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Abstract

The Second Food Security Measurement and Research Conference (February 23-24, 1999) was co-sponsored by the U.S. Department of Agriculture's Food and Nutrition Service and Economic Research Service and the U.S. Department of Health and Human Services' National Center for Health Statistics. The conference was the second in a series and was attended by researchers from government, academia, and the private sector. The conference was part of an ongoing program of Federal food security research, the goal of which has been to establish a stable measurement strategy to assess annually the food security status of the U.S. population. This report is volume II of a two-volume set and contains a set of research papers that conference participants prepared to provide further detail on the content and findings of some research presented at the conference. The companion publication, *Second Food Security Measurement and Research Conference, Volume I: Proceedings* (February 2001, Stock # ERS-FANRR-11-1) contains abbreviated proceedings of all presentations and remarks by discussants at all sessions from the conference.

Keywords: Food security, hunger, food assistance, nutrition monitoring.

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Overview

The Second Food Security Measurement and Research Conference was held February 23-24, 1999, in Alexandria, VA. The conference was co-sponsored by three Federal agencies that were key players in the development of a national food security measure for monitoring the prevalence of hunger and food insecurity in the United States. These agencies are the U.S. Department of Agriculture's (USDA) Food and Nutrition Service (FNS) and Economic Research Service (ERS), and the U.S. Department of Health and Human Services's (HHS) National Center for Health Statistics (NCHS).

The conference was the second in a series and part of an ongoing program of Federal food security research. The goal of this research conducted in collaboration with academic and private-sector researchers was to establish a stable measurement strategy to annually assess the food security status of the U.S. population. Since 1995, USDA has sponsored an annual Food Security Supplement to the U.S. Bureau of the Census' Current Population Survey (CPS). These data have been used to produce annual estimates of U.S. food security and hunger for 1995-99 and State-level estimates for 1996-98.

The first Food Security Measurement and Research Conference, held in January 1994, brought together experts from government, universities, research institutes, and nonprofit groups interested in food security measurement. The aims of that conference were to synthesize the direction of earlier research, to develop consensus on the contents of a survey instrument for the CPS Food Security Supplement, and to set up a structure for continuing research collaboration.

A similar format was adopted for the Second Food Security Measurement and Research Conference. However, given the earlier successes in collecting national population data and developing a standardized measure, this second conference more tightly focused on developing priorities for a future research agenda. Efforts were made to ensure a wide range of perspectives and to solicit critical review of the standard measure and prior research. Planning for the conference and follow-up activities were coordinated by the Federal Interagency Working Group on Food Security Measurement made up of staff from the three sponsoring agencies as well as representatives from the Center for Nutrition Policy and Promotion and USDA's Agricultural Research Service.[1]

The agenda of the conference was structured to provide a mix of panel presentations and more formal research papers. The conference was opened with a set of welcoming remarks from USDA's Eileen Kennedy, Deputy Under Secretary for Research, Education, and Economics, and Julie Paradis, Deputy Under Secretary for Food, Nutrition, and Consumer Services; and HHS's Linda Meyers, Director, Office of Disease Prevention and Health Promotion.

In session I of the conference, three panelists provided background on various aspects of Federal food security research and monitoring activities. Steven Carlson outlined the concept of food security and the process by which a food security instrument was developed and incorporated into a supplement to the Current Population Survey (CPS). He also reported initial major findings: "For the 12 months ending in April 1995, 12 million households, 12 percent of the U.S. population, experienced some degree of food insecurity. A million of those households, roughly 4 percent of the population, experienced either moderate or severe hunger, and 800,000 households, less than 1 percent, experienced severe hunger." Chris Hamilton covered the basics of the Rasch model, which underlies the measurement of food insecurity, and provided details on the 18 items from the CPS survey questionnaire that make up the food

[1]Members of this working group consisted of Margaret Andrews, ERS, David Smallwood, ERS, Mark Nord, ERS, Gary Bickel, FNS, Steven Carlson, FNS, Ted Macaluso, FNS, Mary Hama, Agricultural Research Service, and Peter Basiotis, Center for Nutrition Policy and Promotion, as well as Karil Bialostosky, NCHS, and Ronette R. Briefel, NCHS.

security scale. He also explained how the Rasch model combines the household's item responses into a number that measures the degree of a household's food insecurity, and how the household is classified into various categories of severity along a food security and insecurity scale. Ronette Briefel reported how other national surveys and demonstration projects are using, or plan to incorporate, the food security instrument.

In session II, James Ohls described work conducted on whether the scale estimated from the 1995 CPS data using a Rasch model is applicable to data collected in the 1996 and 1997 CPS Food Security Supplements. The work affirmed the robustness of the Rasch model and showed the food security scale to be effectively steady over time. The model's assumption of stability across certain demographic subgroups also seemed acceptable. The research explained by Stephen Blumberg used a streamlined six-item scale to classify households into three categories of food insecurity and hunger (one less category than used by the 18-item scale). The research found that the resulting classification was similar to the results of the full 18-item scale, and Blumberg recommended the use of the six-item scale "if resources do not permit 18 items and your research goals do permit the combining of the moderate and severe hunger categories." The session was concluded by Mark Nord, who presented work that addressed whether the (18-item) food insecurity scale—which was developed as a general measure of food insecurity—is well-suited specifically for measuring the national prevalence of households with hungry children. Using the CPS data, Nord reported various possible figures for the number of such households and recommended that the government consider whether development of a second scale is warranted for estimating children's hunger.

In the conference's Luncheon Address, Susan Mayer contrasted the official measure of poverty with the food security measure, and three ways in which the latter is "relative" using historical examples of diet and nutrition from post-World War I and the Great Depression. Mayer went on to stress that people lack a clear intuition for the concept of food security, they view hunger as an attribute of individuals and not households, and the current food security measure results in figures that can be difficult for the public or Congress to interpret.

Session III contained three papers that examined applications of food security measurement. The first paper by Lori Reid focused on food insecurity among children, and presented preliminary results that found a very strong relationship between poverty status and household food insecurity. Other variables such as family structure, homeownership, and mother's education had distinct influences on a child's level of food insecurity. Joda Derrickson reported on work that found the food security measure to be a valid and stable instrument for most groups of Asian and Pacific Islanders in Hawaii, although the concept of "balanced" meal was not well understood. Valerie Tarasuk used a sample of Canadian women who used food banks to examine events that precipitated food insecurity for these women and to estimate the relationships between their food insecurity and their nutrient intake for a number of nutrients.

In session IV, the conference's first day concluded with a series of three speakers who addressed the establishment of a framework for a research agenda. Christopher Jencks observed, "The intricacies of Rasch modeling are not easy to convey" and advised that more transparent ways be considered for providing information about hunger. He identified potential advantages of the current measure, discussed the impact of different time-frames on the measured prevalence of hunger and its interpretation, and examined what is known and how much more needs to be learned about the causes of food insecurity and hunger. Angus Deaton stated that hunger and poverty are closely related concepts to most people (apart from economists, who usually view poverty as low income and not as low consumption of any one item). He questioned the validity of that connection, comparing U.S. food insecurity data with household responses to food consumption questions in India. Deaton considered problems of self-reported measures, including the food security measure, and urged further research on external valida-

tion and on development of a measure of food insecurity at the individual level (in contrast to the current household level). Johanna Dwyer explained how nutritional status, like disease, is a multifactorial concept. Dwyer considered how the food security measure can be applied to target groups at special risks, such as children, the elderly, the mentally retarded, and others, and she noted that it would be of great interest to know the food security histories of people with various chronic illnesses. Dwyer stressed that food security data need to be synthesized with biological data in addition to economic data.

In session V, the conference's second day continued the exploration of applications of food security measurement. Craig Gundersen reported on work that used the data from the Survey of Income and Program Participation, which included a food insufficiency question for a household. The study examined how negative shocks—such as lower earnings or lost food stamps—can precede a household's food insufficiency, and how factors such as liquid savings can help a household weather negative shocks. The work described by Katherine Alaimo used NHANES III data to relate a child's (proxy-reported) health status to the household's response to the food insufficiency question. The study also included a wide variety of other economic, educational, and health factors to isolate the role of food insufficiency. Karin Nelson explained research that used an eight-item measure for assessing the prevalence of hunger and food insecurity among patients at a county medical center. The study also gave special attention to diabetics and their experiences.

Session VI provided conference participants an opportunity to discuss in break-out groups a variety of issues related to food security measurement and research. Upon reconvening all conference participants, the essence of each group's discussion was reported.

In session VII, the conference concluded with a panel discussion on the next steps for a research agenda. Christine Olson reported some additional research results on the body mass index and urged that food insecurity be related to poor health consequences. Lynn Parker reviewed some history of hunger measurement, encouraged communities to use food security measures at the State and local level, and stressed the importance of annually measuring hunger and bringing the results to public attention. Richard Bavier raised several issues critical of how food insecurity is measured, especially the use of the item response theory, and recommended achieving greater discrimination between the frequency, intensity, and duration of disrupted food intake and hunger. Gary Bickel added that Rasch modeling has useful applications outside of educational testing, the area in which it was developed. He provided examples and noted the distinction between hunger as a personal experience and the public perception of hunger as a social problem. Helen Jensen concluded the panel session by surveying the uses of the food security measure, and noting ways through which the measure might be improved, for example, asking questions with shorter periods of recall or developing a high-frequency longitudinal survey.

This publication contains a set of research papers prepared by conference participants that provide further detail on the content and findings of some research presented at the conference. The companion publication, *Second Food Security Measurement and Research Conference, Volume I: Proceedings* (February 2001, Stock # ERS-FANRR-11-1), contains abbreviated proceedings of all presentations and remarks by discussants at all sessions from the conference. Not all conference participants elected to prepare papers for this second volume.

In followup to the conference, the Federal Interagency Working Group on Food Security Measurement met in April 1999 to review and discuss the conference proceedings. The group identified a set of research priorities as outcomes of the conference and posted them to the ERS website. The major themes of highest priority are grouped into two categories and are listed as follows:

Research Priorities: Measurement

- Developing and testing individual (as opposed to household) scales for measurement of prevalence and severity of food insecurity among adults and children;

- Improving the measurement and understanding of the dynamics of food insecurity, such as frequency and duration of episodes;

- Developing better questions and strategies for asking about nutritional quality (alternative to balanced meal questions);

- Assessing the effects of the questionnaire structure, item sequencing, and survey context on response patterns and measured food security levels; and

- Determining research situations appropriate for implementation of abbreviated household food security scales and/or scales with different time frames such as monthly versus annual.

Research Priorities: Applications and Policy

- Focusing on sampling and research on food insecurity and its consequences among high-risk groups with chronic health conditions, mental illness, and other biological vulnerability (especially among the homeless, elderly, and young children);

- Developing a research basis for linking community food insecurity and household food insecurity;

- Better understanding the context and determinants of food insecurity and hunger and their relationship to poverty, household resources, and time management; and

- Applications that assess and investigate the linkages between food insecurity measures, welfare reform, and measures of program performance.

