A Rapid Food Screener to Assess Fat and Fruit and Vegetable Intake

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Background: The U.S. Preventive Services Task Force recommends that Americans lower dietary fat and cholesterol intake and increase fiber and fruit/vegetables to reduce prevalence of heart disease, cancer, stroke, hypertension, obesity, and non–insulin-dependent diabetes mellitus in the United States. To provide preventive services to all, a rapid, inexpensive, and valid method of assessing dietary intake is needed.

Methods: We used a one-page food intake screener based on national nutrition data. Respondents can complete and score the screener in a few minutes and can receive immediate, brief feedback. Two hundred adults self-administered the food screener. We compared fat, fiber, and fruit/vegetable intake estimates derived from the screener with estimates from a full-length, 100-item validated questionnaire.

Results: The screener was effective in identifying persons with high-fat intake, or low–fruit/vegetable intake. We found correlations of 0.6–0.7 ($p<0.0001$) for total fat, saturated fat, cholesterol, and fruit/vegetable intake. The screener could identify persons with high percentages of calories from fat, total fat, saturated fat, or cholesterol, and persons with low intakes of vitamin C, fiber, or potassium.

Conclusions: This screener is a useful tool for quickly monitoring patients' diets. The health care provider can use it as a prelude to brief counseling or as the first stage of triage. Persons who score poorly can be referred for more extensive evaluation by low-cost paper-and-pencil methods. Those who still have poor scores at the second stage ultimately can be referred for in-person counseling .

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The report of the U.S. Preventive Services Task Force recommended that Americans lower their fat and cholesterol intake, and increase fiber intake to reduce the prevalence of heart disease, cancer, stroke, hypertension, obesity, and non–insulin-dependent diabetes mellitus in the United States population.[1] The report went on to state that "Although immunizations and screening tests remain important preventive services, *the most promising role for prevention in current medical practice may lie in changing the personal health behaviors of patients long before clinical disease develops*." The task force acknowledges, however, that clinicians often fail to provide preventive services such as nutritional screening and counseling, due, in part, to insufficient time with patients and the fact that "many lack the skills to obtain a thorough dietary history . . . and to offer specific guidance."

To achieve the dietary recommendations of the Task Force, providers need simple, inexpensive, rapid, and valid tools that can provide a snapshot of the patient's diet, provide immediate feedback to the patient, and afford the clinician the opportunity to use the influence of the office to reinforce the feedback. We report the testing of such an instrument.

A brief fat screener, developed earlier,[2] required computerized scoring. More recently, a one-page Food Screener has been developed, designed to obtain a valid measure of nutrient intake in much less time than required by traditional food records or extensive food-frequency questionnaires. The screener can be completed and scored in 5 minutes or less, and does not require difficult calculations or computer analysis. It includes the top sources of fat and of fruits and vegetables in the diets of Americans, as determined by national surveys and recent research.

In a multi-ethnic population in the San Francisco Bay area, we examined agreement between the Food Screener scores and nutrient estimates produced by the

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Table 1. Demographics of study population ($n = 208$)

Demographic	Frequency	Percent
Gender		
Male	74	35.6
Female	134	64.4
Race		
Hispanic	15	7.2
White, not Hispanic	135	64.9
African American	7	3.4
Asian, Pacific Islander	45	21.6
Missing/not specified	6	2.9
Age		
20–29	21	10.1
30–39	58	27.9
40–49	68	32.7
50–59	40	19.2
60–69	13	6.3
70 or older	0	0
Missing	8	3.8

Block full-length Food Frequency Questionnaire. We examined the role of race, gender, and age as covariates, and constructed prediction equations based on Food Screener scores.

Methods

We invited employees of a company in the San Francisco Bay area to participate in a Nutrition Education and Research Program, conducted by the University of California. Each employee received the one-page Food Screener and the full-length, eight-page Food Frequency Questionnaire. Patients self-administered both forms. As incentive, we offered an individual nutritional analysis, the results of which were kept confidential from company management. Of the 402 employees invited, 208 chose to participate in this program.

Females comprised almost two thirds of the study population (Table 1). The largest ethnic group was white, constituting 65% of the sample. Ages ranged from 20 to 69 years, but more than one half of the respondents were between the ages of 30 and 49 years.

The Food Screener is a one-page self-administered tool, in two sections. The Meat/Snacks section is comprised of 15 items designed to capture dietary fats. The Fruit/Vegetable section is comprised of seven items designed to capture fruit and vegetable intake, fiber, and micronutrients found in fruits and vegetables. (See Table 2 footnote for items and scoring.) The Food Screener requires no software for interpretation because its purpose is to give immediate feedback to respondents. Thus the participants themselves score the screener.

