Original Article

Relative validation of Block Kids Food Screener for dietary assessment in children and adolescents

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Abstract

Food frequency questionnaires (FFQs) are less time consuming and inexpensive instruments for collecting dietary intake when compared with 24-h dietary recalls or double-labelled water; however, the validation of FFQ is important as incorrect information may lead to biased conclusions about associations. Therefore, the relative validity of the Block Kids Food Screener (BKFS) developed for use with children was examined in a convenience sample of 99 youth recruited from the Portland, OR metropolitan area. Three 24-h dietary recalls served as the reference. The relative validity was analysed after natural log transformation of all variables except glycaemic index prior to correlation analysis. Daily cup equivalent totals from the BKFS and 'servings' from 24-h recalls were used to compute average daily intake of fruits, vegetables, potatoes, whole grains, legumes, meat/fish/poultry and dairy. Protein grams (g), total kcalories, glycaemic index (glucose reference), glycaemic load (glucose reference), total saturated fat (g) and added sugar (g) were also calculated by each instrument. The correlation between data obtained from the two instruments was corrected for the within-subject variation in food intake reported by the 24-h recalls using standard nutritional assessment methodology. The de-attenuated correlations in nutritional intake between the two dietary assessment instruments ranged from 0.526 for vegetables, to 0.878 for potatoes. The 24-h recall estimated higher levels of saturated fat and added sugar consumption, higher glycaemic loads and glycaemic indices; the de-attenuated correlations of these measures ranged from 0.478 to 0.768. Assessment of Bland–Altman plots indicated no systematic difference between the two instruments for vegetable, dairy and meat/fish/poultry fat consumption. BKFS is a useful dietary assessment instrument for the nutrients and food groups it was designed to assess in children age 10–17 years.

Keywords: diet, dietary intake assessment, dietary screener, questionnaires, relative validity.

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Introduction

Many nutritional and epidemiological studies call for accurate assessment of dietary intake because of the profound importance of childhood and adolescent nutrition (Hoelscher *et al.* 2003). Methods examining nutrition behaviours should be concise, easily administered, inexpensive, valid, reliable and accurate

enough to be used throughout a variety of demographic subpopulations (Matthys *et al.* 2007). However, measuring dietary intake among children poses challenges. Children may have a difficult time recalling intake and estimating portions (Domel *et al.* 1994; Baxter *et al.* 2004; Foster *et al.* 2009; Margarey *et al.* 2011), intake may vary greatly from day-to-day (Basiotis *et al.* 1987), and children may

misreport foods consumed (Livingstone & Robson 2000). The 24-h recall is widely regarded as the best estimate of dietary intake, but this method is time consuming and costly because more than 1 day is required to capture usual intake (Burrows *et al.* 2010). Generally, 3 recall days are needed to capture usual intake of energy and commonly consumed nutrients and food groups (Burrows *et al.* 2010). More than 3 recall days may be required to capture infrequently consumed food groups such as fruits and vegetables. A review article examining the design characteristics of food frequency questionnaires (FFQs) in relation to their validity found the majority were validated against 24-h recalls or food records (Molag *et al.* 2007). Doubly labelled water is considered the gold standard reference method for validation of measurements of energy intake, but this method is rarely used because of the high costs, moderate participant burden, and the technical skills and equipment required for this technique (Burrows *et al.* 2010). FFQs provide a practical approach to dietary assessment over periods of time (Willett 1998, Treiber *et al.* 1990); however, dietary assessments for use with young populations are limited (Livingstone *et al.* 2004). Therefore, the Block Kids Food Screener (BKFS) was developed in 2007 by NutritionQuest, with researchers from Proyecto Bienstar Laredo, a school-based diabetes and obesity control programme for use with third graders (Garcia-Dominic *et al.* 2011). Later, the Division of Health Promotion and Sports Medicine at the Oregon Health and Science University, sought to use the BKFS to assess dietary intake in young athletes. Hence, the aim of this study was to

assess the relative validation of the BKFS, a brief questionnaire designed to be administered in 10–20 min, in order to assess the usual dietary intake of children and adolescents participating in sport clubs.

