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Improving Food Security Classification of Households With Children

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We examine the extent to which the household food security classification methods currently used by the US Department of Agriculture may bias comparisons of food security between households with and without children and between households with children of different ages. An alternative method for classifying households with children as to their food security status is described that removes the source of those biases by considering the food security of adults and children based on separate measures. Using data from the Current Population Survey Food Security Supplements from 2001 to 2011, the analysis suggests that the current methods may have overstated the prevalence of food insecurity and understated the prevalence of very low food security in households with children vis-à-vis households without children. The extent to which very low food security may have been understated increased during and following the economic downturn of 2008.

KEYWORDS *food security, food insecurity, food security measurement*

INTRODUCTION

Accurate representation of the extent and severity of food insecurity in various subpopulations is an important function of the US food security

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monitoring and reporting system. In this article, we examine the extent to which the classification procedures currently used by the US Department of Agriculture (USDA) may distort such comparisons between households with and without children and between households with children in different age ranges, and we describe a modified classification procedure that would reduce those biases.

Food security, defined as access by all people at all times to adequate food for active healthy lives, is an important foundation for a nation's nutrition and health. The USDA monitors the food security of U.S. households using data from an annual, nationally representative household survey, the Current Population Survey Food Security Supplement (CPS-FSS). Food security is measured in the CPS-FSS, and in several other national surveys in the United States, by responses to a series of questions about experiences and conditions that characterize households when they are having difficulty meeting their food needs.¹⁻⁴

Responses to the food security questions are combined to represent the severity of food insecurity in each household using statistical methods based on a latent trait item response theory (IRT) statistical model. Latent trait models are used in the social sciences to measure constructs that are not directly observable but that may be inferred from observable conditions or occurrences caused by the unobservable (ie, latent) trait. IRT statistical methods, which were developed primarily in the educational testing field, measure the latent trait of competency or ability in a specific field of knowledge by responses to a set of test items. The food security scale, which measures the latent trait of severity of food insecurity experienced by households, is based on one of the simplest IRT statistical models, the single-parameter logistic latent trait model commonly known as the Rasch model.^{5,6}

To summarize the food security of the population overall and of selected subpopulations, households are classified as to their food security status based on their measured severity of food insecurity. The percentages of households (prevalence rates) in these severity categories are then reported as population summary measures. Food security status is typically classified in 4 categories: high, marginal, low, and very low. For reporting purposes, the high and marginal categories are combined and described as "food secure," and the low and very low categories are combined and described as "food insecure." The percentage of households in the most severe category, very low food security, is also reported separately.

This food security measure has been the cornerstone of USDA's domestic household food security monitoring system since its development in the mid-1990s.¹³ It has played important roles in assessing and communicating the extent of food hardship in the country, identifying the subpopulations most vulnerable to food insecurity and supporting research into the causes and consequences of food insecurity and the role of USDA's food and nutrition assistance programs.

Following a decade of use, the measurement methods were reviewed by a panel convened by the Committee on National Statistics at the request of USDA. The panel affirmed the general statistical approach, recommended several minor changes that USDA subsequently adopted, and recommended that USDA investigate several more substantial potential technical enhancements to the statistical methods.⁴ The USDA's Economic Research Service assessed 5 of those potential enhancements with technical assistance from researchers at Iowa State University and Colombia University Teachers College.⁷ In summary, that study concluded that “. . . little would be gained by measuring food security with any of the more complex measures, *provided an alternative methodology can be implemented to remove the current bias in comparing the prevalence of food insecurity between households with and without children*”^(p4) (emphasis added). The “current bias” in this proviso refers to distortions in comparisons of food security between households with and without children, and between households with children in different age ranges, that are inherent in the USDA's current food security classification procedures. In this article, we document the source and extent of those distortions and describe a modified classification procedure that would avoid those biases.

This article explores the classification question only on theoretical and measurement-statistical grounds. It will also be important to assess which of the 2 classification methods is more consistent with alternative indicators of food insecurity and with expected outcomes of food insecurity. That assessment is beyond the scope of this article but will be crucial, along with the evidence provided in this article, for informing a decision on how best to classify the food security status of households with children.

