

ORIGINAL RESEARCH

Validation of a Brief Dietary Questionnaire for Use in Clinical Practice: Mini-EAT (Eating Assessment Tool)

Kyla M. Lara-Breitinger , MD, MSc; Jose R. Medina Inojosa , MD; Zhuo Li, MS; Sarka Kunzova , MD, PhD; Amir Lerman , MD; Stephen L. Kopecky , MD; Francisco Lopez-Jimenez , MD, MSc

BACKGROUND: There is a scarcity of validated rapid dietary screening tools for patient use in the clinical setting to improve health and reduce cardiovascular risk. The Healthy Eating Index (HEI) 2015 measures compliance with the 2015 to 2020 Dietary Guidelines for Americans but requires completion of an extensive diet assessment to compute, which is time consuming and impractical. The authors hypothesize that a 19-item dietary survey assessing consumption of common food groups known to affect health will be correlated with the HEI-2015 assessed by a validated food frequency questionnaire and can be further reduced without affecting validity.

METHODS AND RESULTS: A 19-item Eating Assessment Tool (EAT) of common food groups was created through literature review and expert consensus. A cross-sectional survey was then conducted in adult participants from a preventive cardiology clinic or cardiac rehabilitation and in healthy volunteers ($n=661$, mean age, 36 years; 76% women). Participants completed an online 156-item food frequency questionnaire, which was used to calculate the HEI score using standard methods. The association between each EAT question and HEI group was analyzed by Kruskal-Wallis test. Linear regression models were subsequently used to identify univariable and multivariable predictors for HEI score for further reduction in the number of items. The final 9-item model of Mini-EAT was validated by 5-fold cross validation. The 19-item EAT had a strong correlation with the HEI score ($r=0.73$) and was subsequently reduced to the 9 items independently predictive of the HEI score: fruits, vegetables, whole grains, refined grains, fish or seafood, legumes/nuts/seeds, low-fat dairy, high-fat dairy, and sweets consumption, without affecting the predictive ability of the tool ($r=0.71$).

CONCLUSIONS: Mini-EAT is a 9-item validated brief dietary screener that correlates well with a comprehensive food frequency questionnaire. Future studies to test the Mini-EAT's validity in diverse populations and for development of clinical decision support systems to capture changes over time are needed.

Key Words: cardiovascular disease prevention ■ dietary questionnaire ■ dietary survey ■ food frequency questionnaire ■ Healthy Eating Index 2015 ■ preventive cardiology ■ rapid dietary screener

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The quality of nutrition and diet are critical when managing patients with or at risk for cardiovascular disease. Improvement in dietary quality and cardiometabolic risk factors (body weight, total cholesterol,

low-density lipoprotein cholesterol, fasting glucose, and blood pressure) have been observed with both brief and intensive dietary counseling.¹⁻⁷ Standardized dietary assessments, including 24-hour dietary recalls and validated

Correspondence to: Francisco Lopez-Jimenez, MD, MSc, 200 First Street SW, Rochester, MN 55905. Email: lopez@mayo.edu

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CLINICAL PERSPECTIVE

What Is New?

- A 19-item dietary assessment questionnaire was developed and validated against the Healthy Eating Index (HEI) 2015 score from a reference 156-item food frequency questionnaire in adult volunteers from the community, a preventive cardiology clinic, and cardiac rehabilitation.
- The dietary questionnaire was further reduced to 9 items and maintained good correlation with the HEI-2015.
- Mini-Eating Assessment Tool (Mini-EAT) is a 9-item rapid dietary screener that includes fruits/vegetables, whole grains, refined grains, fish/seafood, legumes/nuts/seeds, low-fat dairy, high-fat dairy, and sweets consumption.

What Are the Clinical Implications?

- The 9-item Mini-EAT could be integrated into clinical practice to rapidly screen diet quality in patients without substantially requiring more time, advanced education for patient providers, and resources.
- Mini-EAT provides an opportunity for discussion on small and actionable dietary interventions between patients and providers.
- Mini-EAT could be integrated in the electronic medical record and coupled with clinical decision support by an integrative multidisciplinary team with the main goal of improving patient dietary quality and prevention of cardiovascular disease.

Nonstandard Abbreviations and Acronyms

AHEI-10	Alternate Healthy Eating Index
AHA	American Heart Association
DASH	Dietary Approaches to Stop Hypertension
EAT	Eating Assessment Tool
FFQ	food frequency questionnaire
HEI	Healthy Eating Index
MEDAS	Mediterranean Diet Adherence Screener
MDS	Mediterranean Diet Score
REAP-S	Modified, Shortened Rapid Eating Assessment for Participants

food frequency questionnaires (FFQs), provide baseline data on dietary quality that can be used by dietitians and medical providers to initiate dietary plans and set goals for subsequent clinic visits. However, the American Heart

Association (AHA) recently highlighted the barriers of implementation in an outpatient clinical setting attributable to time and workflow restraints, lack of nutrition education and provider confidence, and survey fatigue.⁸ These limitations have led to the development of rapid dietary screener tools; however, only a handful of existing tools are validated and are comprised of 14 to 25 questions with poor to moderate correlations, respectively.^{9–11} There continues to be an unmet clinical need for the development of a further abbreviated validated dietary assessment tool with comparable correlation to a standard FFQ to improve the frequency of nutrition assessment by clinical providers. Furthermore, by providing rapid and efficient dietary assessments, actionable management plans for patients to reduce cardiovascular disease risk and improve overall health during the same visit can be prioritized.

The aims of the current study were to stepwise: (1) compare and validate a short 19-item dietary questionnaire we named EAT (Eating Assessment Tool) against a reference validated FFQ; and (2) reduce the number of EAT questions to a minimum without significantly affecting correlation or validity and develop a more simplified tool named Mini-EAT. The main objective of this study was not to replace a full dietary assessment but rather identify the most important dietary components essential for healthy eating based on the Healthy Eating Index (HEI) that all patient providers can comfortably use. We also hypothesized that the reduction in number of items would be possible without losing significant correlation with the HEI score.

METHODS

Study Design

The data that support the findings of the current study are available from the corresponding author upon reasonable request. This was a cross-sectional survey study at the Preventive Cardiology Clinic at the Mayo Clinic in Rochester, MN. Participants were enrolled online and were asked to complete both the EAT and a standard FFQ (Viocare) at least once. A random sample (N=74) completed EAT a second time within 24 hours to assess test–retest reliability. Participants received \$15 per survey they completed. Data management included collection of EAT data using the RedCap database and VioScreen data were collected within their online platform. To control for incomplete surveys, a reminder was sent by email or phone call up to 3 times to request completion. The institutional review board of the Mayo Clinic approved the research protocol and all study participants provided written informed consent.

Study Population

Adults 18 years and older from the preventive cardiology clinic and cardiac rehabilitation at Mayo Clinic,

Rochester, MN, and healthy volunteers were recruited for the study. All participants provided informed consent and the study protocol was approved by the institutional review board. Inclusion criteria included basic English literacy. Exclusion criteria included inability to provide consent.