The "gold standard" against which we compared the screener was the 1995 Block 100-item Food Frequency Questionnaire.[3] Several published studies have validated the Food Frequency Questionnaire as an accurate tool for measuring dietary nutrient intake.[3–5] It gives nutrient estimates that correlate well with those obtained by much more extensive methods of measuring food intake, such as multi-day food-intake records. We analyzed the full-length Food Frequency Questionnaire using DIETSYS, a program developed by the National Cancer Institute to calculate individuals' daily nutrient intake based on responses to the questionnaire. To calculate nutrient intake using the full-length questionnaire,

Table 2. Correlation between food screener scores and full-length questionnaire nutrient estimates (n=208)

	Spearman r Value	Significance (p Value)
Meat/Snack Screener Score[a]—correlation with the following nutrient estimates from full-length questionnaire:		
Total fat (gms per day)	0.69	0.0001
Saturated fat (gms per day)	0.72	0.0001
Monounsaturated fat (gms per day)	0.67	0.0001
Dietary cholesterol (mg per day)	0.60	0.0001
Percent fat (daily percent of total calories)	0.63	0.0001
Fruit/Vegetable Screener Score[b]—(excluding beans/legumes) correlation with the following nutrient estimates from full-length questionnaire:		
Fruit/vegetable servings[c]	0.71	0.0001
Vitamin C (mg per day)	0.57	0.0001
Magnesium (mg per day)	0.41	0.0001
Dietary fiber (gms per day)	0.50	0.0001
Potassium (mg per day)	0.49	0.0001
Fruit/Vegetable Screener Score[b]—(beans/legumes included) correlation with the following nutrient estimates from full-length questionnaire:		
Magnesium (mg per day)	0.46	0.0001
Dietary fiber (gms per day)	0.62	0.0001
Potassium (mg per day)	0.52	0.0001

[a]Meat/Snacks: 15 items (meats, dairy, spread, snacks). Response categories: once per month or less, 2–3 times per month, 1–2 times per week, 3–4 times per week, or 5 or more times per week. Those categories were scored 0, 1, 2, 3, or 4. Scores range 0–60.
[b]Fruit/Vegetables: 7 items (fruits, vegetables, juices). Response categories: less than once per week, about once per week, 2–3 times per week, 4–6 times per week, every day, and 2 or more times per day; scored 0, 1, 2, 3, 4, 5. Scores range 0–35.
[c]Estimates from the full-length questionnaire were calculated using USDA Food Pyramid definitions of servings.

we multiplied the reported frequency of consumption of each food by the nutrient content of that food, and by the reported portion size (small, medium, or large). The software then uses age- and gender-specific portion sizes for small, medium, and large that are derived from national data.[3]

We conducted the statistical analyses using SAS V6.11. To examine the predictive value of the screener scores in identifying persons for whom dietary counseling might be beneficial, we dichotomized the Fruit/Vegetable and Meats/Snacks scores at the lower and upper quartile of their respective distributions. To assess the validity of the Food Screener, we calculated Spearman rank-order correlation coefficients between Food Screener scores and nutrient values measured by the full-length Food Frequency Questionnaire. We repeated these analyses for whites and for "other than white." Study participants who did not indicate their race were excluded from this part of the analysis. We used linear regression models to develop prediction equations, which could be used to estimate actual nutrient intake based on Food Screener scores. Age, gender, and race were considered as potential covariates and, where appropriate, included in the prediction equations. Extreme outliers were excluded from the linear regression analyses (but not from the main correlation analysis) to allow the prediction equations to estimate nutrient intake more accurately for the majority of respondents.

Results

See related Commentary on page 354.

The Food Screener ranked subjects similarly to estimates from the Block full-length Food Frequency Questionnaire, used here as the gold standard, for a number of important nutrients (Table 2). Spearman rank-order correlation coefficient ($r>0.60$) showed that the Food Screener ranked subjects quite well with respect to dietary intake of total fat, saturated fat, dietary cholesterol, and percent of calories from fat. We also obtained an excellent correlation of the screener with servings of fruits and vegetables ($r=0.71$), and with vitamin C as estimated by the full-length questionnaire. Further analysis indicated that inclusion of the bean/legume item on the screener produced an improved correlation of the screener score with the more extensive questionnaire's estimates of magnesium, potassium, and fiber (Table 2).

Data analyses restricted to the white study subjects ($n=135$) produced similar results. All nutrient correlations remained roughly the same, with a slight increase in the vitamin C correlation coefficient (data not shown). The analyses performed on the data from the "other than white" study group ($n=67$) produced results similar to those of the entire population for all nutrients, with a slight decrease in the vitamin C correlation coefficient (data not shown). All results were statistically significant, with p values less than 0.01.

