Published in final edited form as:

J Nutr Educ Behav. 2015 ; 47(5): 459–464.e1. doi:10.1016/j.jneb.2015.06.006.

Test-Retest Reliability of the National Health and Nutrition Examination Survey's 5-Question Food Insecurity Survey Completed by Fourth-Grade Children

Suzanne D. Baxter, PhD, RD, LD, FADA, FAND¹, Albert F. Smith, PhD, MS², David B. Hitchcock, PhD³, Kathleen L. Collins, BS¹, Caroline H. Guinn, RD, LD¹, Christopher J. Finney, MS^{1,4}, Julie A. Royer, MSPH^{1,4}, and Patricia H. Miller, PhD⁵

¹Institute for Families in Society, College of Social Work, University of South Carolina, Columbia, SC

²Department of Psychology, Cleveland State University, Cleveland, OH

³Department of Statistics, University of South Carolina, Columbia, SC

⁴South Carolina Revenue and Fiscal Affairs Office—Health and Demographics, Columbia, SC

⁵Department of Psychology, San Francisco State University, San Francisco, CA

Abstract

Objective—To examine test-retest reliability and internal consistency of a 5-question food insecurity survey used in the National Health and Nutrition Examination Survey.

Methods—Researchers administered the National Health and Nutrition Examination Survey in the classroom to 92 fourth-grade children (74 African American; 48 girls) in 2 sessions 27–30 days apart in spring, 2011. Each classroom administration lasted 5–10 minutes.

Results—Test-retest reliability was 0.66 (Kendall tau), which is modest. Internal consistency (Cronbach alpha) was .67 and .70 for respective administrations. Food insecurity scores were related to gender (adjusted $P = .05$) and academic achievement (adjusted $P = .004$) but not to socioeconomic status or body mass index percentile (binomial regression). On average, boys reported higher food insecurity than girls. Children with lower academic achievement scores reported higher food insecurity than children with higher academic achievement scores.

Conclusions and Implications—The National Health and Nutrition Examination 5-question survey may be group administered to assess food insecurity efficiently as reported by individual fourth-grade children.

Address for correspondence: Suzanne D. Baxter, PhD, RD, LD, FADA, FAND, Institute for Families in Society, 1600 Hampton St, Ste 507, University of South Carolina, Columbia, SC 29208; Phone: (803) 777-1824 ext 12; Fax: (803) 777-1120; sbaxter@mailbox.sc.edu.

Conflict of Interest Disclosure: The authors' conflict of interest disclosures can be found online with this article on www.jneb.org.

CONFLICT OF INTEREST

The authors have not stated any conflicts of interest.

Keywords

food insecurity; children; test-retest reliability

INTRODUCTION

Although food insecurity—inconsistent access to enough food for healthy living as the result of inadequate money and other resources—threatens only a minority of US households, the number of individuals affected is nevertheless substantial.¹ Food insecurity has been associated with inadequate intake of key nutrients, increased risk for chronic disease, poor disease management, and poor psychological and cognitive functioning.²

Adult respondents' reports about household-level conditions for the December, 2013 Current Population Survey Food Security Supplement indicated that at some time during 2013, 14.3% of US households were food insecure; of these, about 39% had very high food insecurity.¹ According to adult respondents, children were food insecure at times during 2013 in 9.9% of US households with children.¹ Food insecurity rates during 2013 were higher for households with incomes at or below the federal poverty line, for single-parent households with children, and for African American and Hispanic households.¹

Most information about child food insecurity comes from parents' reports about household food insecurity, but this is problematic for 2 reasons. First, because parents and children experience food insecurity differently,^{3–5} a parent may not be sensitive to salient aspects of a child's perceptions of and reactions to food insecurity. Second, survey research on various topics (eg, children's exposure to domestic violence, pain, dietary intake^{6–9}) suggests that children are generally better situated than their parents to report their own experiences. Thus, relying on parents' reports may limit accurate assessment of children's food insecurity. Generally, over households, children's food insecurity is correlated with that of adults, but because the relationship between child and adult food insecurity depends on children's ages, measures of individual children's and adults' food insecurity may be more informative than a single household measure.^{4,10}

