*Chapter 3*

# Why the Children's Food Security Scale Is More Reliable than the Household Scale for Identifying Hunger Among Children

From its inception, the Federal interagency food security measurement project has had a strong interest in reliably identifying households with hunger among children by means of the survey and measurement method it developed. Such identification is needed in order for research to provide information on the extent of hunger among children in the U.S. and on the causes and consequences of this condition. The Food Security Supplement questionnaire developed by the project includes a number of items intended to measure the extent of food deprivation among children as well as items that ask about coping mechanisms and strategies used by households to avoid or ameliorate food deprivation among children.

The team charged with developing measures of household food security based on data from the first CPS Food Security Survey in 1995 developed a single, unidimensional household food security scale and identified three thresholds on the scale (Hamilton et al., 1997a; Hamilton et al., 1997b; Price, Hamilton, and Cook, 1997). The least severe threshold identifies households that are food-insecure. The second identifies households in which one or more members (mostly adults) were hungry at times during the year because of insufficient resources to buy food. The third threshold identifies households in which children (if any in the household) were hungry at times during the year, and in which adults experienced more severe and frequent food deprivation, such as going whole days without eating. Thus, although the "severe hunger" threshold was specified to identify households with hunger among children, a combination of child-referenced items and adult-referenced items was used to classify households vis-à-vis the threshold. This was consistent with earlier research findings that, in the United States, children were generally shielded from hunger at less severe levels of household deprivation and began to experience hunger only when hunger among adults in the household reached this more severe level.

A single scale calculated from both child- and adult-referenced items is appropriate for identifying households with hunger among children, provided that the two sets of items measure primarily the same dimension of the complex phenomenon of food insecurity. The preliminary work to develop the household food security scale included exploration of the issue of dimensionality among the items that were considered candidates for the scale using both linear and nonlinear factor analysis (Hamilton et al., 1997b). The nonlinear factor analysis indicated that the set of 18 food insecurity and hunger items that are included in the food security scale lie fairly well on a single dimension.

Nevertheless, the children's food security scale, calculated from only the child-referenced items, identifies a larger proportion, and somewhat different set, of households as having hunger among children than does the household food security scale, even though equivalent thresholds were used for the two scales. This suggests that the assumption of unidimensionality of the 18-item set, while a reasonable and useful approximation, may not be strictly accurate.

In this chapter, we document the extent of misclassification of households with hunger among children produced by the household food security scale and the bias in prevalence rates of children's hunger that results. We then revisit the dimensionality question and find that there is a nontrivial bidimensionality in the item set, and that the second dimension measures the extent to which children share in the food deprivation that exists at the household level. We then examine characteristics of households that are misclassified as

regards hunger among children by the household food security scale and find that there are intuitively sensible reasons for the misclassification, the most important of which is the age of children.

## Bias and Misclassification by the Household Food Security Scale

The prevalence of hunger among children as measured by the children's food security scale was higher than that measured by the severe hunger category of the household food security scale in every year from 1995 to 1999 (table 9). There were 14 to 24 percent fewer households (with children) in the severe hunger category of the household food security scale than were identified as having hunger among children by the children's food security scale. On average across the 5 years, the estimated prevalence rates differed by 20 percent, or about 0.2 percentage points.

The household scale not only fails to identify children's hunger in some households that do have hunger among children (based on the children's food security scale), it also classifies some households in the severe hunger category even though the children's scale indicates an absence of hunger among children in those households. Thus, the two scales identify somewhat different sets of households as having hunger among children. Table 10 shows the extent of these differences in 1999. If we take the children's food security scale as the standard, the household scale (severe range) misclassifies as not having hunger among children (false negatives) 88,000 households of the 219,000 households with hunger among children and misclassifies as having hunger among children (false positives) 51,000 households that did not have hunger among children. Taking as denominator the 219,000 households with hunger among children based on the children's food security scale, these misclassifications amounted to 40.2 percent false negatives, and 23.3 percent false positives. Analysis (not shown) of 1995 and 1998 data found proportions of false negatives and false positives almost identical to those in 1999.

Some difference in classification results from the lower level of precision of the children's food security scale. Because it has only eight items, it is somewhat less precise than the household scale. Analysis not presented here shows that this lower level of precision accounts for about half of the false negatives, most of the false positives, and somewhat less than one-fourth of the bias.