The predictive value of the screener scores was good (Table 3). For purposes of this analysis, the upper category of fruit/vegetable consumption as determined by the full-length questionnaire was set at five or more servings, consistent with several national guidelines. "Quite low" was defined as three to four servings, and "very low" fruit and vegetable consumption was defined as one or two servings per day. Thirty-seven of the 56 persons with low scores (<11) on the fruit/vegetable screener were indeed "very low" by the gold standard (66%), and an additional 13 were "quite low." Thus, 89% of persons who were low on the fruit/vegetable screener were indeed "very low" or "quite low" by the gold standard.

"Very high" fat intake was defined as 35% or more of energy from fat (Table 3). Of those who scored 23 or higher on the screener, 57% were indeed "very high" according to the full-length questionnaire, and 88% were above the desirable 30% of energy. Thus, all but 12% of the persons identified by the screener as having elevated fat intake could benefit from advice to reduce their fat intake. For saturated fat intake, 63% of those flagged by the screener were very high, and another 29% were quite high in saturated fat intake as measured by the full-length questionnaire (Table 3).

We used linear regression techniques to construct prediction equations for each nutrient on the Food Screener. These are reported in Table 4, and can be used to translate the Food Screener scores into estimates of daily nutrient intake. We examined age, gender, and race as potential covariates in the regression analysis. These variables were included in the prediction equations when their level of significance was found to be $p<0.05$. Gender was a significant covariate for all nutrients on the Food Screener. Age was a significant covariate for vitamin C, potassium, and magnesium; and race was significant for only dietary cholesterol (Table 4).

Discussion

The correlations of the meats/snacks score with fats and cholesterol indicate that the screener can provide estimates of these nutrients similar to rankings obtained from a full-length nutrition questionnaire. If intake of fruits and vegetables is of interest, the fruit/vegetable screener (with the omission of the beans item) produced an excellent estimate of servings of those foods. The correlations of the fruit/vegetables score with associated nutrients as opposed to foods tended to be somewhat lower, due in part to the fact that these nutrients (e.g., vitamin C) are also obtained from fortified foods, such as breakfast cereals, found on the full-length questionnaire but not on the screener. Thus, the correlations seen here indicate that the screener can provide a reasonable picture of respondents' intake of fat, and of fruits and vegetables.

The health care provider can use the screeners as a

Table 3. Predictive value of screener scores

Fruit/Vegetable screener[a]	Servings by full-length questionnaire 1–2	3–4	5+	Total
Fruit/vegetable (FV) screener score				
Low (<11)	37	13	6	56
Not low	34	73	48	155
Total	**71**	**86**	**54**	**211**

Fat Screener[b]	Percent of energy from fat by full-length questionnaire Less than 30%	30–34%	35% or higher	Total
Meats/Snacks screener score				
High (23+)	6	16	29	51
Not high	78	47	32	157
Total	**84**	**63**	**61**	**208**

Fat Screener[c]	Saturated fat intake by full-length questionnaire Lower quartile (<15 g)	Middle (15–26 g)	Upper quartile (≥27 g)	Total
Meat/Snacks screener score				
High (23+)	4	15	32	51
Not high	47	89	21	157
Total	**51**	**104**	**53**	**208**

[a]Chi-squared $p < 0.001$. Sensitivity (ability to detect low intake) 37 ÷ 71 = 52%.
Specificity (ability to rule out people with high intake) 48 ÷ 54 = 86%.
Predictive value of a positive (low FV) score 37 ÷ 56 = 66%.
[b]Chi-squared $p < 0.001$. Sensitivity (ability to detect high-fat intake) 29 ÷ 61 = 52%.
Specificity (ability to rule out low-fat intake) 78 ÷ 84 = 93%.
Predictive value of a positive (high-fat) score: 29 ÷ 51 = 57%.
[c]Chi-squared $p < 0.001$. Sensitivity (ability to detect high intake) 32 ÷ 53 = 60%.
Specificity (ability to rule out low intake) 47 ÷ 51 = 87%.
Predictive value of a positive (high-fat) score 32 ÷ 51 = 63%.

stimulus for delivery of brief nutrition advice. The screener identifies those in need of advice, and provides self-scoring that informs the user of his or her status. The health care provider can use the authority of the profession to reiterate those points, and could point to foods frequently eaten by the respondent as first targets for dietary improvement. In addition, providers can use the screener as first-stage triage; patients who score poorly on fat or fruit/vegetable intake could take the full-length instrument or receive more extensive assessment and counseling by a nutrition professional.

The effectiveness of the Food Screener is based on the fact that it includes the most important sources of these nutrients in the diets of most Americans. Correlation coefficients differed only slightly between the "white" and "other than white" categories. The screener may be less appropriate for persons with unusual dietary practices, such as recent immigrants.