Materials and methods

This relative validation study of the BKFS, a study in which a new instrument is validated against another dietary estimator, was approved by the Oregon Health and Science University Institutional Review Board. Signed parental consent and participant assent were obtained. A convenience sample of children was recruited from after-school sports and sport clubs throughout the Portland, Oregon, metropolitan area. Inclusionary criteria were age 10–17, middle-school and high-school age, and ability to speak and write English. Children younger than 10 years were excluded because at that age, children generally lack the conceptual skills needed to provide reliable information on usual intake (Livingstone *et al.* 2004). Coaches were the primary contact after receiving permissions from school principals. The youth were invited to participate in the relative validation study during pre-scheduled meetings that took place during regularly scheduled team practice by a study staff member. When a potential participant expressed interest, consent forms were provided to the parents and assent forms were provided to the youth athletes. After consent and assent forms were collected by study staff, telephone interviews were conducted with each of the youth participants on three occasions. The BKFS was completed by

Key messages

- Young people are often the focus of investigation because the dietary patterns of childhood and adolescents can be indicative of adult dietary patterns.
- The BKFS food frequency questionnaire has good relative validity, can be self-administered to young people of an appropriate age, and is a relatively inexpensive method for assessing dietary intake.
- Because the BKFS assesses food intake over a longer period, it appears to capture food intake that may be missed in 3 days of 24-h dietary recalls. It also estimates whole-grain consumption based on the average whole-grain content of a food, which may increase the accuracy of the dietary intake information.
- Early interventions aimed at young people may benefit from the use of BKFS for assessing dietary intake.

youth at a scheduled meeting following the three dietary recalls. A study staff member was present to answer questions and collect the dietary assessment forms.

24-h recall procedure

Within a 7-day period, participants completed three 24-h dietary recall interviews by telephone. There were some exceptions to the 7-day period when children were difficult to reach, travelling or between parents; however, the majority were over a 7-day period. During these interviews, youth participants reported their dietary intake from the previous day, from the time they woke up to the time they went to sleep, without assistance. Two recalls were taken on weekday afternoons or early evenings following the school day, and one recall on a weekend to capture differences in dietary intake over the course of the week. The 24-h dietary recall data was collected with the Nutrition Data System for Research (NDSR) (version 2008, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA), a Windows-based interview system designed for the purpose of gathering and analysing dietary information (Nutrition Coordinating Center: University of Minnesota 2012). The software allows researchers to standardise the collection of 24-h dietary recalls and provides a multiple-pass interview script. The interview elicits a detailed summary of all foods and beverages consumed by the participant during a 24-h period for the prior day. This script allows the participant repeated opportunities to recall his or her intake for the previous day and to provide detailed food descriptions. During the interview, information was collected on the time of each eating occasion, meal type and meal location, in addition to what and how much was eaten. The interviewers followed the NDSR script protocol during each interview. Following the completion of three dietary recalls by all participants, data was exported from the NDSR software. NDSR uses a food group serving count system that consists of nine food groups and 168 food subgroups. Recommendations made by the Dietary Guidelines for Americans and the US Department of Agriculture's (USDA) Food Guide

Pyramid were used to guide decisions regarding the inclusion of foods within the 168 subgroups (Nutrition Coordinating Center: University of Minnesota 2012). A complete description of available output is available from the Nutrition Coordinating Center, publication appendix 10, but for illustration purposes a vegetable serving is defined per the Dietary Guidelines for Americans 2005 as one cup of raw leafy vegetables, one-half cup of other cooked or raw vegetables, or one-half cup of vegetable juice. When multiple forms of a food are available for a given food, the most common form is selected to represent the serving weight for the food, e.g. chopped, sliced, and grated. (Nutrition Coordinating Center: University of Minnesota 2012).