Development of EAT

The investigational EAT is a shortened 19-item FFQ that was developed by expert consensus via focus groups comprising dietitians and cardiologists. Established evidence-based healthy dietary assessments were reviewed including the HEI,¹² Alternate Healthy Eating Index (AHEI-10),^{13,14} Mediterranean Diet Score (MDS),⁹ and Dietary Approaches to Stop Hypertension (DASH) score.^{15,16} Based on the 2015 to 2020 Dietary Guidelines for the United States,¹⁷ we incorporated similar food items that were deemed important for the development of EAT.¹⁸ Furthermore, compared with the AHA's more recent dietary recommendations for ideal cardiovascular health,¹⁹ the EAT questionnaire encompasses most of the main guidelines including an abundance in fruits and vegetables, whole grain foods and products, plant proteins (legumes/nuts/seeds), fish/seafood, lean unprocessed meat and poultry, low-fat and fat-free dairy, and avoidance of processed meats, salty foods, saturated fats, sweet foods and beverages, ultraprocessed foods, and alcohol.¹⁹ The main food groups important for distinguishing healthy and unhealthy dietary items and patterns were defined and discussed with registered dietician nutritionists and included clear examples of foods and portion sizes. The list of items was revised several times and internally piloted to ensure clarity and interpretation in people without formal training in diet and nutrition, and further revisions were made. EAT incorporates consumption of the main food groups (eg, fruits; vegetables; legumes, seeds, and nuts; grains; dairy; red meat and poultry; and fish and seafood), distinguishes saturated and unsaturated fat, whole and refined grains, cocoa products, processed food, food with high sugar, and salt content (Table S2). Fresh fruits included fresh or frozen fruits without added sugar and excluded preserved, dried, and fruit juices. Vegetables were defined in the screener as raw or cooked, nonfried, and nonstarchy with potatoes mentioned as the main example of starchy vegetables to exclude. Starchy vegetables (ie, potatoes, sweet potatoes, corn, and green peas), have 3 to 6 times more calories and carbohydrates than nonstarchy vegetables, with an association of lower mortality observed with increased consumption of fruits and vegetables but not potatoes, peas, and corn in cohort-based studies.²⁰ Whole grains by definition require >51% of a food item to be composed of a whole grain by weight or have whole grain listed

as the first ingredient. The example of "unsweetened ready-to-eat cereal" was confirmed by a nutritionist as an example of whole grains, which is an unsweetened version of a healthy option of a breakfast cereal, which predominantly includes different types of whole grains. For refined grains, we attempted to provide clear examples such as white bread, white rolls, bagels, English muffins, white rice or pasta, and wheat tortillas with a statement to not include whole grains consumption. Legumes included examples such as cooked or canned beans, lentils, chickpeas or peas, miso tofu, tempeh, and hummus. Regarding nut consumption, nut butters were initially discussed with the nutritionist as part of inclusion; however, evidence suggests that whole nuts rather than peanut butter consumption is associated with lower risk of all-cause and disease-specific mortality.²¹⁻²³ Seeds included examples such as sesame, sunflower, pumpkin, and flaxseeds. Fish or seafood included freshwater fish or sea water fish with examples including salmon, sardines, trout, Atlantic, and Pacific mackerel and seafood, with canned fish/seafood also included in this question. Oil consumption included olive oil, canola/rapeseed oil, sunflower oil, and avocados and also specifically mentions liquid oils used for cooking. Unprocessed red meat included pork, beef, and mutton meat. Poultry included unprocessed turkey, chicken, or rabbit meat. Processed meat included examples such as salami, sausage, ham, bacon, meat pies/pastries, meat snacks, deli (luncheon) meat, and canned meats (Spam Classic canned meat, Great Value corned beef, Keystone all-natural beef). Low-fat dairy included low-fat milk (1%), fat-free (skim) milk or soy milk, yogurt with reduced-fat, low-fat cheese, mozzarella, or cottage cheese. High-fat dairy and saturated fats included 2% milk or whole milk, butter, cream, cream cheese, cheese with no reduced-fat content, yogurt with 2% or higher milk fat, ice cream, butter, and coconut oil or shortening used for cooking. Sugar-sweetened beverages included beverages with high sugar content such as soft drinks (eg, Coca Cola, Pepsi Cola, Mountain Dew, Dr Pepper, Sprite, Fanta, Mirinda), sugar-sweetened iced teas (eg, Honest Tea, Snapple, Arizona, Lipton Pure Leaf, Gold Peak, and Nestea), sugar-sweetened sport drinks (eg, Gatorade and Powerade), and fruit juices (both commercial brands and homemade). Sweets and sweet foods included commercial sweets, candies, cookies, cakes, pastries, and sweet snacks. Cocoa products included milk and dark chocolate, cocoa drinks, and other products with high cocoa content with the exception of white chocolate. Salty snacks included potato and vegetable chips, tortilla/tostada chips, ready-to-eat popcorn, pretzels, corn snacks, and pork rinds. Processed meals included canned, frozen, or dry mix soups, premade meals including frozen pizza or microwaveable frozen dinners, boxed meal mixes, and

other canned ready-to-eat meals. Fast food restaurant meals included meals from fast food chains regardless of location of consumption (ie, restaurant/venue, home delivery, or takeout). Alcohol consumption examples included wine, beer, bourbon, rye whiskey, gin, rum, tequila, vodka, and vermouth.

Dietary Assessment

All participants completed both a validated 156-item FFQ (VioScreen) used as the reference standard and our investigational 19-item nutritional assessment, EAT. VioScreen was performed online within 24 hours using an access link sent by email. Vioscreen calculates the updated HEI-2015, which is a standardized measure for assessing compliance with the Dietary Guidelines for Americans (2015–2020).²⁴ The 13 components (total fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids, refined grains, sodium, added sugars, and saturated fats) sum to a max score of 100, with a score >80 indicating a good diet, 51 to 80 reflecting a diet that needs improvement, and <51 indicating a poor diet.²⁵ Vioscreen uses standard exclusion criteria such as daily total intake <1000 kcal or >4500kcal and/or reporting of <25 different foods. Vioscreen does not allow for any missing data and uses the Nutrition Data System for Research to prevent missing nutrient values.

Clinical Variables

All clinical data were collected via self-reported surveys at the beginning of the 19-item EAT questionnaire (Table S2). Demographic data including age, sex, ethnic group, education, marital status, and household income per year were obtained. Behavioral characteristics including smoking status, physical activity level, attention to nutrition levels, and current participation in a weight loss program or changes in diet were also gathered. Clinical characteristics obtained included height, weight, body mass index, and personal history data (hypertension, diabetes, impaired fasting glucose, dyslipidemia, heart attack, and stroke).

Statistical Analysis

Reliability analysis was performed by calculating the intraclass correlation between the 2 sets of the survey responses for participants who completed the EAT twice (N=74) (Table S1–S6). First and last responses were analyzed for participants who completed the EAT 3 times (N=2). The correlations between the answers to the same EAT questions ranged from 0.97 to 1. The correlation between the 2 sets of HEI scores was 0.86. (Figure S1–S6). Continuous variables were summarized as mean (SD) and median (range), while

categorical variables were reported as frequency (percentage). Participants were divided into <51, 51 to 80, and >80 based on total HEI score. Continuous baseline variables were compared between the groups using Kruskal-Wallis test and categorical baseline variables were compared with χ^2 test. Variable reduction was done with the threshold of $R^2=0.7$. Linear regression model was used to find the best prediction model for the HEI score by removing the nonsignificant questions from the predictors (Tables S2 and S3). Ordinal food questions were converted to numeric variables, with the lowest level in the answer set to 1 and each higher-level increases by 1. The coefficients in the final linear model were used to calculate the final Mini-EAT score for each patient. Pearson correlation test was used to test the correlation between the Mini-EAT score and HEI score. Receiver operating characteristic analysis was performed and area under the curve was calculated to reflect the predicting power of the Mini-EAT score in predicting the HEI “healthy” group. Sensitivity and specificity of the Mini-EAT score was calculated and the best cutoff point of the Mini-EAT score in predicting the healthy class group defined by HEI score >80 was identified (Table S4), which achieved the highest true-positive rate together with the lowest false-positive rate. To test the model’s performance, 5-fold cross-validation was performed, where the whole data were divided into 5 subgroups randomly (Table S5). In each fold, a subgroup was used as the test set and the rest of the groups were used to train the model. The calculated model performance metrics included residuals, correlation coefficient between observed and predicted HEI scores, and accuracy of assigning participants into HEI groups (<51, 51–80, >80). All tests were 2-sided with an α level set at 0.05 for statistical significance. R3.6.2 was used for statistical analysis.