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Methodological Findings and Early Conclusions Based on the 1995, 1996, and 1997 Food Security Data

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The publication of the U.S. Department of Agriculture's 1997 report on food security levels in the United States (Hamilton et al., 1997a) has spurred widespread interest in measuring food security for various groups in the U.S. population. Using data from the April 1995 Current Population Survey (CPS), that report presented a comprehensive method for measuring food security levels. Other major surveys that have measured food security or plan to do so include the Panel Study of Income Dynamics and the National Health and Nutrition Examination Survey.

The 1997 USDA report was based on a single CPS sample for April 1995. An important next step in food security research is to extend that analysis to later years and develop a method for measuring changes in food security over time. Important research questions include:

- Are estimated model parameters stable over time?
- How is the prevalence of food insecurity in the U.S. population changing?
- How robust are prevalence estimates to alternative ways of implementing the procedures used in the 1997 report?

A Brief Summary of the Literature Informing the Food Security Concept

Although hunger has long been a concern of American nutrition policy, attempts to measure it systematically have posed major challenges to advocates and policy analysts. Early attempts to equate hunger directly to malnutrition were not successful, because they encountered conceptual difficulties in defining malnutrition and operational difficulties in developing reliable and inexpensive ways of measuring people's nutrient intake. Furthermore, as additional discussion took place, it was recognized that feeling physical hunger, a sensation experienced by most people fairly frequently, is not equivalent to the social problem of hunger, a situation related to economic deprivation. Further development of the concept was needed.

From the late 1970s through the early 1980s, there was growing interest in broadening the concept of hunger to the more general construct of resource-constrained food insecurity. This broader concept came to be defined in terms of phenomena and experiences associated with being at risk of hunger as well as actually experiencing hunger. Lacking access to food because of resource constraints also came to be included in the consensus definition of hunger as a policy issue.

The broadening of the relevant concepts took place partly within the government, with the inclusion of sets of questions related to food insecurity in the two most recent administrations of the Nationwide Food Consumption Survey. Two private research efforts also gave substantial impetus to the evolving focus on food insecurity. First, the Community Childhood Hunger Identification Project (CCHIP), organized by the Food Research and Action Center and funded by local and national business and philanthropic organizations, demonstrated that reasonable and consistent answers could be obtained, using a set of survey questions designed to measure food insecurity (Wehler, Scott, and Anderson, 1995). Second, work at Cornell University provided additional theoretical support and advanced the development of measurement scales based on answers to survey questions about food security (Radimer et al., 1992).

Beginning in 1992, staff of the Office of Analysis and Evaluation within the USDA Food and Nutrition Service (FNS) began a systematic effort to develop a battery of questions about food insecurity that could be administered regularly in government-conducted surveys. Drawing on

previous research findings about food insecurity, together with additional research commissioned from outside researchers, USDA staff assembled the full range of food security survey questions that were used and identified sets of items that had promise as reliable indicators. FNS was assisted in this work by an expert panel that included many leading food security researchers.

FNS passed an important milestone when it won approval from the U.S. Office of Management and Budget for a supplement to the April 1995 CPS containing a set of questions designed to measure food security. The supplement gathered information about households' shopping patterns and various aspects of food insufficiency and insecurity during the 30 days and 12 months prior to the interview.

In 1995, Abt Associates, assisted by staff from Tufts and Cornell Universities, was engaged by USDA to analyze the 1995 CPS data. Faced with a questionnaire containing more than 50 items, the Abt team worked with the USDA to further refine the underlying concepts of food insufficiency and food insecurity. Along with this conceptual work, the team had to identify which of the CPS questionnaire items measured food insecurity. In the early stages of their work, they relied heavily on factor analysis to identify a group of items that, taken together, appeared to measure food insecurity. Then the Abt team applied a scaling procedure (described later in this paper) to assign a food security measure to each household. Based on these measures, households were classified into four categories—food secure, food insecure without hunger, food insecure with moderate hunger, and food insecure with severe hunger—and the Abt team estimated the prevalence of these four levels of food insecurity.

This paper extends the research of the CCHIP, Cornell, FNS, and Abt researchers. The work of the Abt team was focused on developing and implementing a measure of food insecurity, using data from the April 1995 CPS. We now have data from two additional rounds of surveys: the September 1996 and April 1997 CPS.[1] With these additional data, the focus has begun to shift to issues that arise in the development of a major ongoing social indicator. Although some issues examined here might not be important if the prevalence of food insecurity were going to be measured only once, or once in a great while, they can be critical when prevalence is measured on a routine basis and changes in prevalence are being closely monitored by policymakers. The recent availability of food insecurity data from two additional years allows us to address issues that arise when tracking changes over time. We present our preliminary empirical findings after briefly discussing the data used in our analysis and the Rasch model used to assign food security scores to households.

The CPS Data on Food Security

The data for the current study come from the Current Population Survey (CPS). The CPS is a monthly survey of about 50,000 households conducted by the Bureau of the Census for the Bureau of Labor Statistics. The sample is designed to represent the civilian noninstitutional population. Each monthly sample is divided into eight representative subsamples or rotation groups. A given rotation group is interviewed for a total of 8 months: it is in the sample for 4 consecutive months, leaves the sample during the following 8 months, and then returns for another 4 consecutive months. In each monthly sample, one of the eight rotation groups is in the first month, another rotation group is in the second month, and so on.[2] Under this system, 75 percent of the sample was common from month to month and 50 percent from year to year for the same month.

[1]The food security supplement was also fielded in subsequent years.

[2]More formally, the CPS sample is actually one of geographic addresses rather than households. If sample members move to a new address, they are not interviewed at that new address and they thus leave the sample. However, the address those sample members moved from remains in the sample, and the new residents are interviewed. These are known as replacement households.

The primary purpose of the CPS is to provide information about the labor force characteristics of the U.S. population. In each month, however, a supplement is added to the core questionnaire. In March of each year, for instance, the U.S. Bureau of the Census sponsors the Annual Demographic Supplement. This survey is the data source for the official income and poverty statistics published by the U.S. Bureau of the Census each year. In April 1995, September 1996, and April 1997, a special supplement was added to the CPS core questionnaire that included questions about household food sufficiency, food security, food expenditures, and a number of other related items. The structure of the food security supplement used in these surveys was as follows:

(1) Food expenditures during the prior week;

(2) Participation in food assistance programs (food stamps, elderly meal programs, school meal programs, and the Special Supplemental Nutrition Program for Women, Infants, and Children);

(3) Food insufficiency during the prior 12 months and ways of coping with that insufficiency; and

(4) Food security during the prior 12 months and the prior 30 days.

Not all households were asked the full set of questions in the supplement. To minimize respondent burden, a set of preliminary screening questions was used to determine whether there was evidence that a household might have experienced any food insecurity. If there was no such evidence, most of the subsequent food security questions were skipped. Across the three CPS samples, different screening procedures were used.

Table 1 shows unweighted sample sizes for the three CPS samples used here.[3] The initial sample size for the April 1995 CPS was 53,665 households. Budget cuts in January 1996 resulted in reduced sample sizes. This is reflected in the initial sample sizes for September 1996 and April 1997 shown in table 1. The initial sample for September 1996 was 47,795, and for April 1997, it was 47,306. In all three samples, roughly 85 percent of the core households entered the food security supplement.[4] Of those households, about 40 percent of the April 1995 sample passed the screening questions and were asked the balance of the food security supplement. For the two more recent surveys, tighter screening procedures resulted in only about 26 percent of households being asked the balance of the food security supplement. In all cases, there is a presumption that households failing to pass the screen are food secure. The differences in the screening procedures used across these three samples have important implications for the consistent measurement of food insecurity, a necessary prerequisite for measuring change in the prevalence of food insecurity. These issues are discussed in more detail below. Most of the research reported below is based on 18 key questions (items) that are used for the measurement of household food insecurity. Households with one or more children are asked all of these questions; childless households are asked only the 10 items that do not pertain to children. Once the differences between households with and without children are taken into account, there was very little item nonresponse. In all three samples, more than 97 percent of the households that passed the initial screen responded to all of the items used to measure food insecurity that they were asked. Even so, the fact that childless households responded

[3]Tables are at the end of this paper.

[4]The sample attrition at this stage is due mainly to households in the CPS being told that they are about to start a new module and their declining to do so.

to only 10 of the 18 items asked of households with children presents an additional complication, as discussed below.

The One-Parameter Logistic Item Response Theory (Rasch) Model

The Food Security Supplement to the April 1995 CPS contained more than 50 questions. Of those, about six were used as a preliminary screen to identify households that showed no indication of any food insecurity during the prior 12 months and, therefore, were not to be burdened with additional questions. Of the remaining items, 18 are used directly to measure households' food insecurity levels over the prior 12 months. (Of the questions not used, some apply only to the 30 days prior to the interviews and others were found during preliminary analysis not to be useful in developing the full food insecurity scale.)

In the first round of research on the 1995 data, it was desired to develop a method for combining answers on the 18 items into a single scale measuring household food security. In doing this, it was necessary to take the following factors into account:

(1) Not all questions applied to all households; in particular, 10 of the questions were not relevant to households that did not have children; and

(2) The data included some item nonresponse, involving households that did not answer all questions relevant to them.

In developing the desired food insecurity scale, the researchers involved drew heavily on a rich body of procedures used in the educational testing literature called Rasch modeling and item response theory (IRT). IRT methods have been widely used in educational contexts, such as the Scholastic Aptitude Tests (SAT) and the National Assessment of Educational Progress, to measure student attributes (such as math ability), using tests that, for test security reasons and other factors, are not identical.[5] In applying similar methods to the food insecurity measurement context discussed in this paper, the attribute being examined is food insecurity, and the test items are the individual food security questions on the CPS supplement.

The methods that are in the original analysis of the 1995 food security data and that are applied in the current paper involve a closely related technique called Rasch modeling.[6] The salient characteristic of the Rasch model is that the model involves estimating only a single parameter, often called the severity level, with which to characterize each question on the scale. Other versions of IRT theory estimate either two or three parameters per question.

The appendix provides a more detailed summary of the Rasch model. We conclude this section by noting certain salient properties of Rasch models that are relevant to the discussion below:

- The scale measure for households with complete data can be calculated based only on the number of questions about food insecurity that they answer affirmatively.
- The scale measure determined by the model are only unique up to a linear transformation; once a scale is developed, any linear transformation of the scale conveys the same information.
- In a Rasch model, each household's level of food security and each item's level of severity are items to be estimated in the model.

[5]For summaries of IRT theory, see Hambleton and Jones (1993) and Wright and Masters (1982).

[6]Some researchers view Rasch modeling as a subset of the IRT theory; others disagree with that characterization. In any event, they are clearly closely related.

Methodological Issues

Several important issues arise in constructing food security estimates from the 1995-97 data. These include the following:

- Screening households for evidence of food insecurity.
- Treatment of households with missing data.
- Estimating the standard errors of the estimated parameters.
- Whether to use weighted data in the estimation work.
- Standardizing the scale into a common metric across years.
- Establishing cutpoints for classifying households into various food insecurity categories.
- Choice of software to use in estimating the Rasch model.