BKFS

The BKFS is a 41-item, two-page FFQ developed by NutritionQuest (Berkeley, CA, USA). This instrument was designed to evaluate dietary intake of nutrients and food groups in youth age 2–17 years. The questionnaire can be self-administered to children of appropriate age and to younger children with the assistance of a parent or caregiver. BKFS asks the subject to reflect on the frequency and quantity of foods and beverages consumed during the previous week. The frequency of consumption ranges from 'none' to 'every day'. Quantities consumed are assessed with three to four categories related to food type. For example, the BKFS asks subjects to report cold cereal quantity as the number of bowls consumed per day. Subjects also provide information on the type of cereal typically eaten and the type of milk typically consumed.

The BKFS is used to estimate the intake of fruit, vegetables, dairy, whole grains, protein sources (meat, poultry and fish in ounce equivalents), saturated fat and sources of added sugars. BKFS were administered between April 2009 and August 2010 during pre-scheduled meetings set up by researchers. Most of these meetings took place during a scheduled practice at the school or club. A researcher explained the BKFS was to be filled out based on what they had

eaten during the previous week and was available to answer questions. The participants completed BKFS the week following their three 24-h recalls. All BKFS were analysed for the following predetermined dietary variables:

- Fruit/fruit juice (cup equivalents);
- Vegetables excluding potatoes and legumes (cup equivalents);
- Potatoes, including french fries (cup equivalents);
- Whole grains (ounce equivalents);
- Saturated fat (g);
- Meat, poultry, and fish (ounce equivalents);
- Dairy (cup equivalents);
- Legumes (cup equivalents);
- Sugar/syrup added to foods/beverages during processing/preparation (teaspoons);
- Average daily glycaemic index (GI) (glucose scale); and
- Average daily glycaemic load (glucose scale).

Cup equivalents are defined in the USDA's My Pyramid Equivalents Database (MPED; version 2.0 for USDA Survey Foods, 2003–2004) and food codes identified in the food list development of BKFS were linked to the USDA's Food and Nutrient Database for Dietary Studies (FNDDS) and the USDA's MPED (Continuing Survey of Food Intakes by Individuals 2012). The BKFS food list was developed through an analysis of the National Health and Nutrition Examination Survey 24-h dietary recall data, years 2002–2006 based upon approximately 10 000 dietary recalls. The questionnaire's nutrient and food group analysis database was developed by identifying consumption and population weighted, mean nutrient and food group intakes for five different age–sex groups, for all questionnaire line items. NDSR food groups are not identical to USDA MPED 2.0 food groups used by BKFS, as fruit, vegetable, potato and legume consumption is measured in half cup servings in the NDSR, but the BKFS computes the cup equivalent consumption for these food groups. For these food groups, one BKFS cup equivalent serving was converted to two half cup 'servings' to allow comparison of the two methods.

Compensation

At the conclusion of this study, the subjects received a summary report of their dietary intake from NDSR in servings per day and were referred to MyPyramid.gov for further information on recommended servings per day (MyPyramid 2012). Participants also received a \$10 gift card to Fred Meyer, a local retail chain, Subway or iTunes as a thank you gift.

Analyses

Because of the skewed nature of the data distributions, all variables except GI from both BKFS and 24-h recalls were natural log-transformed prior to correlation analysis. Because zero values cannot be log-transformed, and many subjects did not report consuming specific food categories in the time period assessed by this study, floor values were imputed for subjects with zero values before log transformation. The imputed values were 0.5 times the minimal observed consumption/kcalories multiplied by the recorded calorie consumption for the day. The use of a floor imputation allowed for the estimation of the within-subject variance component to determine de-attenuated correlations. The subject means of the log-transformed NDSR variables and of the GI values over the 3 days of data collection were generated (equivalent to the geometric mean for the log-transformed values) for use in evaluating the agreement with the BKFS data. The BKFS were analysed by NutritionQuest (Berkeley, CA) for nutrients and food group servings (NutritionQuest 2012). In general, it was necessary to impute NDSR values more often than for BKFS, as it is more common for a food group to be missing from 3 days of food consumption than from a full week. The effect of imputation on correlation between results was checked by repeating the analyses excluding any subjects with imputed values. Sensitivity analyses indicated imputations did not significantly change the results of the correlation.