RESULTS

Participant Characteristics

A total of 742 survey records from 661 recruited participants were collected. The overall mean age was 36 years (SD, 13 years) with 75.5% women, 78.3% of White race, and 93.1% college graduates or higher degree (Table). Among the participants, a medical history of hypertension (13.1%), diabetes and impaired fasting glucose (4.6%), dyslipidemia (12.7%), heart attack (2.3%), and stroke (0.9%) were self-reported.

Validation of EAT and Development of Mini-EAT

The 19-item EAT answers by total HEI group (HEI score <51, HEI score 51–80, HEI score >80) are provided in Table S6. Among the 74 participants who completed

Table. Self-Reported Participant Characteristics by HEI Score

Participant characteristics	HEI <51 (n=93)	HEI 51–80 (n=516)	HEI >80 (n=52)	Total (N=661)	P value
Age, y*					0.970
Mean (SD)	35.6 (11.3)	36.4 (12.4)	36.8 (13.8)	36.3 (12.3)	
Median (range)	33.0 (21.0–73.0)	32.5 (19.0–79.0)	32.0 (19.0–75.0)	32.0 (19.0–79.0)	
Sex					0.172
Women	64 (12.3)	398 (79.8)	37 (7.4)	499 (75.5)	
Men	29 (17.9)	118 (72.8)	15 (9.3)	162 (24.5)	
Racial or ethnic group					0.014
Missing	2	0	0	2	
White	62 (12.0)	411 (79.7)	43 (8.3)	516 (78.3)	
Black	1 (10.0)	8 (80.0)	1 (10.0)	10 (1.5)	
Hispanic	4 (12.9)	26 (83.9)	1 (3.2)	31 (4.7)	
Native American	0 (0.0)	1 (100.0)	0 (0.0)	1 (0.2)	
Asian or Pacific Islander	6 (13.0)	38 (82.6)	2 (4.3)	46 (7.0)	
Indian	10 (40.0)	15 (60.0)	0 (0.0)	25 (3.8)	
Middle Eastern	4 (26.7)	8 (53.3)	3 (20.0)	15 (2.3)	
Other	4 (26.7)	9 (60.0)	2 (13.3)	15 (2.3)	
Marital status					0.574
Missing	0	2	0	2	
Single	40 (14.8)	207 (76.4)	24 (8.9)	271 (41.1)	
Married	45 (13.2)	270 (79.2)	26 (7.6)	341 (51.7)	
Divorced	8 (19.0)	33 (78.6)	1 (2.4)	42 (6.4)	
Widow(er)	0 (0.0)	4 (80.0)	1 (20.0)	5 (0.8)	
Education					0.108
Missing	0	3	0	3	
High school	8 (17.8)	36 (80.0)	1 (2.2)	45 (6.8)	
College	55 (15.7)	273 (77.8)	23 (6.6)	351 (53.3)	
Graduate school or higher	30 (11.5)	204 (77.9)	28 (10.7)	262 (39.8)	
Average household income					0.146
Missing	1	11	1	13	
<\$25 000	12 (23.1)	36 (69.2)	4 (7.7)	52 (8.0)	
\$25 000 to \$34 999	12 (21.4)	43 (76.8)	1 (1.8)	56 (8.6)	
\$35 000 to \$49 999	17 (18.5)	71 (77.2)	4 (4.3)	92 (14.2)	
\$50 000 to \$74 999	20 (11.6)	135 (78.0)	18 (10.4)	173 (26.7)	
\$75 000 to \$99 999	11 (11.0)	82 (82.0)	7 (7.0)	100 (15.4)	
\$100 000 to \$149 999	16 (13.6)	89 (75.4)	13 (11.0)	118 (18.2)	
\$150 000 to \$199 999	3 (7.0)	36 (83.7)	4 (9.3)	43 (6.6)	
≥\$200 000	1 (7.1)	13 (92.9)	0 (0.0)	14 (2.2)	
Hypertension					0.272
Missing	2	4	0	6	
No	73 (12.9)	450 (79.4)	44 (7.8)	567 (86.6)	
Yes	18 (20.9)	60 (69.8)	8 (9.3)	86 (13.1)	
Unsure	0 (0.0)	2 (100.0)	0 (0.0)	2 (0.3)	
Diabetes/impaired fasting glucose					0.406
Missing	2	2	0	4	
No	84 (13.4)	490 (78.4)	51 (8.2)	625 (95.1)	
Yes	6 (20.0)	23 (76.7)	1 (3.3)	30 (4.6)	
Unsure	1 (50.0)	1 (50.0)	0 (0.0)	2 (0.3)	

(Continued)

Table. Continued

Participant characteristics	HEI <51 (n=93)	HEI 51–80 (n=516)	HEI >80 (n=52)	Total (N=661)	P value
Dyslipidemia					0.369
Missing	1	0	0	1	
No	76 (13.3)	452 (79.3)	42 (7.4)	570 (86.4)	
Yes	15 (17.9)	59 (70.2)	10 (11.9)	84 (12.7)	
Unsure	1 (16.7)	5 (83.3)	0 (0.0)	6 (0.9)	
Myocardial infarction					0.825
Missing	0	4	1	5	
No	92 (14.4)	499 (78.0)	49 (7.7)	640 (97.6)	
Yes	1 (6.7)	12 (80.0)	2 (13.3)	15 (2.3)	
Unsure	0 (0.0)	1 (100.0)	0 (0.0)	1 (0.2)	
Stroke					0.703
Missing	0	6	0	6	
No	92 (14.2)	506 (78.0)	51 (7.9)	649 (99.1)	
Yes	1 (16.7)	4 (66.7)	1 (16.7)	6 (0.9)	
Smoking history					0.459
Missing	1	4	0	5	
Never smoker	74 (14.0)	414 (78.3)	41 (7.8)	529 (80.6)	
Former smoker, quit ≤12 mo ago	4 (19.0)	15 (71.4)	2 (9.5)	21 (3.2)	
Former smoker, quit >12 mo ago	9 (10.3)	69 (79.3)	9 (10.3)	87 (13.3)	
Current smoker	5 (26.3)	14 (73.7)	0 (0.0)	19 (2.9)	
Regular exercise					<0.001
Missing	0	3	0	3	
I do not exercise regularly	38 (32.8)	74 (63.8)	4 (3.4)	116 (17.6)	
I exercise occasionally, but no more than twice a wk	27 (12.9)	171 (81.8)	11 (5.3)	209 (31.8)	
I exercise 3–5 times a wk	27 (10.5)	208 (80.6)	23 (8.9)	258 (39.2)	
I exercise most or all days of the wk	1 (1.3)	60 (80.0)	14 (18.7)	75 (11.4)	

