Validation of 2 Brief Fruit and Vegetable Assessment Instruments Among Third-Grade Students

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ABSTRACT

Objective: To evaluate the validity of 2 brief instruments to estimate fruit and vegetable (FV) intake among third-grade children.

Methods: Children from an elementary school and a community center (n = 107) completed 2 retrospective questions for FV intake (fruit and vegetable questionnaire [FVQ]) and a food record (A Day in the Life Questionnaire [DILQ]) to estimate FV intake. Agreement between intake based on these instruments and 3 24-hour dietary recalls was determined.

Results: Disattenuated Pearson correlation coefficients ranged from 0.40 to 0.69 for FV intake; however, the low reliability of multiple 24-hour recalls may have inflated the strength of the correlations. Altman-Bland difference plots suggested that the FVQ overestimated FV intake whereas the DILQ overestimated fruit and underestimated vegetable intake. Limits of agreement were wide for both tools, indicating poor overall agreement.

Conclusions and Implications: The FVQ and DILQ were not valid instruments to evaluate FV consumption under current study conditions. Other assessment methods and instruments should be considered for young children.

Key Words: validation, fruit, vegetable, assessment, children (*J Nutr Educ Behav*. 2015;47:446-451.)

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INTRODUCTION

Consumption of fruit and vegetables (FV) among children (aged 2–19 years) in the US is well below national recommendations.[1] Therefore, many community and school-based programs have been developed to encourage FV consumption among children by organizations, including those implementing Supplemental Nutrition Assistance Program–Education (SNAP-Ed). Evaluating the effectiveness of these programs within the constraints of community settings using validated dietary assessment tools remains a challenge. Current assessment tools used with children include food records or diaries[2,3] such as A Day in the Life Questionnaire (DILQ),[4] 24-hour dietary recalls,[5] food frequency questionnaires,[6,7] and observational methods.[8] Evidence documenting the validity of these tools is typically based on 24-dietary recalls or weighed food records as reference standards, but many potentially useful tools remain unvalidated.[9]

Nutrition education objectives of SNAP-Ed[10] are consistent with the Dietary Guidelines for Americans[11] including improvement in FV intake among children. Measures to evaluate SNAP-Ed outcomes should be "valid, reliable, sensitive to change and practical for use."[12] Two instruments used in Minnesota SNAP-Ed to evaluate the long-term impact of a school-based FV curriculum for third-grade children based on time and cost considerations included the DILQ[4] and a 2-item fruit and vegetable questionnaire (FVQ) adapted from a Food Behavior Checklist[13] used with adult SNAP-Ed participants. Because these simple and brief dietary intake measures (DILQ and FVQ) had not been validated for use in this program, the current study was conducted to determine whether they could capture the self-reported FV intake accurately in third-grade children while also acknowledging the challenges inherently associated with young children's recall capabilities.[14]

The DILQ is a 1-day chronological food diary developed for use with children aged 7–9 years.[4] Daily activity questions are included to enhance recall and mask the intention of

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measuring FV intakes. Several questions vary from the original version[4] based on modifications to suit the nomenclature of meal occasions in the US. The FVQ includes 2 questions asking about FV intake on most days and includes measuring cup pictures[15] with response options ranging from 0 to 3 cups in half-cup increments. Pictured cups contain either fruit or vegetables at the designated cup level. Readability and validity were acceptable among adults[16-18] but were not tested with children. Food Behavior Checklist questions regarding FV intake were reliable among children (aged 8–9 years) but were not tested for agreement with a reference measure.[19]

The DILQ and FVQ are practical assessment tools because they can be quickly administered to school-aged children in a group setting at low cost; however, analysis of the DILQ data may be challenging. Validation of the DILQ is necessary across an entire day and validation of the FVQ is necessary for convergent validity with children. Therefore, the objective of this study was to validate these 2 brief FV intake assessment tools among third-grade children using 24-hour dietary recalls as the reference method.

METHODS

Participants

Data were collected from third-grade students attending 1 elementary school (n = 100) and children participating in a community-based summer program during 2012–2013 (n = 7). Approximately 488 students were enrolled in the school, with 76% classified as racially and ethnically diverse.[20] The majority of children (84% and 88%, respectively) were eligible for free or reduced price school meals from the school[21] and summer camp, respectively. Recruitment fliers were sent home to parents with children in any of 5 classrooms in the school (n = 124) and parents of third-grade children attending the summer camp (n = 15); this resulted in a response rate of approximately 77%. Children were given $10 gift cards for participation and teachers were given $50 gift cards for their assistance. The University of Minnesota Institutional Review Board, school principal, and community center director approved this study; the researchers obtained informed consent and assent from parents and youth, respectively.