BIASES IN THE CURRENT MEASUREMENT AND CLASSIFICATION METHODS

The methods that the USDA uses to measure the severity of food insecurity in households and to classify them as to food security status are justified statistically to the extent that responses to the food security questions are consistent with assumptions of the Rasch measurement model. Provided that those assumptions are met, a household's raw score on a specific set of items—that is, the number of potentially food insecure conditions reported—is an ordinal measure of the severity of food insecurity experienced by the household. In the original development of the food security measure, items were assessed for inclusion in the scale with the intention of meeting Rasch model assumptions in order to achieve that ordinality.¹ So, for example, households with children with raw scores 0–2 (out of 18) are classified as food secure, those with raw scores 3–7 are classified as having low food security, and those with raw scores 8–18 are classified as having very low food security.³

In recent years, as the food security measure has been used for increasingly detailed and complex analysis, researchers have become aware that the current standard methods of food security measurement and classification have 2 characteristics that cause biases in prevalence rates large enough to be substantively important.⁷ The first is that response data to the 18 items administered to households with children represent 2 dimensions, whereas the Rasch model assumes unidimensionality. Though not egregious, the violation is large enough to cause a modest distortion in some food security prevalence comparisons. The model assumption is expressed more generally as conditional independence of item responses. That is, the correlations among item responses across households are entirely due to the common associations of those items with the latent trait, and responses to items are uncorrelated across households that have the same value on the latent trait.

Responses to the 18 items in the household scale, however, generally represent 2 dimensions, corresponding to the severity of food insecurity among adults and the severity of food insecurity among children. The difference between the 2 dimensions is due primarily to the ages of children.⁸ Younger children are generally shielded by their parents from effects of food insecurity to a greater extent than older children at a given level of severity of food insecurity among adults in the household.^{9,10} The distortion that results from this bidimensionality in the measure is that the food insecurity of households with only very young children is understated relative to that of households with older children or households without children. Although this is true across the range of severity of food insecurity, it is most noticeable for very low food security. For overall food insecurity, this bias is more than offset by the second source of bias, which is described next.

The second source of bias in the current standard method of household food security classification is that the threshold for food insecurity applied to households without children differs in severity from the threshold applied to households with children. This biases comparisons of prevalence rates of food insecurity between households with and without children. This problem does not result from any violation of assumptions of the measurement model but rather from USDA's policy of classifying households discretely as food secure or food insecure based on raw score. The problem occurs because no raw score-based threshold on the 10-item scale that is applied to households without children is exactly equivalent in severity to the 3+ threshold for food insecurity on the 18-item scale applied to households with children. The same raw-score threshold of 3+ is applied to households with no children, but it represents a more severe level of food insecurity (Figure 1). A raw score of 2+ for households with no child would represent a less severe level of food insecurity. The USDA is aware of this bias and includes a footnote in its annual food security report describing the source and approximate extent of the bias. For example, Coleman-Jensen et al. (footnote 11),³ commenting on the difference in prevalence rates of food insecurity in 2012 between households with children (20.0%) and without children (11.9%), stated,

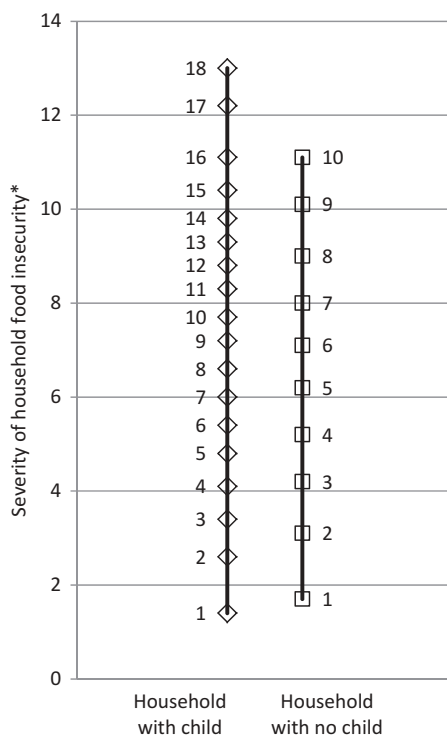


FIGURE 1 Severity of food insecurity (latent trait measure) by raw score for households with and without children. *The vertical axis represents the Rasch model estimate of the household parameter for the indicated raw score. This is the estimated mean measure on the latent trait (severity of food insecurity) for households with that raw score. The parameter for households with maximum scores, those that affirmed all 18 items (all 10 items for households with no children), are technically undefined. The values shown are approximations based on raw scores a half-unit below maximum. Source: Guide to Measuring Household Food Security: Revised 2000, Exhibit C-2.2.

