Published in final edited form as:

J Hunger Environ Nutr. 2018 ; 13(2): 205–227. doi:10.1080/19320248.2017.1315325.

The National Health and Nutrition Examination Survey's Food Insecurity Questionnaire Completed by Children: Effects of Assessment Mode (Classroom versus Interview)

Suzanne D. Baxter, PhD, RD, LD, FADA, FAND [co-first author],

Research Professor, Institute for Families in Society, College of Social Work, University of South Carolina, 1600 Hampton Street, Suite 507, Columbia, SC, USA, 29208, orcid.org/0000-0002-9031-9087

Albert F. Smith, PhD, MS [co-first author],

Associate Professor, Department of Psychology, Cleveland State University, Cleveland, OH, USA, 44115, orcid.org/0000-0002-3442-8123

David B. Hitchcock, PhD,

Associate Professor, Department of Statistics, University of South Carolina, Columbia, SC, USA, 29208

Kathleen L. Collins, BS,

Research Specialist (at the time of the study), Institute for Families in Society, College of Social Work, University of South Carolina, Columbia, SC, USA, 29208

Caroline H. Guinn, RD, LD,

Research Dietitian, Institute for Families in Society, College of Social Work, University of South Carolina, Columbia, SC, USA, 29208

Alyssa L. Smith, MPH, and

Research Specialist II (at the time of the study), Institute for Families in Society, College of Social Work, University of South Carolina, Columbia, SC, USA, 29208

Christopher J. Finney, MS

Analyst, Institute for Families in Society, College of Social Work, University of South Carolina, Columbia, SC, USA, 29208; Manager, South Carolina Revenue and Fiscal Affairs Office, Health and Demographics, Columbia, SC, USA, 29201

Abstract

The National Health and Nutrition Examination Survey's food insecurity questionnaire was administered to 155 children (77 African American, 65 White, 13 "Other" [7 Hispanic; 6 mixed races]) in grade 4 twice, 28–32 days apart. Test-retest reliabilities were modest and somewhat similar for assessment mode (classroom, interview) and subgroup variables (gender, race, socioeconomic status, academic achievement, body mass index percentile, social desirability). As academic achievement increased, White and Other children reported less food insecurity, and African-American children reported slightly less. As social desirability increased, White and

African-American children reported slightly more food insecurity, and Other children reported substantially more. Although the questionnaire may be acceptable for use with diverse groups of children in grade 4, validation is needed.

Keywords

child-reported food insecurity; assessment mode; gender; race/ethnicity; socioeconomic status; academic achievement; body mass index percentile; social desirability

INTRODUCTION

Food insecurity is inconsistent access to enough food for healthy living due to inadequate money and other resources.¹ National estimates of the prevalence of food insecurity in the United States come from responses to questions in the food insecurity module of the National Health and Nutrition Examination Survey (NHANES); these questions have assessed food insecurity at the household level, but some NHANES cycles have included 5 items for children aged 12–15 years to self-report food insecurity, as Table 1 shows.²

This article describes a study in which psychometric properties of NHANES's 5-item children's food insecurity questionnaire completed by children in grade 4 (approximately 10 years of age) were examined as a function of assessment mode (classroom versus one-on-one interview) and various socio-demographic and anthropometric variables, or "characteristics of children" (gender, race/ethnicity, socioeconomic status [SES], academic achievement, body mass index [BMI] percentile, social desirability). Also, the association of children's self-reported food insecurity to these characteristics of children were investigated.

The Introduction summarizes food insecurity measurement, focusing on specific issues in using children's self-reports, and then presents the rationale for examining the association of children's self-reported food insecurity to particular characteristics of children.

Measurement of Children's Self-Reported Food Insecurity

Most information about child food insecurity comes from parents' reports about household food insecurity. This is problematic because parents and children experience food insecurity differently.^{3–5} Over households, children's food insecurity is correlated generally with that of adults, but because the association between child and adult food insecurity depends on such factors as children's ages, and because food insecurity may vary over children in a household, separate measures of children's and adults' food insecurity may be more informative than a household measure.^{4,6} For example, Kaur et al.,⁷ who used proxy-reported data from NHANES about both household and individual food insecurity for children aged 2–11 years, found that household food insecurity was not associated with obesity among children, but individual food insecurity was associated with obesity in children aged 6–11.⁷

Food insecurity questions for children have been developed and examined with various methods. Connell et al.⁸ used cognitive interviewing with children aged 11–15 years to adapt food insecurity questions for adults for administration to children, and pilot-tested a self-

administered 9-question survey in a middle school. Scaling analysis of surveys with “nonextreme” response patterns (surveys affirming 1 item, but not all items) indicated the 9-question survey had sufficient reliability to be a useful tool.⁸ From semi-structured, in-depth interviews with children aged 11–16 years, Connell et al.⁹ found that children described food insecurity in terms of quantity (e.g., eating less than usual), quality (e.g., having only a few low-cost foods), and psychosocial states (e.g., worry, sadness, shame, fear), and indicated that they understood that adults tried to shield children from food insecurity. Using separate semi-structured interviews of adults and their children aged 9–16 years, Fram et al.⁵ found that children’s food insecurity experiences differed from parents’ experiences and parents’ reports of children’s experiences. Using focus groups and interviews with children aged 10–17 years, Bernal et al.³ found that children were aware of food insecurity at home and that their parents worried about it; that children reported being hungry and experiencing poor dietary intake; and that children were not always protected by parents from food insecurity. Using interviews and debates in “friendship groups” of 2–3 children, Fairbrother et al.¹⁰ found that even children aged 9–10 years had knowledge of family finances and how those impacted food choices. Using cognitive interviews, Fram et al.⁴ modified questions from prior surveys into a 30-question survey that they field-tested with children aged 6–17 years and validated by comparing survey responses to food insecurity classifications based on in-depth interviews with children. Children reported food insecurity on the 30-question survey with high accuracy, with 6-year-olds as accurate as older children. However, using parent interviews, parents’ reports about children were inaccurate, missing half of children experiencing hunger.⁴

Three NHANES cycles (2005–06, 2007–08, 2009–10) included a computerized self-administered food insecurity questionnaire for children aged 12–15 years; 5 items (Table 1) asked about food conditions during the last 30 days.² The 5 items were a somewhat revised subset of Connell et al.’s 9 questions.⁸ Connell et al. found that responses to their 9-question survey were consistently ordered for children aged 12 and older, but less so for children aged 9–11 years.⁸ Sharkey et al.¹¹ used that 9-question survey but changed the reference period from the last 12 months to the last 3 months, and found good internal consistency (0.81, Cronbach’s alpha) among 50 children aged 6–11 years. Baxter et al.¹² investigated psychometric properties of NHANES’s 5-item food insecurity questionnaire, administered via classroom assessment mode to 92 grade 4 children (about age 10 [2 years younger than the youngest children asked the questions in NHANES]). Internal consistency (Cronbach’s alpha) was 0.67 for administration-1 and 0.70 for administration-2; 1-month test-retest reliability was 0.66 (Kendall’s tau).¹²

Children aged 10–11 years in the United States, Ireland, and Greenland have completed food insecurity surveys with 1–9 items, various response options, and 3- or 12-month reference periods. Table 2 summarizes 7 studies,^{8,11–16} some of which were described above, and identifies items used that were identical, or similar, to those in NHANES’s 5-item questionnaire.