## Re-examining the Dimensionality Question

The substantial difference in prevalence rates of severe household hunger and children's hunger imply that the child and adult items in the scale do not, in fact, lie on a single dimension. Hamilton et al. assessed the dimensionality issue in terms of whether all of the items related strongly enough to the same dimension to justify including them in a scale to measure that dimension. They concluded that, "… the RMSR [root mean square residual] was well within the acceptable range with a single factor, and was not materially improved by adding further factors, making the single-factor model the most parsimonious solution" (Hamilton et al., 1997b, p. 10). We do not dispute this finding. The 18 items do, in fact, measure *primarily* a single phenomenon—household food security—and it is appropriate to include the child-referenced items in the measure of that phenomenon. What we want to investigate further, however, is whether any multidimensionality that does

**Table 9—Estimated prevalence of households with hunger among children, 1995-99, based on the children's food security scale and on the household food security scale**

| Year | Based on children's food security scale | | Based on severe hunger category of household food security scale | | Difference | |
|---|---|---|---|---|---|---|
| | *1,000* | *Percent* | *1,000* | *Percent* | *Percentage points* | *Percent*[1] |
| 1995 | 416 | 1.09 | 325 | 0.85 | -0.24 | -21.88 |
| 1996 | 384 | 1.01 | 329 | .86 | -.15 | -14.32 |
| 1997 | 310 | .81 | 239 | .63 | -.18 | -22.90 |
| 1998 | 331 | .87 | 252 | .66 | -.21 | -23.87 |
| 1999 | 219 | .58 | 182 | .48 | -.10 | -16.89 |

[1]Difference, as a percentage of estimated prevalence based on children's food security scale.

Source: Calculated by ERS based on Current Population Survey Food Security Supplement data.

**Table 10—Misclassification of households with hunger among children by the severe hunger category of the household food security scale, 1999**

| Food security status based on household food security scale | Children's hunger status based on children's food security scale | | |
|---|---|---|---|
| | No hunger among children | Hunger among children | Total |
| | *1,000* | | |
| Food secure | 32,290 | 0 | 32,390 |
| Food insecure, without hunger | 4,340 | 0 | 4,340 |
| Food insecure with moderate hunger | 984 | 88 (False negative: 0.23% of households, 40.2% of households with hunger among children) | 1,072 |
| Food insecure with severe hunger | 51 (False positive: 0.13% of households; 23.3% of households with hunger among children) | 131 | 182 (0.48%)[1] |
| Total | 37,665 | 2,191 (0.58%)[1] | 37,884 |

[1]Prevalence rates of households with children's hunger as measured by the two scales, i.e., percentage of all households with children.

Source: Calculated by ERS based on April 1999 Current Population Survey Food Security Supplement data.

exist in the 18 items compromises the reliability of the scale for identifying households with hunger among children. The dimesionality issue is somewhat different in this case. Even a modest extent of bidimensionality could be problematic. If even a small proportion of "moderate hunger" households have hunger among children, the proportional error in the estimated prevalence of children's hunger could be substantial because there are many more households classified with moderate hunger than with severe hunger.

To investigate the extent and character of a second dimension in the 18 items, we carried out a principle components analysis of the standardized residuals of the items after extracting the first factor by fitting the items to a Rasch model. In this procedure, the items and households are first scaled by Rasch maximum likelihood methods. Then, for each household, the residual—the deviation of each item from its expected value given the household total score—is calculated.[19] Each item's residual is then standardized by dividing by the model standard error for the item-household combination.[20] Then principal components are extracted from a correlation matrix of the standardized residuals.

The principal components analysis reveals a second factor that is correlated negatively with all child-specific items and positively with all adult-specific items (table 11).[21] The highest positive correlations are with the most severe adult items, while correlations are close to zero for two of the three (least severe) general household items. This second factor can be interpreted, then, as the extent to which households protect children

[19] The observed value of the item is 1 if affirmed, 0 if denied. The expected value is the probability of the household affirming the item given the difference between household and item score, calculated as $p=e^{(h-i)} / (1+e^{(h-i)})$, where h is the scale score (severity of food insecurity) of the household, i is the calibration score (severity level) of the item, and e is the base of the natural logarithms.