Data Collection Procedures

On the morning of the first day, a trained researcher administered the FVQ and then the DILQ to children, providing minimal prompts. For the DILQ, the previous day's school breakfast and lunch menus were reviewed to remind children of the foods they were offered in school. For the FVQ, researchers asked whether children usually consumed FV on most days. Because the FVQ pictures did not include juice, researchers instructed children to include juice as a part of their usual intake. Researchers did not provide additional information to describe the difference between 100% fruit juice and fruit drinks.

An individual 24-hour recall interview was conducted with each child later in the day after administration of the DILQ and FVQ. Recalls were conducted in the school classroom or library, and in a private room in the summer camp setting. A standard multiple pass method was used based on the Nutrition Data System for Research 2012 software program (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, 2012).[22] Because combination dishes such as spaghetti with sauce contribute a substantial amount of vegetables to children's diets,[23] these foods were included in the vegetable category. French fries, potato chips, and baked products containing fruit were excluded.

Within the next 3 weeks, 2 food record–assisted 24-hour recalls were conducted. Children were instructed to complete a food record and reminded to return it the next day for their 24-hour recall interview. A letter was included for parents, asking them to assist in recording food consumed by their children at home immediately after consumption. One third completed and returned food records for both recalls. Recalls included 2 weekdays and 1 weekend day.

Comparison of FV Intake

To compare questionnaire intake data with dietary recall data, DILQ frequency data were transformed into cups using an algorithm developed for the Eating at America's Table Study (using National Health and Nutrition Examination Survey 2003–2006 data)[24] and the 24-hour recall data (servings)[11] from Nutrition Data System for Research 2012 output were converted to cups. The use of this algorithm was described by Thompson et al[25] to convert FV screener frequency data to quantities for adults. Data from children with only 1 24-hour recall and those whose recalls were deemed unreliable (eg, FV consumption > 10 cups) were excluded from analysis (n = 5). Results from children who completed 2 or 3 24-hour recalls were included in data analysis (n = 102).

Results from the first 24-hour recall were compared with the DILQ results because the DILQ measures reported intake on 1 day. Results from all of the recalls were compared with the FVQ results because the FVQ measures reported intake on most days.

Data Analysis

The authors used Pearson correlation, disattenuated Pearson correlation, and Bland-Altman analysis to assess agreement. The disattenuated Pearson correlation adjusted for measurement error in the 24-hour recall,[26] which was estimated with a linear mixed model.[27] Bland-Altman analyses are frequently used to assess the extent of agreement between 2 continuous measures. The primary advantage of a Bland-Altman analysis is the interpretation, which remains on the scale of the outcome of interest (eg, cups of fruit intake). Bland-Altman analysis provided the bias and limits of agreement. Bias represents the average difference between 2 measures. The agreement limits define the interval containing 95% of the differences.[28] Two instruments were considered in agreement to the extent that bias was close to 0 and the limits of agreement were narrow.[29] Analysis was done with SAS software (version 9.3, SAS Institute, Inc, Cary, NC, 2011) and R (version 3.1.2, R Foundation

Table. Fruit and Vegetable Intakes Measured Using the 2 Brief Instruments and Agreement Among Multiple 24-Hour Recalls (n = 100)

Food Group	Measure	n[a]	Cups/d (SD)	P[b]	Pearson Correlation	Disattenuated Correlation	Bias[c] (Limit of Agreement)
Fruit	24-h recalls[d]	101	1.05 (0.76)	< .001	0.23	0.58	0.86 (–1.20 to +2.92)
	FVQ	99	1.92 (0.91)				
	First d 24-h recall	96	1.37 (1.27)	.17	0.16	0.40	0.26 (–2.83 to +3.35)
	DILQ	102	1.60 (1.16)				
Vegetable	24-h recalls	101	0.85 (0.68)	< .001	0.16	0.69	0.79 (–1.09 to +2.68)
	FVQ	100	1.61 (0.84)				
	First d 24-h recall	96	0.92 (1.28)	.007	0.11	0.47	−0.39 (−2.97 to +2.20)
	DILQ	102	0.54 (0.48)				

DILQ indicates A Day in the Life Questionnaire; FVQ, fruit and vegetable questionnaire.
[a]Where n ≠ 102, data were excluded; [b]*P* indicates significance level of differences in intakes between measures according to Pearson correlation analysis; [c]Bias is the average of differences between measures according to Bland-Altman analysis (difference = FVQ – 24-hour recalls or DILQ – first-day 24-hour recall). Limit of agreement = Bias ± 1.96 SD; [d]Mean intake of 2 or 3 days.

for Scientific Computing, Vienna, Austria, 1999–2012).

