RESEARCH
Original Research

Development of a Diet Quality Screener for Global Use: Evaluation in a Sample of US Women

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ARTICLE INFORMATION

Article history:
Submitted 27 May 2020
Accepted 29 December 2020

Keywords:
Diet quality questionnaire
Prime Diet Quality Score
Short-form diet screener
ASA24
24-hour diet recall

Supplementary materials:
Tables 4, 6, 10, and 11 are available at www.jandonline.org

https://doi.org/10.1016/j.jand.2020.12.024

ABSTRACT

Background Valid and efficient tools for measuring and tracking diet quality globally are lacking.

Objective The objective of the study was to develop and evaluate a new tool for rapid and cost-efficient diet quality assessment.

Design Two screener versions were designed using Prime Diet Quality Score (PDQS), one in a 24-hour recall (PDQS-24HR) and another in a 30-day (PDQS-30D) food frequency format. Participants completed two 24-hour diet recalls using the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) and 2 web-based diet quality questionnaires 7 to 30 days apart in April and May 2019. Both dichotomous/trichotomous and granular scoring versions were tried for each screener.

Participants/setting The study included 290 nonpregnant, nonlactating US women (mean age ± standard deviation 41 ± 11 years) recruited via Amazon Mechanical Turk.

Main outcome measures The main outcome measures were Spearman rank correlation coefficients and linear regression beta-coefficients between ASA24 nutrient intakes from foods and beverages and PDQS values.

Statistical analyses performed The Spearman rank correlation and linear regression were used to evaluate associations of the PDQS values with ASA24 nutrient intakes from food, both crude and energy-adjusted. Correlations were de-attenuated for within-person variation in 24-hour recalls. Wolfe's test was used to compare correlations of the 2 screening instruments (PDQS-24HR and PDQS-30D) with the ASA24. Associations between the ASA24 Healthy Eating Index 2015 and the PDQS values were also evaluated.

Results Positive, statistically significant rank correlations between the PDQS-24HR values and energy-adjusted nutrients from ASA24 for fiber ($r = 0.53$), magnesium ($r = 0.51$), potassium ($r = 0.48$), vitamin E ($r = 0.40$), folate ($r = 0.37$), vitamin C ($r = 0.36$), vitamin A ($r = 0.33$), vitamin B6 ($r = 0.31$), zinc ($r = 0.25$), and iron ($r = 0.21$); and inverse correlations for saturated fatty acids ($r = -0.19$), carbohydrates ($r = -0.22$), and added sugar ($r = -0.34$) were observed. Correlations of nutrient intakes assessed by ASA24 with the PDQS-30D were not significantly different from those with the PDQS-24HR. Positive, statistically significant correlations between the ASA24 Healthy Eating Index 2015 and the PDQS-24HR ($r = 0.61$) and the PDQS-30D ($r = 0.60$) were also found.

Conclusions The results of an initial evaluation of the PDQS-based diet quality screeners are promising. Correlations and associations between the PDQS values and nutrient intakes were of acceptable strength and in the expected directions, and the PDQS values had moderately strong correlations with the total Healthy Eating Index 2015 score. Future work should include evaluating the screeners in other population groups, including men, and piloting it across low- and middle-income countries.
J Acad Nutr Diet. 2021;■(■):■-■.

DIET IS THE LEADING RISK FACTOR FOR MORBIDITY and mortality globally, associated with risks of noncommunicable diseases (NCDs) and nutrient deficiencies.[1-3] However, traditional nutrition surveillance systems and dietary assessment instruments are complex and costly, resulting in dietary data gaps across Africa, Asia, South East Europe, and South America.[4] Therefore, new tools are required for evaluating diets and monitoring success in achieving specific dietary goals[5] on both national (eg, health and nutrition surveys) and international levels (eg, the United Nations' Sustainable Development Goals 2 and 3[6]). Such instruments should be developed considering both intakes of key nutrients and prevention of diet-related NCDs; be able to rank people according to their dietary quality; be applicable across various country settings (ie, in low-, middle-, and high-income countries [LMICs]) and population groups (ie, among women,[5] children, and adolescents) to allow for cross-country and cross-group comparisons; be easy to use by nonexpert personnel and ideally without relying on food composition data; and, whenever possible, consider the effect of human diets on the environment.[7,8]

Diet quality, a term that aims to describe overall diet and its effect on human health rather than focusing on associations with specific nutrients, has gained attention in nutritional epidemiology during the past 2 decades.[9,10] This multidimensional concept includes adequate amounts and diversity of healthy foods, limited intakes of unhealthy foods, and overall balance of macronutrients.[11] The Prime Diet Quality Score (PDQS),[12,13] a food-based diet quality metric, was developed as a response to the need to characterize human diets in a standard way, considering the principles of simplicity, comprehensiveness, and associations with health outcomes. The PDQS, using primary data from a comprehensive, semi-quantitative food frequency questionnaire (FFQ), was previously found to predict coronary heart disease, gestational diabetes, hypertension in pregnancy, salivary telomere length,[12-14] and all-cause mortality (S. Gicevic, E. Tahirovic, S. Bromage, and W. Willet, unpublished data, June 2020). It was also associated with a lower prevalence of individual and cluster cardiovascular risk factors (ie, obesity, diabetes, hypertension, and dyslipidemia) among elderly people with metabolic syndrome[15] and with better pregnancy outcomes in low-income country setting.[16] Although poor diet quality affects all population groups, women's diets are especially important due to their roles as mothers and "household nutrition gatekeepers."[5]

The objective of this study was to develop 2 versions of a PDQS-based, self-administered diet quality screener among US women, and evaluate them in relation to nutrient intakes obtained by the reference method, 24-hour diet recall. It was hypothesized that diet quality would be positively correlated with essential nutrients and dietary constituents associated with good health, such as fiber, vitamins A, C, and folate, and negatively correlated with saturated fatty acids (SFAs), total and added sugar.[17-19] It was also expected that there would be either null or weak associations with those nutrients that have not been clearly associated with health outcomes, such as total protein, carbohydrates, and fat.[18,19]

MATERIALS AND METHODS

Study Participants

A sample of nonpregnant, nonlactating women, aged 18 to 65 years, residing in the United States were recruited via Amazon Mechanical Turk (MTurk)[20] in April 2019. An advertisement was posted on MTurk, inviting all eligible "workers" to participate. Participants were invited to join the study only if they were available to complete both waves and to provide data only if they consumed their typical diet during the past month (eg, no extreme dieting or fasting). In line with the MTurk policies, participants received monetary compensations for their time after completing each wave in the amount responding to the pro rata minimum hourly US wage. In order to collect valid data from both waves from at least 200 women,[19,21] and accounting for up to 30% attrition in the second wave, 300 female MTurk workers were recruited for participation in the study. In addition, 10 women were excluded from the study due to incomplete Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24)[22] data.

> **RESEARCH SNAPSHOT**
>
> **Research Question:** How well does diet quality, measured by the newly developed Prime Diet Quality Score-based screener (24-hour and 30-day versions), correlate with the intakes of some key nutrients measured by the reference diet assessment tool (two 24-hour diet recalls adjusted for within-person variation using the National Cancer Institute method), in a sample of US women?
>
> **Key Findings:** In this validation study among 290 nonpregnant, nonbreastfeeding US women, the majority of correlations and associations between the PDQS values and nutrient intakes were of acceptable strength and in the expected directions. Both screener versions performed similarly well and were robust in terms of different scoring approaches.

Data Collection

During the first wave, participants completed a 24-hour recall version of the PDQS (PDQS-24HR) screener to provide information about their food intakes during the previous day (Tables 1 and 2), and some basic demographic and anthropometric data (ie, age, race and ethnicity, education, income category, weight, and height), followed by the first 24-hour diet recall on the same day. During the second wave, 7 to 30 days later, they completed a 30-day version (PDQS-30D) to report food intakes during the previous month, and the second 24-hour diet recall (Figure 1). Dietary intake data for 24-hour recalls were collected and analyzed using the ASA24,[22] version 2018, developed by the National Cancer Institute. ASA24 uses the US Department of Agriculture's Food and Nutrient Database for Dietary Studies (2013-2014)[23] to convert data on consumed foods and beverages to total daily nutrient intakes. Participants were invited to complete 24-hour diet recalls only for those days when they consumed their typical diet, in order to avoid fasting days, major dietary restrictions, or diet changes due to illness that would lead to ineligible reference dietary intakes and reduce correlations with the PDQS values. The Harvard University Institutional Review Board approved the study protocol (IRB18-1996) and all participants provided written informed consent electronically via MTurk.