Children's Self-Reported Food Insecurity and Characteristics of Children

Psychometric properties (i.e., internal consistency and test-retest reliability) of NHANES's 5-item food insecurity questionnaire could be related to the context within which data are collected and to characteristics of children. Table 2 shows questions used by the studies cited in the following paragraphs to assess food insecurity.

Assessment mode—Psychometric properties for NHANES's 5-item food insecurity questionnaire completed by children have been examined only for data collected using classroom assessment mode,¹² but one-on-one interviews may be used to obtain children's food insecurity, too. Mode of assessment (e.g., classroom; one-on-one interview) could affect results on food insecurity reported by children.

Gender—In a study with children in grades 3–5 and 8 in Baltimore and Philadelphia, Murphy et al.¹³ used children's responses to 5 items to categorize hunger levels (not hungry, at risk for hunger, hungry) for the Community Childhood Hunger Identification Project (CCHIP). Hunger category scores differed significantly by gender, with girls somewhat more likely to be at risk for hunger than boys and somewhat less likely to be hungry or not hungry.¹³ Murphy et al.¹³ concluded that the gender difference was artifactual because gender was not related to hunger in other CCHIP studies, including a larger study in Pittsburgh.¹⁷ For most CCHIP studies, including the Pittsburgh study, children's food insecurity was parent-reported rather than self-reported. Connell et al.⁸ found that response patterns of boys and girls to 9 items were generally similar. Likewise, Khan et al.¹⁴ did not find significant differences in food insecurity status by gender in children aged 10–14 years who answered 9 items. In contrast, Baxter et al.¹² found a significant association of self-reported food insecurity to gender in grade 4 children who answered 5 items, with boys, on average, reporting higher levels of food insecurity than girls.

Race/ethnicity—Murphy et al.¹³ found that the composition of 3 hunger groups (not hungry, at risk for hunger, hungry [using children's reports to 5 items]) did not differ by race, but 80% of children were African American (AA). Psychometric properties for NHANES's 5-item food insecurity questionnaire have been assessed only on a sample of 92 children, with 80% AA.¹² There is a need to assess food insecurity reported by children of various races/ethnicities.

SES—Because food insecurity is more common in households with incomes at or below the Federal poverty line, food and nutrition assistance programs for these households are intended to decrease food insecurity.¹ Households should be more food secure after receiving program benefits than before, but it is the more food-insecure households that seek program assistance.¹ Research on SES and food insecurity reported by children is sparse. Baxter et al.¹² did not find a significant association of self-reported food insecurity to SES (based on eligibility for free/reduced-price school meals and for Supplemental Nutrition Assistance Program [SNAP] benefits) in grade 4 children who answered 5 questions.

Academic achievement—Studies^{17,18} have found that household food insufficiency is associated with negative academic outcomes (e.g, lower arithmetic scores, repeated a grade)

in children aged 6–12. Variation over children in self-reported food insecurity may be associated with academic achievement, too. Academic achievement and general intelligence test scores are highly correlated, so academic achievement is a reasonable proxy for cognitive ability,^{19–24} and food insecurity responses may be more reliable for children with higher than lower cognitive ability. Baxter et al.¹² found a significant association of food insecurity scores and academic achievement in grade 4 children; children with lower scores on standardized tests of academic achievement reported higher levels of food insecurity than children with higher scores.

BMI percentile—None of Khan et al.,¹⁴ Sharkey et al.,¹¹ and Baxter et al.¹² found a significant association of BMI percentile to food insecurity reported by children. Gundersen et al.,²⁵ who analyzed data from NHANES 2001–04 and adjusted for race/ethnicity and gender, found no association between food insecurity (reported by mothers) and obesity (from measured height and weight) among low-income children aged 8–17 years. However, Alaimo et al.,²⁶ who analyzed data from NHANES III, found an increased prevalence of overweight and food insufficiency in older (aged 8–16 years), non-Hispanic white, low-income children in the United States; for younger children (aged 2–7 years) and non-Hispanic black and Mexican-American children, the prevalence of overweight was unrelated to family income. (Height and weight were measured. Parents reported information on food insufficiency.) Casey et al.,²⁷ who analyzed data from the Continuing Survey of Food Intakes by Individuals 1994–96, found that although the percentage of overweight children (from parent-reported height and weight) was similar among low-income households, whether food-sufficient or insufficient (46.7% and 46.5%, respectively, reported by an adult for the household), the low-income groups included more overweight children than the higher-income food sufficient group (31.5%). Using proxy-reports for children aged 2–11 years from NHANES 2001–10, Kaur et al.⁷ found that individual food insecurity was associated with obesity (from measured height and weight) for children aged 6–11 years, but household food insecurity was not.⁷ Despite increased research on the association of food insecurity and childhood obesity, a consistent association has not been identified.^{28–31} It is of interest to investigate the psychometric properties of child-reported food insecurity by BMI percentile, and the association of child-reported food insecurity to BMI percentile.

Social desirability—Food insecurity questions may be perceived as sensitive, so responses to them may contain systematic error associated with such stable personality characteristics as social desirability; the extent to which such characteristics influence responding could depend on questionnaire assessment mode. Social desirability is a response bias which involves reporting that one *never* performs a behavior that most people perform at least occasionally (e.g., gossiping) or *always* performs a behavior that most people usually perform but occasionally omit (e.g., admitting mistakes).³² People who respond in a socially desirable way may systematically err in responding to a variety of questions, including questions about food availability and eating. Researchers who use children's dietary reports have been concerned about social desirability.^{33,34} An association between social desirability and food insecurity is plausible; children with high levels of social desirability may under-report food insecurity, and the extent to which they do so may

depend on the data collection mode. To date, children's social desirability has not been assessed in studies for which children have self-reported food insecurity.

METHODS

Participants

Data were collected from grade 4 children in Spring 2014, as part of a dietary recall validation study.³⁵ Children were from 21 classes at 5 schools (3 urban, 2 rural) in 4 districts in South Carolina. Each school had 2–7 grade 4 classes. Schools in 2 districts were identified based on high student participation in school-meal programs and the district's permission for outside research studies. Each of the other districts had only 1 elementary school. Permission to collect data was obtained from each district, and from each school principal for each school year. The University of South Carolina's Institutional Review Board approved the research protocols. Written parental consent and child assent were obtained.

Design

Classes within schools were assigned at random to assessment mode to answer food insecurity and social desirability questionnaires either in the classroom or in one-on-one interviews on 2 occasions about 30 days apart. Eleven classes were assigned to the classroom assessment mode and 10 to the interview assessment mode. For all children within a class, assessment mode was the same for both administrations of both questionnaires. Administration-1 was in mid-March. Administration-2 was to the same children, 28–32 days later, in mid-April. Time between administrations approximated the food insecurity questionnaire's 30-day reference period, and was sufficiently long so that it would be unlikely for any child to simply repeat answers from administration-1 of either questionnaire in administration-2. Administrations were in the middle of consecutive months when SNAP household benefits were expected to be similar.