[20] The model standard error of the item-household combination depends only on the probability of the household affirming the item (see previous footnote). The model standard error is the square root of the model variance, which is calculated as $v = p(1-p)^2 + (1-p)p^2 = (p-p^2)$. Conceptually, this model variance is the sum of two terms: (1) the squared deviation if the item is affirmed, weighted by the probability of it being affirmed, plus (2) the squared deviation if the item is denied, weighted by the probability of it being denied.

[21] This is actually the first factor extracted from the principal components analysis of the item deviations, but the scale itself should be considered the first factor in the raw data, although it is extracted using a nonlinear model.

**Table 11—Factor loadings of the first factor extracted by principal components from the correlation matrix of the standardized deviations of items from their expected values given the household score**

| Item | Loading |
|---|---|
| Household items: | |
| Worried food would run out | 0.04 |
| Food bought didn't last | .03 |
| Couldn't afford to eat balanced meals | -.24 |
| Adult-specific items: | |
| Adults cut size of meals or skipped meals | .42 |
| Respondent ate less than felt he/she should | .30 |
| Adult cut size of meals or skipped meals, 3 or more months | .40 |
| Respondent hungry but didn't eat | .38 |
| Respondent lost weight | .33 |
| Adults did not eat for whole day | .62 |
| Adults did not eat whole day, 3 or more months | .60 |
| Child-specific items: | |
| Relied on a few kinds of low-cost food for children | -.26 |
| Couldn't feed the children a balanced meal | -.57 |
| Children were not eating enough | -.56 |
| Cut size of child's meal | -.35 |
| Child hungry but couldn't afford more food | -.31 |
| Child skipped meal | -.43 |
| Child skipped meals, 3 or more months | -.38 |
| Child did not eat for whole day | -.03 |

Notes: The analysis is based on households with children who answered at least one food security or hunger question affirmatively (N=4,340). The factor explained 15 percent of the total shared variance, or about 2.7 times the proportion expected under random conditions.

Source: Prepared by ERS based on data from the Current Population Survey Food Security Supplement, April 1995.

from hunger by accepting more severe levels of adult hunger. The factor is of only modest strength, accounting for about 15 percent of the shared variance of the residuals. This is consistent with the assessment by Hamilton et al. (1997b) that the phenomenon represented by these items is largely unidimensional. Still, the factor is strong enough to account for the fact that some households with hunger among children do not register severe household-level hunger.[22]

[22] In principle, this bidimensionality also affects the accuracy with which the household scale represents hunger among adults. However, this effect is negligible at the household-level (i.e., adult) hunger threshold except in households with only very young children. Analysis (not shown) found that for all households with children, the prevalence rate of hunger among adults based on the 18-item household scale differed by only 0.1 percentage point from that based on the 10-item scale that excludes the child items (i.e., the standard scale used for households without children). However, among households in which the oldest child was 2 years old or younger, the 18-item scale understated the prevalence of adult hunger by about 20 percent compared with the 10-item scale.

## Which Households Are Misclassified by the Household Scale?

Differences between the prevalence of children's hunger based on the children's food security scale and the prevalence of severe hunger based on the household scale varied among demographic and economic categories of households, and the differences shed some light on why the two measures differ (table 12). Data from the 2 years, 1998 and 1999, were combined for these calculations to reduce sampling variation.

The most notable variation is across categories based on the age of the oldest child in the household. The severe range of the household scale overestimates by 48 percent the prevalence of children's hunger in households with no child older than 5 years, and underestimates by 33 percent and 20 percent the prevalence of children's hunger in the two older age groups. This indicates that younger children are protected from hunger at much more severe levels of food deprivation among adults than are older children. The bivariate association of the prevalence bias with age is nonmonotonic—it is highest for the middle of the three age categories. However, as will be seen below in the regression analysis, this is an artifact of associations with other household characteristics. The relationship becomes monontonic when other characteristics are controlled. Table 12 also points to substantial bivariate associations of bias of the household scale with family structure, number of children, race and ethnicity, household income, and metropolitan/nonmetropolitan residence.

The characteristics that mediate the relationship between severity as measured by the household scale and severity as measured by the children's scale are interrelated, and their effects are therefore better assessed in a multivariate context. This was accomplished by estimating a logistic regression of hunger among children, as measured by the children's food security scale, on severe hunger, as measured by the household scale, and a set of dummy variables for the household characteristics (table 13). A dummy was also added for year of survey, since the observed prevalence of children's hunger was substantially lower in 1999 than in 1998.