PDQS

The PDQS[12-16] is a food-based diet quality index developed *a priori* through synthesis of the current nutrition knowledge and defining dietary components considered important for health promotion and associated with major diet-related diseases.[24] Initially, it consisted of 14 "healthy" food group components (eg, dark green leafy vegetables, cruciferous vegetables, carrots, other vegetables, citrus fruits, other fruits, legumes, nuts, poultry, fish, eggs, whole grains, low fat dairy, and liquid vegetable oils) and 7 "unhealthy" (eg, red meat, processed meats, potatoes, refined grains and baked goods, sugar-sweetened beverages, fried foods away from home, and sweets and ice cream). In the present analysis, some

Table 1. PDQS-24HR[a] and PDQS-30D[b] screener questions and answer choices used for data collection

Screener	Screener questions (part 1)	Screener questions (part 2)	Screener questions (part 3)	Answer choices
PDQS-24HR	Yesterday, from midnight to midnight, how often did you eat, drink, or use:	Food groups: 1. Dark green leafy vegetables 2. Cruciferous vegetables 3. Deep orange vegetables 4. White roots and tubers 5. Other vegetables 6. Citrus fruits 7. Deep orange fruits 8. Other fruits 9. Beans, peas and soy products 10. Nuts and seeds 11. Poultry 12. Fish 13. Red meat 14. Processed meats 15. Eggs 16. Low fat dairy 17. Whole grains 18. Refined grains and baked products 19. Sugar-sweetened beverages 20. Sweets and ice-cream 21. Fried foods 22. Liquid oils	1. List of examples of foods from each food group (as in Table 3) 2. Additional instructions on what to include/exclude (eg, include fresh, frozen, canned fruits, do not include fruit juices, include both foods consumed separately or as part of a composite dish, "in food preparation," etc.)	Did not eat, drink, or use Once Twice 3 times or more
PDQS-30D	Over the past month, how often did you eat, drink, or use:			1 time/mo or less 2-3 times/mo 1-2 times/wk 3-4 times/wk 5-6 times/wk 1 time/d ≥2 times/d

[a]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[b]PDQS-30D = Prime Diet Quality Score 30-day version.

modifications were made, such as creating 2 separate score components, "deep orange fruits" and "deep orange vegetables," from previously used "carrots," "white roots and tubers" from "potatoes," "beans, peas and soy products" from "legumes," "fried foods" regardless of the location where it was prepared from "fried foods away from home," and converting "eggs" from a positively scored to a neutral component for adults, while keeping them as a positive component for small children. This decision was made in line with findings that although eggs have a minimal overall association with cardiovascular disease in developed countries, there is a possible positive association among people with diabetes,[25,26] and that eggs are an important source of protein and choline for women and children in developing countries.[27] Therefore, the PDQS version used in this study (scoring approach 1) included 14 healthy and 7 unhealthy components and 1 neutral component (Figure 2).

This PDQS was developed to promote dietary habits inversely associated with risk of NCDs, as well as intakes of some key nutrients, such as beta-carotene and provitamin A, vitamin C, folate, calcium, vitamin E, unsaturated fatty acids, dietary fiber, and protein from healthy sources (ie, plants, fish, and poultry). Given that red meat is negatively scored in the PDQS because of associations with risks of type 2 diabetes, coronary heart disease, and other adverse outcomes,[28-30] and eggs are treated as neutral among adults, it can be expected that some nutrients, such as protein, iron, zinc, and vitamins B12 and D will have relatively weak correlations with the PDQS. To evaluate the effects of this negative scoring on associations between the PDQS and intake of specific

Table 2. Different PDQS-24HR[a] and PDQS-30D[b] screener scoring approaches used in evaluation

	PDQS-24HR		PDQS-30D	
Variable	**Scoring**	**Range**	**Scoring**	**Range**
Granular scoring (approach 1)	14 Healthy[c]: 0 = did not eat 1 = 1 time 2 = 2 times 3 = 3 or more times 7 Unhealthy[d] coded reversely. 1 Neutral[e]: not coded	0-63	14 Healthy[c]: 0 = 1 time/mo or less 1 = 2-3 times/mo 2 = 1-2 times/wk 3 = 3-4 times/wk 4 = 5-6 times/wk 5 = 1 time/d 6 = ≥2 times/d 7 Unhealthy[d] coded reversely. 1 Neutral[e]: not coded	0-126
Dichotomous/ trichotomous scoring (approach 2)	14 Healthy[c]: 0 = did not eat, 1 = 1 or more times 7 Unhealthy[d] coded reversely. 1 Neutral[e]: not coded	0-21	14 Healthy[c]: 0 = 1 time/mo or less, 2-3 times/mo 1 = 1-2 times/wk, 3-4 times/wk 2 = 5-6 times/wk, 1 time/d, ≥2 times/d 7 Unhealthy[d] coded reversely. 1 Neutral[e]: not coded	0-42
Red meat and eggs as positive components, granular (approach 3)	16 Healthy[c]: (include red meat and eggs): 0 = did not eat 1 = 1 time 2 = 2 times 3 = 3 or more times 6 Unhealthy[d] coded reversely	0-66	16 Healthy[c]: (include red meat and eggs): 0 = once/mo or less 1 = 2-3 times/mo 2 = 1-2 times/wk 3 = 3-4 times/wk 4 = 5-6 times/wk 5 = 1 time/d 6 = ≥2 times/d 6 Unhealthy[d] coded reversely	0-132
Red meat and eggs as positive components, dichotomous and trichotomous (approach 4)	16 Healthy[c]: (include red meat and eggs): 0 = did not eat 1 = 1 or more times 6 Unhealthy[d] coded reversely	0-22	16 Healthy[c]: (include red meat and eggs): 0 = 1 time/mo or less, 2-3 times/mo 1 = 1-2 times/wk, 3-4 times/wk 2 = 5-6 times/wk, 1 time/d, ≥2 times/d 6 Unhealthy[d] coded reversely	0-44

[a]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[b]PDQS-30D = Prime Diet Quality Score, 30 day version.
[c]Healthy PDQS components: dark green leafy vegetables, cruciferous vegetables, deep orange vegetables, other vegetables, citrus fruits, deep orange fruits, other fruits, beans, peas and soy products, nuts and seeds, poultry, fish, low fat dairy, whole grains, and liquid oils.
[d]Unhealthy PDQS components: red meat, processed meats, white roots and tubers, refined grains and baked goods, sugar-sweetened beverages, sweets and ice cream, and fried foods.
[e]Neutral components: eggs.

nutrients, a scoring approach in which red meat and eggs were treated as healthy components was also devised (Table 2).

Diet Quality Screener Development

Two versions of the screener were developed, 1 for reporting food intake during the past day (PDQS-24HR) and another for assessing the past month's diet (PDQS-30D). Both questionnaires consisted of 22 questions each (Table 1) based on the PDQS components (Figure 2). Every question included examples of commonly consumed foods in the United States based on the data from several cohort studies and the National Health and Nutrition Examination Survey.[31,32] For some food groups, such as deep orange fruits, examples of foods that should not be reported (such as oranges) were also listed to avoid double counting, as these were already included in a previous question.

The answer options were frequency-based, with the PSQS-24HR including 4 possible answers ("did not eat/drink/use,"

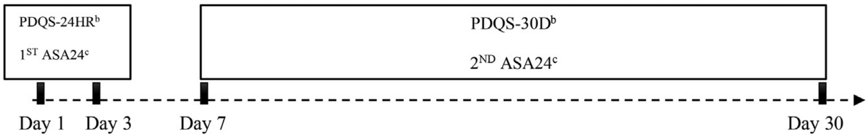

Figure 1. Data collection timeline of the PDQS-based[a] diet screener validation study. [a]PDQS = Prime Diet Quality Score. [b]Each PDQS-based screener was completed on the same day as the ASA24. [c]ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool. 30D = 30-day version; 24HR = 24-hour version.

"once," "twice," or "3 times or more"), and the PDQS-30D including 7 possible answers (from "once a month or less to "2 or more times a day"). Participants were instructed to sum up all foods from a given food group and respond how often they consumed any foods from that food group during the reference period. For example, for the question on whole-grain intakes during the past month, individuals who consumed whole-grain bread 3 to 4 times/week and brown rice or pasta 3 to 4 times/week should have responded having consumed whole-grains "once a day." Two scoring approaches for each screener version were developed and tested (Table 2). For the PDQS-24HR, both a "granular scoring" (approach 1: healthy components were coded as 0 = did not eat, 1 = 1 time, 2 = 2 times, 3 = 3 or more times, with a reverse coding for the unhealthy ones, possible range 0 to 63 points), and a "dichotomous scoring" (approach 2, where healthy components: 0 = did not eat, 1 = 1 or more times, with reverse coding for the unhealthy ones, range 0 to 21 points) were used. For the PDQS-30D, granular scoring (approach 1) included scoring healthy components as: 0 = once or less/month, 1 = 2 to 3 times/month, 2 = 1 to 2 times/week, 3 = 3 to 4 times/week, 4 = 5 to 6 times/week, 5 = once/day, 6 = 2 or more times/day, with a reverse coding for the unhealthy components (range 0 to 126 points), and a simplified, "trichotomous scoring" (approach 2): 0 = once or less/month or 2 to 3 times/month, 1 = 1 to 2 times/week or 3 to 4 times/week, and 2 = 5 to 6 times/week, once/day, or 2 or more times/day, with a reverse coding for the unhealthy components (range 0 to 42 points). Although dichotomous/trichotomous coding is sometimes preferred due to its simplicity,[33] it is yet to be seen whether such crude ranking is "good enough" for the purposes of assessing diet quality. Both scoring approaches also included a variation in which red meat and eggs were scored positively (scoring approaches 3 and 4). Therefore, the total of 4 scoring variations were tried for each screener (Table 2). Both screeners were developed and distributed using a web survey tool Lime Survey,[34] in conjunction with the Amazon MTurk Crowdsourcing marketplace.

Statistical Analysis

The usual nutrient intakes were assessed from two 24-hour diet recalls using the National Cancer Institute's macros (mixtran and indivint)[35] to adjust for day-to-day variation. Nutrient intakes from ASA24 were also adjusted for energy using the residual method[36] in order to assess between-person differences in nutrient intake while keeping total energy intake constant. The total PDQS values were derived from each PDQS-based screener using the scoring approaches described. De-attenuated Spearman rank correlation coefficients between the intakes of key nutrients (both crude and energy-adjusted) and the total PDQS values were calculated. This provides an estimate of the correlation between the PDQS and the average of a large number of 24-hour recalls. The adjusted mean nutrient intakes by tertiles of the PDQS were obtained using the LSMEANS statement. Associations between continuous PDQS values and nutrient intakes were evaluated by linear regression models adjusted for age (continuous), race/ethnicity ("non-Hispanic White" as a reference category), education ("college education and greater" as a reference category), and body mass index (BMI) (continuous). Wolfe's test was used to evaluate equalities in related correlation coefficients of the PDQS values (from PDQS-24HR and PDQS-30D) with nutrient intakes, while differences in independent correlations by age ($\leq$38 years vs $\geq$38 years), education level (college education and greater vs less than college education) and BMI ($<$25 vs $\geq$25) were assessed using Fisher z score. Associations of the PDQS-24HR values with nutrient intakes were compared with those of the PDQS-30D with nutrient intakes by using both scores as continuous variables in a single model (previously standardized to the same scale by converting to a z score) and running a Wald test. Finally, Spearman rank correlation coefficients between the total Healthy Eating Index (HEI) 2015[37] score obtained from ASA24 (as a "per person" score using both recall days) and the PDQS values were also calculated.

