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Use of a Brief Food Frequency Questionnaire for Estimating Daily Number of Servings of Fruits and Vegetables in a Minority Adolescent Population

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Abstract

The validity of the Five A Day food frequency questionnaire (FADFFQ) for estimating fruit and vegetable consumption was examined in a sample of 156 African American adolescents aged 10 to 14 years. To determine validity, the correlation between FADFFQ fruit, juice, and vegetable intake and three-day intake measured by direct observation (OBS) was assessed. Correlations were calculated separately by food type (i.e., fruits, juices, and vegetables) and by gender and age to determine whether the accuracy of youths' recording differed based on these factors. Paired-samples *t* tests were used to test for differences between FADFFQ and OBS intake estimates. The ability of the FADFFQ to correctly classify youths according to intake level (i.e., intake $\geq$ five daily servings) was also examined. FADFFQ intake was significantly correlated with OBS intake ($r = 0.39$, $P < .01$). The correlations were weaker by food type ($r = 0.15$ - $r = 0.28$) and did not differ based on youths' gender or age. Mean FADFFQ intake (6.74 ± 6.00 servings) was significantly higher than mean OBS intake (5.41 ± 1.51 servings), and this was due to the overestimation of vegetable intake. The sensitivity, specificity, and positive and negative predictive value of the FADFFQ were 67.1%, 68.6%, 63.5%, and 71.9% respectively. Findings suggest that the FADFFQ may be more useful as a screening tool for identifying African American adolescents most in need of intervention than for estimating youths' mean intake in dietary intervention programs.

Keywords

Fruit and vegetable consumption; adolescents; food frequency questionnaires; African Americans

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INTRODUCTION

Current dietary guidelines recommend consumption of between five and 13 daily servings of fruits and vegetables (1); yet, average American intakes are well below recommended levels (2). Differences between recommended and actual intake are more pronounced among African Americans (2), underscoring the need for dietary interventions to increase intake in this population. The choice of assessment method for tracking changes in intake is a key consideration in the design of such programs.

Food frequency questionnaires are commonly used for this purpose (3). Data collection and processing costs and respondent burden are lower for food frequency questionnaires than for other intake assessment methods such as multiple food records and 24-hour recalls, features that make them attractive to program planners (4). Although they can be of considerable length, shorter questionnaires for measuring intakes of specific nutrients or food groups have been developed (5-8).

The Five A Day food frequency questionnaire (FADFFQ) is a seven-item measure of fruit and vegetable consumption (6). Correlations between FADFFQ intake and intake measured by full-length food frequency questionnaires, food records, and 24-hour recalls range from 0.50 to 0.52, 0.19 to 0.51, and 0.50 to 0.58, respectively (5,6,9-13). Relative to these reference methods, the FADFFQ has tended to underestimate intake.

Validation studies of the FADFFQ have been conducted primarily with adults (5,6,9-12). The purpose of this study was to examine the validity of the FADFFQ for estimating fruit and vegetable consumption among African American adolescents. In a cross-sectional design, the correlation between FADFFQ intake and three-day intake measured by direct observation (OBS) was assessed. A significant and moderate correlation (i.e., at or above 0.50 by Cohen's conventions) was considered evidence of validity (14). Correlations were calculated separately by food type (i.e., fruits, juices, and vegetables) and by gender and age to determine whether the accuracy of youths' recording differed based on these factors. The ability of the FADFFQ to correctly classify youths according to intake level (i.e., intake $\geq$ 5 daily servings) was also examined. The objectives for this study were (1) to validate the FADFFQ as an assessment of fruit and vegetable consumption among African American adolescents and (2) determine the effect of gender and age on the validity of the FADFFQ.

METHODS

Data were provided by African American adolescents enrolled in a measurement validation study described elsewhere (15). Youths were recruited through summer day camp programs offered at youth services agencies in New York City. One hundred eighty-one youths between the ages of 10 and 14 were enrolled. Because observational data used to validate the FADFFQ were collected during meals served over three consecutive days (as described below), evaluation of the FADFFQ was restricted to youths who were present at all meals and thus for whom complete observational data were available ($n = 156$). Study procedures were approved by the Institutional Review Board of Intersystems Incorporated. Prior to their study involvement, all youths provided written assent and informed written consent was obtained from a parent or guardian.