About one-third of the difference in food insecurity between households with and without children results from a difference in the measures applied to the two types of households. Responses to questions about children as well as adults are considered in assessing the food security status of households with children, but for both types of households, a total of three indications of food insecurity is required for classification as food insecure.^{3, p.12}

The corresponding problem for determination of very low food security is smaller because the raw score thresholds applied to households with children (8+) and households without children (6+) correspond to more nearly equal levels of severity of food insecurity. In addition, the proportions of households in each raw score near the threshold for very low food security are smaller than those near the threshold for food insecurity.

The bias due to the difference in severity of thresholds for food insecurity could be obviated by assigning food security status probabilistically rather than discretely, taking into account the measurement error inherent in the latent trait measure.^{4,7} This method would support estimation of population prevalence rates beyond a consistent threshold for households with and without children. There are, however, advantages to classifying households discretely based on raw scores, provided that this can be done without introducing excessive distortions in the national statistics.⁷ The discrete classification process is more easily explained to policy officials and the public and therefore creates a more transparent measurement system. This simplicity and transparency has considerable value in a highly visible indicator of well-being such as the prevalence of food insecurity. Furthermore, though probabilistic assignment of food security status would solve the problem of unequal thresholds, it would not solve the problem of bidimensionality.

In this article, we describe an alternative food security classification procedure for households with children that avoids both of these biases. The classification procedure incorporates information on the food security status of both adults and children in the households but uses separate measures for the 2 age groups to do so. Using the alternative measure as a baseline, we then assess the extent to which the current standard procedures bias comparisons of statistics routinely published by the USDA.

DATA AND METHODS

Data are from the CPS-FSS conducted in December of each year from 2001 to 2011. The CPS-FSS is sponsored by the USDA's Economic Research Service and fielded annually by the US Census Bureau as a supplement to its monthly Current Population Survey. The CPS-FSS includes about 45 000 households each year and is representative of the civilian, noninstitutionalized population of the nation. It is the data source for the USDA's annual reports on household food security in the United States.³

Food security classifications are based on 3 currently defined scales:

- HH18, the 18-item "household scale" or "combined adult-child scale," includes 3 household-referenced items, 7 adult-referenced items, and 8 child-referenced items. This is the scale currently used to classify households with children as to the food security status of the household. Raw scores range from 0 to 18, with 0–2 indicating food security, 3–7 low food security, and 8–18 very low food security. (Technically, the scale includes 15 items, of which 12 are dichotomous and 3 are trichotomous. The trichotomous items represent whether the condition or behavior occurred never, in only 1 or 2 months, or in 3 or more months. The items contribute 1 raw score point for occurrence in only 1 or 2 months and 2 points for occurrence in 3 or more months.)

- AD10, the 10-item “adult scale” includes the 3 household-referenced items and 7 adult-referenced items in HH18. This is the scale currently used to classify households with no children present. It can also be used to classify households with children as to the food security status of adults in the household. Raw scores range from 0 to 10, with 0–2 indicating food security, 3–5 low food security, and 6–10 very low food security.
- CH8 includes the 8 child-referenced items in HH18. This scale is currently used to classify households with children as to the food security status of children in the household. Raw scores range from 0 to 8, with raw scores 0–1 indicating food security among children, 2–4 low food security among children, and 5–8 very low food security among children.

The alternative household food security classification is based on cross-classification by the AD10 and CH8 scales. Households with children who are food insecure on either the adult or child scale are classified as food insecure. Households with very low food security on either scale are classified as having very low food security. Those classified as food insecure but without very low food security are classified as having low food security. Classification of households with no children is unchanged from the current method. The HH18 scale would have no further role in food security measurement. In the rest of the article, we refer to this as the *cross-classification method*. Health Canada uses this method for their reports on household food insecurity, although they use a less severe threshold—raw score 2 or greater—for adult food insecurity.¹¹

The cross-classification method explicitly takes account of the adult–child bidimensionality in the response data by assessing the 2 dimensions separately. Households with and without children that have the same measured severity of food insecurity among adults will be assigned the same food security status unless children are classified in a more severe food insecurity status than the adults. This is a rare condition, as will be seen in the Findings section. Households in which it does occur are justifiably classified in the more severe food insecure category.