All analyses were performed in SAS software, version 9.4,[38] except testing for equality of related correlation coefficients, which was performed in R statistical software,[39] version 3.5.1.

RESULTS

The final study sample included 290 nonpregnant, nonlactating women (mean age ± standard deviation 41 ± 11 years) (Table 3) who completed the first ASA24 diet recall and the PDQS-24HR. Of these, 199 also completed the second ASA24 diet recall and the PDQS-30D. The participants were predominantly non-Hispanic White (87%), had college education or greater (71%), and had an annual gross income ≥$45,000 (62%). Mean nutrient intakes are presented in Table 4 (available at www.jandonline.org); after adjusting for energy, the majority of standard deviations became lower. On average, participants took fewer than 5 minutes to complete the short-form diet quality questionnaires (PDQS-24HR median was 4.9 minutes; PDQS-30D median was 4.2 minutes), and the ASA24 diet recall required considerably longer (median 21 minutes).

In the analysis of data obtained from the granular scoring approach (Table 2), the total PDQS values ranged from 10 to 40 (out of 0 to 63) for the PDQS-24HR and from 26 to 91 (out of 0 to 126) for the PDQS-30D. The Spearman rank correlations between usual nutrient intakes and the total PDQS values, as well as the heathy and unhealthy PDQS components are presented in Table 5 and Table 6 (available at www.jandonline.org). Positive,

Variable	Details/examples of foods	Scientific rationale for inclusion[a]
Positively scored components		
Dark green leafy vegetables	Spinach, romaine lettuce, kale, turnip greens, collard, chard, arugula, mustard greens, fresh herbs	High in folate, beta-carotene, iron
Cruciferous vegetables	Broccoli, cauliflower, cabbage, Brussels sprouts, kohlrabi, Chinese cabbage	High in folate, vitamin C, fibers; association with cancer
Deep orange vegetables and tubers (>130 RAE[b]/100 g)	Carrot, pumpkin, butternut winter squash (orange varieties), sweet potato	High in folate and beta-carotene
Other vegetables	Tomato, pepper, cucumber, onion, eggplant, zucchini, beetroot, mushrooms, garlic, summer squash (yellow varieties)	Phytochemicals' and fibers content; associations with disease
Deep orange fruits (>130 RAE/100 g)	Mango, ripe papaya, cantaloupe, apricot (excludes oranges)	High in folate and beta-carotene
Citrus fruits	Orange, lemon, grapefruit, mandarin, tangerine (whole fruit, not juices)	High in vitamin C and folate
Other fruits	Apple, peach, pear, plum, banana, grapes, berries, melon, guava, avocado (whole fruit, not juices)	Phytochemicals' and fibers content; associations with disease
Beans, peas, and soy products	Beans, peas, lentils, pulses, legume-based products (tofu, soymilk) (excludes peanut)	High in folate, zinc, protein, iron, and fibers
Nuts and seeds	Includes ground (eg, peanut) and tree nuts, nut and seed butters/tahini; nut/seed-based spices or other condiments high in protein/ unsaturated oils	High in PUFAs,[c] zinc, protein, fibers
Poultry	Excludes luncheon meat, and pâté. Includes organs	High in protein, zinc, B6, B12
Fish	Excludes shellfish	High in protein, PUFAs, B6, B12
Whole grains	Breads, cereals, porridges, noodles and products made of cereal flour (fiber: carbohydrate ≥0.1).	High in fibers, B1, B3, manganese, selenium
Liquid oils	Olive, rapeseed, sunflower, peanut, corn, sesame, etc. Excludes semisolid oils (eg, coconut and palm oil)	High in MFA,[d] PUFAs, vitamin E, vitamin D
Low-fat dairy	Milk, cheese, yogurt, kefir, containing 2% or less fat	High in calcium, protein, zinc; association with colon cancer
Negatively scored components		
White roots and tubers	White, yellow, red potato, yam (white), cassava, tapioca, white/beige sweet potato.	Low in fiber, high in starch, proinflammatory
Red meat	Beef, pork, goat, or lamb/mutton, includes organs	High in SFA[e]; proinflammatory, association with colon cancer

(continued on next page)

Figure 2. Components of the Prime Diet Quality Score used for diet screener development.

Variable	Details/examples of foods	Scientific rationale for inclusion[a]
Processed meat	Sausages, salami, bologna, hot dogs, bacon, pâté, luncheon meat	High in sodium and SFA; proinflammatory, association with colon cancer
Refined grains and baked goods	Breads, pan dulce, ready-to-eat breakfast cereals, porridges, noodles and products made of flour containing refined grains only (eg,white pasta, rice, bread, baked goods) (fiber: carbohydrate <0.1).	Low in fiber, high in starch; proinflammatory
Sugar-sweetened beverages	Soft drinks, energy and sport drinks. Excludes sugar-added fruit nectars, milk or cereal-based sugary drinks, fruit syrups, juices	High in sugar; proinflammatory
Sweets and ice cream	Candy, chocolate, cake, cookie, sugar cane, ice cream, including homemade ones; sugar, honey, other sugary sweeteners	High in sugar; proinflammatory
Fried foods	Regardless of where they are obtained/ consumed	High in SFA, potentially also in TFA through reheating or use of semisolid fats
Neutral components		
Eggs		High in protein, vitamins A, D and B12, choline

[a]Only the leading reasons for inclusion are given; there could be other benefits for inclusion of each component not listed here.

[b]RAE = retinol activity equivalent.

[c]PUFA = polyunsaturated fatty acid.

[d]MFA = monounsaturated fatty acid.

[e]SFA = saturated fatty acid.

Figure 2. *(continued)* Components of the Prime Diet Quality Score used for diet screener development.

statistically significant rank correlations were observed between the PDQS-24HR values and energy-adjusted nutrients for fiber (r = 0.53), magnesium (r = 0.51), potassium (r = 0.48), vitamin E (r = 0.40), folate (r = 0.37), vitamin C (r = 0.36), vitamin A (r = 0.33), vitamin B6 (r = 0.31), zinc (r = 0.25), and iron (r = 0.21); and inverse correlations for SFA (r = −0.19), carbohydrates (r = −0.22), and added sugar (r = −0.34) (scoring approach 1, Table 5). These correlations were not statistically significant for vitamin B1 and total fat, calcium (PDQS-24HR only), eicosapentaenoic acid, and vitamin B12 (PDQS-30D only). The correlations of individual nutrients with the PDQS-30D did not significantly differ from those with the PDQS-24HR (Table 5).

Similarly, in the linear regression models adjusted for age, race and ethnicity, education and BMI, statistically significant, positive associations of the PDQS-24HR values with polyunsaturated fatty acids, docosahexaenoic acid (DHA), eicosapentaenoic acid, fiber, vitamins A, B1, B6, B12, C, D, E and folate, beta-carotene, iron, zinc, potassium, and magnesium were found, while inverse associations were observed for total carbohydrates, SFA, total sugar, and added sugar (granular scoring approach, Table 7). These associations were not statistically significant for protein, total fat, and calcium. The results for the PDQS-30D were not significantly different from those for the PDQS-24HR (from Wald test, data not shown), but the associations with protein, total fat, and calcium were positive and statistically significant, and the one with vitamin B1 did not reach statistical significance (scoring approach 1, Table 7).

It was also examined whether alternative scoring approaches, such as a dichotomous/trichotomous one (approach 2, Table 2), and the one that includes red meat and eggs as positively scored components (approaches 3 and 4, Table 2) would result in considerably different correlations. The majority of energy-adjusted correlations (except for the DHA, beta-carotene, and vitamin A for PDQS-24HR) from the dichotomous scoring approach (Table 8) had slightly weaker correlations with nutrient intakes compared with those from the granular scoring approach (Table 5). When red meat and eggs were coded positively (PDQS-24HR and PDQS-30D, red meat and eggs as positive, granular, Table 8), the correlations for protein (0.26 vs 0.30 for the PDQS-30D), total fat (0.08 vs 0.13 and 0.13 vs 0.16), vitamin B12 (0.15 vs 0.20 and 0.14 vs 0.15), vitamin D (0.16 vs 0.19 for the PDQS-30D), zinc (0.25 vs 0.32 and 0.23 vs 0.27), and DHA (0.23 vs 0.27 for the PDQS-30D) were somewhat stronger, while correlations for SFA (−0.19 vs −0.14 and −0.16 vs −0.13), DHA (0.27 vs 0.21 for the

Table 3. Characteristics of US women participating in the Prime Diet Quality Score−based diet screener development and evaluation study in April to May 2019

Characteristics (n = 290)	Data
Age, y, mean (SD[a])	41 (11)
Race/ethnicity, n (%)	
Non-Hispanic White	251 (87)
Black or African American	22 (7)
Hispanic or Latino	7 (2)
Asian	8 (3)
Other	2 (1)
Education (college education and greater), n (%)	206 (71)
Annual income ≥$45,000, n (%)	179 (62)
Body mass index (n = 290), n (%)	
<18.5	8 (3)
18.5-24.9	118 (40)
25-29.9	60 (21)
≥30	104 (36)
PDQS-24HR[b] (n = 290), mean (SD), range	24 (5), 10-40
Healthy components[c]	7 (4), 0-20
Unhealthy components[d]	17 (3), 8-21
PDQS-30D[e] (n = 199), mean (SD), range	56 (12), 26-91
Healthy components[c]	28 (10), 6-59
Unhealthy components[d]	28 (6), 10-42

[a]SD = standard deviation.
[b]Possible Prime Diet Quality Score (PDQS) 24-hour (24HR) range (granular scoring (approach 1), 0 to 63; healthy components range, 0 to 42; unhealthy components range, 0 to 21.
[c]Dark green leafy vegetables, cruciferous vegetables, deep orange vegetables, other vegetables, citrus fruits, deep orange fruits, other fruits, beans, peas and soy products, fish, poultry, nuts and seeds, whole grains, low-fat dairy, and liquid oils.
[d]Red meat, processed meats, white roots and tubers, refined grains and baked products, sugar-sweetened beverages, desserts and ice cream, and fried foods.
[e]Possible PDQS 30-day (30D) range (granular scoring (approach 1), 0 to 126; healthy components range, 0 to 84, unhealthy components range, 0 to 42.