Questionnaires and Scoring

Food insecurity—For each assessment mode, NHANES's 5-item food insecurity questionnaire was administered. Table 1 shows the 5 items with response options. Items were scored using USDA guidelines:³⁶ Affirmative responses (*a lot, sometimes, once or twice*) were coded as 1 and other responses (*never, refuse to answer, don't know*) as 0.⁸ For each child, for each administration, codes were summed over items to yield a score of 0 (food secure) to 5 (very high food insecurity). The questionnaire concerned the previous 30 days. Before each administration for each assessment mode, a researcher told children, “Each of these 5 questions is about the last 30 days. Thirty days is about the number of days in a month. Today's date is __. If we go back 1 month on the calendar, that date would be __. So, the last 30 days would start __ and go through today.” This explanation was used previously with grade 4 children.^{12,37}

Social desirability—For each assessment mode, a 14-item social desirability questionnaire was administered immediately after each administration of the food insecurity questionnaire. Each item had “yes” and “no” response options. Items were scored by

assigning 1 point to each answer matching the socially desirable choice and summing these so that for each child, for each administration, a score of 0–14 was obtained, with higher scores indicating a greater tendency toward socially desirable responding. The questionnaire was used previously with grade 4 children.^{38,39} A study³⁷ of 97 grade 4 children, who completed the questionnaire via classroom assessment mode on 2 occasions 1 month apart, found acceptable internal consistency (Cronbach's alpha) of 0.82 for administration-1 and 0.85 for administration-2, and 1-month test-retest reliability of 0.70 (Pearson's correlation). A study⁴⁰ of 157 grade 4 children, who participated in the current study, found acceptable internal consistency (Cronbach's alpha) of 0.81 for classroom assessment mode and 0.84 for interview assessment mode, and 1-month test-retest reliability of 0.83 and 0.85 (Pearson's correlation) for the respective assessment modes.

Assessment Mode Procedures

Classroom—The classroom procedure described here for both questionnaires was used previously with grade 4 children.^{12,37} Two of 3 researchers distributed a paper food insecurity questionnaire to each child in the class. A researcher read each item with response options aloud while children followed along, and asked children to circle 1 response per item. Another researcher walked around the classroom to ensure that children answered each item by circling a single response. After collecting completed food insecurity questionnaires, researchers repeated this process for the social desirability questionnaire. Both questionnaires were administered again to the same children in the same classes in the same manner, 28–32 days later.

Interview—One of 3 researchers read items aloud to individual children in a private location at school and circled children's verbal responses on paper questionnaires. For the food insecurity questionnaire (Table 1), the researcher read item #1 aloud, laid a laminated card with response options for items #1–4 in front of the child, and left it there until item #4 was answered. The researcher read each response option for item #1; after reading each of items #2 through #4, the researcher said, “please choose one of these” and pointed to the response options on the laminated card. After reading item #5 aloud, the researcher laid a laminated card with response options for item #5 in front of the child, and read the response options aloud for item #5. For the social desirability questionnaire, the researcher instructed the child to answer “yes” or “no” for each item. Both questionnaires were administered again to the same children, in the same manner, by a different researcher, 28–32 days later. Each interview was audio-recorded. A non-interviewing researcher compared the audio-recording against the questionnaire for each child for each administration to ensure that each answer by the child was what the researcher had circled on the form.

Measures of Characteristics of Children

Gender and race/ethnicity—This information, reported by parents to schools, was obtained from school records. Because only 7 children were described as Hispanic and 6 as mixed races, these 13 children were combined into an “Other” group for analyses.

SES—A child was classified as “lower SES” or “higher SES” based on eligibility of the child (or child's family) for free/reduced-price school meals during the school year and for

SNAP benefits for 30 days before either administration of questionnaires. A child who was eligible for at least 1 of these programs was classified as “lower SES”; otherwise, the child was classified as “higher SES.” Children from families with incomes $\leq 130\%$ of the poverty level were eligible for free meals, and those from families with incomes $>130\%$ and $\leq 185\%$ of the poverty level were eligible for reduced-price meals.⁴¹ The state’s Revenue and Fiscal Affairs Office-Health and Demographics received permission from the state’s Departments of Education (for school-meal eligibility) and Social Services (for SNAP eligibility) to link data sets, conduct analyses, and provide aggregate results to the authors.

Academic achievement—A child’s scores on the Mathematics and English Language Arts scales of the Palmetto Assessment of State Standards (PASS)⁴² standardized academic achievement tests were summed. These summed PASS scores could range from 600–1,800.

BMI percentile—Weight and height were measured later on the day that a child completed administration-1 of the questionnaires. Researchers used established procedures to obtain measurements in the morning at school in duplicate.⁴³ Inter-measurer reliability, assessed on 10% of children per measurement day, was 0.99 for weight and for height. Weight and height were used to calculate BMI; BMI percentile was determined from age/gender BMI charts.⁴⁴

Analyses

Cronbach’s alpha quantified internal consistency of the food insecurity questionnaire completed by children. (Cronbach’s alpha most effectively estimates internal consistency when all items on a scale have essentially equivalent status as indices of a construct. Items on NHANES’s 5-item food insecurity questionnaire do not quite have that property: For example, it is unlikely that a child would affirm item #5 [“went for a whole day without food”] without having affirmed all other items. The nonequivalence of this item to the others would lead to Cronbach’s alpha underestimating internal consistency, but should approximate it well.⁴⁵) Kendall’s tau coefficient quantified test-retest reliability of the food insecurity questionnaire completed on 2 occasions about 30 days apart.⁴⁶ A paired *t*-test compared scores between administrations.

Differences in test-retest reliability of the food insecurity questionnaire between assessment modes and between subgroups of children formed by each of the studied variables (gender, race/ethnicity, SES, academic achievement, BMI percentile, social desirability) were examined using *z*-tests to compare Kendall’s tau coefficients converted to Pearson correlations via Walker’s method.⁴⁷ For academic achievement, children were classified as below versus at or above the sample median academic achievement score of 1,261. For BMI percentile, children were classified as below versus at or above the 85th percentile, an expert committee’s definition of “overweight or obese” for children.⁴⁸ For social desirability, summed scores from the 14-item questionnaire were used to categorize children as “low social desirability” (scores of 0–7) or “high social desirability” (scores of 8–14). To account for the multiple dependent inferences produced by splitting the sample in several ways, a Holm-Bonferroni correction was used to control the family-wise Type I error rate at 0.05.

To investigate the association between food insecurity scores and assessment mode, gender, race/ethnicity, SES, academic achievement, BMI percentile, and social desirability, binomial regression was used to regress food insecurity scores on these variables and their 2-way interactions. An initial model was fit with all 2-way interactions. Non-significant ($P>0.05$) interactions were removed, their sums of squares were pooled into the error term, and the resulting model was the final model. (Food insecurity scores from administration-1 were analyzed because researchers would typically administer the questionnaire only once.) Academic achievement, BMI percentile, and social desirability were continuous for the binomial regression. The Benjamini-Hochberg procedure⁴⁹ adjusted for multiple simultaneous tests, controlling the false discovery rate at 0.05. Statistical analyses used SAS/STAT® (9.4© 2002–12, SAS Institute Inc, Cary, NC). All reported P -values are 2-sided and adjusted.