Household demographic and economic data from the CPS labor force core survey are used to classify households as to household composition, income (relative to the federal poverty line), race and Hispanic ethnicity of household reference person, area of residence relative to metropolitan areas, and census geographic region. These follow the methods used in the USDA’s annual food security reports.³

The extent and practical importance of the biases in the current methods are assessed by comparing prevalence rates of food insecurity and very low food security based on current methods with those based on the cross-classification method. Prevalence rates based on the 2 methods are compared at the national level, over time from 2001 to 2011, and across subpopulations defined by the household demographic and economic variables.

FINDINGS

Before examining the detailed comparisons, it may be helpful to examine the source and scale of the differences in classification between the current standard method and the cross-classification method. Most of the cells in a cross-tabulation of households by raw score on the adult and child scales are assigned to the same food security status by both methods (Table 1). Food security status differs between the two methods in just 14 cells, of which 8 represent nonnegligible numbers of cases in national data. Looking first at the food insecure threshold, on average over the study period, 1.98% of

TABLE 1 Percentage of Households With Children by Raw Score on the Adult and Child Food Security Scales, Average 2001–2011^a

		Raw score, adult scale	Child food secure		Child food insecure					
					Child low food security			Child very low food security		
			Raw score on child food security scale							
		0	1	2	3	4	5	6	7	8
Adult food secure	0			0.15			*	*	*	
	1						*	*		
	2		1.98				*			
Adult food insecure	Adult low food security	3								
		4					0.07			
		5				0.35	0.08			
	Adult very low food security	6	0.29	0.43						
		7	0.17							
		8								
		9								
		10								

^aPercentages are displayed only for cells for which food security status based on cross-classification differs from that based on the current standard method.

*Households in these cells would be classified as having very low food security by the cross-classification method but not by the current standard method. However, each of the cells had either no observed households or fewer than 0.01%, and the total in the 6 cells was less than 0.01%. Percentages are displayed only for cells for which food security status based on cross-classification differs from that based on the current standard method.

Shading indicates the current standard classification of households with children, which is based on a “household” raw score that is the sum of adult and child raw scores:

Food secure, combined raw score 0–2 (82.08 percent of households with children)	
Low food security, combined raw score 3–7 (13.06 percent of households with children)	
Very low food security, combined raw score 8–18 (4.86 percent of households with children)	

Source: Calculated by the authors using data from the 2001–2011 Current Population Survey Food Security Supplements (CPS-FSS). U.S. Census Bureau. 2001–2011. Microdata files on CD-ROM.

households with children were classified as food insecure by the standard method but as food secure by the cross-classification method. These were households with raw score 2 on the adult scale and raw score 1 on the child scale. Thus, neither adults nor children were food insecure, although both were only marginally secure. Depending on the level of severity considered to be appropriate for identifying food insecurity, these households could be considered either food secure or food insecure. We do not make any claim in that regard because within some range of severity, the precise level at which households should be declared food insecure is somewhat arbitrary. We argue only that within that range it is advantageous to classify households with and without children by consistent criteria.

The 1.98% of households that are classified as food insecure by the current method but not by cross-classification was partially offset by a small proportion (0.15%) of households with children that are classified as food insecure by cross-classification but not by the standard method. These are households with food insecurity among the children (raw score 2 on the child scale) and with no reported food insecure conditions among the adults (raw score 0 on the adult scale). The net bias on the prevalence of food insecurity in the current method, then, was 1.83 percentage points, which amounted to about 10% of the average prevalence of food insecurity in households with children over the study period (17.9%) and about 22% of the difference in prevalence of food insecurity between households with and without children as measured by current standard methods (8.4 percentage points).

Classification of very low food security differs between the standard and cross-classification for 3 raw score clusters, although only 2 had nonnegligible percentages of households. Households with raw scores 6 and 7 on the adult scale and 0 on the child scale or with raw score 6 on the adult scale and 1 on the child scale had very low food security among adults but are classified as having low food security by the current standard method because their combined raw score on the HH18 scale is 6 or 7. Six cells at the other extreme, those with very low food security among children but combined raw scores less than 8, would be similarly misclassified; however, most of these cells were empty, and their combined total was less than 0.01% of households with children. Thus, a total of 0.89% of households with children had very low food security based on cross-classification but were classified as having low food security by the standard method. This percentage was partially offset by 0.50% of households classified as having very low food security by the current methods but not having very low food security among either adults or children (raw scores 4 and 5 on the adult scale and raw scores 3 and 4 on the child scale). This leaves an average net downward bias for very low food security in households with children of 0.39 percentage points over the study period.