PDQS-24HR), fiber (0.53 vs 0.47 for the PDQS-24HR), and folate (0.37 vs 0.31 for the PDQS-24HR) were weaker compared with those from the granular approach (Table 5). At the same time, the correlations with iron (0.21 vs 0.21 and 0.21 vs 0.23), protein (0.14 vs 0.15 for the PDQS-24HR), and vitamin D (0.16 vs 0.19 for the PDQS-24HR) in the granular scoring (red meat coded negatively, eggs neutral, Table 5) did not differ significantly from the correlations resulting from the scoring approach in which red meat and eggs were coded positively (Table 8).

In a stratified analysis by age, BMI, and education (Table 9), somewhat stronger correlations with vitamins A, C, and E, folate, beta-carotene, potassium, and magnesium among leaner, and with zinc, iron, folate, added sugar, SFA, and protein were observed among highly educated individuals. However, the majority of these differences (except for iron and zinc among highly educated individuals) did not reach statistical significance. Finally, statistically significant correlations were found between the total HEI-2015 score and the PDQS-24HR ($r = 0.61$; $P < .0001$) and the PDQS-30D ($r = 0.60$, $P < .0001$) (data not shown).

DISCUSSION

As an effort to devise a global diet quality assessment tool, a low-burden, short-form diet quality screener in a sample of US women was developed and evaluated in this study. The magnitude of the correlations and associations of the PDQS values with usual nutrient intakes estimated from two 24-hour diet recalls were statistically significant and in the expected directions for the majority of the nutrients. The correlations with fiber, magnesium potassium, beta-carotene, vitamins A, B6, C, E, folate, and added sugar were somewhat stronger than those for other food constituents. This is not unexpected, as these nutrients are concentrated in a small number of either positively or negatively scored PDQS components. However, for those nutrients that are widely present across both healthy and unhealthy components, such as protein or total fat, weaker associations were observed, as expected. For carbohydrates, the correlation even became negative, perhaps due to the fact that the major source of carbohydrates in US diet are refined grains and baked goods, potatoes, and sugar-sweetened beverages,[40] all of which scored negatively in the PDQS. Calcium results were null (for the PDQS-24HR) or weak (for the PDQS-30D). This is not surprising, as some of the leading sources of calcium in this population[41,42] (eg, calcium-fortified juice or high-fat dairy products) are not scored in the PDQS, and other calcium sources were spread across both healthy (eg, beans) and unhealthy (fortified refined wheat flour products) food groups. Similarly, vitamin B1 is present across multiple food groups in US diets, including some fortified foods (eg, refined wheat flour and white rice),[43] which might explain its null associations with the PDQS values. Given that both of these findings were US population−specific, it will be important to evaluate the associations with the PDQS in different national settings (eg, income levels, geographic location, and eating culture). It should also be noted that the associations with the SFA, total sugar, and added sugar were attenuated when these dietary components were adjusted for total energy intake. This might be explained by the fact that fat and sugar are highly correlated with energy intake,[36] and adjusting these dietary components for total energy intake to compare them with a crude PDQS value resulted in weaker associations.

The findings of this study were, in terms of magnitude and directions of associations, similar to the findings from several other studies that evaluated composite diet quality measures with individual nutrient intakes.[44-47] Correlations between a composite dietary measure, such as the PDQS, and a single nutrient cannot be directly compared with the findings of studies in which nutrient intakes from 2 different sources (eg, from FFQs and diet records) are correlated. Another reason for not expecting as high correlations as in traditional validation studies (in which nutrients and diet scores obtained

Table 5. Spearman rank correlations of PDQS-24HR[a] and PDQS-30D[b] values[c] with usual nutrient intakes (ASA24[d])[e] in a sample of US women participating diet screener development study in April to May 2019

Variable	PDQS-24HR (n = 290)		PDQS-30D (n = 199)		Difference in correlations,[g] *P* value
	Crude	Energy-adjusted[f]	Crude	Energy-adjusted[f]	
	←Spearman's rho→				
Macronutrients					
Energy (kcal)	−0.27***	—	−0.42***	—	—
Protein (g)	−0.01	0.14*	−0.08	0.26***	.86
Carbohydrate (g)	−0.35	−0.22***	−0.47***	−0.17*	.23
Total fat (g)	−0.21***	0.08	−0.30***	0.13	.50
Saturated fatty acids (g)	−0.34***	−0.19**	−0.41***	−0.16*	.40
Polyunsaturated fatty acids (g)	−0.05	0.17**	−0.06	0.30***	.22
Eicosapentaenoic acid (mg)	0.08	0.15**	0.01	0.11	.57
Docosahexaenoic acid (mg)	0.24***	0.27***	0.19**	0.23**	.34
Fiber (g)	0.37***	0.53***	0.34***	0.56***	.31
Total sugar (g)	−0.32***	−0.18***	−0.43***	−0.17*	.86
Added sugar (g)	−0.45***	−0.34***	−0.52***	−0.30***	.90
Vitamins					
Vitamin A (μg RE[h])	0.26***	0.33***	0.23***	0.34***	.60
Beta-carotene (μg)	0.50***	0.50***	0.53***	0.52***	.52
Vitamin B1 (mg)	−0.09	0.11	−0.23**	0.09	.97
Vitamin B6 (mg)	0.13*	0.31***	0.01	0.27***	.29
Vitamin B12 (μg)	0.02	0.15**	−0.05	0.14	.95
Vitamin C (mg)	0.31***	0.36***	0.27**	0.35***	.58
Vitamin D (μg)	0.09	0.16**	0.05	0.16*	.68
Vitamin E (mg)	0.20***	0.40***	0.09	0.37***	.55
Folate (μg DFE[i])	0.19**	0.37***	0.07	0.32***	.78
Minerals					
Calcium (mg)	−0.06	0.10	−0.08	0.17*	.13
Zinc (mg)	0.02	0.25***	−0.10	0.23***	.72
Iron (mg)	−0.03	0.21***	−0.14	0.21**	.76
Potassium (mg)	0.23***	0.48***	0.07	0.42***	.87
Magnesium (mg)	0.28***	0.51***	0.18*	0.51***	.33

[a]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[b]PDQS=30D = Prime Diet Quality Score, 30-day version.
[c]Values based on the granular scoring (approach 1).
[d]ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool.
[e]Usual nutrient intakes calculated using 2 days of 24-hour diet recall and the National Cancer Institute approach for reducing within-person variation.
[f]ASA24 values adjusted for energy intake using the residual method (PDQS values not energy-adjusted).
[g]*P* values from Wolfe's test for equality of related correlation coefficients (energy-adjusted).
[h]RE = retinol equivalent.
[i]DFE = dietary folate equivalent.
*$P < .05$ from Spearman's rank test.
**$P < .01$.
***$P < .001$.

from any 2 "total diet" assessment tools, such as diet records, full-length FFQ, or 24-hour diet recall are compared) is that in this study nutrients obtained from a total diet instrument (24-hour recall) were assessed against values from a short-form diet instrument that includes only a limited number of dietary sources of these nutrients (PDQS does not capture intakes of high-fat dairy, shellfish, diet energy drinks, or condiments, nor does it account for intake of eggs among

Table 7. Adjusted mean daily intakes[a] of nutrients assessed by 24-hour diet recalls for tertiles of PDQS[b] values in a sample of US women participating diet screener development study in April to May 2019