*Categorical variables are reported as number (row percentage) for subgroups and number (percentage) for overall. Abbreviations: HEI, Healthy Eating Index. Score <51=poor diet, 51 to 80=fair diet, >80=good diet.

the EAT survey twice, the intraclass correlation between the 2 sets of HEI score was 0.86 (95% CI, 0.79–0.91), indicating good test–retest reliability. Using a multivariable linear regression model for the 19 items, fruits (2.12 [95% CI, 1.67–2.56]; $P<0.01$), vegetables (0.85 [95% CI, 0.33–1.37]; $P<0.01$), whole grains (1.44 [95% CI, 1.05–1.84]; $P<0.01$), refined grains (–1.14 [95% CI, –1.52 to –0.76]; $P<0.01$), fish or seafood (0.90 [95% CI, 0.22–1.57]; $P<0.01$), legumes/nuts/seeds (0.72 [95% CI, 0.25–1.18]; $P<0.01$), low-fat dairy (0.81 [95% CI, 0.48–1.15]; $P<0.01$), high-fat dairy (–1.03 [95% CI, –1.42 to –0.63]; $P<0.01$), and sweets (–0.89 [95% CI, –1.33 to –0.46]; $P<0.01$) remained statistically significant with predicting the HEI score after adjusting for each other (Table S3). These 9 questions were subsequently used in the final model and were strongly correlated with the HEI score ($R=0.71$) (Figure 1). The remaining 10 questions of EAT were nonsignificant and therefore not included in the final model (Table S2). In the 5-fold cross-validation step, mean residual of the models ranged from –0.86 to

1.18, correlation coefficients between the HEI score and predicted HEI score ranged between 0.65 and 0.73, and the accuracy of predicting the correct HEI group ranged from 0.73 to 0.86.

Receiver operating characteristic analysis of Mini-EAT as a continuous variable resulted in good predictive power of an HEI score >80 with a sensitivity of 0.73 and specificity of 0.85 (area under the curve, 0.87 [95% CI, 0.83–0.92]) (Figure 2). The Mini-EAT cutoff score >69 for a healthy diet was determined by receiver operating characteristic analysis using Mini-EAT as a binary variable (sensitivity 0.73, specificity 0.85). Utilizing the same analysis, the best cutoff point in a Mini-EAT score for the unhealthy class was <60 (sensitivity 0.73, specificity 0.87).

DISCUSSION

The aim of the current study was to evaluate the validity of our 19-item abbreviated dietary questionnaire, EAT,

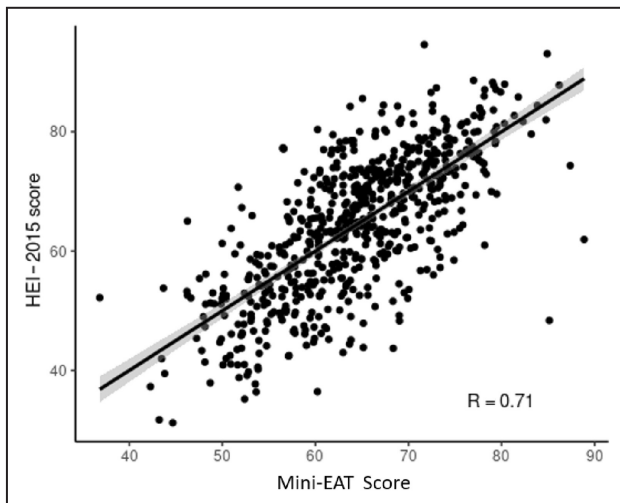


Figure 1. Scatter plot of Mini-Eating Assessment Tool (Mini-EAT) score vs Healthy Eating Index 2015 (HEI-2015) score.

against the HEI score assessed by an FFQ and identify healthy eating behaviors in adults presenting to a preventive cardiology clinic or cardiac rehabilitation and from the community. From our knowledge, our analysis of further reducing the 19-item questionnaire to the 9-item Mini-EAT is novel and maintained very good predictive power when compared with the reference standard FFQ, which is extensive and time consuming. Mini-EAT also meets most of the AHA's theoretical and practice-based validity criteria including validity against a complete dietary assessment, brevity, and ability to be completed and scored at administration without special knowledge or software.⁸ Additionally, it describes food consumption of the main components

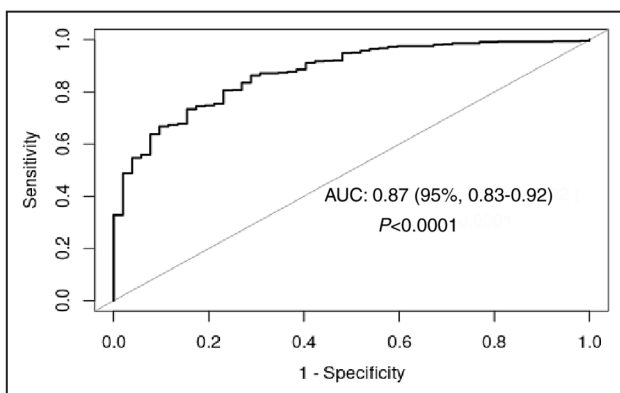


Figure 2. Receiver operating characteristic curve for the predictive power of the Healthy Eating Index (HEI) (HEI score >80) by using Mini-EAT score as a continuous variable. Mini-EAT score as a continuous variable with sensitivity of 0.85 and specificity of 0.73. Best cutoff point for Mini-EAT score: 69. AUC indicates area under curve.

included in the AHA-recommended dietary patterns and allows practitioners to identify room for improvement regarding specific food groups. The 9-item Mini-EAT further distinguishes itself by maintaining validity with substantial correlation ($r=0.71$) and may have the potential to be adopted into health clinics' electronic medical record.

Validation studies of rapid diet screener tools that assess total diet, reflect the most up-to-date dietary guidance, and meet most of the AHA's validity criteria include the Mediterranean Diet Adherence Screener (MEDAS), the modified, shortened Rapid Eating Assessment for Participants (REAP-S), and the PrimeScreen tool. The original MEDAS tool was composed of 14 items and showed only moderate correlation ($r=0.52$, $P<0.001$) compared with a full-length FFQ.⁹ The REAP-S was studied in 81 healthy adults and was composed of 16 questions and had poor correlation with the older 2010 HEI score ($r=0.23$, $P=0.047$).¹⁰ The PrimeScreen dietary screening tool was validated with 160 adults and was composed of 25 items (including 7 questions on nutrients) and achieved a good correlation ($r=0.70$).¹¹ While these existing dietary screeners are similar to our 19-item questionnaire, our analysis executes an additional step to remove items that do not contribute to the correlation to the reference standard, making it more efficient and able to be distributed in a busy clinical practice. Our Mini-EAT tool was also validated with a significantly larger number of participants compared with prior studies.

