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Validating the Food Behavior Questions from the Elementary School SPAN Questionnaire

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ABSTRACT

Background: The School Physical Activity and Nutrition (SPAN) questionnaire was developed as a surveillance instrument to measure physical activity, nutrition attitudes, and dietary and physical activity behaviors in children and adolescents. The SPAN questionnaire has 2 versions.

Objective: This study was conducted to evaluate the validity of food consumption items from the elementary school version of the SPAN questionnaire.

Design: Validity was assessed by comparing food items selected on the questionnaire with food items reported from a single 24-hour recall covering the same reference period.

Setting: 5 elementary schools in Indiana.

Participants: Fourth-grade student volunteers (N = 121) from 5 elementary schools.

Main Outcome Measure: Agreement between responses to SPAN questionnaire items and reference values obtained through 24-hour dietary recall.

Analysis: The agreement between the questionnaire and the 24-hour recall was measured using Spearman correlation, percentage agreement, and kappa statistic.

Results: Correlation between SPAN item responses and recall data ranged from .25 (bread and related products) to .67 (gravy). The percentage agreement ranged from 26% (bread and related products) to 90% (gravy). The kappa statistic varied from .06 (chocolate candy) to .60 (beans).

Conclusions and implications: Results from this study indicate that the SPAN questionnaire can be administered in the classroom quickly and easily to measure many previous day dietary behaviors of fourth graders. However, questions addressing consumption of “vegetables,” “candy,” and “snacks” need further investigation.

Key Words: validity, food behavior questions, elementary, children

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INTRODUCTION

Obesity is a major public health problem in the United States. The prevalence of overweight in the United States increased from 13.9% in 1999-2000 to 17.1% in 2003-2004 among children aged 2-19 years.¹ Results from the National Health and Nutrition Examination Survey (NHANES) showed that the prevalence of overweight tripled over the

past 3 decades among children aged 6 to 11 years from 4% (1971-1974) to 18.8% (2003-2004). Studies have shown overweight children tend to become obese adults.²⁻⁴

A major risk factor for obesity is an unhealthful dietary pattern. Analysis of eating patterns in children from the Bogalusa Heart Study revealed that consumption of sweetened beverages, sweets, meats, and low-quality food (including salty snacks, candy, desserts, and fats/oil) were positively associated with overweight.⁵ Dietary patterns developed in childhood are often carried into adolescence.⁶ Therefore, it is important to be able to monitor children's dietary habits. Measurement methods such as 24-hour dietary recall and food record methods measure the amount actually consumed by individuals, but they are expensive, time consuming, and a burden to the subjects,⁷ especially in school settings.⁸ Hence most studies use self-administered questionnaires to measure dietary habits. These question-

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naires should be valid and reliable for the population. The purpose of this article is to report validity of food-related questions in the School Physical Activity and Nutrition (SPAN) elementary-level questionnaire administered to rural fourth-grade school children.

METHODS

With support from the Centers for Disease Control and Prevention (CDC) and the United States Department of Agriculture (USDA), the School Physical Activity and Nutrition (SPAN) questionnaire was developed as a surveillance instrument to measure physical activity, nutrition attitudes, and food behaviors in children and adolescents.⁹ This questionnaire has 2 versions, for elementary students and for middle/high school students. The elementary school version studied here is 10 pages long with 54 questions. It contains pictures to help children understand the questions and was found to have a reading level appropriate for a 9-year-old child using the Dale-Chall formula.⁹ The first page contains personal information including age, gender, ethnicity/race, and date of birth (6 questions). Pages 2-6 contain 20 questions addressing intake frequency of various food items. The food behaviors measured by this instrument include recall of high fat food items, high calorie/low nutrient food items, fruits, vegetables, and grain products⁹ from the previous day. This type of short-term recall is better for children because their cognitive skill is not developed sufficiently to estimate averaging and frequency as found in a traditional food frequency questionnaire.¹⁰ Other items on this questionnaire measure nutrition knowledge, attitudes, and physical activity patterns. The elementary version of the questionnaire was previously tested for reliability, and results indicated that it is reliable for food choice behaviors but less reliable for nutrition knowledge and attitudes.¹¹

The 20 food intake behavior questions in the elementary school version were validated by comparison of questionnaire responses to food items measured by a 24-hour dietary recall. The SPAN questionnaire is intended to measure the food consumed the previous day in a group, therefore a single 24-hour recall was selected as the standard measure.