	PDQS-24HR[c] (n = 290)				PDQS-30D[d] (n = 199)			
	Tertile 1 (n = 98)	Tertile 2 (n = 92)	Tertile 3 (n = 100)	*P* value[e]	Tertile 1 (n = 63)	Tertile 2 (n = 71)	Tertile 3 (n = 65)	*P* value[e]
	←——*mean (95% CI)*——→				←——*mean (95% CI)*——→			
Macronutrients								
Protein (g)	71 (67-75)	73 (69-77)	78 (74-82)	.06	79 (75-82)	85 (82-88)	87 (84-91)	<.0001
Carbohydrate (g)	224 (217-231)	213 (206-220)	205 (198-212)	.0002	225 (216-234)	207 (199-217)	208 (199-216)	.02
Total fat (g)	81 (79-83)	82 (80-84)	83 (81-84)	.11	79 (77-82)	83 (81-85)	83 (81-86)	.05
SFA (g)	27 (26-27)	27 (26-27)	25 (24-26)	.01	26 (26-27)	27 (26-28)	25 (24-26)	.04
PUFA(g)	18 (17-18)	18 (18-19)	19 (19-20)	.0003	17 (16-18)	18 (18-19)	20 (19-21)	<.0001
EPA (mg)	27 (24-29)	28 (26-31)	33 (30-35)	.0004	26 (23-30)	29 (26-33)	32 (29-35)	.002
DHA (mg)	68 (62,76)	79 (72-87)	94 (87-101)	<.0001	69 (60-78)	80 (72-89)	91 (83-100)	<.0001
Fiber (g)	15 (15-16)	16 (16-17)	20 (19-20)	<.0001	15 (14-15)	16 (15,17)	20 (19-21)	<.0001
Total sugar (g)	98 (92-105)	90 (84-97)	84 (78-90)	.0007	102 (94-110)	86 (79-93)	84 (76-92)	.007
Added sugar (g)	16 (15-17)	14 (13-16)	11 (9-12)	<.0001	17 (15-18)	12 (11-14)	11 (10-13)	<.0001
Vitamins								
Vitamin A (μg RE[f])	693 (652-734)	761 (729-803)	878 (838-919)	<.0001	705 (652-758)	736 (686-786)	884 (831-936)	<.0001
Beta-carotene (μg)	3,114 (2,674-3,553)	4,096 (3,644-4,547)	5,916 (5,480-6,351)	<.0001	3,157 (2,609-3,704)	4,000 (3,482-4,517)	5,933 (5,390-6,475)	<.0001
Vitamin B1 (mg)	1.6 (1.5-1.6)	1.6 (1.6-1.7)	1.7 (1.6-1.8)	.02	1.6 (1.5-1.6)	1.6 (1.5-1.7)	1.7 (1.6-1.8)	.14
Vitamin B6 (mg)	1.2 (1.1-1.2)	1.2 (1.1-1.3)	1.5 (1.4-1.6)	<.0001	1.1 (1.0-1.2)	1.2 (1.1-1.4)	1.4 (1.3-1.5)	<.0001
Vitamin B12 (μg)	4.0 (3.7-4.2)	4.3 (4.0-4.5)	4.3 (4.1-4.6)	.02	4.1 (3.8-4.4)	4.0 (3.7-4.3)	4.3 (4.0-4.6)	.04
Vitamin C (mg)	73 (68-79)	81 (75-87)	98 (92-104)	<.0001	74 (67-82)	80 (73-86)	94 (87-102)	<.0001
Vitamin D (μg)	3.6 (3.4-3.9)	3.9 (3.6-4.1)	4.1 (3.9-4.4)	.004	3.6 (3.3-3.9)	3.8 (3.5-4.1)	4.1 (3.7-4.4)	.007
Vitamin E (mg)	7.8 (7.2-8.3)	8.2 (7.6-8.8)	10 (9.8-11.0)	<.0001	7.6 (6.9-8.3)	8.3 (7.7-9.0)	10 (9.3-10.6)	<.0001
Folate (μg DFE[g])	370 (354-386)	397 (380-413)	443 (428-459)	<.0001	374 (354-394)	373 (354-391)	434 (416-454)	<.0001

(*continued on next page*)

Table 7. Adjusted mean daily intakes[a] of nutrients assessed by 24-hour diet recalls for tertiles of PDQS[b] values in a sample of US women participating diet screener development study in April to May 2019 (*continued*)

	PDQS-24HR[c] (n = 290)				PDQS-30D[d] (n = 199)			
	Tertile 1 (n = 98)	**Tertile 2 (n = 92)**	**Tertile 3 (n = 100)**	***P* value**[e]	**Tertile 1 (n = 63)**	**Tertile 2 (n = 71)**	**Tertile 3 (n = 65)**	***P* value**[e]
Minerals								
Calcium (mg)	919 (889-949)	939 (925-984)	954 (925-984)	.13	921 (882-960)	898 (862-935)	970 (932-1,008)	.009
Zinc (mg)	9.7 (9.4-10.0)	9.9 (9.6-10.1)	11 (10-11)	<.0001	9.5 (9.2-9.9)	10 (9.6-10.3)	10 (10-11)	.0005
Iron (mg)	13 (12-14)	13 (13-14)	15 (14-15)	.005	13 (12-14)	12 (11-13)	15 (14-16)	.02
Potassium (mg)	2,467 (2,388-2,546)	2,619 (2,538-2,700)	2,925 (2,846-3,003)	<.0001	2,498 (2,403-2,592)	2,644 (2,556-2,734)	2,856 (2,762-2,949)	<.0001
Magnesium (mg)	274 (264-283)	295 (286-305)	332 (323-342)	<.0001	271 (260-283)	290 (279-302)	330 (318-341)	<.0001

[a]From linear regression models with PDQS values categorized into tertiles; adjusted for age (continuous), race/ethnicity (non-Hispanic white as a reference), education (higher education as a reference), and BMI (continuous). Nutrient values from ASA24 previously adjusted for within-person variation using the National Cancer Institute method and for energy using the residual method.
[b]PDQS = Prime Diet Quality Score. PDQS values from the "granular scoring" (approach 1).
[c]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[d]PDQS-30D = Prime Diet Quality Score, 30-day version.
[e]*P* values from linear regression models with PDQS values as a continuous variable; adjusted for age (continuous), race/ethnicity (non-Hispanic white as a reference), education (higher education as a reference), and BMI (continuous).
[f]RE = retinol equivalent.
[g]DFE = dietary folate equivalent.

adults in high-income settings). When the PDQS values were compared with the total HEI-2015 score, however, the correlations were moderately strong and highly significant.

In several other studies that have developed and validated diet quality screeners, including Mediterranean Diet Adherence Screener,[44] Diet Quality Score in Finnish Twins,[46] or Dutch Healthy Diet Index,[47] both differences and similarities in methodological approaches compared with the present study have been observed. For example, in 2 of these studies,[44,47] FFQ was used as a reference diet assessment method, and food diaries in one.[46] Next, 2 studies compared individual nutrient intakes with the total screener scores similar to the present study,[46,47] and in the third one,[44] total scores derived from both the reference method and the screener were correlated. In 2 studies,[44,46] considerably larger samples were used, and 1 used a sample size[47] similar to the one used in this study. When approaches to developing the screener are concerned, 2 studies developed it based on the national dietary guidelines,[44,46] and one based on national diet survey data.[47] Finally, the reference time period used in these studies ranged from a combination of day and week,[44] 1 month,[47] to 1 year.[46]

Evaluation of several PDQS scoring approaches suggested that the tool was rather robust. Although, as expected, a more granular scoring system resulted in somewhat stronger correlations for a majority of nutrients compared with a dichotomous/trichotomous one, these differences were minimal, and additional studies would be warranted before making any conclusions. Dichotomous/trichotomous scoring, however, resulted in stronger correlations for DHA, vitamin A, and beta-carotene in PDQS-24HR, possibly due to a wide between-person variation in consumption of dietary sources of these nutrients. Dichotomous scoring can also be advantageous for evaluating intakes in cases where a high proportion of nonconsumers is present across all PDQS components, such as in very low-income settings; in such cases, using a more complex scoring scheme would not yield different results. Our recent analysis of Ethiopian 24-hour diet recall data (S. Bromage and colleagues, unpublished data, 2020), for example, produced similar results to those obtained by a simple dichotomous scoring from the Minimum Diet Diversity—Women.[48] It is also important to note that, although the associations with zinc and vitamin B12 did become somewhat stronger when red meat and eggs were coded as "positive" components, the correlations with iron (both scores), and protein (PDQS-24HR only) did not significantly change. Red meat consumption is associated with a range of adverse health[49-51] and environmental[52] outcomes and, therefore, high intake should not be encouraged. Eggs, however, remain a positively scored PDQS component for children in LMICs as a readily available source of protein and choline.[27] In addition, there were no significant differences in association with the PDQS-24HR vs the PDQS-30D. This finding suggests that both tools can be considered as useful instruments for diet quality assessment; PDQS-24HR for use in diet surveys to track population-level diet quality over time (it may be somewhat easier to complete, as it does not require respondents to make estimations of food consumption frequency over a month), and the PDQS-30D for instances where understanding individual's usual diets might be of interest, such as in epidemiologic studies and in health clinics. It is also worth noting that, although some

Table 8. Spearman rank correlations of PDQS[a] values (alternative scoring approaches) with usual nutrient intakes (ASA24[b])[c] in a sample of US women participating diet screener development study in April to May 2019

	PDQS-24HR[d] (n = 290)			PDQS-30D[e] (n = 199)		
	Dichotomous scoring[f]	Red meat and eggs as positive components, granular[f]	Red meat and eggs as positive components, dichotomous[f]	Trichotomous scoring[f]	Red meat and eggs as positive components, granular[f]	Red meat and eggs as positive components, trichotomous[f]
Range	1-18	11-39	1-18	5-34	25-90	5-34
Mean (standard deviation)	10 (3)	23 (5)	10 (3)	19 (6)	56 (12)	20 (6)
	←—— *Spearman's rho (energy-adjusted[g])* ——→					
Macronutrients						
Protein (g)	0.14**	0.15*	0.17**	0.25**	0.30***[h]	0.27***
Carbohydrate (g)	−0.19**[h]	−0.28***	−0.25***	−0.16*	−0.22**	−0.19**
Total fat (g)	0.05	0.13*[h]	0.10	0.12	0.16*[h]	0.13
Saturated fatty acids (g)	−0.19**[h]	−0.14*[h]	−0.13*	−0.14*	−0.13[h]	−0.12
Polyunsaturated fatty acids (g)	0.16**	0.16**	0.15**	0.27**[h]	0.31***	0.26**
Eicosapentaenoic acid (mg)	0.13*	0.16**	0.15*	0.09	0.13	0.11
Docosahexaenoic acid (mg)	0.29***	0.21**[h]	0.36***	0.18**	0.27***[h]	0.22*
Fiber (g)	0.49***	0.47***[h]	0.41***	0.55***	0.54***	0.51**
Total sugar (g)	−0.11[h]	−0.21**	−0.12*	−0.17*	−0.20**	−0.17*
Added sugar (g)	−0.26***[h]	−0.37***	−0.28***	−0.29***	−0.33***	−0.29***
Vitamins						
Vitamin A (μg RE[i])	0.36***	0.31***	0.34***	0.34***	0.33***	0.32***
Beta-carotene (μg)	0.51***	0.50***	0.51***	0.51***	0.51***	0.49***
Vitamin B1 (mg)	0.06	0.09	0.01	0.07	0.09	0.06
Vitamin B6 (mg)	0.26***	0.28***	0.23***	0.26**	0.27***	0.26**
Vitamin B12 (μg)	0.12*	0.20**[h]	0.18**	0.13	0.15*[h]	0.15*
Vitamin C (mg)	0.36***	0.34***	0.35***	0.33***	0.36***	0.32***
Vitamin D (μg)	0.15**	0.19**	0.20**	0.14	0.19**[h]	0.16*
Vitamin E (mg)	0.37***	0.39***	0.35***	0.35***	0.36***	0.32***
Folate (μg DFE[j])	0.34***	0.31***[h]	0.28***	0.30***	0.32***	0.29***