Youths were served breakfast, lunch, and dinner at collaborating sites over three consecutive days. At each meal, youths were given a tray with one serving each (as defined by Five A Day criteria) of fruits, juices, and vegetables and were offered a variety of main course options (16). Between meals, youths participated in recreational activities. They were not offered fruits and vegetables to snack on at these other times.

Trained staff present at meals observed the amounts of fruit, juice, and vegetables youths left after eating using the plate-waste-by-visual-estimate method (17). They recorded the portion consumed of each serving on a form that contained the following response options: zero, one-fourth, one-half, three-fourths, and one. Because meals were served in a large-group format, each staff member observed different groups of up to ten youths each; they did not concurrently observe the same youths at each meal.

After dinner on the third day, youths were administered the FADFFQ, a non-quantitative measure that queries the number of times respondents ate or drank the following items over the past month: 100% orange juice or grapefruit juice; other 100% fruit juices; green salad; French fries or fried potatoes; baked, boiled, or mashed potatoes; other vegetables; and fruit. The specific wording of items is shown in Table 1. Because the reference periods for the measures differed (i.e., the preceding month vs. the preceding three days, respectively), FADFFQ and OBS intake estimates were converted to a common metric. Youths' FADFFQ responses were transformed to a daily equivalent and summed to provide a composite measure of servings per day. Comparable estimates of OBS intake were computed by determining the number of servings youths were observed eating on each day and averaging these amounts across days. FADFFQ and OBS intake estimates by food type (i.e., fruits, juices, and vegetables) were also calculated. The FADFFQ item for measuring intake of French fries and fried potatoes was excluded from scoring procedures because these foods are high in fat and are not recommended in the Five A Day program (18). French fries and fried potatoes were included in the FADFFQ to help respondents distinguish them from non-fried potatoes the measure was intended to count. The item for measuring these foods was specifically designed to identify and then omit them from intake estimates of recommended foods and juices (19). French fries and fried potatoes were not included in meals provided to youths; thus, they were also not reflected in OBS intake estimates.

Pearson correlations were calculated to provide an index of relation between FADFFQ and OBS intake and intake by food type. To examine whether and how the correlations differed among the gender and age groups studied, youths were stratified by gender and age and separate correlations were calculated for males and females and for younger (i.e., aged 10 to 11 years) and older (i.e., aged 12 to 14 years) youths. To determine whether pairs of correlations (e.g., males vs. females) were statistically different, the Fisher transformation method was used (20). Paired samples *t* tests were used to test for differences between FADFFQ and OBS intake estimates.

To examine the ability of the FADFFQ to correctly classify youths according to intake level, FADFFQ and OBS intake were dichotomized (< five daily servings, ≥ five daily servings). The sensitivity, specificity, and positive and negative predictive value of the FADFFQ were examined using these dichotomized scores. All analyses were conducted using SPSS (version 12.0.1 for Windows, 2003, SPSS Inc, Chicago, IL).

RESULTS AND DISCUSSION

Participants had a mean age of 11.89 (± 1.24) years and were 55% female. Although FADFFQ intake was significantly correlated with OBS intake, $r = 0.39$, $P < .01$, youths significantly overestimated their intake using the FADFFQ, $t_{155} = 2.97$, $P < .01$ (Table 2).

The correlations were weaker by food type and were significant for fruits ($r = 0.24$, $P < .01$) and vegetables ($r = 0.28$, $P < .01$) but not juices ($r = 0.15$, $P > .05$). FADFFQ intake of fruits and juices did not differ from OBS fruit and juice intake. However, FADFFQ intake of vegetables was significantly higher than OBS vegetable intake, $t_{155} = -4.65$, $P < .01$. The

correlations between FADFFQ and OBS intake and intake by food type did not differ based on youths' gender or age.

The sensitivity, specificity, and positive and negative predictive value of the FADFFQ were 67.1%, 68.6%, 63.5%, and 71.9%, respectively. This means that 67.1% of youths with OBS intake < five daily servings were classified by the FADFFQ as consuming < five daily servings, and 68.6% of youths with OBS intake $\geq$ five daily servings were classified by the FADFFQ as consuming $\geq$ five daily servings. Moreover, if the FADFFQ determined that intake was < five daily servings, it was correct 63.5% of the time, and if it determined that intake was $\geq$ five daily servings, it was correct 71.9% of the time. These performance indicators suggest that the FADFFQ is useful for confirming intake levels (as indicated by its positive and negative predictive value) and it will correctly classify sizable and similar proportions of youths with intakes below and at or above five daily servings (as indicated by its sensitivity and specificity, respectively).