With controls for the household classification vis-à-vis the severe hunger threshold and other relevant characteristics, the effects of almost all the characteristics make intuitive sense. The age of the oldest child in the

**Table 12—Difference between prevalence rates of children's hunger estimated from the household food security scale and the children's food security scale, average 1998-99, by household characteristics**

| Household characteristics | Households with hunger among children based on children's food security scale | Households with severe hunger based on household food security scale | Difference: household scale less children's scale | |
|---|---|---|---|---|
| | | | As proportion of all households with children | As proportion of households with children's hunger |
| | | *Percent* | | |
| All households | 0.72 | 0.57 | -0.15 | -20.8 |
| Family structure: | | | | |
| Two-parent family | .34 | .24 | -.10 | -29.4 |
| Single mother with children | 1.80 | 1.49 | -.31 | -17.2 |
| Single father with children | .85 | .59 | -.26 | -30.6 |
| Number of children: | | | | |
| One | .63 | .58 | -.05 | -7.9 |
| Two | .58 | .46 | -.12 | -20.7 |
| Three or more | 1.17 | .75 | -.42 | -35.9 |
| Age of oldest child: | | | | |
| 0-5 | .25 | .37 | .12 | 48.0 |
| 6-14 | .69 | .46 | -.23 | -33.3 |
| 15-17 | 1.2 | .96 | -.24 | -20.0 |
| Sex of children: | | | | |
| Boys only | .72 | .62 | -.10 | -13.9 |
| Girls only | .58 | .48 | -.10 | -17.2 |
| Both | .85 | .61 | -.24 | -28.2 |
| Race/ethnicity of reference person: | | | | |
| White non-Hispanic | .47 | .43 | -.04 | -8.5 |
| Black | 1.37 | 1.07 | -.30 | -21.9 |
| Hispanic | 1.27 | .87 | -.40 | -31.5 |
| Income of household: | | | | |
| Below 130% of poverty line | 2.33 | 1.83 | -.50 | 21.5 |
| Above 130% of poverty line | .31 | .27 | -.04 | -12.9 |
| Residence: | | | | |
| Metro | .72 | .55 | -.17 | -23.6 |
| Nonmetro | .73 | .65 | -.08 | -11.0 |

Notes: Tabled values are population estimates based on household weights prepared by the Census Bureau for the Food Security Supplement. The unweighted number of cases is 27,377.

Source: Prepared by ERS based on data from the U.S. Census Bureau Current Population Survey Food Security Supplements, August 1998 and April 1999.

household has a very strong effect. All other things equal (including the severity level of household hunger), the odds of observing hunger among children in which the oldest child is age 6-14 are 5 times the odds of observing hunger among children in households in which the oldest child is age 0-5. That odds ratio increases to 7 for households in which the oldest child is age 15-17. Younger children, especially those age 5 and under, are protected from hunger at more severe levels of adult hunger in the household than are older children. It should be noted, nevertheless, that even in households with older children, hunger among the children was registered in only about one-fourth of the households with adult hunger (i.e., moderate or severe household-level hunger).[23]

[23] The statistics for this comparison are not shown in the table. In 1998 and 1999, among households in which the oldest child was age 15-17, 4.7 percent registered adult hunger (i.e., moderate or severe household hunger), while only 1.2 percent registered hunger among children on the children's food security scale.

**Table 13—Logistic regression of children's hunger on severe household hunger and household characteristics**

| Household characteristics | Coefficient | Odds ratio | Significance |
|---|---|---|---|
| Intercept | -8.66 | | |
| Household severe hunger | 6.58 | 718.00 | <0.001 |
| Two-parent family (reference) | | | |
| Single mother with children | 0.63 | 1.88 | .008 |
| Single father with children | .61 | 1.84 | .121 |
| Other household with children[1] | .50 | 1.65 | .421 |
| One child in household (reference) | | | |
| Two children in household | .10 | 1.11 | .718 |
| Three or more children in household | .37 | 1.45 | .267 |
| Oldest child age 0-5 (reference) | | | |
| Oldest child age 6-14 | 1.60 | 4.97 | <.001 |
| Oldest child age 15-17 | 1.96 | 7.08 | <.001 |
| Boys only | .13 | 1.14 | .666 |
| Girls only | .20 | 1.22 | .519 |
| Both boys and girls (reference) | | | |
| White non-Hispanic (reference) | | | |
| Black | .66 | 1.94 | .017 |
| Hispanic | .95 | 2.59 | .001 |
| Other non-Hispanic | 1.37 | 3.92 | <.001 |
| Below 130% of poverty line | 1.10 | 3.00 | <.001 |
| Above 130% of poverty line (reference) | | | |
| Metro (reference) | | | |
| Nonmetro | -.07 | .93 | .775 |
| 1998 sample (reference) | | | |
| 1999 sample | -.21 | .81 | .316 |