(*continued on next page*)

Table 8. Spearman rank correlations of PDQS[a] values (alternative scoring approaches) with usual nutrient intakes (ASA24[b])[c] in a sample of US women participating diet screener development study in April to May 2019 (*continued*)

	PDQS-24HR[d] (n = 290)			PDQS-30D[e] (n = 199)		
	Dichotomous scoring[f]	Red meat and eggs as positive components, granular[f]	Red meat and eggs as positive components, dichotomous[f]	Trichotomous scoring[f]	Red meat and eggs as positive components, granular[f]	Red meat and eggs as positive components, trichotomous[f]
Minerals						
Calcium (mg)	0.10	0.08	0.09	0.17*	0.17*	0.18*
Zinc (mg)	0.20**	0.32***[h]	0.27***	0.21**	0.27***[h]	0.24**
Iron (mg)	0.18**	0.21**	0.18**	0.20**	0.23**	0.19**
Potassium (mg)	0.45***	0.46***	0.42***	0.40***	0.42***	0.39***
Magnesium (mg)	0.49***	0.45***	0.43***	0.50***	0.50***	0.48***

[a]PDQS = Prime Diet Quality Score.
[b]ASA24 = Automated Self—Administered 24—hour Dietary Assessment Tool.
[c]Usual nutrient intakes calculated using two days of 24-hour diet recall and the National Cancer Institute approach for reducing within-person variation.
[d]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[e]PDQS-30D = Prime Diet Quality Score, 30-day version.
[f]The original scoring approach was granular scoring; for details on the scoring approaches see Table 2.
[g]ASA24 nutrient values adjusted for energy intake using the residual method (PDQS values not energy-adjusted).
[h]$P < .05$ from Wolfe's test for equalities in related correlation coefficients from dichotomous/trichotomous scoring (approach 2) and red meat and eggs as positive components (approach 3) with the granular scoring (approach 1).
[i]RE = retinol equivalent.
[j]DFE = dietary folate equivalent.
*$P < .05$ from Spearman's rank test.
**$P < .01$.
***$P < .001$.

Table 9. Spearman rank correlations of PDQS-24HR[a] and PDQS-30D[b] values[c] with usual nutrient intakes (ASA24[d]),[e] by subgroup, in a sample of US women participating in the PDQS-based diet screener development study in April to May 2019

	PDQS-24HR (n = 290)						PDQS-30D (n = 199)					
	Age ≤38 y (n = 149)	Age >38 y (n = 141)	BMI[f] <25 (n = 126)	BMI ≥25 (n = 164)	HE[g] degree (n = 206)	Less than HE degree (n = 84)	Age ≤38 y (n = 97)	Age >38 y (n = 102)	BMI <25 (n = 88)	BMI ≥25 (n = 111)	HE degree (n = 140)	Less than HE degree (n = 59)
	←Spearman's rho (energy-adjusted[h])→											
Macronutrients												
Protein (g)	0.20*	0.06	0. 17*	0.07	0.17**	0.08	0.27**	0.26**	0.27**	0.23**	0.33***	0.13
Carbohydrate (g)	−0.25**	−0.18*	−0.22**	−0.21**	−0.22**	−0.19	−0.10	−0.23*	−0.16	−0.18	−0.17*	−0.18
Total fat (g)	0.03	0.12	0. 11	0.06	0.04	0.13	0.13	0.15	0.14	0.13	0.07	0.25
Saturated fatty acids (g)	−0.20**	−0.20**	−0.21**	−0.18*	−0.24**	−0.07	−0.10	−0.23*	−0.23*	−0.10	−0.21**	−0.02
Polyunsaturated fatty acids (g)	0.16	0.17*	0. 17*	0.20**	0.14*	0.24*	0.27**	0.33**	0.31**	0.30**	0.26**	0.39**
Eicosapentaenoic acid (mg)	0.17*	0.14	0.24**	0.07	0.17*	0.07	0.04	0.18	0.15	0.10	0.14	0.06
Docosahexaenoic acid (mg)	0.23**	0.32***	0.33**	0.20**	0.28***	0.24*	0.15	0.32**	0.23*	0.22*	0.20**	0.30*
Fiber (g)	0.53***	0.52***	0.62***	0.44***	0.52***	0.54***	0.59***	0.54***	0.58***	0.52**	0.58***	0.49***
Total sugar (g)	−0.17*	−0.19*	−0. 13	−0.21**	−0.20**	−0.13	−0.04	−0.32**	−0.13	−0.23**	−0.19*	−0.14
Added sugar (g)	−0.31***	−0.39***	−0.31**	−0.32***	−0.36***	−0.29***	−0.21*	−0.41***	−0.30**	−0.30**	−0.33***	−0.26*
Vitamins												
Vitamin A (µg RE[i])	0.34***	0.31**	0.46***	0.21**	0.30***	0.39**	0.33**	0.34**	0.40***	0.27**	0.40***	0.20
Beta-carotene (µg)	0.49***	0.50***	0.58***	0.42***	0.48***	0.56***	0.28**	0.56***	0.56***	0.45***	0.53***	0.47***
Vitamin B1 (mg)	0.09	0.14	0. 10	0.11	0.16*	0.02	0.11	0.07	0.11	0.04	0.17*	−0.08
Vitamin B6 (mg)	0.31***	0.31***	0.38***	0.23**	0.33***	0.26*	0.28**	0.25**	0.34**	0.18	0.25**	0.30*
Vitamin B12 (µg)	0.22**	0.07	0.22**	0.07	0.21**	−0.01	0.19	0.08	0.21*	0.08	0.17*	0.06
Vitamin C (mg)	0.42***	0.28**	0.46***	0.28**	0.33***	0.46***	0.39***	0.30**	0.48***	0.23**	0.36***	0.37**
Vitamin D (µg)	0.21**	0.11	0.23**	0.08	0.16**	0.19	0.22**	0.11	0.19	0.10	0.13	0.22
Vitamin E (mg)	0.42***	0.38***	0.47***	0.34***	0.37***	0.47***	0.36**	0.34**	0.39**	0.33**	0.35***	0.39**
Folate (µg DFE[j])	0.38***	0.34***	0.41***	0.31***	0.38***	0.33**	0.28**	0.35**	0.39**	0.26**	0.40***	0.15

(*continued on next page*)

Table 9. Spearman rank correlations of PDQS-24HR[a] and PDQS-30D[b] values[c] with usual nutrient intakes (ASA24[d]),[e] by subgroup, in a sample of US women participating in the PDQS-based diet screener development study in April to May 2019 (*continued*)

	PDQS-24HR (n = 290)						PDQS-30D (n = 199)					
	Age ≤38 y (n = 149)	Age >38 y (n = 141)	BMI[f] <25 (n = 126)	BMI ≥25 (n = 164)	HE[g] degree (n = 206)	Less than HE degree (n = 84)	Age ≤38 y (n = 97)	Age >38 y (n = 102)	BMI <25 (n = 88)	BMI ≥25 (n = 111)	HE degree (n = 140)	Less than HE degree (n = 59)
Minerals												
Calcium (mg)	0.11	0.09	0.09	0.07	0.19	0.14	0.22*	0.12	0.21	0.10	0.24**	0.03
Zinc (mg)	0.31***	0.17*	0.27**	0.22	0.31***	0.10	0.28**	0.19	0.26**	0.19*	0.34***	−0.01[k]
Iron (mg)	0.18*	0.24**	0.21**	0.19**	0.22**	0.19	0.14	0.27**	0.26**	0.16	0.32***	−0.02[k]
Potassium (mg)	0.53***	0.43***	0.54***	0.40***	0.46***	0.54***	0.49***	0.34**	0.47***	0.32**	0.41***	0.43**
Magnesium (mg)	0.52***	0.50***	0.54***	0.45***	0.50***	0.51***	0.57***	0.45***	0.55***	0.46***	0.51***	0.49***

[a]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[b]PDQS = 30D = Prime Diet Quality Score, 30-day version.
[c]Based on the granular scoring (approach 1).
[d]ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool.
[e]Usual nutrient intakes calculated using 2 days of 24-hour diet recall and the NCI approach for reducing within-person variation.
[f]BMI = body mass index; calculated as kg/m^2.
[g]HE = higher education.
[h]ASA24 values adjusted for energy intake using the residual method (PDQS values not energy-adjusted).
[i]RE = retinol equivalent.
[j]DFE = dietary folate equivalent.
[k]$P < .05$ from Fisher *z* score 1-tailed test for independent correlations.
*$P < .05$ from Spearman's rank test.
**$P < .01$.
***$P < .001$.

investigators might not be interested in the PDQS, they might want to use the screeners to study food group intake per se. Lastly, the majority of differences in subgroup analyses did not reach statistical significance, and those that did might be due to chance. It will be important to investigate further the effect that factors like level of education might have on the ability to complete dietary questionnaires.