RESULTS

Although 157 children completed administration-1 of the food insecurity questionnaire, only 155 children completed it at administration-2; thus, the sample analyzed for test-retest reliability was 155 children. For 14 children, SNAP benefits changed between administrations or SES could not be linked, and for 2 children, academic achievement scores were unavailable; thus, the sample analyzed for the binomial regression was 139 children.

The 155 children (71 girls) who completed 2 administrations of the food insecurity questionnaire 1 month apart had a mean ($\pm$ SD) age = 10.0 years $\pm$ 0.4 at administration-1. Mean academic achievement score was 1,268.2 $\pm$ 91.1 (range 1091–1546); the statewide mean was 1,286.1.⁵⁰ Mean BMI percentile was 68.8 $\pm$ 30.1 (range 1.0–99.8). Most children (82.3%) were lower SES. Mean social desirability score was 7.6 $\pm$ 3.7 (range 0–14). The classroom assessment mode had 78 children (35 girls; 41 AA, 29 White, 8 Other). The interview assessment mode had 77 children (36 girls; 36 AA, 36 White, 5 Other).

Test-Retest Reliability and Internal Consistency of the Food Insecurity Questionnaire

Table 3 shows mean scores and internal consistencies by administration, along with test-retest reliabilities, of the food insecurity questionnaire for various subgroups (gender, race/ethnicity, SES, academic achievement, BMI percentile, social desirability).

As Table 3 shows, for the classroom assessment mode, test-retest reliability (Kendall's tau) was 0.60, and internal consistency (Cronbach's alpha) was 0.69 for administration-1 and 0.82 for administration-2. For the interview assessment mode, test-retest reliability was 0.65, and internal consistency was 0.51 for administration-1 and 0.73 for administration-2. Thus, for each assessment mode, test-retest reliability was modest, and internal consistency was low for administration-1, and higher for administration-2.

For the various subgroups formed by splitting the total sample on each of the studied variables, test-retest reliabilities ranged from 0.46–0.73, with the lowest and highest values for the 2 smallest subgroups. Child subgroup internal consistencies ranged from 0.51–0.83 for administration-1, and from 0.69–0.93 for administration-2. As with assessment mode, for

each child subgroup, internal consistency was better for administration-2 than administration-1.

Table 3 also shows that Holm-Bonferroni *P*-values for comparing test-retest reliabilities between subgroups for several variables ranged from 0.38 (BMI percentile) to 0.46 (gender) to 0.97 (race/ethnicity) to 1.0 (assessment mode, SES, academic achievement, social desirability). These data do not suggest that test-retest reliability differs for assessment modes or between levels of any of the child variables.

Associations between Food Insecurity Scores and Characteristics of Children

Table 4 shows results from the final binomial regression model. The main effects of race/ethnicity and social desirability were significant, but their modulation by the academic achievement $\times$ race/ethnicity and social desirability $\times$ race/ethnicity interactions indicate that the association of food insecurity and race/ethnicity depended on levels of both academic achievement and social desirability. The academic achievement $\times$ race/ethnicity interaction is explained as follows: For a 100-point increase in academic achievement PASS score, which is about 1 SD, holding other variables constant, average food insecurity score decreased by 0.59 for White children, by 0.42 for AA children, and by 0.58 for children of Other races/ethnicities. In other words, food insecurity score decreased as academic achievement increased for all race/ethnicity groups, but the amount of decrease varied sufficiently among the race/ethnicity groups for the interaction to be significant. The social desirability $\times$ race/ethnicity interaction is explained as follows: Although food insecurity score increased on average as social desirability increased, the association varied by race/ethnicity. For a 1-SD increase in social desirability score, holding other variables constant, average food insecurity score decreased by 0.05 for White children, increased by 0.22 for AA children, and increased by 1.03 for Other children.

Degree of Food Insecurity Self-Reported by Children

For 78 children in the classroom assessment mode, the difference in reported food insecurity from administration-1 (1.14 ± 1.39 , mean $\pm$ SD) to administration-2 (1.06 ± 1.55) was not significant (paired *t*-test, *P* = 1.0). However, for 77 children in the interview assessment mode, reported food insecurity decreased from administration-1 (1.57 ± 1.34) to administration-2 (1.04 ± 1.41) (paired *t*-test, *P* < 0.0007). Table 3 shows that for alternative splits of child subgroups, average food insecurity scores decreased from administration-1 to administration-2 for boys (1.44 to 1.04), AA children (1.47 to 1.05), children with high academic achievement (0.97 to 0.62), children with high BMI percentile (1.49 to 1.10), and children with high social desirability (1.54 to 1.16) (all *P*-values = 0.04).

For 78 children in the classroom assessment mode and 77 children in the interview assessment mode, over administrations, food insecurity scores ranged from 0–5, showing that children's responses yielded the full range of scores. For the classroom assessment mode, of 35 children (44.9%) with scores of 0 on administration-1, 33 (94.3%) had scores of 0 on administration-2; of 43 children (55.1%) with non-0 scores on administration-1, 29 (67.4%) had non-0 scores on administration-2, and for these 29 children, administration-2 scores were lower than administration-1 scores for 6 children. For the interview assessment

mode, of 21 children (27.3%) with scores of 0 on administration-1, 20 (95.2%) had scores of 0 on administration-2; of 56 children (72.7%) with non-0 scores on administration-1, 35 (62.5%) had non-0 scores on administration-2, and for these 35 children, administration-2 scores were lower than administration-1 scores for 16 children. On average, food insecurity scores for the interview assessment mode at administration-2 were similar to averages for the classroom assessment mode at administration-1 and administration-2. At administration-1, a larger percentage of children in the classroom (44.9%) than in the interview (27.3%) assessment mode had scores of 0, which may explain the lower score for the classroom assessment mode.

Response frequency was explored by assessment mode, administration, and item. Across 5 items, for both assessment modes and 2 administrations, the response most frequently used by children was “*never*” (54.0–70.9%), followed by “*sometimes*” (17.2–24.7%). Children rarely responded “*refuse to answer*” (1.0–2.3%) and rather infrequently responded “*don’t know*” (7.3–12.7%). The change in average score between 2 administrations for the interview assessment mode may be because children responded “*sometimes*” more often at administration-1 (24.7%) than at administration-2 (17.9%), and these children responded “*a lot*” or “*once/twice*” almost twice as often as children in the classroom assessment mode at administration-1 (6.8% versus 3.6%) and twice as often as they did at administration-2 (6.8% versus 2.9%).