This section discusses these issues and presents preliminary recommendations and empirical findings pertaining to them.

Screening Households for Evidence of Food Insecurity

As noted previously, to reduce respondent burden, the survey asked several screening questions to determine whether households should be asked the full battery of food security questions. Households that failed the screen—i.e., showed no significant evidence of food insecurity in their screening question responses—were skipped past the subsequent detailed questions and were classified as food secure in the subsequent analysis.

The screening questions used were different for each of the 3 years. If no adjustment were made for these differences, there would be the risk that similar households would be treated differently in different years. This could happen, for instance, if a household that in one year failed the screen and was classified as food secure would in a different year have passed the screen and possibly been found to be food insecure, based on answers to subsequent questions. This lack of consistency across years could confound attempts to examine changes over time in rates of food insecurity.

To avoid this problem, for much of the analysis in this paper, we have applied common screens for the 3 years. These common screens are based on questions that are used in the screens for all 3 years, and they ensure that the households passing the screen have all provided consistent answers to the same set of questions. Two possible ways of specifying common screens are considered. We discuss these after describing the individual screening questions used.

The Screening Questions Used

In all of the relevant years, the following screening questions were used in various combinations:[7]

- Did [the household] sometimes or often not have enough to eat?
- Did [the household] run out of food in the previous 12 months?
- Did [the household] feel that it sometimes did not have the kinds of food it wanted to eat?
- Did [the household] ever run short of money and try to make its food or money go further?

We have examined the screening questions in detail to identify the "loosest common screen," which we define as the screen that: (1) can be commonly applied to all households in all 3 years, and (2) allows the maximum number of

[7]The discussion in the text paraphrases the relevant questions. The exact wording of the questions can be found by accessing the CPS Food Security Supplement questionnaires at: www.ers.usda.gov/data/foodsecurity/cps/index.htm

households to pass the screen.[8] This loosest common screen is summarized in the Loosest Common Screen box.

As can be seen in this box, the only difference in the treatment of low- and high-income households is that the high-income households have to meet both—rather than just one—of the last two criteria, to pass the screen on the basis of these factors.

The loosest common screen allows maximum use in the analysis of households' responses to food security questions, subject to the constraint of commonality of screening criteria across years. However, the lack of symmetry between low- and high-income households may be troubling to some. Furthermore, the implementation with these data of screening criteria based on income is problematic, due to inadequacies in the income information available on the CPS. In particular, the income data are based on information supplied by the households when they entered or rotated back into the CPS sample, which could have been as much as 3 months earlier. Two other problems are: (1) that all types of income are included in the same question, and (2) that households are asked to respond only in terms of broad income intervals, e.g., $10,000 to $12,499.[9] These factors mean that it is likely that there may be substantial errors in the data. Another problem is that the interval end points are not changed from year to year. With inflation, there is drift over time in the real values of the interval boundaries, leading to differences across years in the real incomes that distinguish low- and high-income households.

Another potential drawback of using the loosest common screen—a drawback that is only applicable to low-income households—is that some analysts believe that the third criterion listed in the upper part of the Loosest Common Screen box ("didn't have the kinds of food wanted") may, by itself, be too ambiguous to be an appropriate basis for allowing households to be classified based on the full battery of questions. There are many possible reasons, other than resource constraints that prevent effective access to food, for not having the kinds of food a household wants. For instance, household members may be on diets to lose weight or may have unrealistic standards about what constitutes a good diet. As a result, it may be better to couple the "didn't have the kinds of food wanted" criterion with the "tried to make food or money go further" criterion, as is done in the Loosest Common Screen box for high-income households, so as to emphasize the resource-constrained aspect of food insecurity.

[8]The first condition means that the actual screen used in a year was never tighter than the common screen. In other words, a household could not pass the common screen and fail the actual screen.

Loosest Common Screen

Low-income households

- Sometimes or often not enough to eat;
- Ran out of food in last 12 months;
- Didn't have the kinds of food wanted; or
- Tried to make food or money go further.

High-income households

- Sometimes or often not enough to eat;
- Ran out of food in last 12 months; or
- Didn't have the kinds of food wanted; and tried to make food or money go further.

[9]Once a year, in March, the CPS collects detailed income data. However, none of the food security supplements have been administered in March. Although data from different months can be merged for some households, doing so involves substantial loss of sample, because there are households rotating into and out of the CPS sample each month. The loss is 25 percent for the 1995 and 1997 samples, and 100 percent for the 1996 sample due to the rotation group design.

A different potential set of screening criteria, which is intended to avoid these difficulties is summarized in the Tighter Common Screen box.

This tighter common screen applies to both low- and high-income households the criteria applied to high-income households by the loosest common screen. This tighter screen thus completely avoids reliance on the CPS income data and is also less reliant on the "didn't have the kinds of foods wanted" criterion.

Table 2 shows the number of households that pass the alternative screens and thus have their food security status determined using their answers to the full battery of food security questions, rather than being classified as food secure based on the screening questions. If no common screen is applied at all, the number of households that pass the actual screen used—the maximum sample screen—is over 18,000 in 1995 and about 11,000 in 1996 and 1997. About half of the low-income households passed the loosest common screen in 1995, and all of them passed in 1996 and 1997. Whereas all of the high-income households passed that screen in 1995, between one-half and three-quarters passed in 1996 and 1997. All high-income households that passed the loosest common screen also passed the tighter screen because the screens are the same for those households. However, about one-third of the low-income households passing the loosest common screen fail the tighter screen.

Tighter Common Screen

Low-income households

- Sometimes or often not enough to eat;
- Ran out of food in last 12 months; or
- Didn't have the kinds of food wanted; and tried to make food or money go further.

High-income households

(Same as for low-income households above.)

We recommend using the tighter common screen, in part because of our concern about the quality of the available income data needed for the looser screen. However, a final decision has not been made about which screen to use. We examine below the sensitivity of the results to the choice of screen. Except in that sensitivity analysis, the results presented were obtained using the tighter common screen.

Treatment of Households With Missing Data

The rates of item nonresponse among the households tracked into the detailed set of food security questions is quite low. Fewer than 3 percent of respondent households failed to answer one or more questions that they were asked. Nevertheless, while item nonresponse is relatively low, decisions must still be made as to how to deal with it in analyzing the data. Alternatives are discussed below.

A convenient feature of the Rasch model is that it is capable of assigning household scale levels to households with only partial data. Essentially, it determines the best fit for a household, given whatever data are available. The results of this fitting process depend on: (1) the responses given to the answered questions, and (2) items with the missing data. The previous study based on the 1995 CPS included all cases in the modeling that had nonmissing data for at least half of the relevant items, and this approach was feasible and yielded reasonable conclusions.

However, a drawback of including cases with any missing items is that doing so significantly complicates the interpretation and analysis of the modeling results. The main reason for this is that including cases with missing data greatly increases the number of possible levels of estimated household food insecurity observed in a data set. In particular, as noted earlier, it is a property of Rasch models that for households

with complete data, a household's estimated attribute score is based only on its count of affirmative answers. It follows from this property that, with a survey containing 18 questions, all households with nonmissing data will be classified into 1 of only 19 food security levels.[10] This is often very convenient in examining model results and in parsimoniously presenting analysis findings. However, once the possibility of missing data on individual survey items is allowed, and recognizing that there are many possible permutations of which items are missing, the number of possible food security measure values greatly increases, and intuition can suffer.

On the other hand, excluding observations essentially involves discarding data that can improve the accuracy of the model estimation work. On balance, our preliminary recommendation is to include in the analysis all or most of the cases with missing data; however, this is still subject to review and discussion. In the meantime, in the sections below, we examine the sensitivity of key results to alternative assumptions.

Standard Errors of Estimates

It is important to calculate standard errors of model parameters and prevalence estimates to assess their precision and judge whether estimated changes over time are statistically significant. We have developed approximations to the relevant standard errors and are continuing work to improve those estimates. The following discussion focuses on two sets of standard errors—those for estimated item severity levels and those for prevalence estimates.

Standard Errors of Item Severity Estimates

The Rasch model calculates for each survey question (item) an estimate of its severity, in terms of the level of the attribute (in this case, food insecurity) being examined. The available software programs for estimating the parameters of Rasch models calculate standard errors for each of these item severity levels. However, these calculations essentially assume that the data represent a simple random sample and do not take into account the complex design of the CPS. Therefore, it is likely that they underestimate the true sampling variability, since they ignore the effects of clustering of households in the CPS. We have developed software to use replication methods to estimate standard errors that account for the effects of the CPS's complex design.

Prevalence Estimates

The estimates of food insecurity prevalence rates presented in this paper are based on tabulations of the estimated food insecurity levels of the households in the CPS samples. There are two potential sources through which sampling variability affects these estimates: (1) variability due to sampling error in estimating the model parameters used to calculate each household's food security level, and (2) variability due to sampling error in aggregating across households in the CPS. In the estimates presented below, we take account of this second source of error but not the first. We will soon revise the estimation procedures to take account of both sources of error, using replication methods (see above) to reflect the CPS's complex design.

Weighting the Data

Not all households in a CPS sample have the same probabilities of selection. In deriving model parameter and insecurity prevalence estimates, we have weighted households to reflect their differential selection probabilities (and the effects of unit nonresponse adjustment and post-stratification), using the weights on the CPS files. Not using the weights does not clearly bias the estimates, since the underlying theory of the Rasch model does not require that the data set used to estimate parameters be representative of the population from which it was drawn. Indeed, item severity levels are explicitly defined to be independent of the estimation sample. Nevertheless, it seems prudent to determine whether our estimates are sensitive to whether weights are

[10] 18 positive scores plus zero.

used. Even if they are not, weights may be used to enhance the face validity of the work, given that most of the analysis of CPS data use the sampling weights.[11]

Standardizing the Rasch Scale

As noted earlier, a Rasch scale is uniquely determined only up to a linear transformation. That is, without loss of information, a specific Rasch scale can be rescaled so that the estimated parameters (or some subset of them) have any desired mean and standard deviation. Alternatively, the metric of a Rasch scale can be determined by anchoring any two parameters (such as the lowest and highest item severity levels) at any desired numerical values. The available software packages for estimating Rasch models use varying ways of normalizing the results they report.

In parts of the analysis—particularly those involving comparisons of item parameters across years—we have reported our results just as they come from the software that we are using to minimize the possibility (and the appearance) of inadvertently affecting comparisons through our choice of standardization. In other parts of our analysis, we have drawn on results based on a transformed food insecurity measurement metric ranging from zero to 10 to make them comparable to results reported from past work.

Establishing Cutpoints For Years Other Than 1995

The Rasch model estimates food insecurity levels for households on the basis of a numerical scale that is, in principle, continuous. (Though, with a finite number of questions, only a limited number of actual places on the continuous scale are observed.) One important objective of the government's food insecurity research has been to translate scores on this continuous scale into a small number of discrete food insecurity categories. To make this translation, it is necessary to establish cutpoints on the continuous scale that define the category boundaries. This section summarizes how this was done in the original 1995 analysis and then describes an approach that makes it possible to extend these methods to data for the later years.