The differences in classification at the very low food security threshold would not necessarily indicate a problem with the current standard method if

the differences were random with respect to household characteristics. But in fact, ages of children differ substantially between households in the 2 groups that differ in classification on the standard and cross-classification methods. On average, children are younger in the first group, those with very low food security based on cross-classification, but not on the current standard classification. In 27.6% of those households, the oldest child was 4 years old or younger, compared to 9.1% of households in the second group—those with very low food security based on the current methods but not on cross-classification (analysis not shown). The corresponding percentages in which the oldest child was 12 years old or older were 38.0% and 55.5%.

Trends From 2001 to 2011

Over the study period, the prevalence of food insecurity in households with children averaged 1.8 percentage points lower based on cross-classification (16.1%) than on the current standard measure (17.9%; [Figure 2](#)). The difference in prevalence rates for all households was about one third as large (0.6 percentage point) because the classification of households with no children is the same in both methods and about two thirds of US households have no children present. Over the study period, the difference in prevalence rates based on the 2 measures ranged from 1.2 to 2.4 percentage points for households with children and 0.4 to 0.8 percentage points for all households. Thus, the 2 methods represent trends in food insecurity similarly, although at different levels.

Trends in the estimated prevalence of very low food security differed between the 2 methods in more complex ways ([Figure 3](#)). Estimates of very low food security in households with children were higher based on cross-classification than on the current standard method throughout the study period, but the gap widened beginning in 2008. The difference between

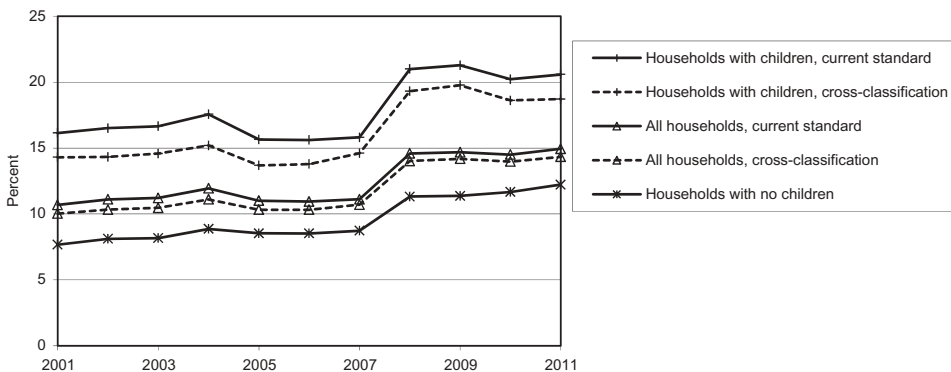


FIGURE 2 Prevalence of food insecurity based on current standard method and cross-classification method. Source: Calculated by the authors using data from the 2001–2011 Current Population Survey Food Security Supplements.

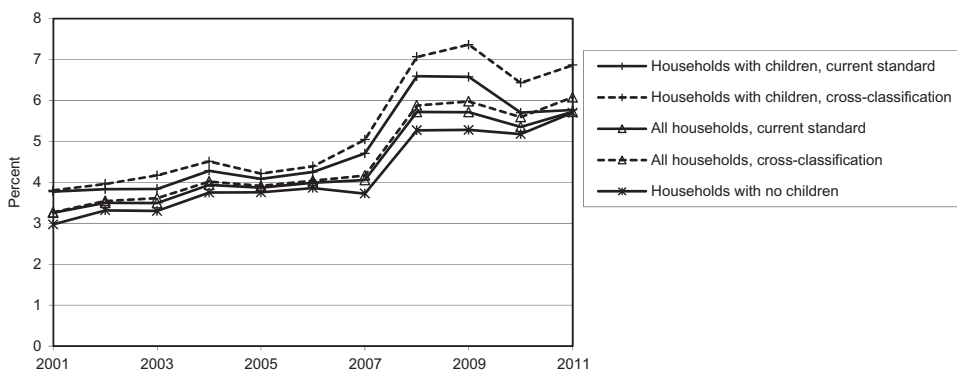


FIGURE 3 Prevalence of very low food security based on current standard method and cross-classification method. Source: Calculated by the authors using data from the 2001–2011 Current Population Survey Food Security Supplements.

the 2 methods averaged 0.2 percentage points from 2001 to 2007 and then increased to 0.8 percentage points from 2008 to 2011. The current standard method indicates that the prevalence of very low food security in households with children declined by almost a percentage point after reaching a high in 2008–2009 and was essentially equal to that in households with no children in 2011. Cross-classification indicates a greater increase in very low food security in households with children during and following the economic downturn and little improvement subsequently, with very low food security remaining more than a percentage point higher than the prevalence in households with no children.