A convenience sample of 120 fourth-grade students from 5 elementary schools in south-central Indiana participated in this study during the spring and fall of 2004. The study protocol and survey instrument were approved by the Indiana University Campus Committee for the Protection of Human Subjects and by administrators from the participating schools. Active consent by the parent/guardians and assent by the students were obtained before collecting the data.

Over 50% of the fourth-grade students from 5 schools participated in the study (specifically, 28.3%, 33.3%, 42.3%, 73.1%, and 73.3% participated at the individual schools). Nine boys and 2 girls were excluded from the

study, as their dietary recalls were considered unreliable based on the judgment of the interviewers. The 24-hour recall data were also checked for plausibility by determining energy intake exceeding 5000 kcal; none of the students included in the analysis exceeded this value. Data were also checked for underreporting by looking for daily caloric intake below 500 kcal. None of the calculated energy intakes fell below 500 kcal.

Recalls were collected during face-to-face interviews using standard protocols for the Nutrition Data System for Research (NDS-R) software, version 4.06 (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, Food and Nutrition Database 34, May 2003). This protocol used a multiple-pass approach¹² to reduce underreporting and to aid in further standardization of the interviews. Food items were directly entered into the computer by name. Data were collected at the schools by trained personnel using NDS-R. Training consisted of a 2-day session at the Nutrition Coordinating Center, University of Minnesota, Minneapolis. In addition, before collecting the data, interviewers practiced the techniques for 2 weeks with 20 volunteers in monitored interviews. Volunteers were interviewed by multiple interviewers, and variability in data collection was discussed and consensus on interpretation was reached. Variation in interviewers' results was addressed, and interviewers further practiced techniques that incorporated the group suggestions. Inter-interviewer reliability was not formally determined. In addition, during actual data collection interviews, notes were made by the interviewer on any items that were unclear; these items were discussed among the interviewers at a later time to arrive at a consistent interpretation. The purpose of training and practicing was to ensure standardization during the actual interviews.

At each school, the student volunteers were randomly divided into 2 groups. Group 1 completed the questionnaire in the morning, followed by a 24-hour recall at least 2 hours later. Group 2 completed the 24-hour dietary recall in the morning, followed by the questionnaire at least 2 hours later. The maximum amount of time between the recall and the survey was 5 hours. Maintaining at least a two-hour difference between recall and survey administration was necessary to reduce the memory effect of the previous treatment. Between the 2 procedures, students attended classes and ate lunch; both activities might have further reduced memory effects. The recall and questionnaire were administered to the student volunteers on Tuesday through Friday; the specific day was coordinated to be convenient to the specific classroom teacher. This data collection arrangement was followed because dietary habits tend to vary on weekends more than weekdays.⁹ In addition, data were not collected on the day following a holiday. Typically, 3 investigators traveled to the school, 2 of whom began individual recalls with the group 2 children during the first period of the school day, while the third investigator administered the SPAN questionnaire to the group 1 children. The group 2 children completed the SPAN question-

naire at least 2 hours following the completion of the recall of the last child in group 2. The SPAN questionnaire was read aloud to students in a quiet place to avoid distraction from nonparticipants using a standard protocol that included examples of how to answer the questions. Eight to 16 students participated in the study per day.