DISCUSSION

For the current study, children aged 10 years completed the 5-item food insecurity questionnaire that was completed by children aged 12–15 years for 3 cycles of NHANES. Children completed the questionnaire on 2 occasions 28–32 days apart, either with their class or in individual interviews, with classes within schools randomly assigned to assessment mode. Test-retest reliability and internal consistency were similar for both assessment modes. However, for administration-1, average food insecurity reported by children was higher with the interview than classroom assessment mode. Test-retest reliability and internal consistency were similar for the various child subgroups of gender, race/ethnicity, SES, academic achievement, BMI percentile, and social desirability. To the authors’ knowledge, whether the psychometric properties of NHANES’s food insecurity questionnaire vary with assessment mode or over various child subgroups has not been previously examined. A single past study¹² examined psychometric properties of NHANES’s food insecurity questionnaire; that study used only classroom assessment mode with a sample of mainly AA grade 4 children. Reliability values for the classroom assessment mode of the current study were similar to those from the past study that used the same questionnaire.¹²

A significant academic achievement $\times$ race/ethnicity interaction was found for self-reported food insecurity: Although as academic achievement increased, scores decreased for children of every race/ethnicity (White, AA, Other), the rate of decrease was more pronounced in White and Other children than in AA children. These results essentially replicate the authors’ past findings with classroom assessment mode of NHANES’s 5-item food insecurity questionnaire: Children with lower academic achievement reported higher levels

of food insecurity than children with higher academic achievement.¹² (Race/ethnicity was not analyzed in the past study because the sample was mainly AA.¹²) Strikingly, controlling for all other variables, self-reported food insecurity in the current study appeared to be more related to academic achievement than to SES; SES was marginally related to food insecurity ($P = 0.08$), with higher levels of food insecurity reported by lower- than higher-SES children (Table 3).

A significant social desirability $\times$ race/ethnicity interaction was also found: Although on average, reported food insecurity increased as social desirability increased, the association varied by race/ethnicity such that as social desirability increased, White children reported slightly less food insecurity, AA children reported more food insecurity, and children of Other races/ethnicities reported substantially more food insecurity. These findings seem counterintuitive—children who report higher levels of social desirability (i.e., who have a greater tendency toward socially desirable responding) might be expected to report less food insecurity.

Given the relatively small sample and adjustments for multiple tests, inferential analyses may have failed to detect main effects of assessment mode, gender, and SES, and race/ethnicity $\times$ SES and gender $\times$ academic achievement interactions, for which the P -values modestly exceeded 0.05 (Table 4). For example, mean food insecurity scores were somewhat, although not significantly, higher with the interview than classroom assessment mode, for boys than girls, and for lower-SES than higher-SES children. To further examine these main effects and interactions, the same binomial regression analysis conducted on administration-1 scores was conducted on administration-2 food insecurity scores. None of the main effects or interactions with P -values that modestly exceeded 0.05 in analysis of administration-1 scores was significant in analysis of administration-2 scores (P -values = 0.14–0.86). In practice, children would usually only complete a single food insecurity questionnaire.

To the authors' knowledge, only 2 analyses of NHANES's child-reported food insecurity data have been published. With NHANES 2005–08 data, Nord and Hanson⁵¹ compared food insecurity reported by 395 adolescents aged 15–17 years to adult proxy reports. With NHANES 2001–08 data, Nord⁵² compared food insecurity reported by 1,150 youth aged 12–17 years and 1,090 adults. However, neither of these 2 analyses concerned psychometric properties of NHANES's 5-item food insecurity questionnaire completed by children.

There are limitations to the current study. Children were of a single grade level in one state. The sample size was relatively small given the numerous interactions tested. Although the sample was diverse, the number of children of Other races/ethnicities was small.

There are strengths to the current study, too. One is the novel examination of the association of grade 4 children's self-reported food insecurity using NHANES's 5-item questionnaire to numerous variables of interest (assessment mode, gender, race/ethnicity, SES, academic achievement, BMI percentile, social desirability). Other strengths are quality control for the interview assessment mode and inter-measurer reliability for weight and height measures.

Although the values of test-retest reliability and internal consistency found in this study are, for the most part, modest, NHANES's 5-item food insecurity questionnaire may be acceptable for use with diverse groups of grade 4 children for relatively crude discrimination of food insecure children from children who are more secure. Because of the potential utility of reports of food insecurity obtained from children themselves, it is important to continue investigation of methods to measure food insecurity in children. Such research should follow a 2-pronged approach: First, a better understanding of the validity of elementary school children's reports of food insecurity is needed. This is pertinent to the studies described in this article because, for example, test-retest reliability should *not* be high if food insecurity actually did change between administrations. The finding that lower-SES children reported higher levels of food insecurity, on average, than higher-SES children indicates some orderliness to children's reports. A methodological challenge is determining how to validate children's reports of food insecurity with information that is finer-grained than eligibility for SNAP and school-meal benefits, and that does *not* rely either on children themselves or their parents. Second, the best questionnaire and assessment mode need to be identified to obtain valid reports of food insecurity from elementary school children. Specifically, given the cognitive limitations of children at these ages, with what questions, and with which assessment mode, would valid reports of food insecurity be best elicited?

In conclusion, NHANES's 5-item food insecurity questionnaire may help identify food insecurity from self reports by diverse groups of grade 4 children. This type of tool is needed to assess individual-level effects of food insecurity on children.⁸ Modest test-retest reliability and internal consistency were found for both assessment modes for diverse groups of children. The classroom assessment mode is more efficient; this study found that children may report more food insecurity with the interview than classroom assessment mode, but only at administration-1. Based on this study, caution is advised against mixing assessment modes in a single study; if the NHANES's food insecurity questionnaire is used on multiple occasions with children, a single assessment mode should be used throughout the study. Further research needs to determine whether children typically report more food insecurity in an administration-1 interview assessment mode, and report less food insecurity in subsequent administrations whether interview or classroom assessment mode. A better understanding is needed of the associations of child-reported food insecurity, social desirability, and assessment mode. Also, investigation is needed of the validity of children's reports of food insecurity and the generality of associations of reported food insecurity to covariates of interest. This study's results inform public policy by showing feasibility to assess the prevalence of child food insecurity as *self-reported by grade 4 children* rather than, or in addition to, using household food insecurity as *reported by adults*.

Acknowledgments

This research was supported by grant R01HL103737 (Principal Investigator SD Baxter) from the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) and funding from the University of South Carolina ASPIRE II program (Advanced Support for Innovative Research Excellence; Principal Investigator AD Liese). This article's content is solely the authors' responsibility and does not necessarily represent views of NHLBI, NIH, South Carolina Revenue and Fiscal Affairs Office-Health and Demographics, or South Carolina Departments of Education and Social Services.

The authors appreciate the cooperation of children, faculty, and staff of 5 elementary schools in 4 school districts (Richland One, Lexington Three, Lexington Four, and Lexington-Richland Five) in South Carolina. The authors thank Megan P. Puryear, MS, RD, LD for help with data collection, and Kate K. Vaadi, RD, LD for help with scheduling.