The prevalence of very low food security among adults in households with children was very near that of very low food security based on cross-classification as depicted in [Figure 3](#) during the entire study period (analysis not shown). Thus, the current standard method underrepresents the extent to which very low food security increased among adults in households with children during the economic downturn and remained high subsequently. The difference is large enough to be of substantive importance, because it affects the relative standing of households with and without children with regard to very low food security.

Associations With Household Characteristics

The cross-classification and current standard methods suggest similar associations of food insecurity with household characteristics that are routinely reported by the USDA ([Figure 4](#)). Rankings across households with different characteristics were the same based on either measure, and proportionate differences were generally similar. Within each category, the relative size of the difference between the 2 methods reflected primarily the share of households with children in the category.

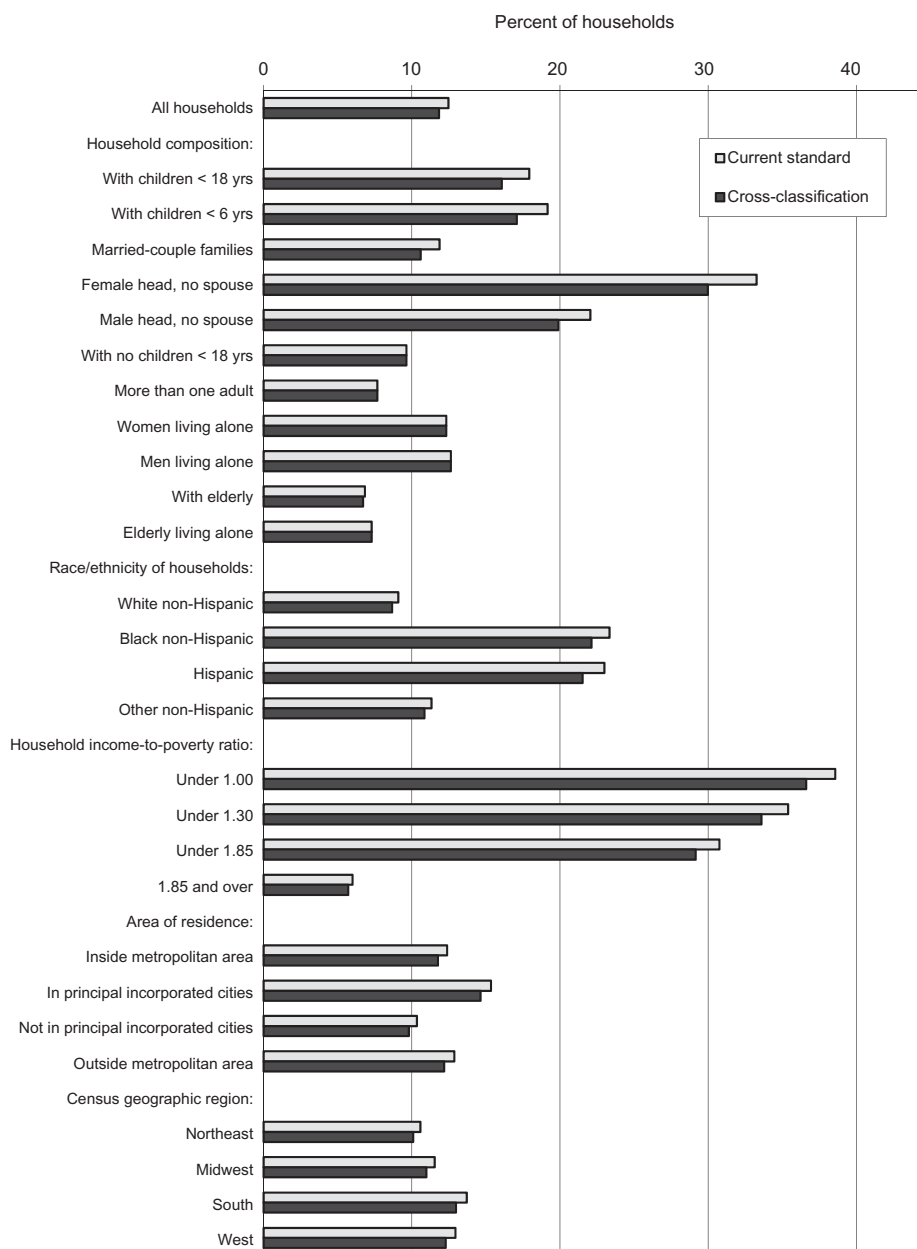


FIGURE 4 Prevalence of food insecurity by current standard method and cross-classification method, average 2001–2011. Source: Calculated by the authors using data from the 2001–2011 Current Population Survey Food Security Supplements.

The 2 classification methods also suggest similar associations of very low food security with household characteristics (Figure 5). Proportionate differences in the prevalence of very low food security were also generally similar

across categories of households except that Hispanic households registered essentially the same prevalence based on either method.

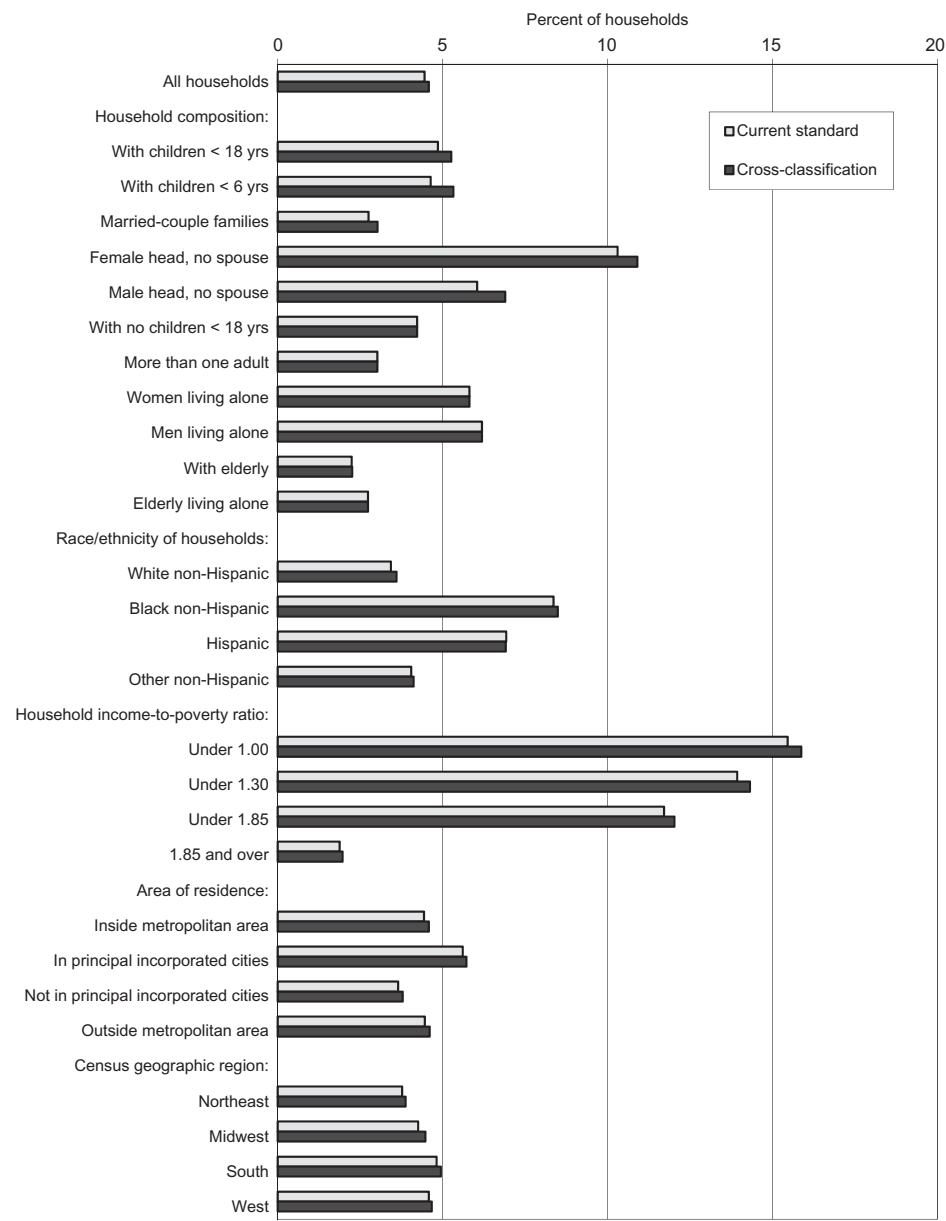


FIGURE 5 Prevalence of very low food security by current standard method and cross-classification method, average 2001–2011. Source: Calculated by the authors using data from the 2001–2011 Current Population Survey Food Security Supplements.