Data Analysis

Several steps were followed to organize and analyze data. The SPAN questionnaires were examined for multiple markings or other evidence of discrepancies that could invalidate them for the purpose of the study. After examination, the completed SPAN questionnaires were scanned to reduce errors that might have resulted during manual data entry. Scanned data were transformed to Statistical Package for the Social Sciences (SPSS) format.

The 24-hour dietary recall reports were edited after the recall. The previous day's lunch and breakfast menus and portion sizes were obtained from school food services to facilitate editing. For example, if the student did not know the type of milk they consumed from school lunch, the information obtained from school services was used for editing purposes. The 24-hour dietary recall data from the NDS-R software food and meal output files were obtained for each student and grouped into food categories to match the food items in the SPAN survey. For example, all the vegetables reported as consumed were matched to the SPAN survey vegetable consumption question. Food items that were not an exact match with the SPAN survey food categories were coded after review by a panel of 4 trained nutrition professionals. Most of these food items included mixed dishes containing food listed in several questions. For example, ravioli that contained meat, pasta, and vegetable was matched with questions pertaining to consumption of meat, pasta, and vegetables, respectively.

Analyses were conducted to test for agreement between the responses to food questions in the SPAN survey and food items recorded during the recall. Data obtained from boys and girls were analyzed separately and pooled later. For each food-related SPAN question evaluated, 3 different analyses—correlation, percentage agreement, and weighted kappa statistic—were used to assess the validity. The kappa statistic (unweighted) was used for the 2 yes/no response items, ie, to “Yesterday, did you eat breakfast?” and “Yesterday, did you take a vitamin pill?” Spearman correlations were computed because data were not normally distributed. Data were analyzed using Statistical Package for the Social Sciences version 12.0 (SPSS, Inc. Chicago, IL, 2003) and Statistical Analysis System 8.0 for Windows (SAS Institute, Cary, NC, 1999). An α level of .05 was selected for hypothesis testing to reduce chances of Type 1 errors.

RESULTS

The study sample consisted of 110 students, 47% boys and 53% girls, with ages ranging from 9 to 11 years and a mean

of 10.31 years ($SD \pm 0.5$). Ethnicity, as reported by the students, was primarily “White, non-Hispanic, non-Latino” (70%), followed by “Others” (19.1%), “American Indian or Alaskan Native” (7.3%), “Hispanic or Latino” (18%), “Black or African American” (0.9%), and “Native Hawaiian or Other Pacific Islander” (0.9%). Students took approximately 25-35 minutes to complete the survey and 20-30 minutes to complete the 24-hour dietary recall interview.

Spearman Correlation

Correlation between food items recoded on the 24-hour recall and questionnaire responses and their confidence intervals are reported in the Table. Correlation coefficients ranged from 0.11 for chocolate candy to 0.67 for gravy. Correlation coefficients for questions on consumption of french fries or any chips and consumption of gravy were different between girls and boys. In both cases, the correlation coefficient was higher for girls ($r = 0.86$ for consumption of gravy, $r = 0.78$ for consumption of french fries or any chips) than boys ($r = 0.49$ for consumption of gravy, $r = 0.32$ for consumption of french fries or any chips).

Kappa Statistics

The kappa statistic values are shown in the Table. The kappa statistic values also covered a wide range, from .06 for chocolate candy to .60 for beans. Items addressing consumption of gravy, hot or cold cereal, and beans showed agreement above .5. Confidence intervals of the kappa statistic indicated that there was no significant difference between boys and girls for all the food items except gravy and french fries or any chips. Girls showed higher agreement (kappa = .85 for consumption of gravy, kappa = .63 for consumption of french fries or any chips) compared to boys (kappa = .36 for consumption of gravy, kappa = .20 for consumption of french fries or any chips). All 3 tests—percentage agreement, Spearman correlation, and kappa statistics—showed similar results.