Food insecurity questions for children have been developed and examined. Connell and colleagues¹¹ used cognitive interviewing with children aged 11–15 years to develop a 9-question, child-reported survey deemed to have adequate internal validity for children aged 12 years. Using semi-structured, in-depth interviews with children aged 11–16 years, Connell and colleagues found that children described food insecurity in terms of quantity (eg, eating less than usual), quality (eg, having only a few low-cost foods), and psychosocial states (eg, worry, sadness, shame, fear), and expressed an understanding that adults tried to shield children from food insecurity.¹² Fram and colleagues⁵ separate interviews of adults and their children aged 9–16 years showed that children's food insecurity experiences differed from parents' experiences and from parents' reports of children's experiences. Bernal and colleagues³ found similar results with Venezuelan children aged 10–17 years. Interviews with British children showed that even children aged 9–10 years had knowledge of family finances and how those affected food choices. Fram and colleagues⁴ used cognitive interviews to develop prior survey questions into a 30-question, child-reported

survey that was field-tested with children aged 6–17 years and validated by comparing survey responses with food insecurity classifications based on in-depth interviews with children. Children reported their food insecurity with high accuracy, with 6-year-olds as accurate as older children. Parents of these children also were interviewed; parents' reports about children were inaccurate, missing half of children experiencing hunger.⁴

During 3 National Health and Nutrition Examination Survey (NHANES) cycles (2005–2006, 2007–2008, and 2009–2010), children aged 12–15 years answered the 5 food insecurity questions in the Figure.¹⁴ These were a slightly revised subset of Connell and colleagues'¹¹ 9 questions. Connell and colleagues found that children's responses to the 9-question survey were internally consistent. However, little is known about test-retest reliability of children's responses to the NHANES 5-question survey or about correlates of child-reported food insecurity.

This study investigated 1-month test-retest reliability and internal consistency of the NHANES 5-question food insecurity survey with fourth-grade children (who are 2 years younger than the youngest children asked these questions in NHANES). Also, this study investigated, for these children, the relationship of food insecurity scores to gender, socioeconomic status (SES), academic achievement, and body mass index (BMI) percentile.

METHODS

Participants

Data were collected during the pilot-study phase (spring, 2011) of a multi-year dietary reporting validation study with fourth-grade children¹⁵ from all 6 fourth-grade classes at 2 schools in a metropolitan school district in South Carolina. The University of South Carolina's Institutional Review Board provided approval. Written parental consent and child assent were obtained.

Instruments and Measures

The Figure lists the 5 food insecurity questions and response options. Following US Department of Agriculture scoring guidelines (<http://www.ers.usda.gov/media/476115/youth2006.pdf>), affirmative responses (*a lot*, *sometimes*, and *once/twice*) were coded 1 and other responses (*never*, *refuse to answer*, and *don't know*) were coded 0.¹¹ These codes were summed over the 5 questions to yield a score of 0 (food secure) to 5 (very high food insecurity).

Children's scores on standardized academic achievement tests served as a proxy for cognitive ability. Academic achievement was quantified by summing each child's scores on the English Language Arts and Mathematics scales of the South Carolina Palmetto Assessment of State Standards.¹⁶

Each child was classified as low-SES or non-low-SES based on the eligibility of the child (or child's family) for free/reduced-price school meals during the school year and for Supplemental Nutrition Assistance Program (SNAP) benefits for 30 days before either survey administration. A child eligible for at least 1 of these programs was classified as low-

SES; otherwise the child was classified as non-low-SES. Children from families with incomes $\geq 130\%$ of the poverty level were eligible for free meals, and those from families with incomes $> 130\%$ and $< 185\%$ of the poverty level were eligible for reduced-price meals.¹⁷ The state's Revenue and Fiscal Affairs Office–Health and Demographics section was authorized by the state's Department of Education (for school meal eligibility) and Department of Social Services (for SNAP eligibility) to link data sets, conduct analyses, and provide aggregate results to researchers.

To calculate BMI, researchers measured children's weight and height in the morning at school using established procedures¹⁸ after the first survey administration. Inter-measurer reliability, assessed on 10% of children per day of measurements, was 0.99 for weight and for height. Age/gender BMI charts were used to determine BMI percentiles.¹⁹

Survey Administration

In each classroom, for each administration, 2 researchers distributed paper surveys. Because the 5 questions concerned the past 30 days, before starting the survey, 1 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.

Dates were written on the classroom's board. One researcher read each question with response options aloud while children followed along, and asked children to circle 1 response per question. The other researcher walked around the classroom to ensure that children answered accordingly. The first administration was in mid March. The second administration, in mid April, to the same children by the same researchers, followed the first administration by 27–30 days. The time between administrations was chosen to approximate the survey's 30-day reference period and to decrease the likelihood that a child would simply repeat the first administration's answers on the second administration. Each classroom administration lasted 5–10 minutes.