Procedures Originally Used in Analyzing the 1995 Data

In the original analysis of the 1995 CPS data for categorizing households into discrete food security levels, the procedures used began by arraying the 18 food security questions in order of severity as estimated using the Rasch model. Then, based on the substance of the questions, the researchers, together with FNS, judgmentally assessed the seriousness of the food insecurity levels associated with modal sequences of answers. For instance, it was judged that, given the nature of the relevant questions, a household with children that answered the first 13 questions affirmatively should appropriately be placed in the most severe category of insecurity, while one that answered the first 12 questions affirmatively should be placed in the second most severe category. Thus, a cutpoint was established between the 12th and 13th question for the complete-data households with children. For this group of households (those that include children and have no missing data), all households answering 13 or more questions affirmatively were assigned to the most severe hunger category; conversely, those answering slightly fewer were assigned to the next less severe category.[12]

Table 3 summarizes the cutpoints that were established in this way. All households with complete data were assigned to one of the food insecurity categories shown in the table on the basis of how many affirmative answers they gave to the 18 questions, or 10 questions in the case of households without children.

[11]One other issue related to weighting should be noted. The weights on the 1995 file are incorrect, due to a Census Bureau processing error. We are attempting to obtain corrected weights, and we hope to use the corrected weights in later reports of our work.

[12]The approach draws on the characteristic of Rasch models, noted earlier, that scores for households with no missing data are uniquely determined by the number of affirmative answers; which of the questions have been answered affirmatively does not affect the score.

By itself, table 3 only applies to households with complete data. The method used to assign households with incomplete data to food insecurity categories was directly based on the numerical food security scores assigned to those households by the Rasch model. Implementing this procedure required establishing numerical cutoff values to define the borders of each food insecurity category. In doing this, the numerical cutoff between each adjacent pair of food security categories was set at approximately the level that separated cases with complete data in the two categories. (Remember, these cases with complete data were classified based on their numbers of affirmative answers, as described in the previous paragraphs.)

To illustrate this, we will continue to use the earlier example from the Hamilton et al. analysis. In that analysis, complete-data households with 13 affirmative answers, who were placed in the most severe hunger category on the basis of their number of affirmative answers, were assigned a food insecurity level of approximately 6.8 by the Rasch model, while those with 12 affirmative answers, who were placed in the next less severe category on the basis of their affirmative answers, were assigned a score of 6.4 by the Rasch model. Therefore, the numerical cutpoint between these categories used for households without complete data was a point between these two values, i.e., 6.4 and 6.8.

Procedures Used to Set Cutpoints for the 1996 and 1997 Data

In parts of our analysis, it has been necessary to establish cutpoints for the 1996 and 1997 data. This raises a number of complex issues, as discussed here.

Issues. One possibility for setting cutpoints for the 1996 and 1997 data is simply to take the numerical cutpoints for the 1995 data established in Hamilton et al. (1997) and to directly apply them to the households in the 1996 and 1997 data sets, including those with complete data and those without complete data. Several issues led us to reject this approach, however. One problem with doing this is that this approach logically requires that the Rasch model parameters be fully normalized so that they are on a comparable basis across the 3 years. While we are exploring ways of doing this, the most useful normalization to use in such work is not yet clear.

Perhaps more importantly, use across different years of fixed numerical cutpoints could potentially lead to measurement instability, caused by cross-year shifts of households between food insecurity categories as a result of very minor variations in the Rasch scoring. In particular, cutpoints in the previous analysis are very close to the numerical scores assigned by the model to large clusters of households. For instance, the numerical score assigned to all households with complete data and 13 affirmative answers is located only slightly above (in terms of severity) the numerical cutpoint established with the 1995 data as the boundary between the two most severe hunger categories. If the numerical cutpoints were kept the same across years and if all households were assigned to food security categories according to the cutpoints, then a slight change in model parameters between years could potentially cause the score assigned to this cluster of households to fall below the cutpoint into a different food insecurity category in the second year, resulting in considerable apparent instability in prevalence measures.[13]

How we have assigned the 1996 and 1997 cutpoints. To avoid the instability problem described above and preserve the basic logic under which categories were initially defined in the 1995 analysis, we have focused the cutpoints for observations with complete data on the numbers of affirmative answers, rather than on

[13]This instability issue pertains largely to households with complete data (10 or 18 answers, depending on the presence of children), since they form large clusters of observations in the data sets with identical scale scores. Households with incomplete data are more evenly distributed along the scale, because of the large number of permutations in which missing data can occur.

their numerical model scores.[14] In particular, all households with complete data have been assigned to food security categories on the basis of the decision rules summarized in table 3. This is essentially the exact procedure used for complete-data households in 1995, and it thus ensures comparability with that earlier work. Furthermore, as is reported below, our analysis of the 1996 and 1997 data suggests that the ordering of the severity of the items remains very similar across years, which lends further support to preserving the logic of the earlier analysis.

Households with incomplete data in the 1996 and 1997 data sets have been assigned to categories on the basis of their Rasch model numerical measures. New numerical cutpoints have been defined for each year. These new cutpoints have been defined in ways that are analogous to the approach used in 1995, except that they are based on the 1996 and 1997 model parameters. In particular, the cutpoints have been set such that they are the numerical values that separate different categories of households with complete data for the relevant years.[15]

Summarizing the above, the sequence of steps is essentially the following: households with complete data are being assigned to food insecurity categories, based on their numbers of affirmative answers to the CPS questions. Once those complete-data households have been assigned to categories, their scores are used to determine numerical scale levels, or cutpoints, that divide the various categories. Those numerical cutpoints are then used to assign households with incomplete data to categories.

Correspondence With Earlier Findings

This paper draws on data for 3 years: 1995, 1996, and 1997. The data set we have used for 1995 is the same as that used in the earlier analysis, a fact that we have verified by fully reproducing selected key tables from Hamilton et al. (1997). However, the 1995 results reported in this paper differ slightly from those presented in Hamilton et al. The reasons for this include the following: (1) in most of the analysis we have imposed common screens to make the samples comparable across year, which had the effect of excluding some cases from the full 1995 data set; (2) in parts of our analysis, it has been convenient to report results using different Rasch model normalization conventions from that used in the earlier analysis; and (3) in parts of the analysis, we have used different conventions as to how cases with missing data are treated. While none of our 1995 results are in any way materially different from those reported in Hamilton et al., all or most of the exact numbers vary for the above reasons.

Software Used

Various software packages are available for estimating IRT models. These packages, while basically performing the same functions, often vary considerably along a variety of dimensions, including reporting formats, estimation algorithms used, statistical fit data reported, treatment of weighted data, and other features. Two of the available packages have been used in various parts of the analysis reported here, Bigsteps, which is maintained by Mesa Laboratories at the University of Chicago, and BILOG-MG, which is distributed by Scientific Software International. Various parts of the analysis reported below have been conducted with one or the other of these packages. Prior to our decision to use them interchangeably, we confirmed that both packages yield essentially identical estimates of basic model parameters, once differences in normalization metrics are taken into account.

[14] In the text, when we refer to "complete" data, we mean households with children that have 18 responses and households without children that have 10 responses. Technically, the households without children are treated as having missing data when estimating the Rash model. However, it is useful to think of them as complete for the discussion in the text, because they have no individual item nonresponse, and they, therefore, form clusters of households with the same values on the Rasch scale.

[15] The simpler alternative of keeping the 1995 cutpoints for use in assigning categories to households with incomplete data in the later years was rejected because of the danger that the 1995 values could become "out of line" over time with the Rasch scores for the households with complete data. In fact, as described below, over the 3 years currently under analysis, there is no appreciable difference in the results depending on whether the 1995 cutpoints or the updated cutpoints are used.

Key Preliminary Findings

This section presents preliminary findings concerning the research questions highlighted in the introduction:

- Are estimated model parameters stable over time?
- How is the prevalence of food insecurity in the U.S. population changing?
- How robust are prevalence estimates to judgmental choices over alternative methods?

In addressing these questions and, in particular, the third question, we often present alternative model parameter or prevalence estimates, reflecting different methodological choices.

It should be emphasized that analysis of the data is still ongoing, and it is possible that some results presented may be revised, as additional analysis results become available.

Are Estimated Model Parameters Stable Over Time?

An important issue in examining the validity of the Rasch modeling approach is whether the model parameter estimates are stable over time. The underlying theory on which the Rasch model is based posits: if the wording of an item does not change, its estimated severity level should not change. Even if food insecurity became more prevalent over time, for example, a household at a given level of insecurity this year is assumed to answer each item the same as a household at that level of insecurity a year ago. Because of sampling variability and other factors, such as minor wording changes, we do not expect estimated model parameters to remain exactly the same over time, but a finding of major changes over time would call into question the validity of the model. Particularly problematic would be a finding of important changes in the ordering of the items by severity.

Table 4 shows estimated item parameters based on separate estimation, using data from each of the 3 years. (In estimating these models, we have used the tighter common screen, and households with missing data are retained in the analysis.) To avoid the possibility of influencing the results by imposing a normalization on the data, we have chosen in this table to present the model results directly as they were printed by the software program used.

These model estimates show considerable stability of model parameters across years. Particularly important, the order of the 18 items, in terms of their estimated severity, remains completely constant over the 3 years.[16]

As shown in table 4, the item severity estimates vary somewhat over time, but the degree of variation is quite small, relative to the overall range of the scale that extends about 3.5 units. For instance, the severity of the most severe (and least precisely estimated) item, item 50, fluctuates only slightly. From a value of 3.01 in 1995, it drops to 2.89 in 1996 and rises to 3.07 in 1997. Fluctuations are greater for some other items. The largest difference over time is for item 47, which rises from 1.85 to 2.08 between 1995 and 1997, an increase of 0.23.

In assessing these results, it is important to note that, as indicated above, we have not normalized the scales in any way to keep them comparable over the 3 years. Some differences across years in parameters may be an artifact of different implicit normalizations. For instance, all but 2 of the 18 scores in the 1997 data are higher than those in 1995. If we had chosen to anchor one of the 1997 items to its 1995 value, it is likely that the degree of apparent variation in the scores would have been lessened.[17]

[16] In other variants of these analyses, such as those with different screens, there was some tendency for one pair of adjacent items, items 28 and 40, to invert their order in different years. However, this inversion does not significantly affect other components of the analysis, and after examining many variants of the estimated results, our conclusion is that the item ordering is highly stable across years.

[17] We anticipate that in later work from the project, some normalization will be used in reporting cross-year scale comparisons. We are still examining the issue for the most appropriate normalization for this purpose.