References

1. Coleman-Jensen, A., Gregory, C., Singh, A. Household Food Security in the United States in 2013 (ERR-173). US Department of Agriculture, Economic Research Service; <http://ers.usda.gov/publications/pub-details/?pubid=45268> [Accessed October 30, 2016]
2. Centers for Disease Control and Prevention. [Accessed October 30, 2016] National Health and Nutrition Examination Survey, NHANES 2005–2006, 2007–2008 and 2009–2010, Questionnaire Instruments. Audio Computer Assisted Personal Self Interview (ACASI) Questionnaire; Food Security (ages 12–15). http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/questionnaires05_06.htm, http://www.cdc.gov/nchs/nhanes/nhanes2007-2008/questionnaires07_08.htm, and http://www.cdc.gov/nchs/nhanes/nhanes2009-2010/questionnaires09_10.htm
3. Bernal J, Frongillo EA, Herrera H, Rivera J. Children live, feel, and respond to experiences of food insecurity that compromise their development and weight status in peri-urban Venezuela. *J Nutr.* 2012; 142:1343–1349. [PubMed: 22623397]
4. Fram MS, Frongillo EA, Draper CL, Fishbein EM. Development and validation of a child report assessment of child food insecurity and comparison to parent report assessment. *J Hunger Environ Nutr.* 2013; 8:128–145.
5. Fram MS, Frongillo EA, Jones SJ, Williams RC, Burke MP, DeLoach KP, Blake CE. Children are aware of food insecurity and take responsibility for managing food resources. *J Nutr.* 2011; 141:1114–1119. [PubMed: 21525257]
6. Nord M, Hopwood H. Recent advances provide improved tools for measuring children's food security. *J Nutr.* 2007; 137:533–536. [PubMed: 17311935]
7. Kaur JK, Lamb MM, Ogden CL. The association between food insecurity and obesity in children—The National Health and Nutrition Examination Survey. *J Acad Nutr Diet.* 2015; 115:751–758. [PubMed: 25737437]
8. Connell CL, Nord M, Lofton KL, Yadrick K. Food security of older children can be assessed using a standardized survey instrument. *J Nutr.* 2004; 134:2566–2572. [PubMed: 15465749]
9. Connell CL, Lofton KL, Yadrick K, Rehner T. Children's experiences of food insecurity can assist in understanding its effect on their well-being. *J Nutr.* 2005; 135:1683–1690. [PubMed: 15987850]
10. Fairbrother H, Curtis P, Goyder E. Children's understanding of family financial resources and their impact on eating healthily. *Health Soc Care Comm.* 2012; 20:528–536.
11. Sharkey JR, Nalty C, Johnson CM, Dean WR. Children's very low food security is associated with increased dietary intakes in energy, fat, and added sugar among Mexican-origin children (6–11 y) in Texas border *Colonias*. *BMC Pediatrics.* 2012; 12:16. [PubMed: 22348599]
12. Baxter SD, Smith AF, Hitchcock DB, Collins KL, Guinn CH, Finney CJ, Royer JA, Miller PH. Test-retest reliability of the National Health and Nutrition Examination Survey's 5-item food insecurity questionnaire completed by fourth-grade children. *J Nutr Educ Behav.* 2015; 47:459–464. [PubMed: 26363937]
13. Murphy JM, Wehler CA, Pagano ME, Little M, Kleinman RE, Jellinek MS. Relationship between hunger and psychosocial functioning in low-income American children. *J Am Acad Child Adolesc Psychiatry.* 1998; 37:163–170. [PubMed: 9473912]
14. Khan S, Pinckney RG, Keeney D, Frankowski B, Carney JK. Prevalence of food insecurity and utilization of food assistance program: An exploratory survey of a Vermont middle school. *J Sch Health.* 2011; 81:15–20. [PubMed: 21158861]
15. Molcho M, Gabhainn SN, Kelly C, Friel S, Kelleher C. Food poverty and health among schoolchildren in Ireland: findings from the Health Behaviour in School-aged Children (HBSC) study. *Public Health Nutr.* 2007; 10:364–370. [PubMed: 17362532]
16. Niclasen B, Petzold M, Schnohr CW. Adverse health effects of experiencing food insecurity among Greenlandic school children. *Int J Circumpolar Health.* 2013; 72:20849.

17. Kleinman, RE., Murphey, JM., Little, M., Pagano, M., Wehler, CA., Regal, K., Jellinek, M. [Accessed October 30, 2016] Hunger in children in the United States: potential behavioral and emotional correlates; *Pediatrics*. 1998. p. 101<http://pediatrics.aappublications.org/content/pediatrics/101/1/e3.full.pdf>
18. Alaimo K, Olson CM, Frongillo EA Jr. Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. *Pediatrics*. 2001; 108:44–53. [PubMed: 11433053]
19. Brody N. Intelligence, schooling, and society. *Am Psychol*. 1997; 52:1046–1050.
20. Luo D, Thompson LA, Detterman DK. The causal factor underlying the correlation between psychometric *g* and scholastic performance. *Intelligence*. 2003; 31:67–83.
21. Deary IJ, Strand S, Smith P, Fernandes C. Intelligence and educational achievement. *Intelligence*. 2007; 35:13–21.
22. Koenig KA, Frey MC, Detterman DK. ACT and general cognitive ability. *Intelligence*. 2008; 36:153–160.
23. Sternberg RJ, Grigorenko EL, Bundy DA. The predictive value of IQ. *Merill Palmer Q*. 2001; 47:1–41.
24. Smith AF, Baxter SD, Hardin JW, Guinn CH, Royer JA. Relation of children's dietary reporting accuracy to cognitive ability. *Am J Epidemiol*. 2011; 173:103–109. [PubMed: 21059806]
25. Gundersen C, Garasky S, Lohman BJ. Food insecurity is not associated with childhood obesity as assessed using multiple measures of obesity. *J Nutr*. 2009; 139:1173–1178. [PubMed: 19403713]
26. Alaimo K, Olson CM, Frongillo EA Jr. Low family income and food insufficiency in relation to overweight in US children. *Arch Pediatr Adolesc Med*. 2001; 155:1161–1167. [PubMed: 11576013]
27. Casey PH, Szeto K, Lensing S, Bogle M, Weber J. Children in food-insufficient, low-income families: prevalence, health, and nutrition status. *Arch Pediatr Adolesc Med*. 2001; 155:508–514. [PubMed: 11296080]
28. Eisenmann JC, Gundersen C, Lohman BJ, Garasky S, Stewart SD. Is food insecurity related to overweight and obesity in children and adolescents? A summary of studies, 1995–2009. *Obesity Reviews*. 2011; 12:e73–e83. [PubMed: 21382151]
29. Larson NI, Story MT. Food insecurity and weight status among U.S. children and families, a review of the literature. *Am J Prev Med*. 2011; 40:166–173. [PubMed: 21238865]
30. Franklin B, Jones A, Love D, Puckett S, Macklin J, White-Means S. Exploring mediators of food insecurity and obesity: A review of recent literature. *J Community Health*. 2012; 37:253–264. [PubMed: 21644024]
31. Dinour LM, Bergen D, Yeh M-C. The food insecurity-obesity paradox: A review of the literature and the role food stamps may play. *J Am Diet Assoc*. 2007; 107:1952–1961. [PubMed: 17964316]
32. Paulhus, DL. Measurement and control response bias. In: Robinson, JP, Shaver, PR., Wrightsman, LS., editors. *Measures of Personality and Social Psychological Attitudes*. San Diego, CA: Academic Press; 1991. p. 17-59.
33. Fisher JO, Johnson RK, Lindquist C, Birch LL, Goran MI. Influence of body composition on the accuracy of reported energy intake in children. *Obes Res*. 2000; 8:597–603. [PubMed: 11156436]
34. Domel SB, Baranowski T, Davis HC, Leonard SB, Riley P, Baranowski J. Fruit and vegetable food frequencies by fourth and fifth grade students: Validity and reliability. *J Am Coll Nutr*. 1994; 13:33–39. [PubMed: 8157851]
35. Baxter SD, Smith AF, Hitchcock DB, Guinn CH, Royer JA, Collins KL, Smith AL, Puryear MP, Vaadi KK, Finney CJ, Miller PH. Effectiveness of prompts on fourth-grade children's dietary recall accuracy depends on retention interval and varies by gender. *J Nutr*. 2015; 145:2185–2192. [PubMed: 26224752]
36. US Department of Agriculture, Economic Research Service. [Accessed October 30, 2016] Food Security in the US, Survey Tools, Self-Administered Food Security Survey Module for Youth Ages 12 and Older. <http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/survey-tools.aspx#youth>