Percentage Agreement

The percentage agreement between food items recorded on the 24-hour recall and survey responses is shown in the Table. Food items recoded on the 24-hour recalls had a wide range of agreement, from low for bread, bun, bagel, tortilla, or roll (26%) to high for gravy (90%) when compared with responses on the SPAN questionnaire. The SPAN report of having a snack showed low agreement (39%) with the criterion value. There was a gender difference in agreement for the questions on consumption of gravy and consumption of french fries or any chips, indicating questionnaire agreement with recall data was better among girls (97% for consumption of gravy, 71% for con-

Table. Association between Questionnaire Responses and Items Recorded from Recall*†

Food Items	Total <i>r</i> (95% CI)	Total kappa (95% CI)	Total Agreement (%)
Gravy on food or by itself (Q9)	0.67 (0.55, 0.76)	.56 (.34, .77)	90
Beans (all except green beans) (Q19)	0.66 (0.54, 0.75)	.60 (.42, .79)	88
Hot or cold cereal (Q16)	0.66 (0.54, 0.75)	.54 (.42, .67)	76
Rice, macaroni, spaghetti, or pasta noodles (Q14)	0.64 (0.51, 0.74)	.47 (.35, .59)	64
Milk, all flavors, & with other food/drinks (Q12)	0.56 (0.42, 0.68)	.48 (.35, .61)	56
French fries or any chips (Q17)	0.56 (0.42, 0.68)	.44 (.31, .56)	60
Sodas or soft drinks (Q23)	0.52 (0.37, 0.64)	.38 (.25, .50)	53
Frozen desserts (Q24)	0.47 (0.31, 0.60)	.33 (.18, .49)	75
100% fruit juice (Q21)	0.47 (0.31, 0.60)	.40 (.27, .54)	65
Cheese alone, on pizza, or in dishes (Q11)	0.46 (0.3, 0.60)	.31 (.18, .43)	46
Peanuts or peanut butter (Q10)	0.44 (0.28, 0.58)	.33 (.15, .50)	79
Fried meats: chicken, beef, pork, fish (Q8)	0.43 (0.26, 0.57)	.38 (.23, .54)	72
Fruit flavored drinks & sports drinks (Q22)	0.41 (0.24, 0.55)	.27 (.15, .39)	53
Fruit (Q20)	0.40 (0.23, 0.55)	.27 (.15, .39)	51
Sweet, high-fat baked products (Q25)	0.37 (0.20, 0.52)	.24 (.11, .37)	57
Red meats (Q7)	0.37 (0.2, 0.52)	.24 (.11, .37)	40
Vegetables, including salads & potatoes (Q18)	0.34 (0.16, 0.50)	.17 (.05, .29)	27
Yogurt or cottage cheese or a yogurt drink (Q13)	0.31 (0.13, 0.47)	.11 (.05, .27)	83
Bread, bun, bagel, tortilla, or roll (Q15)	0.25 (0.07, 0.42)	.13 (.03, .23)	26
Chocolate candy (Q26)	0.11 (−0.08, 0.29)	.06 (−.06, .19)	48
Other behaviors			
Ate breakfast (Q27)	0.73 (0.63, 0.81)	.72 (.53, .91)	94
Number of meals (Q28)	0.64 (0.51, 0.74)	.49 (.32, .67)	85
Number of snacks (Q29)	0.16 (−0.03, 0.34)	.08 (−.05, .20)	39
Vitamin pill (Q30)	0.54 (0.39, 0.66)	.53 (.36, .70)	80

*Food items and other behaviors are listed in order of decreasing correlation (*r*).

†Titles for food items are condensed from the wording of questionnaire items. For example, data reported in “Red meats” are from “Yesterday, did you eat hamburger meats, hot dogs, sausage (chorizo), steak, ribs?”

sumption of french fries or any chips) than boys (83% for consumption of gravy, 48% for consumption of french fries or any chips) for these 2 items.