The comparisons of associations of household characteristics with food insecurity and very low food security based on the 2 classification methods were repeated with the sample restricted to households interviewed in 2010 and 2011 (analysis not shown). This was the period when the difference in prevalence rates between the two measures was greatest. The results were qualitatively similar to those presented in [Figures 4 and 5](#). The recent divergence of prevalence rates in households with children based on the 2 classification methods, then, appears to have been general and not concentrated in a particular type of household.

DISCUSSION

Comparisons of prevalence rates of food insecurity and very low food security between households with and without children are biased by the current methods used to measure food security and to classify households as to food security status. The alternative cross-classification method more accurately represents the food security of households with children compared to that of households without children because it takes account of food security conditions among adults and children separately. This avoids problems due to bidimensionality in the 18-item scale and classifies households with and without children based on a consistent threshold yet maintains the simplicity of a raw score-based classification.

Comparisons of prevalence rates based on the current and alternative methods indicate that over the past decade the prevalence of food insecurity in households with children as reported by the USDA was biased upward by an average of 1.8 percentage points vis-à-vis households with no children, a bias amounting to about 22% of the difference between the 2 groups. This resulted from the difference in the true severity of the thresholds for households with and without children, which dominated any bias due to bidimensionality.

The reported prevalence of very low food security, on the other hand, was biased downward for households with children vis-à-vis households without children if the cross-classification method more accurately represents true food security status. Prior to the economic downturn in 2008, the bias was about a quarter of a percentage point. However, the bias increased in 2008 and later years. The standard methods indicated that the prevalence rates of very low food security for households with and without children converged from 2008 to 2011 and were essentially identical by 2011 at 5.7%. However, the cross-classification method indicates that very low food security among households with children remained higher than that among households with no children and was about 6.8% in 2011. The difference in these trends reflects an increase during and after the economic downturn in the proportion of households with children in which only the

adults experienced very low food security. It may be that in the wake of the economic downturn, the mix of households in which adults had very low food security shifted somewhat to include a larger share of households with higher long-term average income. Such households may have sufficient resources to provide enough food for the children even though adults are not able to get enough to eat at times.

Other than biasing comparisons between households with and without children, the current methods do not appear to distort comparisons of food insecurity or very low food security among the subpopulations for which the USDA routinely reports food security. Research applications would be minimally affected by adopting the cross-classification method, because most food security analyses include controls for presence and ages of children or use only the adult scale. These practices are necessary irrespective of which measure of household food security is used. It is primarily the food security monitoring function that would be improved by implementing the cross-classification method.

Implementation of the cross-classification method of assigning food security status would be straightforward because the adult and child scales on which it is based are already provided in the public-use data. Communication of results to policy officials and the public would be no more difficult than under the current measurement system and could be somewhat more straightforward. Prevalence rates based on the new methodology could be calculated for previous years at minimal cost and effort in order to provide a consistent statistical series.

A limitation of the analysis is that it does not demonstrate that assigning food security status by the cross-classification method strengthens associations of measured food security with expected health and nutrition outcomes or with alternative measures of food security. Further research is needed to examine the association of food security status by each method with health outcomes in data from surveys such as the National Health and Nutrition Examination Survey. However, because the severity of food security of households that are classified differently by the current and alternative methods differ by only small increments (most of them by a single raw score point on the current measure), large, multiyear samples would be required to obtain reliable results. The CPS-FSS includes several questions about food adequacy that could provide standards for assessing the cross-classification method versus the current method: a question about whether the household would need to spend more for food to just meet their food needs or could spend less; a question about food sufficiency; and a question about whether the household obtained emergency food from a food pantry or similar agency.

If results of the proposed further research are consistent with the theory-based findings described in this article, then it may be worthwhile to make

the relatively simple change to the cross-classification methodology as an incremental improvement to reduce the modest biases in the current system and align the methodology more consistently with the underlying statistical theory.

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