37. Miller PH, Baxter SD, Hitchcock DB, Royer JA, Smith AF, Guinn CH. Test-retest reliability of a short form of the Children's Social Desirability Scale for nutrition and health-related research. *J Nutr Educ Behav.* 2014; 46:423–428. [PubMed: 24418615]
38. Guinn CH, Baxter SD, Hardin JW, Royer JA, Smith AF. Intrusions in children's dietary recalls: The roles of BMI, sex, race, interview protocol, and social desirability. *Obesity.* 2008; 16:2169–2174. [PubMed: 18535542]
39. Guinn CH, Baxter SD, Royer JA, Hardin JW, Mackelprang AJ, Smith AF. Fourth-grade children's dietary recall accuracy for energy intake at school meals differs by social desirability and body mass index percentile in a study concerning retention interval. *J Health Psychol.* 2010; 15:505–514. [PubMed: 20460407]
40. Miller PH, Baxter SD, Royer JA, Hitchcock DB, Smith AF, Collins KL, Guinn CH, Smith AL, Puryear MP, Vaadi KK, Finney CJ. Children's social desirability: Effects of test assessment mode. *Pers Individ Dif.* 2015; 83:85–90. [PubMed: 25870465]
41. US Department of Agriculture, Food and Nutrition Service. [Accessed October 30, 2016] National School Lunch Program. <http://www.fns.usda.gov/sites/default/files/NSLPFactSheet.pdf>
42. South Carolina Department of Education. [Accessed October 30, 2016] Technical Documentation for the 2010 Palmetto Assessment of State Standards of Writing, English Language Arts, Mathematics, Science, and Social Studies. <http://ed.sc.gov/scdoe/assets/File/tests/assessment-information/archives/technical-reports/PASS-2010TechnicalReport.pdf>
43. Maternal and Child Health Bureau. [Accessed October 30, 2016] Growth Charts Training. <http://depts.washington.edu/growth/index.htm>
44. Kuczmarski, RJ., Ogden, CL., Guo, SS., Grummer-Strawn, LM., Flegal, KM., Mei, Z., Wei, R., Curtin, LR., Roche, AF., Johnson, CL. 2000 CDC Growth Charts for the United States: Methods and development. National Center for Health Statistics; 2002. http://www.cdc.gov/nchs/data/series/sr_11/sr11_246.pdf [Accessed October 30, 2016]
45. Hamon, A., Mesbah, M. Questionnaire reliability under the Rasch Model. In: Mesbah, M.Cole, BF., Ting, Lee M-L., editors. *Statistical Methods for Quality of Life Studies: Design, Measurement, and Analysis.* Dordrecht: Kluwer Academic; 2002. p. 155-168.
46. Conover, WJ. *Practical Nonparametric Statistics.* 3. New York: Wiley; 1999.
47. Walker DA. Converting Kendall's Tau for correlation or meta-analytic analyses. *J Mod App Stat Meth.* 2003; 2:525–530.
48. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics.* 2007; 120:S164–S192. [PubMed: 18055651]
49. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Stat Soc Series B (Methodol).* 1995; 57:289–300.
50. South Carolina Department of Education. [Accessed October 30, 2016] South Carolina Palmetto Assessment of State Standards (SCPASS), 2014, State Scores by Grade Level. <http://ed.sc.gov/data/test-scores/state-assessments/scpalmetto-assessment-of-state-standards-pass/2014/state-pass-scores/?ID=9999999>
51. Nord M, Hanson K. Adult caregiver reports of adolescents' food security do not agree well with adolescents' own reports. *J Hunger Environ Nutr.* 2012; 7:363–380.
52. Nord M. Youth are less likely to be food insecure than adults in the same household. *J Hunger Environ Nutr.* 2013; 8:146–163.

Food insecurity questions asked of children ages 12–15 years in the National Health and Nutrition Examination Survey 2005–06, 2007–08, and 2009–10,² and of grade 4 children for the current study.

TABLE 1

Questions	Response options
These 5 questions are about the food situation in your home during the last 30 days.	
1) In the last 30 days, was the size of your meals cut because your family didn't have enough money for food?	<i>a lot sometimes never refuse to answer don't know</i>
2) In the last 30 days, did you eat less than you thought you should because your family didn't have enough money for food?	<i>a lot sometimes never refuse to answer don't know</i>
3) In the last 30 days, were you hungry but didn't eat because your family didn't have enough food?	<i>a lot sometimes never refuse to answer don't know</i>
4) In the last 30 days, did you skip a meal because your family didn't have enough money for food?	<i>a lot sometimes never refuse to answer don't know</i>
5) In the last 30 days, did you not eat for a whole day because your family didn't have enough money for food?	<i>once/twice sometimes never refuse to answer don't know</i>

Scoring: Items were scored according to USDA guidelines.³⁶ Affirmative responses (*a lot, sometimes, once/twice*) were coded 1 and other responses (*never, refuse to answer, don't know*) were coded 0.⁸ For each child, for each administration, these codes were summed over the 5 items to yield a score of 0 (food secure) to 5 (very high food insecurity).