Clearly various subcomponents of total fat (e.g., saturated fat, monounsaturated fat) may have different health effects.[1] Saturated fat increases serum lipids, and as shown in Table 2, the screener does a good job of identifying individuals with high saturated fat intake and, in fact, correlates more highly with that than with

Table 4. Prediction equations for daily nutrient intake based on food screener scores[a]

Meat/Snack Equations:

Total fat (gms) = 32.7 + 2.4 (Meat/Snack score) + 11.2S
Saturated fat (gms) = 9.4 + 0.88 (Meat/Snack score) −3.5S
Percent fat[b] = 19.8 + 0.6 (Meat/Snack score) + 2.3S
Dietary cholesterol (gms) = 120 + 7.8 (Meat/Snack score) − 54.65S + 36.6R

Fruit/Vegetable Equations:[c]
Fruit/vegetable servings (Pyramid definitions of servings per day) = −0.23 + 0.37 (Fruit/Vegetable score) −0.55S
Vitamin C (mg) = 56.5 + 6.6 (Fruit/Veg/Beans score − 26.7S −0.45A
Magnesium (mg) = 272 + 11.6 (Fruit/Veg/Beans score) −92.3S −1.7A
Dietary fiber (gms) = 7.9 + 0.74 (Fruit/Veg/Beans score) −4.5S
Potassium (mg) = 2348 + 114.8 (Fruit/Veg/Beans score) −759S −13.8A

[a]Variables are defined as follows:
S = Sex: Male = 0, Female = 1
R = Race: White = 0, Nonwhite = 1
A = Age: Age can be directly substituted for the A variable.
[b]Accuracy of the percent fat prediction will depend in part on the extent of empty calories (such as from soft drinks or alcoholic beverages) in the respondent's diet.
[c]If only servings of fruits and vegetables is of interest, use the screener without beans, and use the equation for servings per day. If other nutrients such as fiber are of interest, use the screener including beans, and use the other equations.

total fat. On the other hand, a high monounsaturated fat intake may reduce the risk of some diseases, and Table 2 also reveals a high correlation with monounsaturated fat. This illustrates the fact that in the United States, almost all foods high in monounsaturated fat are also high in saturated fat. In data from the Third National Health and Nutrition Examination Survey, seven of the top ten foods contributing saturated fat are also among the top ten monounsaturated fat contributors (GB, unpublished observations). If a respondent scores high on this screener, he or she almost certainly has a high saturated fat intake, *and* high monounsaturated fat intake. Physicians and patients who wish to improve their lipid profile would first need to achieve a lower score on this screener, and *then* address increasing monounsaturated fat from good sources that do not also have a high saturated fat content, such as olive oil.

The meat/snacks and fruit/vegetable scores were designed simply to rank individuals from low to high, and to provide immediate feedback based on those scores; use of the prediction equations is not necessary. However, the prediction equations may be useful for estimating intake of some nutrients. To use the prediction equations properly, the investigator or physician should obtain information regarding the individual's age, sex, and ethnic group. Although both the screener score and the prediction equations can provide reasonable estimates of nutrient intake, misclassification of some individuals with regard to their nutrient intake is inevitable. For screening and counseling, the analyses in Table 3 indicate that the great majority of persons flagged by the screeners could indeed benefit from dietary change. For nutrition research, full-length instruments are to be preferred.

The gold standard used in this study, the 100-item Block dietary questionnaire, has itself been validated against much more intensive assessment methods, namely 12 to 16 days of diet records, and shown to produce good nutrient estimates and correlations.[4,5] The present research compared the Food Screener with this full-length questionnaire. It should be noted that since the screener and criterion Food Frequency Questionnaire were both frequency-type instruments (but with different scoring systems), and were self-administered at approximately the same time, these correlations probably overestimate the correlation of the screeners with "truth." On the other hand, these screeners have also been compared with data from detailed 4-day food records (A. Dowdy et al., unpublished observations, 1994). Those results were also very good, indicating that the screener ranked people similarly to much more detailed and extensive dietary methods.

The Food Screener used in this study was developed to assess fat, fiber, and fruit and vegetable intake. These nutrients are most closely associated with morbidity and mortality, and thus are of interest to physicians, epidemiologists, nutritionists, and diet-conscious individuals. The screeners provide a reasonably accurate ranking of nutrient intake, similar to that of a full-length dietary questionnaire. Thus, they help identify persons with high-fat or high-cholesterol intake, or with low fruit and vegetable intake. Because the screeners are brief, and can be self-administered and self-scored, they offer an inexpensive way to provide basic dietary evaluation and feedback to all patients.

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