This study examined the validity of the FADFFQ for estimating fruit and vegetable consumption among African American adolescents. The correlation between FADFFQ and OBS intake was below the a priori criterion, an indication that the FADFFQ was not a valid measure of intake in this population. Noteworthy is the heterogeneity of responses to FADFFQ items as indicated by the large range of values for FADFFQ intake estimates. Although the reference period for the FADFFQ is the preceding month, response options query the number of times per month, week, or day respondents consumed the included items. The large variation found may be an indication that youths had difficulty quantifying their monthly intake in daily and weekly equivalents, a factor that may account for the poor validity of the measure.

The overestimation found was consistent with findings from a validation study of the FADFFQ in a sample of children (13). In that study, youths overestimated their intake regardless of food type whereas in this study youths overestimated their vegetable intake only. A number of factors may explain this pattern.

Observational data revealed that youths' vegetable intake was lower than their fruit and juice intake. Youths' tendency to consume more fruit (mostly via fruit juice) than vegetables is consistent with intake patterns found among African Americans in other research (21). Because youths consumed fruits and juices more often than vegetables, they may have been recalled with greater accuracy.

Alternatively, the overestimation may be an artifact of the greater number of items used to measure vegetable intake. The FADFFQ uses three items to measure vegetable intake, two items to measure juice intake, and one item to measure fruit intake. In other research, reported servings of fruits, juices, and vegetables increased in direct proportion to the number of questions for measuring these foods (22).

Possibly, youths were influenced by social approval and social desirability biases, the tendencies of individuals to respond in a manner consistent with expected norms (23). Youths may have been aware that vegetables are foods they should be in the habit of eating. This awareness, combined with their low vegetable intake may have encouraged them to report consuming vegetables more often than was the case.

The small and self-selected sample limits the generalizability of findings. The time periods referenced by the measures used differed. Youths may have had difficulty translating servings consumed over three days to servings consumed in a month. Results may therefore underestimate the true validity of the FADFFQ. Respondents did not have the option of selecting from among a variety of fruits and vegetables at meals and they were not given these foods to snack on between meals. There was also the possibility that youths consumed

additional fruits and vegetables before and after camp. Thus, estimates of observed intake may not reflect youths' true eating behavior. Previous research has shown that food frequency questionnaires are susceptible to seasonal reporting bias (24,25). Because this study was conducted in the summer, results may be different than they would be at other times of the year.

This study used observational data to validate the FADFFQ, a criterion measure superior to self-report measures (26). This is the first study to examine the validity of the FADFFQ among African American adolescents. Findings advance understanding of the validity of this tool for estimating fruit and vegetable consumption in this population.

CONCLUSIONS

The poor validity of the FADFFQ suggests that it is less than optimal for program evaluation purposes. The FADFFQ may overestimate the true intervention effect or fail to find an effect on vegetable intake. Investigators are therefore encouraged to administer measures of known validity to confirm study findings based on the FADFFQ alone. The moderate sensitivity, specificity, and positive and negative predictive value of the FADFFQ suggest that it may be more useful as a screening tool for identifying African American youths most in need of intervention. The decision to use the FADFFQ for screening purposes should be based on tolerance for some misclassification.

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Table 1
Questions Asked on the Five A Day Food Frequency Questionnaire (FADFFQ)

In the past month, how often did you drink or eat:

1. 100% orange juice or grapefruit juice?
2. Other 100% fruit juices, NOT COUNTING fruit drinks?
3. Green salad (with or without other vegetables)?
4. French fries or fried potatoes?
5. Baked, boiled, or mashed potatoes?

Response options are: never, one to three times/month, one to two times/week, three to four times/week, five to six times/week, one time/day, two times/day, three times/day, four times/day and five or more times/day.

6. In the past month, about how many servings of vegetables did you eat, NOT COUNTING potatoes and salad?
7. In the past month, about how many servings of fruit did you eat, NOT COUNTING juices?

Response options are: none, one to three/month, one to two/week, three to four/week, five to six/week, one/day, two/day, three/day, four/day and five or more/day.