Analyses

Cronbach alpha assessed internal consistency, although for this type of data, it may slightly underestimate internal consistency.²⁰ Kendall tau coefficient quantified test-retest reliability.²¹ A paired *t* test compared scores between administrations. Using a binomial regression model, scores from the first administration were regressed on gender, SES, academic achievement, BMI percentile, and their first-order interactions; because none of the first-order interactions was significant, they were removed and the model was refit. (Scores from the first administration were analyzed for the binomial regression because researchers would typically administer the survey only once.) For the binomial regression, gender and SES were dichotomous and academic achievement and BMI percentile were continuous. The Benjamini-Hochberg procedure²² adjusted for multiple simultaneous tests controlled the false discovery rate at .05. Statistical analyses used SAS/STAT (version 9.4, SAS Institute, Inc, Cary, NC, 2012).

Although 97 children completed the survey twice, SNAP benefits changed between administrations for 5 children; these children were excluded from analyses, which left a total of 92. Of these 92, academic achievement scores were unavailable for 5 and SES could not be linked for 4 of the 5; thus, for the binomial regression the sample was 87.

RESULTS

There were 92 children (48 girls), mean ($\pm$ SD) age 10.1 ± 0.4 years; 74 were African American, 7 were Hispanic, 7 were white, and 4 were other. Mean academic achievement score was $1,235.3 \pm 77.0$ (range, 1,099–1,440); statewide mean was 1,280.²³ Mean BMI percentile was 71.4 ± 26.7 (range, 1.0–99.7). Most children were low-SES (Table).

Internal Consistency and Test-retest Reliability

For the 92 children, internal consistency (Cronbach alpha) was .67 and .70 for the first and second administrations, respectively. One-month test-retest reliability was 0.66 (Kendall tau, $P < .001$), which is modest.

Relationships

Food insecurity scores were related to gender (adjusted $P = .05$) and academic achievement (adjusted $P = .004$) but not to SES or BMI percentile (both adjusted $P > .94$; binomial regression). Controlling for SES, academic achievement, and BMI percentile, on average, boys reported higher levels of food insecurity than girls. Controlling for gender, SES, and BMI percentile, children with lower academic achievement scores reported higher levels of food insecurity than children with higher academic achievement scores. These results are illustrated by the table's mean food insecurity scores for children grouped by gender, SES classification, academic achievement (median split), and BMI percentile (below vs at or above the 85th percentile, an expert committee's definition of *overweight or obese* for children²⁴).

Degree of Food Insecurity

For the 92 children, over administrations, scores ranged from 0–5; this showed that children's responses yielded the full range of food insecurity scores. For the 92 children, most children with scores of 0 on the first administration had scores of 0 on the second administration; 66% of children with nonzero scores on the first administration had nonzero scores on the second administration; for these children, second-administration scores tended to be lower than first-administration scores. For the 92 children, reported food insecurity decreased from the first (0.89 ± 1.26) to the second administration (0.61 ± 1.11) (paired t test, $P = .006$). The table shows that for each gender, SES, academic achievement, and BMI percentile subgroup, average scores for the second administration appeared lower than for the first.

Of the first administration's 460 responses (92 children $\times$ 5 questions) and the second administration's 460 responses, frequencies of responses per administration (first, second) were *a lot* (15, 4), *sometimes* (67, 52), *never* (325, 357), *refuse to answer* (15, 13), *don't know* (38, 34), and *once/twice* (0, 0). Thus, over 2 administrations, children rarely responded

“*refuse to answer*” (28 / 920 = 3.0%) and infrequently responded “*don’t know*” (72 / 920 = 7.8%). Overall change in responses between administrations was for responses concerning frequency of experiences (ie, *a lot, sometimes, never*). The numbers of *refuse to answer* and *don’t know* responses were essentially the same in the first and second administrations.

DISCUSSION

The authors know of no other investigation of test-retest reliability of children’s responses to the 5-question food insecurity NHANES. For NHANES, children aged 12–15 years completed the survey; for this study, children aged 10 years completed the same survey. For this study, children answered the survey similarly on 2 occasions separated by 27–30 days, although mean scores decreased. The survey appears reasonable for use with fourth-grade children.