Even though the changes in parameters are relatively small, many of them are statistically significant, in part because of the very large sample sizes in the CPS. A typical estimated standard error in the middle or bottom part of the table is about 0.03. With this amount of sampling variation, differences across years in item severity levels of 0.08 or more are generally statistically significant. However, two points should be noted: (1) while we are still examining implications of these cross-year differences in item severity, our preliminary assessment is that differences of the magnitude shown in table 4 will not have any material effect on prevalence estimates; and (2) as discussed above, once a common normalization is imposed on the results in table 4, it is likely that the sizes of the cross-year differences and their statistical significance will be reduced.

Table 5 examines the robustness of the item severity results to differences in assumptions concerning screening and the treatment of missing data. For illustration, the table focuses on 1997 data, but similar results are found when data for other years are examined. The table shows that using the loose screen rather than the tight screen results in changes in item severity roughly comparable in magnitude to the cross-year changes observed in the previous table. The choice as to whether to use observations with missing data has virtually no impact. (This latter result is not surprising, given the very low incidence of item nonresponse in the data set.)

How is the Prevalence of Food Insecurity in the U.S. Population Changing?

Final decisions about how to develop estimates of changes in food security levels over time are still under consideration. Key issues include:

- Should model parameters be re-estimated each year?
- Should some sort of intertemporal averaging be used to derive parameter estimates?

To provide a preliminary look at changes in the prevalence of food insecurity over time, we have developed time series estimates based on the 1995 parameter estimates. Specifically, we have applied the 1995 item severity parameters and the 1995 cutpoints to each of the 3 years of data. In addition, we have made preliminary prevalence estimates based on model parameters derived from the 1996 and 1997 data. The results are reported here.

Prevalence estimates based on 1995 model parameters show a noticeable increase in food security over time (table 6). In particular, after increasing by 0.1 percentage point between 1995 and 1996, the percentage of the population classified as food secure increases by a substantial and statistically significant 1.6 percentage points between 1996 and 1997.[18] As indicated in the lower rows of the table, the overall increase of 1.7 percentage points in the percentage of households classified as food secure is reflected in decreases in each of the three levels of food insecurity. Between 1995 and 1997, households categorized as food secure without hunger decrease by 0.8 percentage point, while the two groups classified as experiencing hunger drop by 0.7 and 0.2 percentage point.

Table 7 examines the sensitivity of these findings to alternative methodologies, using the 1997 data for illustration. Applying the loosest common screen rather than the tighter common screen decreases by 0.6 percentage point the percentage of the population classified as food secure. The direction of the effect is expected, because applying the looser screen allows some households to be classified based on their responses to the full battery of food security questions rather than simply being classified as food secure based on the screening questions. Not surprisingly, almost all of the effect of using the looser screen is to transfer cases from the food secure category on to the food insecure without hunger category. The percentages in the two most severe food insecurity categories remain essentially the same.

[18] Work estimating the standard errors of the prevalence estimates in the table is underway but has not yet been completed. However, preliminary calculations suggest that the substantial 1996-97 change discussed in the text is almost certain to prove statistically significant.

The exclusion of households with missing data results in 0.5 percent of households being transferred out of the other categories and into a category of status not determined. About half of the households whose status is changed come from the food secure category. Most of the others are transferred from food insecure without hunger and food insecure with hunger.

Whereas tables 6 and 7 focus on the effects of alternative methodological choices on the estimated prevalence levels, table 8 focuses on the effects of alternative methodologies on the estimated changes in prevalence levels over time. The first column reproduces the 1995-97 change estimates reported in table 6, while the second and third columns show estimated changes under the alternative methodologies that we are examining. In general, only slight variation is observed, and neither of the alternative methodologies being examined appears to substantially affect estimates of changes in prevalence.

Prevalence Estimates Based on 1996 and 1997 Parameters

All of the prevalence analysis up to this point has been based on applying the 1995 model parameters and classification rules to all 3 years of data. As a preliminary step in developing recommendations about how to update the analysis methods over time, we have also experimented with using 1996 and 1997 model parameters separately to estimate food insecurity prevalence levels for those 2 years.

The first two columns of table 9 display 1996 prevalence estimates based on alternative sets of Rasch parameters. The first column reproduces the 1996 prevalence based on 1995 parameters as reported earlier in table 6. The second column shows results based on the methods previously described that draw, in part, on Rasch model parameters estimated with 1996 data. The changes from using the 1996 parameters are minimal. None of the prevalence percentages change by more than 0.1 percentage point.

Comparable data are also presented in the table for the 1997 data. Again, there are no substantial changes in the estimated prevalence rates.

In assessing these results, it should be noted that for more than 97 percent of households with complete data, there is essentially no difference between the analysis in this section and the analysis based fully on 1995 parameters. This is because under the Hamilton et al. analysis approach, as replicated in earlier subsections, households with complete data are essentially being classified based on their numbers of affirmative answers, and this approach is not being changed in the results reported above. Thus, it is essentially only the treatment of households with missing data that can be affected by the new methods being examined in this section, which allows the numerical Rasch model scores to be separately estimated for 1996 and 1997. Further, even for these households, their classification into food insecurity categories is unlikely to be affected unless they are quite near a margin between categories.

Other Empirical Results

In addition to the central findings reported above, several other methodological questions have been examined. Selected issues are discussed in this section.

How Modal are Household Response Patterns?

The Rasch model implies that most households will exhibit item response patterns that are reasonably modal, in the sense that if a household answers “yes” to any of the items, it will tend to answer “yes” to the least severe items first, and then answer “no” to the more severe items. A household that exhibits this pattern exactly—a string of all “yes” answers followed by a string of all “no” answers—is said to be a “modal” household. There is nothing in the Rasch theory that predicts that all households will be modal; indeed, the model cannot be estimated if all households are exactly modal. Still, it is of interest in understanding the data to examine the

degree of modality that is present. Large numbers of strongly non-modal response patterns could call into question the validity of the model.

One approach to examining the degree to which households exhibit modal answers is to calculate for each household the minimum number of answers that would have to be different in order to make the household responses be modal. Of course, if the household's answers are already perfectly modal, then the number of answers that would have to be changed is zero. However, consider, as an example, a household with the following response pattern: three "yes" answers, then a "no," then a "yes," then all "no's." For such a household, only one item (the first "no" or the last "yes") would have had to be changed to make the response pattern modal. Similarly, to take a second example, suppose a household has two "no" answers, four "yes" answers, then all "no" answers. It would require at least two changes (the first two "no" answers) to make the household modal.

Table 10 tabulates the minimum number of answer changes required to make the households in the 1995 sample modal. It shows that 37 percent of the households in the 1995 data are perfectly modal. For another 36 percent, there is only one discrepancy between their scores and a modal pattern. Sixteen percent have two such discrepancies, and 10 percent have three or more. Overall, this suggests a pattern of substantial adherence to modal response patterns.[19]

Households without children appear to exhibit more modality than those with children. However, this may be due to the fact that there are fewer questions applicable to the group without children (10 rather than 18 for households with children) and, hence, fewer opportunities for non-modality.

[19]Of course, for a household with just one non-modal answer, that answer could be severely non-modal (a "no" at the beginning of a long string of "yes" answers or a "yes" many items after the previous "yes"). A little later, we will examine the severity of non-modality.

Table 11 presents a more detailed look at these issues, focusing on households with children. The central section of the table shows, for each possible number of "yes" answers, the frequency distribution of the highest item (in terms of severity) to which the non-modal households with children answered "yes." For instance, the fifth row shows data for the 335 non-modal households that gave five "yes" answers. For 119 of them, the highest "yes" answer was on item 6, while for another 75, the highest "yes" answer was item 7, and so on.

The shading in the table reflects the fact that certain cell entries are logically impossible—if, for instance, there are five "yes" answers, the highest non-modal item with a "yes" answer cannot come before the sixth item. To the extent that the non-modal households are almost modal, we would expect households to be clustered just to the right of the shaded area. For instance, using the previous example, a household with five "yes" answers that has the sixth item as its highest "yes" answer has only one non-modal answer in its overall string of answers. For most rows in the table, non-modal households do cluster near the shaded diagonal, suggesting that the non-modal response patterns are not severely non-modal. About 50 percent of households are in the first two off-diagonal cells, and an additional 20 percent are in the third cell.

Bounds on the Effects of Non-Modality on Prevalence Estimates

A useful way to understand the implications of non-modal response patterns is to assess their effects on prevalence estimates. Accordingly, in this section, we calculate for each household the minimum and maximum food insecurity levels that can be obtained by making the household's response pattern modal. To obtain the minimum insecurity level, we classify a household based on the items before its first "no" answer. This effectively converts all higher "yes" answers to "no" answers, giving a modal pattern. To obtain the maximum insecurity level, we classify a household based on the items up to and including its last "yes" answer. This effectively converts

all lower "no" answers to "yes" answers, again giving a model pattern.

Consider, as an example, a household with children that answers "yes" to the first 2 items, "no" to the third and fourth items, "yes" to the next 4 items, and "no" to the last 10 items (for six "yes" answers in all). For this household, the minimum food insecurity level is based on the modal pattern of "yes" to the first two items and "no" to the last 16 items. The maximum food insecurity level is based on the modal pattern of "yes" to the first 8 items and "no" to the last 10 items.[20]

When every household is classified at its minimum food security level, the overall prevalence of insecurity (in the highest category and across the three categories) is at a minimum. Likewise, when every household is classified at its maximum food insecurity level, the overall prevalence of insecurity is at a maximum.

The results of this analysis are reported in table 12. In each of the 3 years, going to the "minimum insecurity" scenario tends to increase the estimated proportion of food secure households by about 1 percentage point, compared with the base estimates, and there is a decrease in the proportion classified as experiencing hunger of between 1 and 2 percentage points. Going to the scenario with "maximum insecurity" raises the proportion with hunger by between 2 and 5 percentage points, depending on the year.

Interestingly, the category that involves the minimum food insecurity estimate causes the proportion of households in the middle category—food insecure without hunger—to be higher in each of the 3 years. This is because more households move into this category from the most severe category than leave it to go into the food secure category.

[20]In contrast, the Rasch model would assign this household the same insecurity score as any other household with 6 "yes" answers (and no missing responses), effectively treating it as though it had the modal response pattern of "yes" to the first 6 items and "no" to the last 12.

Conclusions

This paper has summarized selected preliminary results from work that is still very much in progress. It is possible that some results we have presented could change significantly after further analysis and review, and additional lines of analysis remain to be carried out. However, it may be useful to conclude by summarizing key findings to date. They include:

- The Rasch model parameters do not change greatly, depending on which data set is used to estimate the model; importantly, the item ordering remains approximately constant.
- It has been possible to identify two data screens that place the data from the 3 years on a comparable basis; results do not appear highly dependent on which of these screens is used, or indeed on whether any screen is used.
- The prevalence of food insecurity appears to have declined between 1995 and 1997.
- It is useful in applying the model to other years to rely heavily on the relationships between numbers of affirmative answers and food insecurity categorization developed in the original analysis of the 1995 data. By doing this, it has been possible to develop an approach that appears to obtain reasonable prevalence results, even using models estimated from different years' data sets.