Variability in food intake between time intervals is expected

The BKFS and the NDSR 24-h food recalls assessed food intakes for different periods of time; therefore,

Table 1. Participant summary

	Average (<i>n</i> = 99)	Males (<i>n</i> = 35)	Females (<i>n</i> = 64)
Age	15.2 ± 1.8	15.1 ± 1.8	15.2 ± 1.8
10	3	1	2
11	4	1	3
12	1	0	1
13	5	4	1
14	16	6	10
15	23	6	17
16	19	7	12
17	28	10	18

some of the differences in intake as assessed by the two instruments will be due to actual differences in consumption, not differences in assessment. In order to adjust for this, the ratios of within-person food intake variation at different time points to between-person variation in consumption patterns, the log-transformed variables and the GI data were determined by variance decomposition (SAS, PROC VARCOMP command, SAS Institute Inc., Cary, NC, USA) of the NDSR data, which was available for multiple time points. This ratio was used in the calculation of the de-attenuated correlations presented here. The de-attenuated correlations adjusts the correlation between the two instruments for the within-subject variance expected for measurements assessed over different time intervals (Rockett *et al.* 1997). Because measurements obtained by different methods can be systematically different, but still be highly correlated, agreement between the two instruments was also visually assessed using the Bland–Altman method (Bland & Altman 1986), following the recommendations for scaling the vertical axis presented by Dewitte *et al.* (2002). Bland–Altman plots are used to compare two methods of measurement or a new with an established method to detect systematic differences between the two methods.

Results

Ninety-nine student athletes completed both the three 24-h recalls and the BKFS. Subjects were females (*n* = 64) and males (*n* = 35) with a mean age of 15 years (range 10–17) (Table 1). A summary of

average energy and macronutrient intake from the NDSR data is presented in Table 2 for males and females. De-attenuated correlations between the two instruments range from 0.526 for vegetables, to 0.878 for potatoes (Table 3). For the reported summary nutrient variables, saturated fat, added sugar consumption, glycaemic loads and glycaemic indices, the de-attenuated correlations (Table 4) range from 0.478 to 0.768. Total kcalories and protein intake in g are also shown (Table 4), although BKFS was not originally constructed to measure these nutrients. Examination of Bland–Altman plots (not shown) indicated good agreement between the two instruments. The Bland–Altman plots for vegetable, dairy, meat/fish/poultry and saturated fat consumption indicate that there were no systematic differences between the two instruments for subjects with no days of zero consumption reported in the NDSR nutrient or food groups. For subjects with no consumption reported for 1 or more days in the NDSR data, the BKFS estimates of consumption were systematically higher.

Whole grain and fruit consumption estimates show the same pattern observed for the vegetable, dairy meat/fish/poultry and saturated fat estimates except that there is also a noticeable increase in the variability between measures for students whose average log consumption is less than zero (one serving) even if there are no imputed values for NDSR intake. In these subjects, the greater size of the absolute difference does not appear to be biased. For whole grain, there were three subjects with no imputed floor values with differences less than the mean minus one standard deviation and two students with estimates greater than the mean difference plus one standard deviation. For fruit consumption, there were five subjects with differences less than the mean minus one standard deviation and five with differences greater than the mean plus one standard deviation. NDSR reports higher consumption estimates for added sugar consumption than the BKFS instrument; however, Bland–Altman plots showed that the differences between the instruments were uniform across the range of consumption. For the estimated GI and glycaemic load, Bland–Altman plots again showed uniform differences across the range of consumption.