RESULTS

The children were Hispanic (40%), non-Hispanic white (26%), African American (24%), Asian (5%), or other (5%); 51 (50%) were boys. Approximately 80% of all children completed 3 24-hour recalls, with the remainder completing 2 recalls. Mean daily intake based on 24-hour recalls for 102 children whose data were included in the analysis was 1,737 kcal, 243 g carbohydrates, 66 g protein, and 59 g total fat. Intake data for nutrients commonly found in FV include vitamin C (91 mg), beta-carotene equivalents (2,103 μg), and total dietary fiber (15.3 g).

The Table shows mean FV intakes in cups comparing multiple 24-hour recall results with FVQ results, and comparing first-day 24-hour recall results with DILQ results. Children overestimated FV intake using the FVQ compared with 24-hour recall results. Children also overestimated fruit intake using the DILQ but underestimated vegetable intake. All agreements (Pearson correlation coefficients) between measurements ranged from 0.11 to 0.23. However, agreement increased when disattenuation was applied. Bland-Altman analysis estimated the bias and limit of agreement between each tool (Figures 1, 2). Children overestimated fruit intake by 0.26 cup and underestimated vegetable intake by 0.39 cup using the DILQ vs the first-day 24-hour recall. Using the FVQ, children overestimated FV intake by 0.86 and 0.79 cup, respectively, vs the multiple 24-hour recalls. The widest limit of agreement or spread of differences between 2 instruments ranged from –2.83 to 3.35 cup when the DILQ was used to measure fruit intake (Table). Because the FVQ responses are discrete, differences between continuous variables (24-hour recall) and categorical variables (FVQ) tend to produce diagonal lines shown in Figure 1. In addition, because many children did not report consuming vegetable items using the DILQ, and reported some vegetable intake via the 24-hour recalls, the differences resulted in the diagonal line shown in Figure 2(B).

DISCUSSION

The results suggest that the DILQ was not valid in the current study for assessment of FV intake among third-grade children for an entire day and when intake included FV from a combination or mixed dishes. However, when used to estimate intake of whole FV by children (aged 7–9 years), the instrument had performed well.[4] Moore and colleagues[30] tested the DILQ by comparing FV intake results with 24-hour dietary recalls with children (aged 9–11 years). Spearman's rank correlations for FV intakes were 0.39 and 0.41, respectively, for the whole day excluding breakfast. Wallen et al[31] compared DILQ results for FV intake against plate waste at school lunch with children (aged 9–11 years), modifying the questionnaire to include reported portion size with moderate to strong agreement for FV intake and plate waste measures. The comparison in the current study was for an entire day vs a partial day, which may account for the inconsistency in findings. The previous studies[30,31] included only whole FV whereas mixed dishes were included in the analysis for the current study, as well as a conversion of intake frequency based on the DILQ to cup servings, which also could have affected the results. However, attention to intake from mixed dishes is important because a large portion of vegetable intake (about 40%) for children has been attributed to intake from mixed dishes.[23]

Although the FVQ had a higher disattenuated Pearson correlation coefficient compared with the DILQ especially for vegetable intake, it was also not valid for assessment of FV intake among third-grade children in the current study. The disattenuated correlation coefficients for the FVQ and repeated 24-hour recalls for FV intakes were 0.58 and 0.69, respectively, indicating moderate agreement.[29] However, the low reliability of repeated measures in the 24-hour