In addition to refining the analysis done to date, we anticipate that we will:

- Develop appropriate ways to estimate the substantive and statistical significance of changes in prevalence estimates over time,

- Finalize decisions concerning what screen to use and how to treat missing data,
- Finalize decisions as to how to establish model parameters and cutpoints for longitudinal analysis,
- Develop appropriate procedures for normalizing Rasch scales estimated with data from different years,
- Apply the analysis to the 30-day data, and
- Conduct analysis of subgroups of the overall household population.

References

Hamilton, W.L., J.T. Cook, W.W. Thompson, L.F. Buron, E.A. Frongillo, Jr., C.M. Olson, and C.A. Wehler. 1997a. *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project.* U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA.

Hambleton, R.K., and R.W. Jones. Fall, 1993. "An NCME Instructional Module on Comparison of Classical Test Theory and Item Response Theory and Their Applications to Test Development," *Educational Measurement: Issues and Practice*. Vol. 12, No. 3. pp. 38-47.

Radimer, K.L., C.M. Olson, J.C. Greene, C.C. Campbell, J.P. Habicht. 1992. "Understanding Hunger and Developing Indicators to Assess It in Women and Children," *Journal of Nutrition Education*. Vol. 24. pp. 36S-45S.

Wehler, C.A., R.I. Scott, J.J. Anderson, L. Summer, and L. Parker. 1995. *Community Childhood Hunger Identification Project: A Survey of Childhood Hunger in the United States.* Food Research and Action Center, Washington, DC.

Wright, B.D., and G.N. Masters. 1982. *Rating Scale Analysis.* Chicago: MESA Press.

Table 1—CPS sample sizes, unweighted number of households

Item	April 1995	September 1996	April 1997
		Number	
Full CPS	53,665	47,795	47,306
Households in supplement	44,730	41,811	41,146
Households tracked into food security module[1]	18,453	10,957	11,175
Answered all key questions asked	18,179	10,685	10,937
Answered at least half of key questions asked, but not all	195	203	171
Answered fewer than half of key questions asked	79	69	67

[1]There are 18 key questions for households with children and 10 for those without children.

Table 2—Sample sizes under alternative screens

Item	Low-income households	High-income households	Total
		Number	
1995:			
Maximum sample available	15,662	2,791	18,453
Loosest screen[1]	7,891	2,791	10,682
Tighter screen[2]	5,049	2,791	7,840
1996:			
Maximum sample available	7,259	3,698	10,957
Loosest screen[1]	7,259	2,674	9,933
Tighter screen[2]	4,760	2,674	7,434
1997:			
Maximum sample available	6,293	4,882	11,175
Loosest screen[1]	6,293	2,640	8,933
Tighter screen[2]	4,084	2,640	6,724

[1]See the Loosest Common Screen box.
[2]See the Tighter Common Screen box.

Table 3—Food insecurity status by number of affirmative answers, households with complete data

Food insecurity status	Affirmative answers: Households with children	Affirmative answers: Households without children
	Number	
Food secure	0-2	0-2
Food insecure without hunger	3-7	3-5
Food insecure with moderate hunger	8-12	6-8
Food insecure with severe hunger	13-18	9-10

Table 4—Item parameter estimates based on cases that pass the tighter common screen, includes complete cases and all cases with item non-response, 1995-97

Item	Description	1995 Parameter	1995 Standard error	1996 Parameter	1996 Standard error	1997 Parameter	1997 Standard error
NHES50	Child not eat for whole day	3.01	0.11	2.89	0.07	3.07	0.11
NHES44	Child skipped meal, 3+ mos.	2.51	.06	2.43	.09	2.47	.09
NHES43	Child skipped meal	2.28	.05	2.22	.07	2.22	.08
NHES29	Adult not eat whole day, 3+ mos.	2.02	.05	1.98	.03	2.13	.04
NHES47	Child hungry	1.85	.04	1.95	.04	2.08	.07
NHES28	Adult not eat whole day, 3+ mos.	1.78	.04	1.77	.06	1.91	.05
NHES40	Cut size of child's meals	1.76	.04	1.72	.02	1.89	.03
NHES38	Adult lost weight	1.68	.03	1.55	.04	1.74	.03
NHES35	Adult hungry but didn't eat	1.19	.02	1.14	.04	1.33	.03
NHES57	Child not eating enough	1.10	.03	1.10	.03	1.22	.05
NHES25	Adult cut size or skipped meals, 3+ mos.	.82	.03	.80	.02	.96	.03
NHES56	Adult eat less than felt they should	.53	.03	.52	.04	.73	.04
NHES32	Couldn't feed child balanced meals	.49	.03	.45	.02	.62	.03
NHES24	Adult cut size or skipped meals, 3+ mos.	.44	.03	.40	.02	.55	.02
NHES58	Adult fed child few low-cost foods	.03	.03	.04	.03	.20	.03
NHES55	Adult not eat balanced meals	-.12	.02	-.13	.02	.05	.03
NHES54	Food bought didn't last	-.25	.03	-.24	.02	-.14	.02
NHES53	Worried food would run out	-.53	.03	-.57	.02	-.48	.02

Note: Standard errors are computed using a balanced repeated replication jackknife procedure to account for the complex sample design used in the Current Population Survey. These estimates are based on weighted data.

Table 5—Sensitivity of item severity estimates to different assumptions, 1997 data

Item	Description	Estimated item severity levels: Basic analysis[1]	With looser screen	Excluding all cases with item nonresponse
NHES50	Child not eat for whole day	3.07	3.13	3.08
NHES44	Child skipped meal, 3+ mos.	2.47	2.56	2.48
NHES43	Child skipped meal	2.22	2.32	2.23
NHES29	Adult not eat whole day, 3+ mos.	2.13	2.23	2.14
NHES47	Child hungry	2.08	2.20	2.09
NHES28	Adult not eat whole day, 3+ mos.	1.91	2.04	1.92
NHES40	Cut size of child's meals	1.89	2.01	1.90
NHES38	Adult lost weight	1.74	1.87	1.74
NHES35	Adult hungry but didn't eat	1.33	1.51	1.34
NHES57	Child not eating enough	1.22	1.36	1.23
NHES25	Adult cut size or skipped meals, 3+ mos.	.96	1.17	.97
NHES56	Adult eat less than felt they should	.73	.91	.74
NHES32	Couldn't feed child balanced meals	.62	.84	.62
NHES24	Adult cut size or skipped meals, 3+ mos.	.55	.79	.56
NHES58	Adult fed child few low-cost foods	.20	.43	.21
NHES55	Adult not eat balanced meals	.05	.29	.05
NHES54	Food bought didn't last	-.14	.15	-.14
NHES53	Worried food would run out	-.48	-.22	-.48

[1]Reproduced from table 4.

Table 6—Food insecurity prevalence estimates by year with severity levels based on 1995 data

Food security status	1995[1]	1996	1997	Change in estimates, 1995-97
	----------*Percent*----------			*Percentage points*
Food secure	89.4	89.5	91.1	1.7
Food insecure without hunger	6.4	6.2	5.6	-.8
Food insecure with hunger	3.3	3.3	2.5	-.8
Food insecure with severe hunger	.8	.9	.6	-.2
Food security status not determined	.2	.1	.2	0

Note: Estimated for each year, using model parameters based on 1995 data. Based on the tight screen and inclusion of all cases with missing data.

[1]Estimates differ from those published in Hamilton et al. (1997) because the screens used to track households into the detailed food security analysis have been adjusted to make them consistent across the 3 years.

Table 7—Effects of alternative methodologies on estimated prevalence levels, 1995 data

Food security status	Main analysis[1]	Excluding cases with missing data	Using looser screening criteria
		Percent	
Food secure	89.4	89.2	88.8
Food insecure without hunger	6.4	6.3	7.1
Food insecure with hunger	3.3	3.2	3.3
Food insecure with severe hunger	.8	.8	.8
Food security status not determined	.2	.5	—

[1]From table 6.

Table 8—Effects of alternative methodologies on estimated changes in prevalence levels, 1995-97

Food security status	Main analysis[1]	Excluding cases with missing data	Using looser screening criteria
		Percentage points	
Food secure	1.7	1.7	1.8
Food insecure without hunger	-.8	-.9	-.9
Food insecure with hunger	-.8	-.8	-.8
Food insecure with severe hunger	-.2	-.2	-.2
Food security status not determined	—	.2	—

[1]From table 6.

Table 9—Prevalence estimates based on 1996 and 1997 model parameters

Food security status	Prevalence estimates			
	1996 data		1997 data	
	1995 parameters[1]	1996 parameters	1995 parameters[1]	1997 parameters
		Percent		
Food secure	89.5	89.6	91.1	91.2
Food insecure without hunger	6.2	6.2	5.6	5.7
Food insecure with hunger	3.3	3.3	2.5	2.5
Food insecure with severe hunger	.9	.9	.6	.6
Food security status not determined	.1	—	.2	—

Note: Based on tight screen and inclusion of all cases with missing data.

[1]From table 6.

Table 10—Percentage of households by the minimum number of non-modal responses to the food security items, 1995 data

Non-modal responses[1]	All households	Households without children	Households with children
		Percent	
0	37	49	28
1	36	37	34
2	16	10	21
3	7	3	10
4	2	1	4
5	1	0	2
6+	0	0	1
Total	100	100	100

[1]Minimum number of responses that would have to be changed for the household to be modal.

Table 11–Analysis of modality by number of "yes" responses to food security items (1995 data: Unweighted households with children)

	All		Modal		Non-modal - highest "yes" response iter																		
Number of "yes" responses	HH[1]	Percent	HH	Percent	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	HH	Percent
1	970	22.6	583	48.6	107	62	131	28	4	24	0	3	3	1	3	2	0	0	0	0	1	367	12.5
2	661	15.4	273	22.8		64	177	22	32	34	19	6	6	1	0	0	3	1	1	0	0	366	12.5
3	550	12.8	113	9.4			171	37	86	78	24	18	8	2	3	2	7	0	1	0	0	437	14.1
4	386	9.0	70	5.8				29	101	84	42	29	11	6	6	3	2	0	1	0	0	316	10.2
5	343	8.0	8	.7					119	75	60	34	22	7	4	3	3	4	2	2	0	335	10.9
6	353	8.3	14	1.2						63	84	127	57	7	10	4	7	4	1	0	0	344	11.1
7	255	5.9	17	1.4							65	57	43	21	13	15	11	8	2	2	1	238	7.7
8	189	4.4	38	3.2								31	33	29	14	13	12	12	4	1	2	150	4.8
9	176	4.1	35	2.9									31	21	28	22	16	15	2	2	2	141	4.6
10	132	3.1	20	1.7										14	24	12	26	22	4	6	2	112	3.6
11	86	2.0	6	.5											14	3	23	28	7	5	0	80	2.6
12	59	1.4	3	.3												3	19	16	2	14	2	56	1.8
13	59	1.4	0	0													13	24	9	8	5	59	1.9
14	28	.7	0	0														14	2	11	1	28	.9
15	15	.3	4	.3															0	8	3	11	.4
16	12	.3	0	0																7	5	12	.4
17	13	.3	9	.8																	4	4	.1
18	6	.1	6	.5																		0	0
Total	4,297	100.0	1,199	100.0	107	166	479	114	342	353	294	307	194	110	119	82	146	148	38	66	26	3,096	100.0
Percent					3.5	5.4	15.5	3.7	11.0	11.6	9.5	9.9	6.3	3.6	3.8	2.6	4.7	4.8	1.2	2.1	.9	100.0	