Table 2. Nutrition Data System for Research energy and macronutrient intakes summary

	Average (<i>n</i> = 99)	Males (<i>n</i> = 35)	Females (<i>n</i> = 64)
Energy intake (kcalories per day)	1950 ± 662	2399 ± 827	1705 ± 373
Mean ± SD			
Fat (grams per day)	69 ± 29	86 ± 36	60 ± 20
Mean ± SD			
Fat (% total kcalories)	31 ± 6	31 ± 5	31 ± 7
Mean ± SD			
Carbohydrate (g per day)	262 ± 92	315 ± 111	233 ± 65
Mean ± SD			
Carbohydrate (% total kcalories)	53 ± 7	52 ± 6	53 ± 8
Mean ± SD			
Protein (g per day)	78 ± 29	100 ± 34	66 ± 20
Mean ± SD			
Protein (% total kcalories)	16 ± 3	17 ± 3	16 ± 3
Mean ± SD			
Saturated fat (g per day)	25 ± 12	32 ± 15	22 ± 9
Mean ± SD			
Added sugars (g per day)	70 ± 35	79 ± 37	65 ± 34
Mean ± SD			
Glycaemic index (glucose scale)	60 ± 4	60 ± 4	60 ± 4
Glycaemic load (glucose scale)	148 ± 53	177 ± 63	132 ± 38

SD, standard deviation.

Discussion

Although there are systematic differences between the two instruments in the estimation of food group servings (except whole grain and meat/fish/poultry, which are the two cases in which the scales of the two assessments are closest to each other), the de-attenuated correlations are good. Compared with other FFQ validation studies, the correlations we found, 0.478–0.878, are good. The observed correlations are in the ranges observed in other validation studies (Khani *et al.* 2004; Paalanen *et al.* 2006; Deschamps *et al.* 2009; Petkeviciene *et al.* 2009; Haftenberger *et al.* 2010), and in some cases are better. For example, a German study found correlations ranging between 0.15 and 0.80 with approximately two-thirds values higher than 0.30 (Haftenberger *et al.* 2010). For the reported summary nutrient variables, NDSR reported higher values for saturated fat, added sugar consumption, glycaemic loads and glycaemic indices, yet the de-attenuated correlations are high. Total kcalories and protein intake in g were also compared and demonstrated good de-attenuated correlations; however, these are variables that are expected to be

less accurate as the BKFS was not originally constructed to measure these nutrients.

The inherent variability in consumption is likely to be greater in students with low average consumption of food groups, but because this scenario is not common, it is difficult to draw conclusions. The interpretation of Bland–Altman plots for legumes and potato consumption is problematic because these are food items that are not consumed daily by all youth, therefore, many participants have imputed floor values on these items for at least 1 day.

Differences between NDSR reports and BKFS are most likely due to the higher probability of failing to capture a food item that is eaten infrequently when assessing intake over 3 days rather than reporting intake frequency over a longer time period and the ability of the BKFS instrument to capture food groups consumed as ingredients of mixed dishes. Although the NDSR instrument contains information on common mixed dishes, mixed dishes (home- or restaurant-prepared dishes) not found in NDSR must be captured by the dietary interviewer by collecting as much information as possible from the participant

Table 3. Summary of report values

Variable	Median (interquartile) range	
	NDSR	Block Kids Food Screener
	Mean of 3 days	
Fruit/fruit juice cup servings* or cup equivalent	0.99 (0.33–1.62) 0–4.32	1.65 (0.91–2.42) 0.09–4.81
Vegetable cup servings* or cup equivalent	0.69 (0.38–1.18) 0–2.33	0.80 (0.46–1.38) 0.16–2.67
Potatoes cup servings* or cup equivalent	0.05 (0–0.21) 0–2.96	0.17 (0–0.33) 0–0.98
Whole grains cup servings* or cup equivalent	1.68 (0.71–2.50) 0–7.71	0.81 (0.38–1.20) 0.02–3.45
Sat fat (g)	21.6 (16.8–30.9) 8.7–68.3	17.4 (12.5–23.7) 5.6–77.4
Meat/fish/poultry oz equivalent	3.31 (2.01–4.78) 0–9.97	2.30 (1.62–3.61) 0.24–17.7
Dairy servings (1 cup) or cup equivalent	2.08 (1.61–3.01) 0.07–8.58	1.81 (1.20–3.00) 0.37–5.80
Legumes cup servings* or cup equivalent	0 (0–0.21) 0–1.67	0 (0–0.08) 0–0.49
Added sugar (g)	64.4 (42.0–95.5) 9.18–162.5	30.8 (21.9–41.3) 2.6–167.5
Average daily glycaemic load	137.6 (107.9–177.6) 41.0–313.5	71.8 (55.6–93.3) 28.5–264.1
Average daily glycaemic index [†] (glucose scale)	60.5 (56.9–63.0) 42.7–69.5	49.4 (47.3–51.5) 40.0–56.6