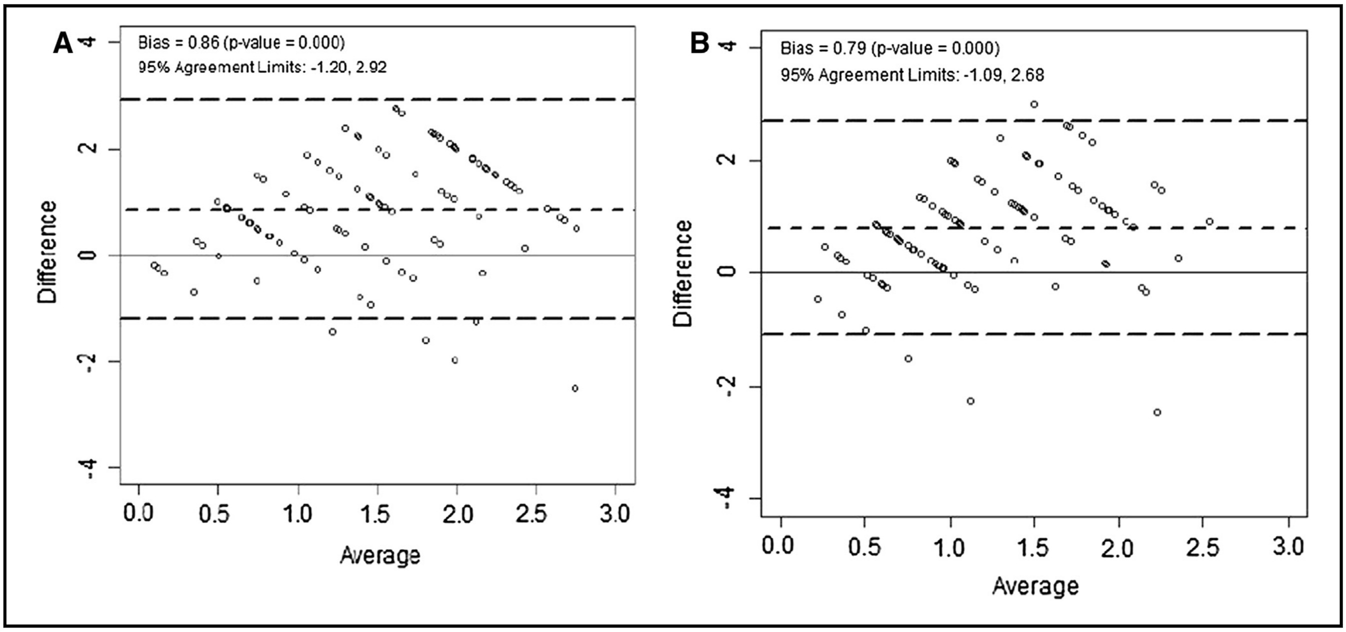

Figure 1. Bland-Altman plots indicating agreement among multiple 24-hour recalls for fruit intake (A) and vegetable intake (B) assessed by the fruit and vegetable questionnaire (n = 100). (A) The upper and lower lines (dashed) indicate limits of agreement within ±2 SD. The middle solid line indicates 0 difference. The bias line (dotted) is the average of the differences between the 2 instruments. (B) Difference = FVQ – multiple 24-hour recalls. Average = 0.5 (FVQ + average of multiple 24-hour recalls).

recalls for vegetable intake in this population makes it difficult to interpret the disattenuated correlation coefficient. This is a noted limitation of the disattenuated Pearson correlation.[32] Reliability based on intake over several days may be expected to be low because children eat different foods for meals; for example, elementary school breakfast and lunch menus typically change on a daily basis.

Other validation studies conducted among young children found low correlations between FV intake assessed with FFQs and reference tools. Domel et al[14] determined the validity of a 45-item FV FFQ among fourth- and fifth-grade children (aged 9–11 years) that was developed based on the Willett FFQ.[33] Spearman's correlation coefficients observed between a food record and FV FFQ were from –0.04 to 0.21 in a month and –0.01 to 0.25 in a week.[14] Another 7-item FV FFQ was validated among third-grade students by comparing results with those obtained from food records.[34] The