[1]Children in this category are not related to the reference person. These include children of an unmarried housemate or partner, foster children, and other unrelated children.

Logistic regression analysis was based on unweighted household data. Households with no children or with missing income information were excluded. Number of cases was 25,620.

Source: Prepared by ERS based on data from the U.S. Census Bureau Current Population Survey Food Security Supplements, August 1998 and April 1999.

Household income also has a strong effect on the extent to which children are protected from hunger. All other things equal (including the severity level of household hunger), the odds of observing hunger among children in households with income below 130 percent of the poverty line are 3 times the odds of observing hunger among children in households with income above that level. Households with higher incomes are likely to experience shorter spells of food stress and are thus better able to avoid hunger among children. Higher income households also may have more resources to draw on to avoid hunger among children. Adults may "tighten their belts" and skip a few meals to avoid selling assets, refinancing a home, or taking an undesirable job, but they may resort to these exigencies to avoid subjecting their children to hunger.

Household structure also affects the extent to which children are protected from hunger, although the effects are not as strong as those of household income and the age of children. All other things equal (including the severity level of household hunger), the odds of observing hunger among children in households headed by a single parent are 1.8 times the odds of observing hunger among children in two-parent households. In part, this effect results from income effects not captured by the single dummy variable. In a logistic

regression analysis (not shown) with income-to-poverty ratio entered as a third-order polynomial instead of the single dummy variable, the effects of single-parent household structure declined by about one-third. Even after controlling more adequately for income, however, it still appears that single parents may be less able than two parents to protect their children from hunger, even by accepting more severe levels of hunger themselves.

Race and Hispanic ethnicity have surprisingly strong effects on the relationship between hunger among children and severe household hunger. All other things equal (including the severity level of household hunger), the odds of observing hunger among children in minority households are 1.9 to 3.9 times those in non-Hispanic White households. Analysis (not shown) revealed that about one-third of this effect also resulted from income effects not captured by the single dummy variable. The remainder may result from cultural differences associated with race and ethnicity that affect either the way food deprivation is managed or the way it is discussed and described (Nord and Jemison, 1999).

Neither sex of children nor metropolitan/nonmetropolitan residence had substantial effects on children's hunger once the severity level of household hunger and other characteristics were controlled. The small effects observed were not nearly statistically significant.

## Summary

Accurate measurement of the extent to which children are affected by resource-constrained food shortage is important for understanding the causes and consequences of children's hunger. Children do not usually experience resource-constrained hunger until hunger among adults in the household has reached quite severe levels. But the extent to which children are protected from, or share in, the food deprivation in a resource-constrained household is not the same in all households. There is convincing evidence that a non-trivial second dimension exists in the 18 items in the food security scale, a dimension measuring the extent to which children are protected from hunger at the cost of more severe hunger among adults. As a result, the 18-item food security scale misclassifies a substantial proportion of households with regard to the level of severity of food deprivation among children and understates the prevalence of hunger among children by about 20 percent at the national level. The children's food security scale, based on the eight questions in the food security scale that ask specifically about conditions among children in the household, identifies households with hunger among children more reliably than does the household food security scale.

The extent to which children are protected from hunger at the cost of more severe adult deprivation is associated with household characteristics in ways that are, for the most part, intuitively sensible. In particular, younger children, especially those age 5 and under, are protected from hunger up to more severe levels of adult hunger than are older children. Children in households with higher income are protected from hunger up to more severe levels of adult hunger than are children in lower income households. Children in two-parent households are protected from hunger up to more severe levels of adult hunger than are children in single-parent households. These associations provide a reasonable explanation of the difference between prevalence rates based on the two scales. They also underscore the superiority of the children's food security scale for comparing prevalence rates of children's hunger across demographic and economic groups, since the extent of bias associated with the household scale varies across many of the groups of interest.