NDSR, Nutrition Data System for Research. *NDSR reported servings (one-half cup) were divided by 2 to approximate the cup equivalent measure reported by BKFS. [†]Glycaemic load for the day is calculated by summing the glycaemic load of all items for the day. Glycaemic load for individual items is the product of grams of carbohydrate $\times$ the glycaemic index/100.

regarding name of the dish or food, country of origin, ingredients, amount eaten, method of preparation which may not be known.

The systematic differences in the consumption of added sugar reflect the fact that NDSR reports for 'added sugars' the total carbohydrate value of a food rather than its total sugar value, for component ingredients like high-fructose corn syrup (P. Harara, 'unpublished observations'). By contrast, the BKFS values are derived from the USDA FNDDS and MPED (Continuing Survey of Food Intakes by Individuals 2012), which both assign to 'added sugars' only the portion of the carbohydrate identified as a sugar. For the most commonly consumed added sugar, high-fructose corn syrup, there is nearly a threefold difference in USDA and NDSR's estimates of total sugar. According to USDA, in 100 g of high-

fructose corn syrup there are 76.00 g of carbohydrate and 26.36 g of total sugar in contrast, NDSR assigns all 76.00 g to total sugar.

For whole-grain carbohydrates, the BKFS would be expected to estimate a lower intake of whole grains than NDSR because of the differences in rules for assignment of values. NDSR considers the entire amount of grain in a food to be 'whole grain' if whole grain is the first ingredient. If 'whole grain' is not the first ingredient, NDSR assigns half of total grain as whole grain regardless of the actual proportion. In contrast, the BKFS approximates the whole grain portion in foods that contain some whole grain based on USDA MPED data and assigns to 'whole grain' only the portion of the total grain that is whole grain. To illustrate with a common food item, the BKFS item 'whole-wheat bread or rolls (NOT white bread)',

Table 4. Instrument agreement

Variable	Correlation between instruments (all students)		Difference in values (BKFS – NDSR)	
	Pearson correlation	Ratio of within-subject to between-subject variance	De-attenuated correlation	All students
				Students with no imputed floor values
				Mean $\pm$ SD
Fruit cup servings or cup equivalent	0.465 [†]	1.97	0.600	-1.71 $\pm$ 1.60 [†]
Vegetable cup servings or cup equivalent	0.384 [†]	2.63	0.526	-0.84 $\pm$ 1.44 [†]
Potatoes cup servings or cup equivalent	0.250*	34.04	0.878	-1.99 $\pm$ 1.37 [†]
Legumes cup servings or cup equivalent	0.445 [†]	6.83	0.820	0.42 $\pm$ 0.87 [†]
Whole grains cup servings or cup equivalent	0.453 [†]	3.05	0.643	0.23 $\pm$ 1.19
Dairy servings (1 cup) or cup equivalent	0.629 [†]	2.73	0.869	-0.27 $\pm$ 0.83*
Meat/fish/poultry	0.521 [†]	2.13	0.681	-0.16 $\pm$ 0.92
Total calories	0.580 [†]	0.94	0.664	0.33 $\pm$ 0.34 [†]
Total Protein (g)	0.582 [†]	1.30	0.697	-0.22 $\pm$ 0.37 [†]
Sat Fat (g)	0.593 [†]	2.04	0.768	0.19 $\pm$ 0.42 [†]
Added sugar (g)	0.325 [†]	3.48	0.478	0.54 $\pm$ 0.83 [†]
Glycaemic load	0.473 [†]	1.72	0.593	0.58 $\pm$ 0.42 [†]
GI	0.222 [†]	16.52	0.567	10.79 $\pm$ 4.67 [†]

BKFS, Block Kids Food Screener; GI, glycaemic index; NDSR, Nutrition Data System for Research; SD, standard deviation. All data were log-transformed except GI. *Significant at $P < 0.05$.