Mini-EAT can be adopted by most health clinics because of its simplicity, convenience, and minimal expertise required in nutrition (Figure 3). It can be easily integrated in the electronic medical record and coupled with clinical decision support by an integrative multidisciplinary team including the clinical provider (physician, nurse practitioner, physician assistant), registered nurses, behavioral therapists, and registered dietitians. For example, one pathway to consider might include providing patients with a smart tablet that administers the Mini-EAT in the waiting room after checking in. A low score would result in an automatic referral to a dietitian for a more formal and comprehensive evaluation. The dietitian would provide practical strategies for making healthier decisions based on childhood learned experiences, cultural barriers, psychosocial influences, and socioeconomic status implications. If a referral to dietetics is not feasible, online or physical educational materials on how to improve their diet can be disseminated at the end of the visit. Rather than a formal assessment, for an intermediate score, which likely reflects a balance of good and bad dietary habits, a conversation between the provider and patient with a goal of identifying 2 or 3 actionable predefined algorithmic modifications to improve diet with a plan for close follow-up by phone would provide a quick yet

The Mini-EAT (Eating Assessment Tool) is a quick and simple dietary screener comprised of the following 9 questions aimed to assess your food intake:

- How often do you eat fresh fruits?**

Examples: Apples, bananas, pears, oranges, grapes, strawberries, blueberries, etc.
Include fresh fruits and frozen fruits with no added sugar.
Please do not include preserved or dried fruits or fruit juice in your estimates.

[One serving equals: 1 small apple or ½ large banana (approximately 1cup, size of a small fist); 1 cup mandarin oranges, melon or raspberries; ¼ cup blueberries; 1½ cup whole strawberries]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
- How often do you eat vegetables?**

Examples: Tomatoes, peppers, cucumbers, broccoli, carrots, green beans, cabbage, spinach, arugula and other leafy vegetables.
Include raw or cooked non-starchy vegetables.
Please do not include starchy vegetables (such as potatoes) and fried vegetables in your estimates.

[One serving equals: 1 cup raw vegetables (e.g. tomatoes, baby carrots, celery, green peas); ½ cup cooked vegetables (such as broccoli and spinach); 1 cup arugula]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)
- How often do you eat legumes, nuts, and seeds?**

Examples: Legumes - cooked or canned beans, lentils, chickpeas or peas; miso, tofu, tempeh, hummus
Nuts - almonds, walnuts, hazelnuts, peanuts, etc.
Seeds - sesame, sunflower, pumpkin, flax seeds, etc.

[One serving equals: ½ cup of cooked or canned legumes; ½ hummus or bean dip; ½ cup tofu; ¼ cup tempeh; a small handful of nuts or seeds]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)
- How often do you eat fish or seafood?**

Examples: Fresh water fish or sea water fish (e.g. salmon, sardines, trout, Atlantic, Pacific mackerel etc.) and seafood.
Include canned fish/seafood in your estimates.

[One serving equals: 3 oz. of cooked or canned fish (about the size of a deck of cards); a palm-size piece of raw fish]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
- How often do you eat whole grains?**

Examples: Whole grain bread, whole grain bread roll, muesli, unsweetened ready to eat cereal, cooked grits/porridge, brown rice, whole grain pasta, corn tortilla.
Please do not include white bread, white roll or bagels; white rice or pasta; or wheat tortilla in your estimates.

[One serving equals: 1 slice of whole grain bread; ½ cup cooked cereal (oats, oatmeal, quinoa); ½ cup cooked brown rice or whole grain pasta; 1 small corn tortilla; ½ cup cooked grits; 1 cup ready-to-eat cereal flakes]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)
- How often do you eat refined grains?**

Examples: White bread; white roll, bagel or English muffin; white rice or pasta, wheat tortilla.
Please do not include whole grains considered in the above question (such as whole grain bread or bread roll).

[One serving equals: 1 slice white bread; ½ roll; ½ small white bagel or English muffin; ½ cup cooked white rice or pasta; 1 small wheat tortilla]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)
- How often do you eat low-fat dairy?**

Examples: Low-fat milk (1%) or fat-free (skim) milk or soy milk; yogurt with reduced fat content; low fat cheese, mozzarella, cottage cheese.

[One serving equals: 1 cup low fat or skim milk; ¼ cup (6oz.) yogurt low fat; 1 pre-packaged slice low fat cheese; 1½ oz. mozzarella]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)
- How often do you eat high-fat dairy and saturated fats?**

Examples: 2% milk or whole milk; butter; cream; cream cheese; cheese with not reduced-fat content; yogurt with 2% or higher milk fat; ice cream.
Butter, coconut oil or shortening used for cooking.
Please do not include low fat dairy in the above question in your estimates.

[One serving equals: 1 cup 2% milk and whole milk; ¾ cup (6 oz.) yogurt; 1 pre-packaged slice of cheese; 2 oz. processed cheese; 1/2 cup ice cream; 1 teaspoon butter, shortening or coconut oil]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)
- How often do you eat sweets and sweet foods?**

Examples: Commercial sweets, candies, cookies, cakes, pastries, sweet snacks.

[One serving equals: 1.5 oz. gummi candy (e.g. Haribo); 3 pcs hard candy (e.g. Werther's); 1 small piece of cake or pastry; 1 medium doughnut or sweet snack; 2-3 sweet biscuits or cookies (about 1 oz.)]

I do not eat it at all
 Less than 1 serving per week
 1-2 servings per week
 3-4 servings per week
 5-6 servings per week
 1 serving per day
 2-3 servings per day
 4-5 servings per day
 6 or more servings per day
 (Optional informational text displayed underneath the field.)

Figure 3. Mini-Eating Assessment Tool (Mini-EAT) 9-item survey.

efficient pathway. For example, a pop-up screen after taking the Mini-EAT would involve the patient selecting 2 goals from 5 or 6 options and may include any of the following examples: drinking at least 8 glasses of water per day, cutting the portion of refined carbohydrates by 50% and replacing with whole grain products, avoiding sweet foods 5 days of the week, and replacing at least 3 dinners with fish/seafood or plant proteins. Present comorbidities including obesity, prediabetes, diabetes, coronary heart disease, hypertension, and heart failure should prompt long-term dietary follow-up with the patient based on the Mini-EAT score. Further ideas for development of the Mini-EAT include rapid “click bait” of graphics or videos and “eat this not that” recommendations based on where their scores were specifically suboptimal would provide meaningful nutrition education for practical use. A high score would validate the patient with positive feedback and continued motivation to maintain a healthy diet.

Interestingly, fats, healthy oils, and meat consumption were not found to be statistically significant nor

associated with the HEI score in the multivariable model and did not add to the correlation coefficient and were therefore not included in Mini-EAT. This is likely explained by the food groups strongly correlating with other food items associated to HEI score. However, the exclusion of fat and meat intake in the Mini-EAT should not be interpreted as noncontributors in the quality of diet but rather they do not provide incremental correlation with the HEI score. These findings contrast with prior studies, which utilize the above food groups as part of determining dietary patterns in their screening tools.

Limitations of the present study include selection bias, random and systematic errors in self-reported dietary assessment, misclassification of food group reporting, and a nondiverse study population of mostly highly educated women. We acknowledge the potential challenge in accurately designating food items to the correct food groups, such as the vast majority of items such as cereal products that may market themselves as unrefined whole grain products but more

accurately reflect refined grains. Future research is needed to develop specific definitions survey responders can understand with the goal of accurately categorizing food groupings. The inaccuracies of validated FFQs to measure dietary intake is also a known limitation in nutrition research. Although Mini-EAT lacks Viocare's graphics of pictures and portions of food groups to assist in more accurate responses, Mini-EAT was still able to achieve good correlation. The 2015 HEI is also commonly used in nutrition research; however, there are multiple ways to arrive at the same HEI score, resulting in more confidence in extreme scores due consistency in diet and less confidence in intermediate scores. Important information concerning macronutrients such as total protein intake may also not be captured because of the truncated HEI components and total scores. The lack of diversity in our sample population is a significant limitation of the current study and more extensive testing of the Mini-EAT within different sample populations is essential for Mini-EAT's generalizability. Furthermore, input from healthcare providers regarding the utility and effectiveness of Mini-EAT will need to be further investigated.