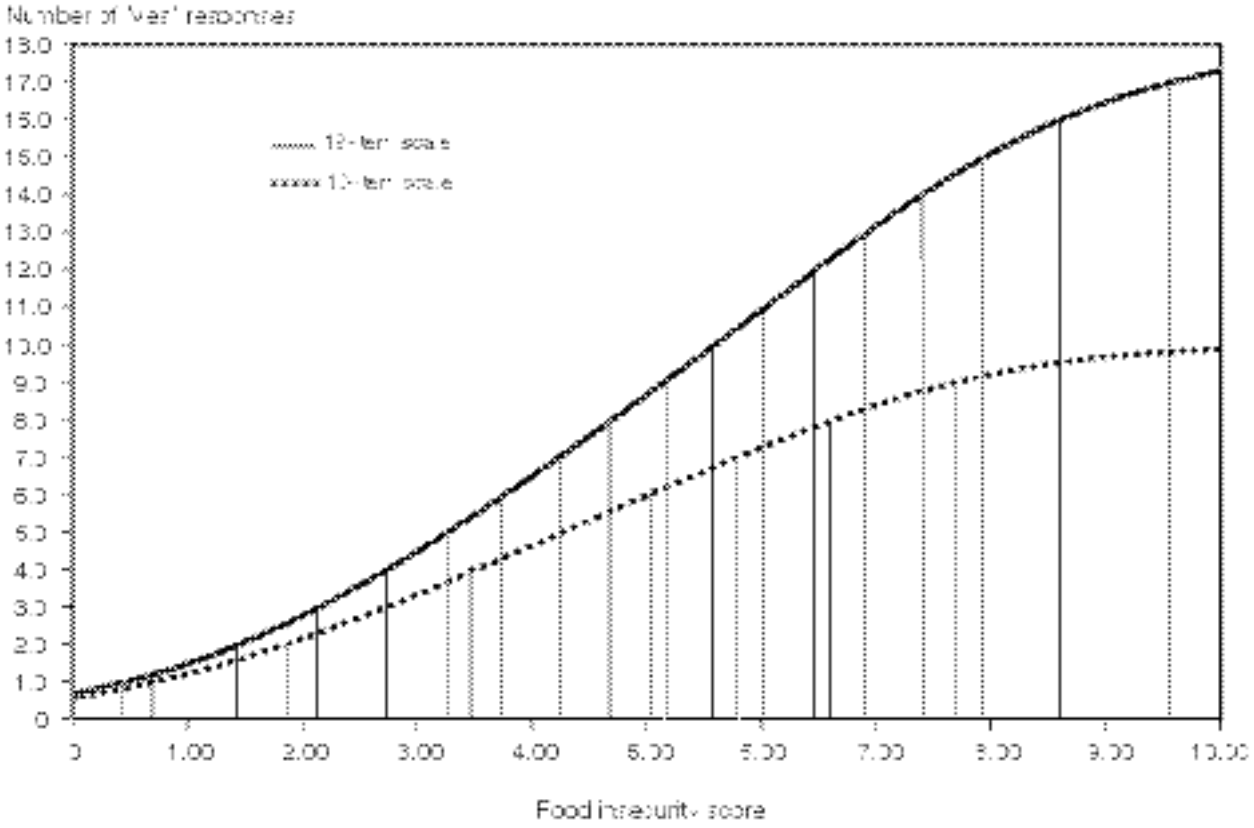
[1]HH is the abbreviation for households.

Table 12—Minimum and maximum food insecurity prevalence estimates, percentage of households, 1995-97

Food security status	Base estimate	Estimate involving minimum estimate of food insecurity	Estimate involving maximum estimate of food insecurity
		Percent	
1995:			
Food secure	89.4	90.33	87.16
Food insecure, hunger not evident	6.4	6.84	6.06
Food insecure, hunger evident	4.1	2.68	6.78
Food security status not determined	.2	.15	
1996:			
Food secure	89.5	90.42	87.13
Food insecure, hunger not evident	6.2	6.70	6.08
Food insecure, hunger evident	4.2	2.72	6.79
Food security status not determined	.1	.17	
1997:			
Food secure	91.1	91.95	88.14
Food insecure, hunger not evident	5.6	5.83	3.97
Food insecure, hunger evident	3.1	2.10	7.89
Food security status not determined	.2	.12	

Notes: To compute the maximum estimate of food insecurity, households were classified based on the most severe item with "yes" responses. To compute the minimum estimate of food insecurity, households were classified based on the most severe "yes" item preceding the least severe "no" response. Percentages may not add to 100 due to rounding.

Figure 1
18- and 10-item test characteristic curves
(Based on 1995 item calibrations as reported in Hamilton et al., 1997)



Note: Positions of vertical lines represent item scores.

Appendix
Key Aspects of the Rasch Model

As noted in the text, household answers to 18 questions from the Current Population Survey (CPS) supplements have been used to develop food insecurity scales. This appendix summarizes the scaling methods used.

As with most surveys, not all the CPS questions were asked of all households. Questions that were not applicable to a household were skipped during the interview. The most important example in the food security supplement is that questions about children were not asked of households with no children. While households with children answered 18 items, childless households answered only 10 items, skipping the 8 items pertaining to children. This creates a problem: how do we measure the food insecurity status of all households, both those with and those without children, on a common scale?

Item response theory (IRT) provides a solution to this problem. (See, for instance, Hambleton (1993) for a discussion of IRT procedures.) One way to understand how IRT deals with this problem is to consider a more traditional application of IRT models: student testing. The problem is found in testing because students are given different versions of a test to deter cheating, but all students need to be graded on a common scale. This issue arises with the Scholastic Aptitude Test (SAT) and other standardized tests, as well as in educational research studies, such as the National Assessment of Educational Progress.

The problem is resolved by first determining how difficult each test item is relative to every other item. In general, a more difficult item is answered correctly by fewer students than is a less difficult item. Difficulty can be quantified and estimated using maximum likelihood statistical methods. Difficulty levels are the item scores—or item parameters—in the IRT model.[1] The difficulty of the overall test can be expressed as a function of the difficulty of all items that comprise the test. This function is the test characteristic function, and a graph of the function is the test characteristic curve. A grade can then be assigned to each student based on the number of items answered correctly and the characteristic function for the version of the test taken. It is the use of the test characteristic function that adjusts each student's raw score (the number of correct responses) for the difficulty of the items in that student's version of the test. These grades are the respondent scores (or respondent parameters) in the IRT model. Taken together, these two pieces of information—the number of correct responses and the characteristic function of each student's test—allow all students to be graded on the same scale, even though they are given different tests. For example, a score of 8 out of 11 items on an easy test might turn out to be equivalent to a score of 6 out of 13 items on a more difficult test. The IRT model provides the theoretical foundation and the mathematical relationships needed to quantify the measures of item difficulty and student performance. The IRT model also provides the statistical theory needed to estimate the item parameters and student scores.[2]

In our application to food insecurity measurement, two different versions of a test are administered in the CPS. The first version, administered to households with children, has 18 items. The second version, administered to childless households, has only 10 of the 18 items. Just as different items on an educational test tap different levels of student ability—that is, some items are more difficult than others—each of the 18 CPS questionnaire items taps a different level of household food insecurity. To measure the food insecurity status of all households on the same scale and use all available information from the survey, we score households with children using

[1]There are a variety of IRT models in use in testing applications. The differences among them are primarily related to the number of parameters—typically, one to three—associated with each item. The work done by Abt with the 1995 CPS food security data and the work presented in this paper for all 3 years are based on a one-parameter IRT model, also known as a Rasch model.

[2]Neither item parameters nor student scores are unique; they are determined only up to a linear transformation.

the 18 items that they are asked, and score childless households using the 10 items that they are asked.[3]

Figure 1 illustrates how households were scored for the 1995 food security prevalence estimates (Hamilton et al., 1997).[4] The figure shows the test characteristic curves for the 18-item test (the dotted curve) and for the 10 item test (the dotted curve). The figure is based on the item parameters estimated from the April 1995 data. For measuring food insecurity, responses to each of the 18 items have been coded as "yes" or "no." A "yes" provides evidence of food insecurity. The process used to assign each household a food insecurity score is as follows:

- Count the number of "yes" responses to the 18 items—or to the 10 items, in the case of childless households.
- Find that number on the vertical axis in figure 1.
- For households with children, read across to the heavy black curve. For households without children, read across to the dotted curve.
- Read down to the horizontal axis. The value on the horizontal axis is the score assigned to the household.

For example, a household with children that answers "yes" to seven items would be assigned a score of about 4.25. In contrast, a childless household that answers "yes" to seven items would be assigned a score of about 5.75, substantially higher than the score of 4.25 assigned to the household with children. As it turns out, a childless household that answers "yes" to five items would be assigned roughly the same score as a household with children that answers "yes" to seven items, indicating that according to this one-parameter IRT model and the 18 CPS items, these two households are experiencing about the same levels of food insecurity.

In the current application, as we discussed earlier, there are actually more than two versions of the food security test, because of the many possible different patterns that can be observed in the missing data. The different scoring of households with and without children is an example of how the more general problem of missing data is handled in much of the analysis reported here. A test characteristic function can be defined for each household based on the set of items to which the household responded. For example, a household with children that had missing data for items 5 and 17 would be scored using a different test characteristic function than a household with children that had missing data for items 9 and 13. By using the appropriate test characteristic function for each household, all households are placed along a common food insecurity scale.

[3]Another option would be to use only the 10 items common to all households. This has the appeal of simplicity. However, doing this would mean disregarding a substantial amount of information about households with children.

[4]Figures follow tables at the end of this paper. This figure does not directly appear in the Hamilton et al. report but is based on parameters reported there.

Estimating the Prevalence of Children's Hunger From the Current Population Survey Food Security Supplement

Mark Nord and Gary Bickel

Abstract

The USDA measure of food insecurity and hunger combines items measuring household food insecurity, adults' hunger, and children's hunger into a single scale. Although these three constructs lie largely on a single dimension, principal components analysis of the residuals of the items of the scale for households with children reveals that they are not perfectly unidimensional. The second dimension can be interpreted as the extent to which children in the household are protected from hunger at the expense of more serious adult hunger. Because of this multidimensionality, estimates of the prevalence of children's hunger based on the household-level measure understate the true prevalence of children's hunger. A measure of children's hunger based on child-specific items finds children's hunger in only 1.12 percent of households with children, compared with 0.87 percent based on the household-level measure for the same households—a 29-percent greater prevalence. Households with older children and with higher ratios of children to adults tend to register more severe levels of children's hunger on the child-specific scale than would be predicted from their household-level scores.