DISCUSSION

The validity of a food questionnaire is the degree to which the instrument measures the dietary intake of the subjects it was designed to study. Studies of the validity of a food frequency questionnaire (FFQ) are often difficult to carry out owing to the problems in obtaining a sufficiently large and representative sample of the population to which FFQ may be applied, and the lack of a gold-standard reference method. The SPAN questionnaire uses a nonquantified food frequency approach to assess the previous day's food consumption in which the frequency of consumption of food items is noted without the portion sizes. Hence, students should know the food items that they ate and the number of times they ate each food item during that day.

There is no agreement in the literature as to the best statistical method for assessing the validity of dietary assessment tools,¹³ though it is essential to use more than one

statistical method to provide credence to the results.^{14,15} The frequently used method of assessing agreement in ranking between a food frequency questionnaire and the 24-hour dietary recall is Spearman rank correlation for data with non-normal distribution. Other indicators of agreement include percentage agreement and kappa statistic.

Criterion measures, used for validation, should be precise, and errors resulting from one method should be independent of the other method.⁷ The study population was fourth-grade students (aged 9-11 years); hence, a 24-hour recall was selected as the criterion method to overcome the difficulties associated with the literacy and motivational levels. Although the intra-individual variability in diet excludes the use of a single recall as an accurate representation of individual dietary intake, the recalls provide a valid assessment of group level mean intake.⁸ Several studies support the validity of this method in school-aged children.^{16,17}

Individual food-related question responses were compared with the responses obtained from a 24-hour recall where both the testing and the criterion methods covered the same dietary intake period. Values of kappa $\geq .75$

indicate almost perfect agreement, .45 to < .75 indicate substantial agreement, .20 to < .45 moderate agreement, .00 to < .20 fair agreement, and < .00 poor agreement.¹⁸ Well-defined food items and food items consumed less frequently had higher validation scores compared to food in mixed dishes using all 3 methods of validation. For example, gravy, a single food item, had 90% agreement, a kappa = .56, and $r = 0.67$. Less frequently consumed food, such as beans, had 88% agreement, kappa = .60, and $r = 0.60$.

Results of this study were compared with the validation study of middle and high school version of the questionnaire. For fourth-grade students, for the item addressing chocolate candy ($r = 0.11$, kappa = .06, and 48% agreement) had poor or low validity, but a similar question for eighth graders showed a better agreement, $r = 0.57$, kappa = .52, and 75% agreement.⁹ Food items that were consumed more frequently tended to have low validity scores compared to food items that were consumed less frequently. Reported consumption of bread, buns, bagels, and tortillas also had lower validity. This finding may be because the children needed to count the slices of bread in a sandwich as 2 servings, but failed to do so. The percentage agreement was lower for questions addressing intake of vegetables, milk, and cheese (percentage agreement 27% to 56%). These lower scores may be because these food items were consumed most of the time as a part of a mixed dish, such as cheese on pizza or milk on cereal. For example, 90% of the students responded in both the questionnaire and the recall that they consumed milk. But discrepancies were still observed in the frequency of milk consumption between the 2 assessment methods. This finding may be because milk served as a beverage was easier for the child to remember. But the child may have selected cereal on the questionnaire but then forgot to count the milk on cereal as another serving of milk, thus this item produced low validity. Further, pizza is such a commonly consumed food in schools that it may be useful to add a question on pizza intake to the questionnaire to prevent the child from having to break down this mixed food into its components. Also, these food behavior questions showed a low reliability compared to other food behavior questions.¹¹

Fruit and fruit juice consumption showed a similar result in eighth-grade students compared to the fourth-grade students, but validation measures for vegetables were lower. These lower scores may be because the younger students have difficulty in reporting vegetables in mixed food items. Also, the intake of fruit and fruit juice was quite low (number of times per day), with a median intake of "none" for yesterday and a mean of 1.32 times for yesterday, respectively. A similar pattern was observed in inner-city fourth- to seventh-grade children.¹⁹

Questions related to meal pattern, such as "Yesterday, did you have breakfast?" or "Yesterday, how many meals did you eat?" tended to have acceptable validity, but the question, "Yesterday, did you have a snack?" had a poor validity. In the criterion measure (24-hour dietary recall), anything other than water that was consumed between meals was

coded as a snack, but the child may have difficulty in differentiating a snack from a meal or may not remember consuming a snack without prompts when they are filling out the questionnaire. The question, "Yesterday, did you take a vitamin pill?" showed acceptable validity.

