[19,25] In the former, the criterion method was the VioScreen^{TM} FFQ (as in the current study); for the latter, repeated 24-h recalls was the criterion method. In the current report, we compared the Vioscreen^{TM} FFQ with a further refined screener, MEPA-III, and observed a correlation of $r = 0.50$ ($p < 0.001$).

Unique to the MEPA-III screener is the ability to report specific frequencies of intake, i.e., specifying both the number of servings and then, how

often the food or beverage was consumed on a daily, weekly or monthly basis, or not at all. In contrast, for the FFQ, the respondent must choose one of six frequency responses (that vary with the individual food item), but options typically range from "never" to "1–2 times each day".[23]

All dietary instruments merit some assessment of acceptability including ease of use by respondents, especially those available online. There are a few examples of such assessments in the literature, mostly of brief FFQs or 24-h recalls. Participants in the study by Kristal and colleagues[23] rated the online FFQ in much the same way as in the present study. In both, acceptability was high. There was one exception in the present study; a low proportion of participants (48%) agreed or strongly agreed with the statement: "It was easy to determine my number of servings." We suggest that the less favorable responses on this item reflect participants' difficulty in estimating servings in general. A low proportion of "agree/strongly agree" responses (67%) were also reported on the exit questionnaire evaluating the online FFQ (data not shown). Albar et al.[26] describe acceptability and usability of an online 24-h recall known as "myfood24" using an exit questionnaire with eight questions similar to those used in the present study. While the overall responses proportionally appear similar to those observed in the present study, the study sample was not; rather, it was comprised of 70 adolescents.

In terms of overall user experience, the online MEPA-III may still be improved. Currently, the MEPA-III screener does not have pictures to aid description of a standard serving size. The GraFFS, also known as the VioScreen™ FFQ[23] used in the present study includes pictures of many food items and all serving size options. However, when the online FFQ was assessed, nearly one third of participants still did not agree that it was easy to determine the number of servings. Future versions of the MEPA screener may include reference pictures to aid in estimating reference serving sizes.

This study has many strengths including PD diagnoses by movement disorders experts and study procedures completed by clinical nutrition graduate students trained in dietary assessment. Limitations of the study include the potential for recall bias, exclusion of those with advanced PD or cognitive impairment and thus, the potential for limited generalizability. Our reference tool, the FFQ also had similar limitations (such as recall bias) but also in terms of establishing relative validity against the MEPA screener. Certain food items on the FFQ did not align directly with items on the screener. For example, on the MEPA III screener there are two parts to component 3 (Table 1): (a) peanuts or peanut butter, and (b) other nuts, nut butters, seeds (e.g., walnuts, almonds, almond butter, sunflower seeds). On the FFQ, there are also two items with the following descriptors:

"Peanuts, peanut butter, and other nuts and seeds"; and then, a separate item: "Roasted soy nuts and soy nut butter". There are no FFQ items in which examples of nuts and seeds (other than soy) are provided. The absence of such an item on the FFQ might have contributed to a poor kappa between screener and FFQ component (0.21, $p = 0.09$).

In future studies, our intent is to examine the MEPA-III screener across a clinically broader sample of PD adults. In addition, future work regarding the feasibility and acceptability of the MEPA-III screener could focus on the mode of screener administration, such as paper, web-based pictorial screeners, or smart-phone based apps[27] as these may have advantages or appeal to different groups of patients.

5. Conclusions

In this study, we examined the validity, acceptability and feasibility of an online Mediterranean diet screener in a sample of PD adults. The benefits of using the MEPA-III screener are reduced completion times, ease of administration, and utility for rapid feedback to the PD patient in clinical and/or research settings (i.e., prospective studies). Because immediate results regarding the diet pattern can be provided by the screener, the tool will also serve to guide dietary interventions in the clinic setting and to track adherence to the Mediterranean diet pattern longitudinally in patients with PD.

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Author roles

- Research Project: A. Design (CCT, HER), B. Organization (CCT, JGG, AC), C. Execution (AC, KEW, CCT, NR, JGG, KARG)
- Statistical Analysis: A. Design (CCT, KW), B. Execution (KW, CCT), C. Review and Critique (CCT, HER, JGG)
- Manuscript Preparation: A. Writing of the first draft (KW), B. Review and Critique: (CCT, HER, JGG, KARG, KW)

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Compliance with Journal's ethical publication guidelines

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this work is consistent with those guidelines.

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