The authors expected modest rather than good test-retest reliability of the 5-question food insecurity NHANES for 2 reasons. First, some fluctuation in reported food insecurity was anticipated because the 2 administrations concerned different 30-day periods. Second, Connell and colleagues¹¹ reported that their 9-question food insecurity survey (from which the NHANES 5 questions were derived) had “sufficient reliability to be a useful tool” (0.69) with children aged 12 years, but that reliability was worse with younger children. However, design and demographic differences challenge direct comparison with the current study because their study did not examine test-retest reliability and their sample was from a school with 85.9% white children, with 50% of the sample eligible for free/reduced-price school meals. The current study’s sample was 80% African American, lower in SES, and younger in age.

Decreased average scores from the first to the second administrations for the 92 children, and each subgroup, were baffling. The 2 administrations were in the middle of consecutive months, when the household SNAP benefits situation was expected to be similar. The authors cannot explain the difference.

Connell and colleagues¹¹ found that the response patterns of boys and girls “were generally similar” on their 9-question survey, although Table 4 in their article shows that boys reported slightly higher food insecurity than girls. For the current study with the 5-question NHANES, boys reported higher levels of food insecurity than girls, on average. The authors cannot explain the gender difference.

Children with lower academic achievement reported higher levels of food insecurity than children with higher academic achievement. Although an association between food insecurity and academic achievement was previously reported,²⁵ finding a relationship between academic achievement and children’s own reports of food insecurity is novel.

No relationship was found between children’s food insecurity scores and SES. Households using food assistance programs can be either more or less food secure than households not using those programs.¹ Because those programs are intended to decrease food insecurity, households should be more food secure after receiving program benefits than before;

however, it is the more food-insecure households that seek program assistance.¹ The authors' method of classifying children by SES may have lacked precision.

One study limitation is that the small sample was inadequate to examine test-retest reliability by children's gender, SES, academic achievement, and BMI percentile. Children were primarily African American and of a single grade level. A strength was the temporal proximity of food insecurity survey administration (March and April), weight and height measurements (March), and school academic achievement testing (March and May).

IMPLICATIONS FOR RESEARCH AND PRACTICE

The 5-question food insecurity NHANES may help researchers and practitioners identify food insecurity reported directly by fourth-grade children. This survey may be group administered to efficiently detect which fourth-grade children provide food-insecure responses. The psychometric properties are modest for fourth-grade children. This type of tool is important to assess individual-level effects of food insecurity on children.¹¹ Research is needed with larger samples of children diverse in race/ethnicity and age.

Acknowledgments

Grant R01HL103737 (Principal Investigator SDB) from the National Heart, Lung, and Blood Institute of the National Institutes of Health (NIH) supported this research. This article's content is solely the authors' responsibility and does not necessarily represent views of National Heart, Lung, and Blood Institute, 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 Richland 1 School District's 2 elementary schools in Columbia, SC. They thank Megan P. Puryear, MS, RD, LD, and Kate K. Vaadi, RD, LD for collecting data. Dr Baxter's current and previous research has been funded externally by competitive grants from the NIH and the US Department of Agriculture. Dr Baxter has served as a grant reviewer for the NIH and the Centers for Disease Control and Prevention. Dr Baxter is on the Board of Editors for the *Journal of the Academy of Nutrition and Dietetics*. Dr Smith's research has been funded externally by competitive grants from the NIH. Dr Hitchcock's research has been funded by the South Carolina Department of Education and the University of South Carolina Research and Productivity Program.

References

1. Coleman-Jensen, A.; Gregory, C.; Singh, A. [Accessed June 10, 2015] Household food security in the United States in 2013 (ERR-173). <http://www.ers.usda.gov/publications/err-economic-research-report/err173.aspx>
2. American Dietetic Association. Position of the American Dietetic Association: food insecurity in the United States. *J Am Diet Assoc.* 2010; 110:1368–1377. [PubMed: 20821887]
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, et al. Children are aware of food insecurity and take responsibility for managing food resources. *J Nutr.* 2011; 141:1114–1119. [PubMed: 21525257]
6. Sheffler LC, Hanley C, Bagley A, Molitor F, James MA. Comparison of self-reports and parent proxy-reports of function and quality of life of children with below-the-elbow deficiency. *J Bone Joint Surg.* 2009; 91:2852–2859. [PubMed: 19952247]
7. Varni JW, Limbers CS, Burwinkle TM. Parent proxy-report of their children's health-related quality of life: an analysis of 13,878 parents' reliability and validity across age subgroups using the PedsQL 4.0 Generic Core Scales. *Health Qual Life Out.* 2007; 5:2.