Most of the food questions showed no gender difference in validity. But for the questions regarding the consumption of gravy and french fries or any chips, girls showed a significantly higher validity than boys. This finding may be because boys overreported their frequency of intake in the survey. In contrast, the validation study with eighth-grade students found no gender differences for any of the food-related questions.¹² Caution is necessary when comparing the kappa statistic with other studies because it is influenced by the number of categories involved.⁷

LIMITATIONS OF THE STUDY

Food behavior questions of the SPAN questionnaire were designed to measure the previous day's (yesterday) intake so it will not reflect usual intake and cannot be used as a proxy to measure usual intake. Testing for validity with an average of 2 or more recalls may provide more information on using this questionnaire as a proxy for the ability to measure the major food groups meeting dietary recommendations. Further, this questionnaire was designed to measure group intake; therefore, inferences should be made at group level, not at the individual level.

A second possible limitation of the study is that the recall and questionnaire errors are not completely independent; both techniques require accurate memory of food items eaten. Observation may be a better standard method, however, it would be much more difficult to recruit subjects and obtain parental consent and accommodation for the study, particularly because observers would need to be present in the home. Observation methods, too, present limitations.²⁰

The population in this study was mainly white, reflecting the majority of Indiana elementary school children in many areas. This instrument needs to be validated with minority populations if it is used in monitoring, intervention or policy decision making among these populations. Further, only five out of the invited 22 schools agreed to participate in the study. This may limit the generalizability to the population in the region.

A new version of the questionnaire has recently been developed with a question on intake of whole grain foods. This question will need to be validated.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study evaluated the capacity of food behavior items in the SPAN questionnaire to provide unbiased estimates of a 1-day dietary intake among fourth graders in Indiana. The analysis was designed to provide validity estimates of indi-

vidual food behavior questions and a comprehensive assessment of the capacity of the SPAN questionnaire food behavior items to provide valid estimates of elementary school student's intake as a monitoring tool. The questionnaire may also prove to be useful in monitoring compliance to dietary guidelines if it is given several times over a period of time.

The SPAN questionnaire fourth-grade version showed fair validity for most nutrition behavior questions that address previous day food choice behaviors. Food items that are straightforward and are commonly consumed as single food items are more valid than food products that are found in mixed dishes. Further, questions about food that is more frequently consumed, like the red meat item, tend to be less valid than less frequently consumed food, such as beans.

Minor revisions to certain items may improve accuracy of these measures. For consumption of bread, buns, bagels, tortillas, or rolls, providing examples—such as having a sandwich with two pieces of bread should be considered 2 servings—in the questionnaire may improve the accuracy of measurement. For vegetables, the 24-hour dietary recall indicated that most of the vegetables were consumed from mixed dishes. Providing examples of mixed dishes that contain vegetables may improve the accuracy of vegetable responses.

Other additions may expand the usefulness of this questionnaire. Revision of items addressing snacking and candy consumption will be needed if these items are needed for planning new policies or reconceptualizing existing policies on better health for children. Expanding vegetable items to reflect dark green and orange categories may increase the utility of this instrument in monitoring food emphasized in the 2005 Dietary Guidelines.

This study showed that 14 out of 20 of the food intake items and 3 out of 4 of the other food behavior items had correlations ranging from 0.40 to 0.78. As revisions continue to be made to the SPAN instrument, further validation will be necessary. The validity using samples of children of other nonwhite ethnicities and other geographical regions, eg, urban areas, should be studied to determine the suitability of the instrument for all children.

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