Mini-EAT is a validated rapid dietary screening tool that correlates well with the HEI-2015 assessed by an FFQ and is feasible for a busy clinical practice to incorporate into the electronic medical record. Opportunities for the development of Mini-EAT into a digital health tool or app would lend convenience to both providers and patients, which is consistent with the AHA's call to improve the integration of diet screener tools into clinical practice.⁸ Furthermore, development into a clinical decision support tool will allow Mini-EAT the ability to capture dietary changes over time and become incorporated into chronic disease management. Future studies validating Mini-EAT in diverse populations along with predictive validity relating to cardiometabolic risk factors are warranted.

ARTICLE INFORMATION

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Affiliations

Mayo Clinic, Department of Cardiovascular Medicine, Rochester, MN (K.M.L., J.R.M.I., A.L., S.L.K., F.L.); Mayo Clinic, Division of Biomedical Statistics and Informatics, Jacksonville, FL (Z.L.); and International Clinical Research Center, St Anne's University Hospital Brno, Brno, Czech Republic (S.K.).

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Supplemental Material

Table S1–S6

Figure S1

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SUPPLEMENTAL MATERIAL

Table S1. Reliability Analysis Using Intraclass Correlation Coefficient

Variable	ICC (95%)
Q1	0.998 (0.997, 0.999)
Q2	0.998 (0.996, 0.998)
Q3	0.995 (0.993, 0.997)
Q4	1
Q5	0.996 (0.994, 0.997)
Q6	1
Q7	0.988 (0.981, 0.992)
Q8	1
Q9	0.996 (0.994, 0.997)
Q10	0.997 (0.995, 0.998)
Q11	0.998 (0.997, 0.999)
Q12	0.992 (0.987, 0.995)
Q13	0.998 (0.997, 0.999)
Q14	0.988 (0.981, 0.992)
Q15	0.997 (0.996, 0.998)
Q16	0.995 (0.993, 0.997)
Q17	0.982 (0.973, 0.989)
Q18	0.994 (0.99, 0.996)
Q19	1
HEI	0.859 (0.788, 0.908)

Table S2. Linear regression model predicting HEI score using all EAT 19 questions

term	Beta95CI	P-value
Question 1/19 How often do you eat fresh fruits?	2.08 (1.63, 2.53)	<0.001
Question 2/19 How often do you eat vegetables?	0.57 (0.02, 1.12)	0.0418
Question 3/19 How often do you eat legumes, nuts and seeds?	0.53 (0.05, 1.02)	0.0312
Question 4/19 How often do you eat whole grains?	1.35 (0.94, 1.75)	<0.001
Question 5/19 How often do you eat refined grains?	-0.99 (-1.39, -0.58)	<0.001
Question 6/19 How often do you eat fish or seafood?	0.73 (0.04, 1.43)	0.0393
Question 7/19 How often do you eat olive oil, canola oil, sunflower oil, or avocado?	0.25 (-0.17, 0.68)	0.2397
Question 8/19 How often do you eat unprocessed red meat?	-0.29 (-0.9, 0.33)	0.3617
Question 9/19 How often do you eat poultry?	0.16 (-0.42, 0.74)	0.5880
Question 10/19 How often do you eat processed meat?	-0.49 (-1.21, 0.22)	0.1770
Question 11/19 How often do you eat low fat dairy?	0.89 (0.55, 1.23)	<0.001
Question 12/19 How often do you eat high fat dairy and saturated fats?	-0.95 (-1.35, -0.54)	<0.001
Question 13/19 How often do you drink sugar-sweetened beverages or fruit juices?	-0.25 (-0.65, 0.15)	0.2177
Question 14/19 How often do you eat sweets and sweet foods?	-0.66 (-1.18, -0.14)	0.0128
Question 15/19 How often do you eat cocoa products?	0.07 (-0.44, 0.58)	0.7793
Question 16/19 How often do you eat salty snacks?	0.05 (-0.43, 0.53)	0.8448
Question 17/19 How many processed meals do you eat in a typical week?	-0.49 (-1.09, 0.1)	0.1054
Question 18/19 How often do you eat fast food restaurant meals?	-0.42 (-1.34, 0.5)	0.3673
Question 19/19 How many drinks of alcohol do you have in a typical week?	0.48 (-0.08, 1.05)	0.0948

Table S3. Linear regression model predicting HEI score using only statistically significant questions from EAT

Question	Beta95CI	P-value
Question 1/19 How often do you eat fresh fruits?	2.12 (1.67, 2.56)	<0.001
Question 2/19 How often do you eat vegetables?	0.85 (0.33, 1.37)	0.0015
Question 3/19 How often do you eat legumes, nuts and seeds?	0.72 (0.25, 1.18)	0.0027
Question 4/19 How often do you eat whole grains?	1.44 (1.05, 1.84)	<0.001
Question 5/19 How often do you eat refined grains?	-1.14 (-1.52, -0.76)	<0.001
Question 6/19 How often do you eat fish or seafood?	0.9 (0.22, 1.57)	0.0094
Question 11/19 How often do you eat low fat dairy?	0.81 (0.48, 1.15)	<0.001
Question 12/19 How often do you eat high fat dairy and saturated fats?	-1.03 (-1.42, -0.63)	<0.001
Question 14/19 How often do you eat sweets and sweet foods?	-0.89 (-1.33, -0.46)	<0.001

Table S4. Distribution of Mini-EAT™ score by HEI score

	<51 (N=93)	51-80 (N=516)	>80 (N=52)	Total (N=661)	p value
Mini-EAT score					< 0.001
Mean (SD)	55.658 (6.498)	64.925 (7.284)	74.836 (5.946)	64.401 (8.342)	
Median (Range)	54.760 (42.273, 85.134)	65.159 (36.822, 88.877)	75.675 (60.238, 86.191)	64.607 (36.822, 88.877)	
Q1, Q3	52.014, 59.426	60.339, 70.012	70.526, 79.133	58.871, 70.198	

Table S5. 5-Fold Cross Validation for Model

Resample	n	Mean residual	Median residual	cor	accuracy
Fold1	132	1.18	2.35	0.73	0.77
Fold2	132	-0.86	-0.72	0.72	0.73
Fold3	133	0.37	1.18	0.73	0.80
Fold4	132	0.17	1.00	0.65	0.86
Fold5	132	-0.80	-0.34	0.70	0.74

Accuracy is defined as the proportion of patients falling into the same category using both HEI and Mini-EAT when scores are divided into <51, 51-80, >80