[†]Significant at $P < 0.0001$.

assigns approximately half of the total grain value to whole grain, representing population-based intake of 'brown' breads made with about 50% whole-wheat flour. The estimation approach used by the NDSR would be expected to overestimate the amount of whole grain actually consumed. We would expect the NDSR values to be higher than BKFS estimates, and the differences between the two to be non-linear in relation, reducing the correlation between the two estimates.

The NDSR programme reported a significant number of nutrient and food group estimates as zero. This is likely because of the fact that the 3 days of recalls we collected were insufficient to adequately measure complete dietary intake, particularly of infrequently consumed food groups such as fruits and vegetables. BKFS reported significantly fewer zero values, likely because of the longer reference period of 7 days, which makes the total omission of food groups less likely. It also seems likely that the BKFS captures more in take for some food groups as ingredients in mixed dishes than NDSR. For example, fruit in baked goods is captured by the BKFS, but not by NDSR.

Limitations

This study did not determine the race and/or ethnicity of participants, and while minorities were not excluded, targeted enrolment could broaden the generalisability of these results. The 3 days of 24-h recall may be too few to measure dietary intake adequately, particularly intake of infrequently consumed food groups (Molag *et al.* 2007). It is important to note that even food groups like vegetables and fruits are likely to be underestimated by only 3 days of recalls. For example, in the 2005 Centers for Disease Control and Prevention Behavioural Risk Factors Surveillance System data, 62.8% of the US population reported eating an average of less than one (but greater than zero) serving of vegetables per day. With 3 days of recall data, the likelihood of capturing fruit and vegetable intake is reduced. Furthermore, 99 subjects may not yield enough statistical power, but this sample size is similar to other validation studies (Cullen *et al.* 2004, 2008). In addition, reaching sub-

jects was difficult at times, and some of the NDSR 24-h recalls and BKFS data were collected over somewhat different time periods. This likely contributed to some of the variability between estimates from the two instruments because of the expected variability in actual consumption from the time periods assessed. Finally, and perhaps most notably, is the manner in which NDSR assigns sugar values, as discussed earlier. One would expect to find differences in added sugars between the two instruments in part because of differences in assignment of added sugar. This issue is likely to impact researchers that use NDSR to calculate added sugars; a subject that may be important to our understanding of the role of added sugars and energy balance. However, it should also be noted that NDSR committed to change the way sugars are calculated in 2012 to correct for this (Nutrition Coordinating Center 2012).

Conclusions

The results suggest that the BKFS has good relative validity for the nutrients and food groups examined for children and adolescents age 10–17 years. Overall correlations with 24-h dietary recalls were high and Bland–Altman plots showed strong agreement. Dietary assessment methods all have their inherent limitations, but an FFQ such as the BKFS takes little time to administer and has useful applications when collecting child and adolescent dietary intake.

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NutritionQuest supplied the BKFS FFQ and a \$10.00 gift card to each participant.

Conflicts of interest

MH and JO'M have no conflict of interest to report. TB and JN are employed by Nutrition Quest; however, they did not assist with data collection or data analysis.

Contributions

MH conceptualised the study and collected data with the assistance of three graduate students (MB, SH and MS), while overseeing quality assurance and control; JO'M completed all statistical analyses; TB assisted with the plan for data collection and analysis, namely, which variables the screener was developed to assess and with the interpretation of data; and JN assisted with definition of data elements and interpretation of data. All authors contributed to the editing of the final paper.

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