The study has several important strengths. To our knowledge, this is the first study that evaluated a PDQS-based questionnaire as a standalone diet quality assessment tool. The instrument is easy to complete and the total score is simple to calculate, with the aim of ranking individuals according to their diet quality levels. The questionnaire can be easily adapted for use in different national settings by using data on locally consumed foods from the United Nations Food and Agricultural Organization's country food balance sheets,[53] national diet surveys, or household budget surveys. The reference nutrient values were assessed using a validated 24-hour diet recall tool ASA24,[22] and the National Cancer Institute method for estimating usual nutrient intakes.[35] Finally, this study was conducted within a very short timeframe (30 days, with the first wave completed within 72 hours from posting on MTurk) and with a very small budget (used to pay MTurk workers), thanks to the use of web-based participant recruitment and data collection tools; as such, it opens up new opportunities for future validation studies.[54] The advantages of the PDQS compared with other available diet scores should also be mentioned: the PDQS is fully food-based and does not require use of food composition data for its calculation; it offers a modestly expanded list of foods, which allows capturing nutritionally relevant components of a wide range of diets around the world, comparing populations and tracking trends in a systematic way; some currently available diet quality indices, such as the HEI-2015[37] or Alternate Healthy Eating Index 2010,[55] contain nutrient components that might make them too complex to use in some global settings; other metrics, such as the modified Mediterranean diet score[56] and Healthy Nordic Diet Score,[57] promote specific diets and cannot accommodate global dietary varieties, while diet diversity scores developed for monitoring maternal and child health outcomes in LMICs, including the Minimum Diet Diversity—Women[48] and Food Group Index,[58] showed null associations with several NCDs and pregnancy complications. A recent review of diet quality indices[59] noted that none of the reviewed indices aimed to capture both maternal and child health and NCD outcomes at the same time, despite the necessity for ability to capture both under- and overnutrition in many LMICs.

The study also has several limitations. The participants were female Mturk workers, who tend to be younger, more educated, earn less, and include a higher proportion of White non-Hispanic and Asian Americans compared with the general US population.[60] Next, the study sample was not random, as participants were self-selected into the study. Therefore, the results of this study cannot be generalized to the general population of US women or men. In addition, the screener was not designed to assess the total diet in details and, therefore, the total energy intake could not be estimated. Also, questions were not formulated to collect data on the exact quantities of consumed foods. Rather, the purpose of this questionnaire was to classify individuals according to their overall diet quality. Then, "satisficing"[54] could have affected survey response; it was minimized by notifying participants in advance that incomplete and "rushed" ASA24 would not be compensated; the distributions of PDQS questionnaires responses (Table 10; available at www.jandonline.org) of the PDQS vary in terms of shape, not suggesting that participants were simply clicking on responses in the middle for each question. Lastly, the PDQS and the 24-hour diet recall questionnaires were administered immediately one after another, which could have led to higher correlations due to correlated errors in reporting; in addition, PDQS-24HR referred to the same day as the 24-hour diet recall, which might have further exaggerated correlations. This bias would be less for the PDQS-30D due to different timeframes. In a sensitivity analysis (Table 11; available at www.jandonline.org), correlations of each ASA24 with the PDQS-24HR values were compared and the majority were reasonably similar to those in Table 5.

CONCLUSIONS

This evaluation of the PDQS-based diet screener showed that the tool is simple to use and significantly associated with intakes of some key nutrients in this sample of US women. This instrument has a potential to enable cost-effective and rapid assessment and tracking of diet quality across different populations and national settings. Further evaluation and optimization across LMICs, and among other population groups is therefore warranted. Future studies should also formally evaluate the environmental aspects of the PDQS.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

FUNDING/SUPPORT

IMMANA Postdoctoral Fellowship research grant (S. Gicevic). The funder had no role in the design, implementation, analysis and interpretation of the data.

AUTHOR CONTRIBUTIONS

S. Gicevic, W. Willett designed the study, S. Gicevic, S. Bromage, T. T. Fung, and W. Willett developed data collection instruments, Y. Mou and S. Bromage performed data analysis, S. Gicevic wrote the first draft, S. Bromage, T. T. Fung, Y. Mou, and W. Willett reviewed and commented on subsequent drafts of the manuscript.

Table 4. Usual nutrient intakes (ASA24[a]) in a sample of US women (n = 290) participating in the PDQS[b]-based diet screener development study in April to May 2019

Variable	Crude	Energy-adjusted[c]
	←mean (standard deviation)→	
Energy (kcal)	2,019 (457)	—
Macronutrients		
Protein (g)	75 (23)	74 (19)
Carbohydrate (g)	224 (73)	214 (36)
Total fat (g)	84 (19)	82 (9.2)
Saturated fatty acids (g)	27 (6.5)	26 (3.8)
Polyunsaturated fatty acids (g)	19 (4.5)	19 (3.2)
Eicosapentaenoic acid (mg)	30 (13)	29 (13)
Docosahexaenoic acid (mg)	81 (37)	81 (38)
Fiber (g)	17 (4.4)	17 (3.9)
Total sugar (g)	98 (50)	91 (32)
Added sugar (g)	15 (9.7)	14 (7.1)
Vitamins		
Vitamin A (μg RE[d])	785 (210)	781 (206)
Beta-carotene (μg)	4,443 (2415)	4,444 (2403)
Vitamin B1 (mg)	1.7 (0.4)	1.6 (0.4)
Vitamin B6 (mg)	1.3 (0.6)	1.3 (0.5)
Vitamin B12 (μg)	4.2 (1.4)	4.2 (1.3)
Vitamin C (mg)	84 (32)	84 (31)
Vitamin D (μg)	3.9 (1.3)	3.9 (1.3)
Vitamin E (mg)	9.0 (3.5)	8.8 (3.1)
Folate (μg DFE[e])	409 (101)	404 (85)
Minerals		
Calcium (mg)	945 (186)	936 (153)
Zinc (mg)	10 (2.1)	10 (1.5)
Iron (mg)	14 (4.9)	14 (3.8)
Potassium (mg)	2,709 (580)	2,672 (450)
Magnesium (mg)	304 (67)	301 (54)

[a]ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool; usual nutrient intakes calculated using 2 days of 24-hour diet recall and the National Cancer Institute approach for reducing within-person variation.
[b]PDQS = Prime Diet Quality Score.
[c]ASA24 values adjusted for energy intake using the residual method (PDQS values not energy-adjusted).
[d]RE = retinol equivalent.
[e]DFE = dietary folate equivalent.

Table 6. Spearman rank correlations of healthy and unhealthy PDQS[a] components[b] with usual nutrient intakes (ASA24[c])[d] in a sample of US women participating in a diet screener development study in April to May 2019

	PDQS-24HR[e] (n = 290)				PDQS-30D[f] (n = 199)			
	Healthy components score[g]		Unhealthy components score[g]		Healthy components score[g]		Unhealthy components score[g]	
Variable	**Crude**	**Energy-adjusted[h]**	**Crude**	**Energy-adjusted[h]**	**Crude**	**Energy-adjusted[h]**	**Crude**	**Energy-adjusted[g]**
Macronutrients								
Energy (kcal)	−0.08	—	−0.44***	—	−0.27***	—	−0.47***	—
Protein (g)	0.08	0.13*	−0.10	0.12	−0.04	0.20**	−0.13	0.23**
Carbohydrate (g)	−0.13*	−0.15**	−0.53***	−0.25***	−0.26***	−0.07	−0.56***	−0.24***
Total fat (g)	−0.06	0.06	−0.34***	0.10	−0.22*	0.05	−0.29***	0.20**
Saturated fatty acids (g)	−0.19**	−0.21***	−0.39***	−0.05	−0.32***	−0.21**	−0.35***	0.02
Polyunsaturated fatty acids (mg)	0.08	0.21***	−0.24***	0.08	0.01	0.27***	−0.16*	0.21**
Eicosapentaenoic acid (mg)	0.15*	0.17**	−0.02	0.09	0.00	0.06	0.02	0.13
Docosahexaenoic acid (mg)	0.27***	0.27***	0.12*	0.16**	0.15*	0.18*	0.11	0.16*
Fiber (g)	0.42***	0.50***	0.12*	0.34***	0.33***	0.49***	0.11	0.33***
Total sugar (g)	−0.14*	−0.12*	−0.45***	−0.19***	−0.24***	−0.07	−0.51***	−0.23**
Added sugar (g)	−0.27***	−0.27***	−0.53***	−0.28***	−0.33***	−0.19**	−0.56***	−0.30***
Vitamins								
Vitamin A (µg RE[i])	0.25***	0.27***	0.12*	0.23***	0.21**	0.28***	0.11	0.22**
Beta-carotene (µg)	0.47***	0.47***	0.30***	0.29***	0.45***	0.45***	0.32***	0.31***
Vitamin B1 (mg)	0.01	0.07	−0.24***	0.09	−0.13	0.08	−0.29***	0.03
Vitamin B6 (mg)	0.16**	0.23***	−0.01	0.27***	0.09	0.26***	−0.16*	0.11
Vitamin B12 (µg)	0.09	0.12*	−0.06	0.14*	−0.03	0.10	−0.08	0.13
Vitamin C (mg)	0.31***	0.32***	0.17**	0.24***	0.27**	0.33***	0.10	0.15*
Vitamin D (µg)	0.13*	0.15*	−0.06	0.06	0.05	0.12	0.00	0.14
Vitamin E (mg)	0.24***	0.35***	0.03	0.28***	0.06	0.25***	0.04	0.33***
Folate (µg DFE[j])	0.25***	0.32***	−0.03	0.22***	0.14	0.30***	−0.15*	0.10

(*continued on next page*)

Table 6. Spearman rank correlations of healthy and unhealthy PDQS[a] components[b] with usual nutrient intakes (ASA24[c])[d] in a sample of US women participating in a diet screener development study in April to May 2019 (*continued*)

	PDQS-24HR[e] (n = 290)				PDQS-30D[f] (n = 199)			
	Healthy components score[g]		Unhealthy components score[g]		Healthy components score[g]		Unhealthy components score[g]	
Variable	**Crude**	**Energy-adjusted[h]**	**Crude**	**Energy-adjusted[h]**	**Crude**	**Energy-adjusted[h]**	**Crude**	**Energy-adjusted[g]**
Minerals								
Calcium (mg)	0.00	0.05	−0.15*	0.11	−0.06	0.11	−0.13	0.12
Zinc (mg)	0.13*	0.21***	−0.13*	0.23***	−0.02	0.20**	−0.20**	0.14
Iron (mg)	0.12*	0.24***	−0.23*	0.08	−0.03	0.21**	−0.29***	0.05
Potassium (mg)	0.29***	0.42***	0.05	0.37***	0.11	0.35***	−0.08	0.25***
Magnesium (mg)	0.32***	0.44***	0.09	0.39***	0.16*	0.39***	0.06	0.38***

[a]PDQS = Prime Diet Quality Score.
[b]Based on the PDQS "granular scoring" (approach 1).
[c]ASA 24 = Automated Self-Administered 24-hour Dietary Assessment Tool.
[d]Usual nutrient intakes calculated using two days of 24-hour diet recall and the NCI approach for reducing within-person variation.
[e]PDQS-24HR = Prime Diet Quality Score, 24-hour recall.
[f]PDQS-30D = Prime Diet Quality Score, 30-day recall.
[g]A higher score means a healthier diet.
[h]ASA24 values adjusted for energy intake using the residual method (PDQS values not energy-adjusted).
[i]RE = retinol equivalent.
[j]DFE = dietary folate equivalent.