Table S6. EAT answers by HEI total score

Question	HEI<51 (N=93)	HEI=51-80 (N=516)	HEI>80 (N=52)	Total (N=661)	p value
Question 1/19 How often do you eat fresh fruits? ¹					< 0.001
- Less than 1 serving per week	17 (39.5%)	26 (60.5%)	0 (0.0%)	43 (6.5%)	
- 1-2 servings per week	33 (31.7%)	71 (68.3%)	0 (0.0%)	104 (15.7%)	
- 3-4 servings per week	23 (21.1%)	83 (76.1%)	3 (2.8%)	109 (16.5%)	
- 5-6 servings per week	10 (14.9%)	53 (79.1%)	4 (6.0%)	67 (10.1%)	
- 1 serving per day	5 (5.0%)	90 (90.0%)	5 (5.0%)	100 (15.1%)	
- 2-3 servings per day	3 (1.5%)	172 (86.0%)	25 (12.5%)	200 (30.3%)	
- 4 or more servings per day	2 (5.3%)	21 (55.3%)	15 (39.5%)	38 (5.7%)	
Question 2/19 How often do you eat vegetables?					< 0.001
- Less than 2 serving per week	37 (43.0%)	49 (57.0%)	0 (0.0%)	86 (13.0%)	
- 3-4 servings per week	17 (18.1%)	76 (80.9%)	1 (1.1%)	94 (14.2%)	
- 5-6 servings per week	17 (20.5%)	64 (77.1%)	2 (2.4%)	83 (12.6%)	
- 1 serving per day	10 (9.9%)	84 (83.2%)	7 (6.9%)	101 (15.3%)	
- 2-3 servings per day	8 (3.4%)	200 (85.1%)	27 (11.5%)	235 (35.6%)	
- 4 or more servings per day	4 (6.5%)	43 (69.4%)	15 (24.2%)	62 (9.4%)	
Question 3/19 How often do you eat legumes, nuts and seeds?					< 0.001
- Less than 1 serving per week	38 (27.5%)	97 (70.3%)	3 (2.2%)	138 (20.9%)	
- 1-2 servings per week	29 (18.1%)	124 (77.5%)	7 (4.4%)	160 (24.2%)	
- 3-4 servings per week	14 (11.5%)	102 (83.6%)	6 (4.9%)	122 (18.5%)	
- 5-6 servings per week	4 (6.9%)	48 (82.8%)	6 (10.3%)	58 (8.8%)	
- 1 serving per day	4 (3.3%)	99 (82.5%)	17 (14.2%)	120 (18.2%)	
- 2 or more servings per day	4 (6.3%)	46 (73.0%)	13 (20.6%)	63 (9.5%)	
Question 4/19 How often do you eat whole grains?					< 0.001
- I do not eat it at all	13 (38.2%)	21 (61.8%)	0 (0.0%)	34 (5.1%)	
- Less than 1 serving per week	22 (30.6%)	48 (66.7%)	2 (2.8%)	72 (10.9%)	
- 1-2 servings per week	17 (14.0%)	102 (84.3%)	2 (1.7%)	121 (18.3%)	
- 3-4 servings per week	18 (13.5%)	110 (82.7%)	5 (3.8%)	133 (20.1%)	
- 5-6 servings per week	8 (13.1%)	50 (82.0%)	3 (4.9%)	61 (9.2%)	
- 1 serving per day	10 (8.9%)	87 (77.7%)	15 (13.4%)	112 (16.9%)	
- 2 or more servings per day	5 (3.9%)	98 (76.6%)	25 (19.5%)	128 (19.4%)	
Question 5/19 How often do you eat refined grains?					< 0.001
- I do not eat it at all	4 (12.1%)	27 (81.8%)	2 (6.1%)	33 (5.0%)	
- Less than 1 serving per week	9 (9.8%)	72 (78.3%)	11 (12.0%)	92 (13.9%)	
- 1-2 servings per week	12 (8.0%)	121 (80.7%)	17 (11.3%)	150 (22.7%)	

- 3-4 servings per week	19 (14.3%)	104 (78.2%)	10 (7.5%)	133 (20.1%)	
- 5-6 servings per week	19 (33.9%)	35 (62.5%)	2 (3.6%)	56 (8.5%)	
- 1 serving per day	9 (10.3%)	73 (83.9%)	5 (5.7%)	87 (13.2%)	
- 2 or more servings per day	21 (19.1%)	84 (76.4%)	5 (4.5%)	110 (16.6%)	
Question 6/19 How often do you eat fish or seafood?					< 0.001
- I do not eat it at all	23 (25.6%)	57 (63.3%)	10 (11.1%)	90 (13.6%)	
- Less than 1 serving per week	33 (14.4%)	182 (79.5%)	14 (6.1%)	229 (34.6%)	
- 1 serving per week	31 (14.7%)	165 (78.2%)	15 (7.1%)	211 (31.9%)	
- 2 or more servings per week	6 (4.6%)	112 (85.5%)	13 (9.9%)	131 (19.8%)	
Question 7/19 How often do you eat olive oil, canola oil, sunflower oil or avocado?					< 0.001
- I do not eat it at all	6 (18.8%)	26 (81.2%)	0 (0.0%)	32 (4.8%)	
- Less than 1 serving per week	24 (24.5%)	68 (69.4%)	6 (6.1%)	98 (14.8%)	
- 1-2 servings per week	17 (12.1%)	117 (83.0%)	7 (5.0%)	141 (21.3%)	
- 3-4 servings per week	20 (14.3%)	110 (78.6%)	10 (7.1%)	140 (21.2%)	
- 5-6 servings per week	12 (16.4%)	59 (80.8%)	2 (2.7%)	73 (11.0%)	
- 1 serving per day	7 (7.0%)	82 (82.0%)	11 (11.0%)	100 (15.1%)	
- 2 or more servings per day	7 (9.1%)	54 (70.1%)	16 (20.8%)	77 (11.6%)	
Question 8/19 How often do you eat unprocessed red meat?					0.063
- N-Miss	0	1	0	1	
- I do not eat it at all	12 (17.9%)	45 (67.2%)	10 (14.9%)	67 (10.2%)	
- Less than 1 serving per week	18 (15.0%)	90 (75.0%)	12 (10.0%)	120 (18.2%)	
- 1-2 servings per week	23 (9.8%)	195 (83.0%)	17 (7.2%)	235 (35.6%)	
- 3-4 servings per week	25 (15.4%)	127 (78.4%)	10 (6.2%)	162 (24.5%)	
- 5 or more servings per week	15 (19.7%)	58 (76.3%)	3 (3.9%)	76 (11.5%)	
Question 9/19 How often do you eat poultry?					0.689
- Less than 1 serving per week	13 (19.4%)	46 (68.7%)	8 (11.9%)	67 (10.1%)	
- 1-2 servings per week	31 (15.3%)	159 (78.7%)	12 (5.9%)	202 (30.6%)	
- 3-4 servings per week	31 (13.0%)	191 (80.3%)	16 (6.7%)	238 (36.0%)	
- 5-6 servings per week	10 (11.4%)	69 (78.4%)	9 (10.2%)	88 (13.3%)	
- 1 serving per day	6 (12.2%)	38 (77.6%)	5 (10.2%)	49 (7.4%)	
- 2 or more servings per day	2 (11.8%)	13 (76.5%)	2 (11.8%)	17 (2.6%)	
Question 10/19 How often do you eat processed meat?					< 0.001
- N-Miss	0	1	0	1	
- I do not eat it at all	11 (15.7%)	45 (64.3%)	14 (20.0%)	70 (10.6%)	
- Less than 1 serving per week	11 (6.0%)	153 (83.2%)	20 (10.9%)	184 (27.9%)	
- 1-2 servings per week	29 (11.7%)	203 (82.2%)	15 (6.1%)	247 (37.4%)	
- 3-4 servings per week	29 (25.4%)	82 (71.9%)	3 (2.6%)	114 (17.3%)	
- 5 or more servings per week	13 (28.9%)	32 (71.1%)	0 (0.0%)	45 (6.8%)	