TABLE 2

Seven studies in the United States, Ireland, and Greenland for which children aged 10–11 years responded to food insecurity questionnaires, some with items identical to, or similar to, those in the National Health and Nutrition Examination Survey's (NHANES's) 5-item food insecurity questionnaire.^a

Study	Sample	Items	Reference period	Response options
Murphy et al. 1998 ¹³	n=204; grades 3–5 (82%) & 8; 80% African American; Baltimore & Philadelphia	1) Did your household ever run out of money to buy food to make a meal? 2) Did you ever eat less than you felt you should because there was not enough money to buy food? [<i>item worded similarly to NHANES's item #2</i>] 3) Did you ever tell your parent(s) that you were hungry because there was not enough food in the house? 4) Did you ever go to bed hungry because there was not enough money to buy food? 5) Did you ever cut the size of your meals or skip meals because there was not enough money to buy food? [<i>item worded similarly to NHANES's items #1 and #4</i>]	last 12 months	yes, no
Connell et al. 2004 ⁸	n=345; grades 5–8 1 school 86% White; Mississippi	1) Did you worry that food at home would run out before your family got money to buy more? 2) Did the food that your family bought run out and you didn't have money to get more? 3) How often were you not able to eat a balanced meal because your family didn't have enough money? 4) Did your meals only include a few kinds of cheap foods because your family was running out of money to buy food? 5) Has the size of your meals been cut because your family didn't have enough money for food? [<i>item worded similarly to NHANES's item #1</i>] 6) Did you have to eat less because your family didn't have enough money to buy food? [<i>item worded similarly to NHANES's item #2</i>] 7) Did you have to skip a meal because your family didn't have enough money for food? [<i>item worded similarly to NHANES's item #4</i>] 8) Were you hungry but didn't eat because your family didn't have enough food? [<i>item worded identically to NHANES's item #3</i>] 9) Did you not eat for a whole day because your family didn't have enough money for food? [<i>item worded identically to NHANES's item #5</i>]	last 12 months	a lot, sometimes, never
Molcho et al. 2007 ¹⁵	n=8,424; 10–17y; Ireland	Some young people go to school or to bed hungry because there is not enough food at home. How often does this happen to you?	not specified	always, often, sometimes, never
Khan et al. 2011 ¹⁴	n=373; 10–14y; Vermont	items same as Connell et al. ⁸	reference period same as Connell et al. ⁸	response options same as Connell et al. ⁸
Sharkey et al. 2012 ¹¹	n=50; 6–11y; Mexican-origin; Texas	items same as Connell et al. ⁸	last 3 months	response options same as Connell et al. ⁸
Nielsen et al. 2013 ¹⁶	n=2,254; 11–17y; Greenland	item same as Molcho et al. ¹⁵	not specified	response options same as Molcho et al. ¹⁵
Baxter et al. 2015 ¹²	n=92; grade 4 (10.1y); 80% African American; South Carolina	items same as NHANES ² [see Table 1]	last 30 days [same as NHANES ²]	response options same as NHANES ² [see Table 1]

^aTable 1 shows the 5 items, response options, and scoring for NHANES's food insecurity questionnaire completed by children.

TABLE 3

The National Health and Nutrition Examination Survey's 5-item food insecurity questionnaire means (and SD) and internal consistencies by administration, and test-retest reliabilities, for grade 4 children by subgroup and overall.

Subgroup	n	Mean (SD) ^a	Administration-1	Mean (SD) Administration-2	Paired <i>t</i> -test <i>P</i> value ^b	Test-retest reliability ^c	<i>z</i> -test <i>P</i> value ^d	Internal Consistency Administration 1/2 ^e
Assessment Mode								
Classroom	78	1.14 (1.39)		1.06 (1.55)	1.0	0.60	1.0	0.69/0.82
Interview	77	1.57 (1.34)		1.04 (1.41)	<0.0007	0.65		0.51/0.73
Gender								
Girls	71	1.25 (1.38)		1.07 (1.62)	1.0	0.66	0.46	0.64/0.85
Boys	84	1.44 (1.38)		1.04 (1.35)	0.0182	0.56		0.58/0.69
Race/ethnicity								
African American	77	1.47 (1.35)		1.05 (1.38)	0.007	0.61	0.97	0.54/0.69
White	65	1.14 (1.27)		0.88 (1.38)	0.5446	0.59		0.58/0.78
Other ^f	13	1.77 (1.92)		1.92 (2.22)	0.4389	0.73		0.83/0.93
Socioeconomic status (SES)								
Lower SES ^g	116	1.52 (1.39)		1.22 (1.53)	0.0623	0.58	1.0	0.57/0.76
Higher SES	25	0.64 (0.95)		0.24 (0.83)	0.154	0.46		0.52/0.81
Academic achievement								
< Sample median (1.261)	76	1.75 (1.41)		1.49 (1.65)	0.4732	0.60	1.0	0.55/0.77
Sample median	77	0.97 (1.26)		0.62 (1.16)	0.0308	0.56		0.65/0.74
Body mass index percentile								
< 85 th percentile	92	1.26 (1.32)		1.02 (1.44)	0.3591	0.57	0.38	0.57/0.77
85 th percentile	63	1.49 (1.47)		1.10 (1.53)	0.0399	0.68		0.66/0.79
Social desirability ^h								
Low	76	1.16 (1.29)		0.93 (1.37)	0.4991	0.59	1.0	0.57/0.74
High	79	1.54 (1.45)		1.16 (1.57)	0.0441	0.63		0.62/0.80
Total	155 ⁱ	1.35 (1.38)		1.05 (1.48)	0.0077	0.61		0.61/0.77

^aFood insecurity questionnaire scores ranged from 0 (food secure) to 5 (very high food insecurity).

^bBonferroni adjusted *P* values from paired *t*-tests to compare scores on administration-1 to administration-2 within each subgroup and overall.

^c Kendall's tau coefficient.

^d Holm-Bonferroni adjusted *P* value for comparing test-retest reliabilities across each subgroup.

^e Cronbach's alphas shown as administration-1/administration-2.

^f 7 children were Hispanic and 6 children were of mixed races; these 13 children were combined into an Other group for analyses.

^g Lower SES children were eligible for free/reduced-price school meals during the school year and/or Supplemental Nutrition Assistance Program benefits for 30 days prior to either administration of questionnaires.

^h On the 14-item social desirability questionnaire, children categorized as "low" scored 0–7 and as "high" scored 8–14 points total.

ⁱ The total *n* was 155. The SES subgroup *n* was 141 because SES could not be linked for 14 children. The academic achievement subgroup *n* was 153 because academic achievement scores were unavailable for 2 children.

TABLE 4

Binomial regression (final model) results on the association between food insecurity scores (from grade 4 children on the National Health and Nutrition Examination Survey's 5-item food insecurity questionnaire) with assessment mode and characteristics of children.

	<i>P</i> -value ^a
Main effects	
Assessment mode (classroom, one-on-one interview)	0.07
Gender (boy, girl)	0.07
Race/ethnicity (African American, White, Other ^b)	0.001
Socioeconomic status (lower, higher)	0.08
Academic achievement ^c	0.7
Body mass index percentile ^c	0.3
Social desirability (score of 0–14) ^c	0.02
Interactions^d	
Academic achievement × race/ethnicity	0.002
Social desirability × race/ethnicity	0.02
Race/ethnicity × SES	0.07
Gender × academic achievement	0.07

^a *P* values are 2-sided and were adjusted for multiple simultaneous tests using the Benjamini-Hochberg procedure.⁵⁰

^b 7 children were Hispanic and 6 children were of mixed races; these 13 children were combined into an Other group for analyses.

^c Continuous variable.

^d An initial model was fit with all 2-way interactions. Non-significant ($P > 0.05$) 2-way interactions were removed, their sums of squares were pooled into the error term, and the resulting model was the final model.