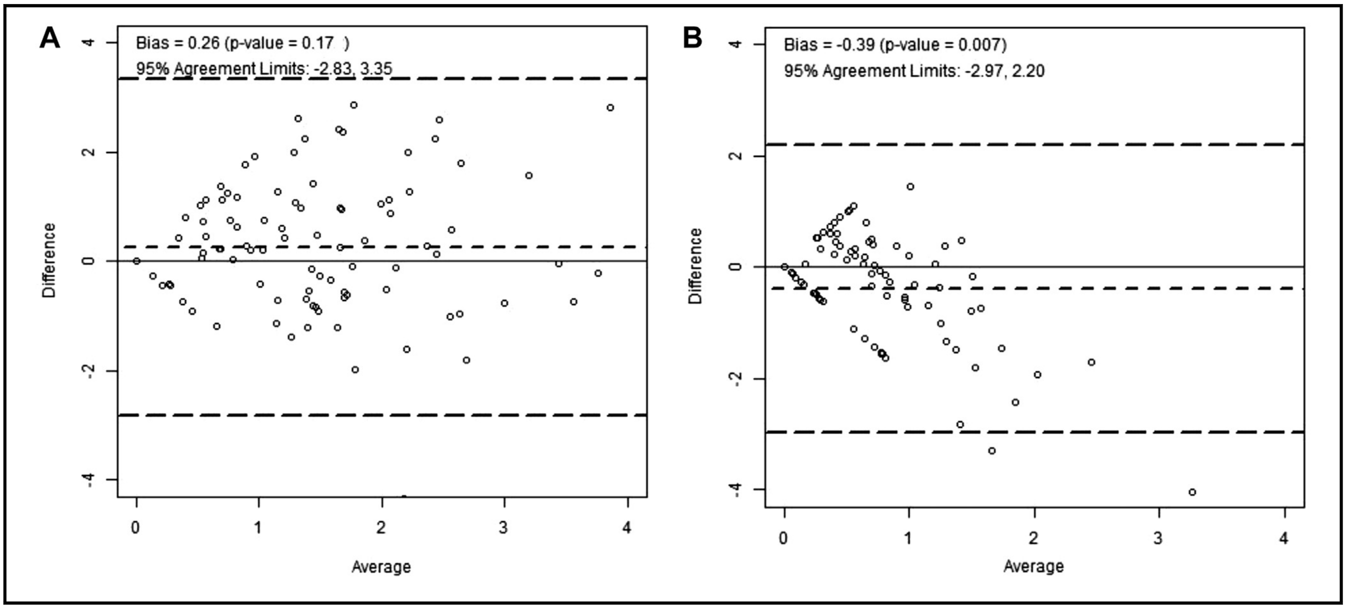

Figure 2. Bland-Altman plots indicating agreement between the first 24-hour recall for fruit intake (A) and vegetable intake (B) assessed by the Day in the Life Questionnaire (n = 99). (A) The upper and lower lines (dashed) indicate limits of agreement within ±2 SD. The middle solid line indicates 0 difference. The bias line (dotted) is the average of differences between the 2 instruments. (B) Difference = FVQ – multiple 24-hour recalls. Average = 0.5 (FVQ + average of multiple 24-hour recalls).

Pearson correlation coefficients for FV intakes were 0.14 and 0.16, which was similar to the findings in the current study. However, when a Block FFQ was compared against 3 24-hour dietary recalls among older children (aged 10–17 years), no systematic differences were observed for vegetable consumption and good agreement was observed for fruit food group intakes when examined with Bland-Altman analysis.[35] The current study found systematic differences and a large variance in mean intakes between FVQ and 24-hour dietary recalls. Agreement between assessment and reference tools may differ between studies based on the age of children and their ability to complete FFQs. Lytle and colleagues[36] validated 24-hour recalls among third-grade children in terms of nutrient intakes; however, students were not able to report accurate portion sizes. The inability to correctly indicate amounts consumed may be based on age limitations and may affect the correlation between measurements.

Limitations

The results from this study are not generalizable beyond a convenience sample of low-income, urban, ethnically diverse 8- to 9-year-old children. This study shares the limitation of other methods that require children to recall their own dietary intake from the previous day. Using biomarkers such as serum carotenoid or plate waste studies are more direct ways to measure dietary intake. For example, Townsend and Kaiser[37] used a serum carotenoid biomarker to ascertain the convergent validity of a 13-item scale to assess FV behaviors. Measuring skin carotenoid levels is another, more objective method of validating dietary intake measures.[38] The current study used brief screening tools that assessed daily intake; therefore, conducting plate waste measurements for 1 meal consumed at school (eg, lunch) was not a reasonable approach to validate the tools. Other limitations include using only 2 to 3 24-hour recalls to assess usual FV intake. Finally, having students complete the FVQ and DILQ sequentially may have resulted in inflation or deflation of reported intake.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Many SNAP-Ed programs and nutrition education programs provided by other community organizations for low-income children are under way in schools to improve FV intake; yet, the availability of practical and valid assessment tools is limited. For example, Townsend et al[39] developed and validated an instrument to assess child FV intake, called Healthy Kids. However, assessment is made via parent report and therefore is not directly comparable to the current study. The DILQ and FVQ do not appear to be wise choices for evaluation of FV nutrition education for young children based on the results of the current study and the current sample. In addition, analysis of the DILQ data from children based on the algorithm to convert frequency to cup quantities is difficult because it requires complex coding and knowledge of statistics. Other validated dietary assessment tools including 24-hour dietary recalls[36] are available to assess change in FV intake among school-aged children (aged ≥ 9 years) based on intervention research studies; however, these methods may be more costly and time-consuming.

Additional studies are needed to examine the validity of the DILQ and FVQ further in other groups of children. The Supplemental Nutrition Assistance Program–Education program as well as other nutrition education programs could benefit from intervention research to identify valid and reliable, yet practical and brief FV assessment tools for use with young children in school and community settings.

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CONFLICT OF INTEREST

The authors have not stated any conflicts of interest.