8. Burrows TL, Truby H, Morgan PJ, Callister R, Davies PSW, Collins CE. A comparison and validation of child versus parent reporting of children's energy intake using food frequency questionnaires versus food records: who's an accurate reporter? *Clin Nutr*. 2013; 32:613–618. [PubMed: 23206381]
9. Hunsberger M, Pena P, Lissner L, et al. Validity of self-reported lunch recalls in Swedish school children aged 6–8 years. *Nutr J*. 2013; 12:129. [PubMed: 24047239]
10. Nord M, Hopwood H. Recent advances provide improved tools for measuring children's food security. *J Nutr*. 2007; 137:533–536. [PubMed: 17311935]
11. 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]
12. 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]
13. 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.
14. Centers for Disease Control and Prevention. [Accessed June 10, 2015] 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
15. Baxter SD, Smith AF, Hitchcock DB, et al. Effectiveness of prompts on fourth-grade children's dietary recall accuracy depends on retention interval and varies by gender. under review.
16. South Carolina State Department of Education. [Accessed June 10, 2015] South Carolina Palmetto Assessment of State Standards (SCPASS) grades 4–8. <http://ed.sc.gov/agency/programs-services/45/>
17. US Department of Agriculture, Food and Nutrition Service. [Accessed June 10, 2015] National School Lunch Program. <http://www.fns.usda.gov/sites/default/files/NSLPFactSheet.pdf>
18. Maternal and Child Health Bureau. [Accessed June 10, 2015] Growth charts training. <http://depts.washington.edu/growth/index.htm>
19. Kuczmarski, RJ.; Ogden, CL.; Guo, SS., et al. CDC growth charts for the United States: methods and development. National Center for Health Statistics; 2000. http://www.cdc.gov/nchs/data/series/sr_11/sr11_246.pdf [Accessed June 10, 2015]
20. Hamon, A.; Mesbah, M. Questionnaire reliability under the Rasch Model. In: Mesbah, M.; Cole, BF.; Lee, M-L.; Ting, editors. *Statistical Methods for Quality of Life Studies: Design, Measurement, and Analysis*. Dordrecht, The Netherlands: Kluwer Academic; 2002. p. 155-168.
21. Conover, WJ. *Practical Nonparametric Statistics*. 3. New York, NY: Wiley; 1999.
22. 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.
23. South Carolina State Department of Education. [Accessed June 10, 2015] Palmetto Assessment of State Standards (PASS) Test Scores. 2011. <http://www.ed.sc.gov/data/pass/2011>
24. 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]
25. 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]

These 5 questions are about the food situation in your home during the last 30 days.

In the last 30 days...

- 1) ...was the **size of your meals cut** because your family didn't have enough money for food?
- 2) ...did you **eat less** than you thought you should because your family didn't have enough money for food?
- 3) ...were you **hungry** but didn't eat because your family didn't have enough food?
- 4) ...did you **skip a meal** because your family didn't have enough money for food?
- 5) ...did you **not eat for a whole day** because your family didn't have enough money for food?

Response options: a lot, sometimes, never, refuse to answer, don't know (except #5 substituted once/twice for a lot)

Figure.

Food insecurity questions asked of children aged 12–15 years in the National Health and Nutrition Examination Survey 2005–2006, 2007–2008, and 2009–2010¹⁴ and fourth-grade children (n = 92) for the current study.

Table

Descriptive Statistics for 5-Question Food Insecurity Survey for Fourth-Grade Children Overall and by Subgroup

Group/Subgroup	n	First Administration	Second Administration
		Mean (SD) ^a	
Overall	92	0.89 (1.26)	0.61 (1.11)*
Gender			
Girls	48	0.60 (1.11)	0.42 (0.99)
Boys	44	1.20 (1.36)	0.82 (1.21)
Socioeconomic status ^b			
Low	68	0.96 (1.23)	0.68 (1.16)
Non-low	20	0.70 (1.38)	0.35 (0.81)
Academic achievement ^c			
Less than sample median (1,234)	45	1.29 (1.41)	0.84 (1.17)
Sample median or higher	42	0.48 (0.94)	0.24 (0.66)
Body mass index percentile			
< 85th percentile	51	0.92 (1.25)	0.55 (1.05)
85th percentile	41	0.85 (1.30)	0.68 (1.19)

* $P < .001$, paired t test;

^a Scoring range was 0 (food secure) to 5 (very high food insecurity);

^b Socioeconomic status could not be linked for 4 children. Low socioeconomic status received free/reduced-price school meals during school year and/or Supplemental Nutrition Assistance Program benefits for 30 days before either survey administration;

^c Academic achievement scores were unavailable for 5 children.