Table 10. Frequencies of reported daily consumption of each food group in the PDQS-24HR[a] and PDQS-30D,[b] in a sample of US women participating in the PDQS-based diet screener development study in April to May 2019

	PDQS-24HR (n = 290)				PDQS-30D (n = 199)						
PDQS component	<1 time	1 time	2 times	≥3 times	≤1 time/mo	2-3 times/mo	1-2 times/wk	3-4 times/wk	5-6 times/wk	1 times/d	≥2 times/d
	←———				*n* (%)						———→
Dark green leafy vegetables	143 (49)	108 (37)	34 (12)	5 (2)	26 (13)	33 (17)	50 (25)	47 (24)	21 (10)	19 (10)	3 (1)
Cruciferous vegetables	177 (61)	98 (34)	14 (4.6)	1(0.4)	39 (20)	34 (17)	58 (29)	44 (22)	10 (5)	10 (5)	4 (2)
Deep orange vegetables	191 (66)	93 (32)	4 (1)	2 (1)	47 (24)	51 (25)	62 (31)	27 (14)	4 (2)	6 (3)	2 (1)
White roots and tubers	156 (54)	103 (36)	27 (9)	4 (1)	14 (7)	26 (13)	67 (33)	59 (30)	27 (14)	5 (3)	1 (1)
Other vegetables	87 (30)	122 (42)	61 (21)	20 (7)	7 (4)	32 (15)	45 (23)	63 (31)	25 (13)	13 (7)	13 (7)
Citrus fruits	211 (73)	60 (21)	15 (5)	4 (1)	67 (34)	53 (27)	47 (23)	18 (9)	7 (4)	5 (2)	2 (1)
Deep orange fruits	274 (94)	14 (5)	2 (1)	0 (0)	139 (69)	37 (19)	18 (8)	2 (1)	1 (1)	1 (1)	1 (1)
Other fruits	134 (46)	109 (38)	37 (13)	10 (3)	15 (8)	43 (22)	54 (26)	47 (24)	20 (10)	11 (6)	9 (4)
Beans, peas, and soy products	173 (60)	100 (34)	15 (5)	2 (1)	29 (15)	44 (22)	66 (33)	40 (20)	11 (5)	8 (4)	1 (1)
Nuts and seeds	158 (55)	104 (35)	19 (7)	9 (3)	24 (12)	48 (24)	54 (27)	50 (25)	9 (5)	11 (5)	3 (2)
Poultry	125 (43)	130 (45)	34 (11.6)	1(0.4)	17 (9)	10 (5)	64 (32)	75 (38)	24 (12)	7 (3)	2 (1)
Fish	262 (90)	22 (8)	6 (2)	0(0.0)	76 (38)	54 (27)	57 (28)	8 (4)	3 (2)	1 (1)	0 (0.0)
Red meat	153 (53)	109 (37)	26 (9)	2 (1)	26 (13)	24 (12)	82 (41)	56 (28)	10 (5)	1 (1)	0 (0.0)
Processed meats	169 (58.7)	111 (38)	9 (3)	1(0.3)	40 (20)	51 (26)	71 (35)	33 (16)	3 (2)	1 (1)	0 (0.0)
Eggs	175 (60)	103 (36)	12 (4)	0(0.0)	23 (12)	33 (16)	63 (32)	40 (20)	28 (14)	12 (6)	0 (0.0)
Low-fat dairy	171 (59)	79 (27)	38 (13)	2 (1)	63 (31)	27 (14)	38 (19)	30 (15)	19 (10)	17 (8)	5 (3)
Whole grains	124 (43)	111 (38)	41 (14)	14 (5)	21 (11)	29 (15)	46 (23)	48 (23)	27 (14)	19 (10)	9 (4)
Refined grains and baked products	99 (34)	117 (40)	57 (20)	17 (6)	14 (7)	31 (16)	44 (22)	55 (28)	30 (15)	16 (8)	9 (4)
Sugar-sweetened beverages	185 (64)	51 (17)	28 (10)	26 (9)	75 (38)	40 (20)	35 (17)	11 (6)	9 (5)	15 (8)	14 (6)
Sweets and ice cream	137 (47)	99 (34)	43 (15)	11 (4)	20 (10)	44 (22)	54 (25)	43 (22)	16 (8)	13 (7)	9 (4)
Fried foods	234 (81)	48 (16)	6 (2)	2 (1)	61 (31)	67 (34)	54 (26)	9 (5)	6 (3)	2 (1)	0 (0.0)
Liquid oils	171 (59)	94 (32)	19 (7)	6 (2)	21 (11)	35 (18)	55 (27)	41 (21)	18 (9)	22 (11)	7 (3)

[a]PDQS-24HR = Prime Diet Quality Score, 24-hour version.
[b]PDQS=30D = Prime Diet Quality Score, 30-day version. Based on the PDQS granular scoring (approach 1).

Table 11. Spearman rank correlations of PDQS-24HR[a] with single-day ASA24[b] nutrient intakes among US women in a diet screener development study (April to May 2019)

Variable	PDQS-24HR vs usual nutrient intakes (n = 290),[c] energy-adjusted[d]	PDQS-24HR vs ASA24 Day 1 (n = 290)		PDQS-24HR vs ASA24 Day 2 (n = 199)	
		Crude	Energy-adjusted[d]	Crude	Energy-adjusted[d]
Macronutrients	←——— *Spearman's rho* ———→				
Energy (kcal)	—	−0.27***	—	-0.19**	—
Protein (g)	0.14*	0.06	0.27***	0.14*	0.31***
Carbohydrate (g)	−0.22***	−0.35***	−0.20**	−0.28***	−0.21**
Total fat (g)	0.08	−0.21**	0.05	−0.14*	0.06
Saturated fatty acids (g)	−0.19**	−0.35***	−0.20**	−0.22***	−0.12*
Polyunsaturated fatty acids (g)	0.17**	−0.03	0.21**	−0.05	0.11
Eicosapentaenoic acid (mg)	0.15**	0.08	0.16**	0.03	0.08
Docosahexaenoic acid (mg)	0.27***	0.24***	0.28***	0.14*	0.17**
Fiber (g)	0.53***	0.37***	0.54***	0.28***	0.39***
Total sugar (g)	−0.18***	−0.31***	−0.13*	−0.28***	−0.21***
Added sugar (g)	−0.34***	−0.45***	−0.33***	−0.38***	−0.31***
Vitamins					
Vitamin A (μg RE[e])	0.33***	0.26***	0.33***	0.18**	0.21**
Beta-carotene (μg)	0.50***	0.49***	0.49***	0.37***	0.38***
Vitamin B1 (mg)	0.11	−0.10	0.08	−0.01	0.11
Vitamin B6 (mg)	0.31***	0.12*	0.28***	0.14*	0.24***
Vitamin B12 (μg)	0.15**	−0.06	0.06	0.07	0.15**
Vitamin C (mg)	0.36***	0.33***	0.36***	0.23***	0.26***
Vitamin D (μg)	0.16**	0.09	0.16**	0.07	0.12*
Vitamin E (mg)	0.40***	0.23***	0.42***	0.18**	0.29***
Folate (μg DFE[f])	0.37***	0.19**	0.34***	0.14*	0.27***

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Table 11. Spearman rank correlations of PDQS-24HR[a] with single-day ASA24[b] nutrient intakes among US women in a diet screener development study (April to May 2019) (*continued*)

Variable	PDQS-24HR vs usual nutrient intakes (n = 290),[c] energy-adjusted[d]	PDQS-24HR vs ASA24 Day 1 (n = 290)		PDQS-24HR vs ASA24 Day 2 (n = 199)	
		Crude	Energy-adjusted[d]	Crude	Energy-adjusted[d]
Minerals					
Calcium (mg)	0.10	−0.03	0.14**	−0.05	0.07
Zinc (mg)	0.25***	−0.10	0.10	0.11	0.28***
Iron (mg)	0.21***	−0.08	0.12*	0.05	0.20**
Potassium (mg)	0.48***	0.24***	0.49***	0.19	0.38***
Magnesium (mg)	0.51***	0.27***	0.50***	0.25***	0.41***

[a]PDQS-24HR = Prime Diet Quality Score, 24-hour version. Based on the granular scoring (approach 1).

[b]ASA24 = Automated Self-Administered 24-hour Dietary Assessment Tool.

[c]Usual nutrient intakes calculated using two days of 24-hour diet recall and the National Cancer Institute approach for reducing within-person variation; data below are originally presented in Table 5, and are included here for comparison.

[d]ASA24 values adjusted for energy intake using the residual method (PDQS values not energy-adjusted).

[e]RE = retinol equivalent.

[f]DFE = dietary folate equivalent.

*$P < .05$ from Spearman's rank test.

**$P < .01$.

***$P < .001$.