Table 2

Comparison of Mean ($\pm$ Standard Deviation) Daily Servings of Fruits, Juices, and Vegetables and Servings by Food Type Estimated by the Five A Day Food Frequency Questionnaire (FAFFQ) and Direct Observation (OBS)

Intake measure	n ^a	Mean FAFFQ	range	Mean OBS	range	Difference $\pm$ SE ^b (FAFFQ - OBS)	P value ^c	Correlation between FAFFQ and OBS
Total intake								
All cases	156	6.74 $\pm$ 6.00	29.80	5.41 $\pm$ 1.51	8.25	1.33 $\pm$ 0.45	0.01	0.39**
Male	70	6.30 $\pm$ 5.05	19.93	5.30 $\pm$ 1.54	6.67	1.00 $\pm$ 0.57	0.08	0.34**
Female	86	7.10 $\pm$ 6.69	29.80	5.51 $\pm$ 1.50	8.17	1.59 $\pm$ 0.67	0.01	0.43**
10-11 years	64	6.41 $\pm$ 6.37	28.80	5.59 $\pm$ 1.49	8.08	0.82 $\pm$ 0.75	0.28	0.36**
12-14 years	92	6.97 $\pm$ 5.76	29.80	5.29 $\pm$ 1.52	6.67	1.68 $\pm$ 0.55	0.01	0.43**
Fruit intake								
All cases	147	1.59 $\pm$ 1.80	5.00	1.61 $\pm$ 0.72	3.33	-0.02 $\pm$ 0.15	0.91	0.24**
Male	64	1.31 $\pm$ 1.59	5.00	1.49 $\pm$ 0.78	2.92	-0.18 $\pm$ 0.20	0.37	0.32*
Female	83	1.81 $\pm$ 1.93	5.00	1.70 $\pm$ 0.66	3.25	-0.11 $\pm$ 0.21	0.60	0.23*
10-11 years	61	1.29 $\pm$ 1.70	5.00	1.56 $\pm$ 0.69	3.17	-0.27 $\pm$ 0.75	0.23	0.20
12-14 years	86	1.81 $\pm$ 1.86	5.00	1.65 $\pm$ 0.75	2.92	-0.16 $\pm$ 0.20	0.42	0.25*
Juice intake								
All cases	156	2.92 $\pm$ 2.89	10.00	2.61 $\pm$ 0.49	3.08	0.31 $\pm$ 0.23	0.18	0.15
Male	70	3.10 $\pm$ 2.88	10.00	2.73 $\pm$ 0.35	1.92	0.37 $\pm$ 0.35	0.28	-0.02
Female	86	2.77 $\pm$ 2.92	10.00	2.52 $\pm$ 0.57	2.83	0.25 $\pm$ 0.31	0.41	0.22*
10-11 years	64	2.96 $\pm$ 2.97	10.00	2.69 $\pm$ 0.43	2.42	0.27 $\pm$ 0.37	0.47	0.10
12-14 years	92	2.89 $\pm$ 2.86	10.00	2.56 $\pm$ 0.52	2.83	0.33 $\pm$ 0.29	0.25	0.18
Vegetable intake								
All cases	156	2.32 $\pm$ 2.95	15.00	1.26 $\pm$ 0.68	4.67	1.06 $\pm$ 0.23	0.01	0.28**
Male	70	2.01 $\pm$ 2.47	10.21	1.21 $\pm$ 0.67	2.67	0.80 $\pm$ 0.29	0.01	0.16
Female	86	2.57 $\pm$ 1.30	15.00	1.30 $\pm$ 0.68	4.58	1.27 $\pm$ 0.34	0.01	0.34**
10-11 years	64	2.22 $\pm$ 3.07	15.00	1.37 $\pm$ 0.70	4.33	0.85 $\pm$ 0.37	0.03	0.26*
12-14 years	92	2.39 $\pm$ 2.88	15.00	1.19 $\pm$ 0.65	2.67	1.20 $\pm$ 0.29	0.01	0.30**

^aFor the fruit category, the sample size was reduced due to the omission of cases with missing data (n = 9).

^b SE = standard error.

^c Values shown indicate the level of significance for paired-samples *t* tests comparing FADFFQ and OBS.

** Pearson correlation between FADFFQ and OBS significant at $P = 0.01$.

* Pearson correlation between FADFFQ and OBS significant at $P = 0.05$