Question 11/19 How often do you eat low fat dairy?					0.008
- I do not eat it at all	16 (19.0%)	64 (76.2%)	4 (4.8%)	84 (12.7%)	
- Less than 1 serving per week	15 (19.2%)	58 (74.4%)	5 (6.4%)	78 (11.8%)	
- 1-2 servings per week	20 (16.8%)	96 (80.7%)	3 (2.5%)	119 (18.0%)	
- 3-4 servings per week	18 (15.0%)	95 (79.2%)	7 (5.8%)	120 (18.2%)	
- 5-6 servings per week	8 (12.1%)	53 (80.3%)	5 (7.6%)	66 (10.0%)	
- 1 serving per day	9 (10.8%)	61 (73.5%)	13 (15.7%)	83 (12.6%)	
- 2 servings per day	7 (6.3%)	89 (80.2%)	15 (13.5%)	111 (16.8%)	
Question 12/19 How often do you eat high fat dairy and saturated fats?					< 0.001
- I do not eat it at all	3 (7.0%)	31 (72.1%)	9 (20.9%)	43 (6.5%)	
- Less than 1 serving per week	10 (9.7%)	75 (72.8%)	18 (17.5%)	103 (15.6%)	
- 1-2 servings per week	19 (11.7%)	133 (81.6%)	11 (6.7%)	163 (24.7%)	
- 3-4 servings per week	28 (18.8%)	114 (76.5%)	7 (4.7%)	149 (22.5%)	
- 5-6 servings per week	15 (21.7%)	54 (78.3%)	0 (0.0%)	69 (10.4%)	
- 1 serving per day	9 (11.8%)	61 (80.3%)	6 (7.9%)	76 (11.5%)	
- 2 or more servings per day	9 (15.5%)	48 (82.8%)	1 (1.7%)	58 (8.8%)	
Question 13/19 How often do you drink sugar-sweetened beverages or fruit juice?					< 0.001
- I do not drink it at all	16 (8.4%)	146 (76.4%)	29 (15.2%)	191 (28.9%)	
- Less than 1 serving per week	18 (10.1%)	148 (82.7%)	13 (7.3%)	179 (27.1%)	
- 1-2 servings per week	16 (16.2%)	75 (75.8%)	8 (8.1%)	99 (15.0%)	
- 3-4 servings per week	11 (15.9%)	56 (81.2%)	2 (2.9%)	69 (10.4%)	
- 5-6 servings per week	8 (25.8%)	23 (74.2%)	0 (0.0%)	31 (4.7%)	
- 1 serving per day	10 (17.5%)	47 (82.5%)	0 (0.0%)	57 (8.6%)	
- 2 or more servings per day	14 (40.0%)	21 (60.0%)	0 (0.0%)	35 (5.3%)	
Question 14/19 How often do you eat sweets and sweet foods?					0.016
- Less than 1 serving per week	13 (10.4%)	98 (78.4%)	14 (11.2%)	125 (18.9%)	
- 1-2 servings per week	17 (9.0%)	150 (79.8%)	21 (11.2%)	188 (28.4%)	
- 3-4 servings per week	19 (14.2%)	106 (79.1%)	9 (6.7%)	134 (20.3%)	
- 5-6 servings per week	11 (21.6%)	39 (76.5%)	1 (2.0%)	51 (7.7%)	
- 1 serving per day	19 (18.3%)	81 (77.9%)	4 (3.8%)	104 (15.7%)	
- 2 or more servings per day	14 (23.7%)	42 (71.2%)	3 (5.1%)	59 (8.9%)	
Question 15/19 How often do you eat cocoa products?					0.204
- I do not eat it at all	12 (16.4%)	57 (78.1%)	4 (5.5%)	73 (11.0%)	
- Less than 1 serving per week	28 (13.9%)	155 (77.1%)	18 (9.0%)	201 (30.4%)	
- 1-2 servings per week	18 (9.8%)	151 (82.1%)	15 (8.2%)	184 (27.8%)	
- 3-4 servings per week	17 (16.2%)	82 (78.1%)	6 (5.7%)	105 (15.9%)	
- 5-6 servings per week	9 (32.1%)	16 (57.1%)	3 (10.7%)	28 (4.2%)	

- 1 or more serving per day	9 (12.9%)	55 (78.6%)	6 (8.6%)	70 (10.6%)	
Question 16/19 How often do you eat salty snacks?					< 0.001
- I do not eat it at all	6 (18.8%)	21 (65.6%)	5 (15.6%)	32 (4.8%)	
- Less than 1 serving per week	13 (9.0%)	121 (84.0%)	10 (6.9%)	144 (21.8%)	
- 1-2 servings per week	24 (14.5%)	123 (74.1%)	19 (11.4%)	166 (25.1%)	
- 3-4 servings per week	17 (11.3%)	126 (83.4%)	8 (5.3%)	151 (22.8%)	
- 5-6 servings per week	17 (24.6%)	45 (65.2%)	7 (10.1%)	69 (10.4%)	
- 1 serving per day	4 (6.3%)	56 (88.9%)	3 (4.8%)	63 (9.5%)	
- 2 or more servings per day	12 (33.3%)	24 (66.7%)	0 (0.0%)	36 (5.4%)	
Question 17/19 How many processed meals do you eat in a typical week?					< 0.001
- I do not eat it at all	12 (10.3%)	86 (73.5%)	19 (16.2%)	117 (17.7%)	
- Less than 1 serving per week	17 (8.4%)	172 (84.7%)	14 (6.9%)	203 (30.7%)	
- 1-2 servings per week	27 (15.1%)	140 (78.2%)	12 (6.7%)	179 (27.1%)	
- 3-4 servings per week	12 (12.8%)	76 (80.9%)	6 (6.4%)	94 (14.2%)	
- 5-6 servings per week	10 (31.2%)	21 (65.6%)	1 (3.1%)	32 (4.8%)	
- 1 or more serving per day	15 (41.7%)	21 (58.3%)	0 (0.0%)	36 (5.4%)	
Question 18/19 How often do you eat fast-food restaurant meals?					< 0.001
- I do not eat it at all	5 (5.9%)	61 (71.8%)	19 (22.4%)	85 (12.9%)	
- Less than 1 meal per week	31 (10.4%)	245 (81.9%)	23 (7.7%)	299 (45.2%)	
- 1-2 meals per week	40 (18.9%)	163 (76.9%)	9 (4.2%)	212 (32.1%)	
- 3 or more meals per week	17 (26.2%)	47 (72.3%)	1 (1.5%)	65 (9.8%)	
Question 19/19 How many drinks of alcohol do you have in a typical week?					0.215
- I do not drink alcohol at all	20 (14.6%)	108 (78.8%)	9 (6.6%)	137 (20.7%)	
- Less than 1 drink per week	36 (18.4%)	149 (76.0%)	11 (5.6%)	196 (29.7%)	
- 1-3 drinks per week	22 (12.0%)	145 (78.8%)	17 (9.2%)	184 (27.8%)	
- 4-6 drinks per week	9 (8.7%)	82 (78.8%)	13 (12.5%)	104 (15.7%)	
- 7 or more drinks per week	6 (15.0%)	32 (80.0%)	2 (5.0%)	40 (6.1%)	
1Categorical variables reported were count (row percent) for subgroups, and count (percent) for overall					

Figure S1. Scatter plot of HEI score from the first and second response