Introduction

Estimating the prevalence of children's hunger and identifying households with children's hunger are important objectives of the interagency Food Security Measurement Project. There is reason to believe that food sufficiency and diet quality are important for children's development, and several food assistance programs are specifically aimed at assuring adequate nutrition for children. Up to this point in the project, the severe-hunger category of the household-level food security scale has been used as a proxy, in households with children, for hunger among children (Hamilton et al., 1997a). A substantial body of research has found that children in the United States are generally shielded from hunger at less severe levels of household deprivation and begin to experience hunger when hunger among adults in the household reaches this more severe level. The data from the Current Population Survey (CPS) Food Security Supplements are consistent with these earlier findings. However, there is concern that the prevalence of children's hunger may be understated by this method (Carlson et al., 1999). Although the severe-hunger category was delineated primarily to identify households with children's hunger, not all households with children conform to the modal pattern of protecting children from hunger until adult hunger in the household reaches a severe level. In some households classified with only moderate adult hunger, evidences of children's hunger are reported.

The nonlinear factor analysis carried out by Hamilton et al. (1997b) in the scale development process confirmed that the food insecurity and hunger items now included in the core module lie fairly well on a single dimension. However, the unidimensionality is not perfect. Child items and adult items may be on somewhat different dimensions. Even if only a small proportion of moderate hunger households have children's hunger, 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.

This paper explores the extent to which the prevalence of children's hunger may be underrepresented by the household-level severe-hunger category. First, we examine the extent to which child hunger, adult hunger, and household items lie on different dimensions by extracting principal components of the deviation of item responses from their expected values given the overall household score. Then, using Rasch modeling techniques, we scale only the 8 items in the core 18-question module that specifically ask about children. We identify the threshold of

child hunger on this child-specific scale that corresponds to the severe-hunger threshold in the household-level measure and compare the prevalence rates for children's hunger based on these two alternative scales. We cross-tabulate households by the two measures and assess the extent to which they identify the same households as having children's hunger. Then, we compare prevalence rates based on the two measures across demographic and economic categories of households to shed light on why the two measures give different results. Finally, we discuss another potentially meaningful threshold based on the child-specific scale: the severity level beyond which the quality of children's diets appears to be reduced.

Data and Methods

From the April 1995 CPS Food Security Supplement and the CPS monthly core data, we created a household analysis file including responses to the 18 items comprising the food security scale along with variables on household structure, income, and demographics. We used the 12-month food security scale score provided by Abt Associates and matched this to the Food Security Supplement file.[1] We restricted the sample to households with children as identified by the Abt file.[2] All items in the food security scale were recoded to dichotomies as specified by Hamilton et al. (1997b).

For the principal components analysis, all 18 items in the food security scale were submitted to the Bigsteps Rasch modeling software, and principal components analysis of the standardized residuals was requested. In this procedure, the items and households are first scaled by Rasch maximum likelihood methods. Then, for each household, the deviation of each item from its expected value given the household total score is calculated.[3] Each item's deviation is standardized by dividing by the model standard error for the item-household combination.[4] Then principal components are extracted from a correlation matrix of the standardized deviations.

To create a child hunger scale, the eight child-referenced items were submitted to Bigsteps Rasch modeling software without the adult-specific and household items. The household scores calculated by Bigsteps were then added to the household data file. A threshold for child hunger was identified consistent with the household-level severe-hunger threshold and conceptually consistent with the household-level threshold for adult hunger as specified by Hamilton et al. (1997a and 1997b).[5] The estimated number of households with children's hunger was then compared with the estimated number of households with severe household-level hunger. Cross-tabulation of the child-specific hunger dichotomy with the household-level severe-hunger dichotomy was examined to assess the consistency with which the two measures identify the same households as having children's hunger.

[1]Households were matched using the variable UNIQHHID, created by Abt Associates based on the CPS variables GESTCEN (State), HRHHID (household ID), and HRSERSUF (household serial suffix).

[2]The identification of households with children specified by Hamilton et al. (1997b) is problematic for a very few households. Hamilton et al. based their identification (as did the CPS survey instrument) on the presence in the household of any person less than 18 years of age. In 26 of these households, however, the only person under age 18 was either the household reference person or the spouse or partner of the reference person. Only six of the incorrectly classified households answered "yes" to any of the child items. So, the potential distortion of the scale or the prevalences estimated here is negligible.

[3]The observed value of the item is 1 if affirmed, zero if denied. The expected value is the probability of the household affirming the item given the difference between household and item score, given by $p = exp(h-i) / (1 + exp(h-i))$, where h is the scale score (severity of food insecurity) of the household and i is the calibration score (severity level) of the item.

[4]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 $v = p(1-p)^2 + (1-p)p^2$. Conceptually this is the sum of the squared deviation if the item is affirmed, weighted by the probability of its being affirmed, plus the squared deviation if the item is denied, weighted by the probability of its being denied.

[5]The thresholds are conceptually consistent in the sense that the child-hunger threshold bears the same relationship to child-specific items as the household-level hunger threshold bears to the analogous adult items. This is described in more detail in the "Findings" section.

The proportion of households affirming the single item that asks directly whether children in the household were hungry,[6] might also be considered a measure of children's hunger. A single-item measure is generally much less reliable than a scaled measure, and we do not recommend its use as a substitute for the full scale. However, we compared it with the two scales to provide a face-validity check on the scale-based measures.

Finally, prevalence rates of children's hunger based on the two scales were compared across categories of households classified by household structure, number of children, age of oldest child, sex of children, race/ethnicity of household reference person, household income, and metropolitan/nonmetropolitan residence.

All prevalence estimates and cross-tabulations are population estimates based on household weights prepared by the U.S. Bureau of the Census for the 1995 Food Security Supplement. The item scaling was carried out using unweighted data. The Bigsteps software we used does not handle weights, but since it uses maximum likelihood methods, the estimates are not biased by unweighted data provided that model assumptions hold.

Findings

Assessing a Second Dimension in the Items

The principal components analysis of standardized item deviations reveals a second factor[7] correlated negatively with all child-specific items, and positively with all adult-specific items. The highest positive correlations are with the more severe adult items (table 1).[8] Correlations are close to zero for two of the three general household items. This factor can be interpreted, then, as the extent to which households protect children from hunger by accepting more severe levels of adult hunger. The factor is not very strong, accounting for only 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 lend credence to the concern that some households with child hunger do not register severe household-level hunger.

Estimating the Prevalence of Child Hunger

Eight of the 18 core items in the food security and hunger module refer specifically to children. The proportions of households affirming these items ranged from 13.6 percent ("We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food") to 0.2 percent "In the last 12 months, did any of the children ever not eat for a whole day because there wasn't enough money for food?" see table 2). The eight child-referenced items, when scaled without the adult and household items, have item scores completely consistent with their relative scores in the all-items scale (fig. 1; see also app. tables for Bigsteps summary statistics and item statistics for the 18-item and child-specific scales).[9] The correlation of item scores between the two scales is 0.998. This is not surprising, since these items have valid values only for households with children. The correlation of scores across households, however, is only moderately high. For nonextreme households on the child-specific scale (i.e., households that neither affirmed nor denied all child-specific items), the Pearson correlation coefficient between the two scales is 0.76. This is consistent with the results of the principal components analysis and suggests that the two scales will identify a somewhat different group of households as having children's hunger.

[6]The question wording was, "In the past 12 months, were the children ever hungry but you just couldn't afford more food?"

[7]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.

[8]Tables are at the end of this paper.

[9]Figures follow tables at the end of this paper.

It is difficult to compare fit statistics between the two scales, both because they include different numbers of items and also because a larger group of households is nonextreme for the all-items scale, and therefore fit statistics are calculated over different groups of households. One informative statistic that can be compared across a common group of households is the mean standard measurement error. This is the expected mean measurement error for households with a given raw score if the data conformed exactly to the model expectations. Since the software provides the measurement error estimate for each household, its mean can be compared across a common group of households—those nonextreme on the child-specific scale. The model error is expressed in the measurement metric, so we adjusted the metric of the child-hunger scale so that the items had the same standard deviation as the child-specific items on the household-level scale, thus making the error estimates commensurate. The larger number of items in the household-level scale is expected to provide a more reliable measure of households' food security status, and the comparison of household standard errors indicates that this is true. The mean household standard errors were 0.80 and 1.02 for the household-level and child-specific scales, respectively. The error varies across the range of each scale, however, and near the relevant thresholds, the errors were more nearly the same, 0.70 for the household-level scale and 0.73 for the child-specific scale. On both scales, the thresholds relevant for the identification of children's hunger fall in the range of minimum measurement error, thus maximizing their discrimination at the severity level most critical for estimating the prevalence of children's hunger.

We set the threshold for children's hunger on the child-specific scale at the severity level midway between the scores of households (with no items missing) that affirmed four and five items (fig. 2). In other words, to be classified as having children's hunger, a household must have affirmed five items — typically the first five, up to and including that children were hungry because the household could not afford more food. This corresponds very nearly with the item score of the item that asked directly whether the children were hungry, and among the child items it corresponds exactly with the severe-hunger threshold in the household-level scale. It is no accident that these two thresholds coincide. The severe-hunger threshold was selected specifically to identify households in which, if children are present, child hunger is very likely. This child-hunger threshold is also conceptually consistent —considering analogous child and adult items— with the operational principles used to set the food-insecure-with-moderate-hunger threshold (i.e., the level of severity of food insecurity beyond which adult hunger is evident) on the 18-item food security scale (Hamilton et al., 1997a and 1997b). To pass each threshold, at least three indicators of reduced intake are required— three indicators of reduced intake among children in the one case, and three indicators of reduced intake among adults in the other. Households with no missing items and with scores just above the child-hunger threshold affirmed at least three items that indicate reduced food intake, typically that children were not eating enough, the size of children's meals were cut, and children were hungry. The only sense in which this threshold is not conceptually consistent with the adult hunger threshold is that it does not require affirmation of any item that indicates repeated experiences of insufficient food intake. Among the child-specific items, frequency information was requested only for the "skipped meals" question, comparatively a much more severe item than the threshold item for adult hunger—"cutting the size of meals or skipping meals in three or more months."

Classifying households based on the child-specific scale produced a population estimate of 425,200 households with children's hunger (table 3). This is 1.12 percent of all households with children and is 29 percent higher than the estimate based on the severe-hunger category of the household-level scale. The estimate based on the single "child hungry" question was 670,700 households, which is 1.76 percent of all households with children and just over twice the

estimate based on the severe adult hunger classification.[10]

About three-fourths of the households in the severe-hunger category were also classified as having children's hunger by the child-specific scale and by the single child hunger item (table 4). The child-specific scale identified additional sample households representing 173,500 households nationally that had children's hunger even though they did not register severe hunger at the household level. This was partially offset by 80,200 households classified as having severe hunger at the household level in which the child-specific scale did not indicate child hunger. The single "child hungry" item was answered affirmatively by households representing 417,100 households nationally that did not register severe adult hunger. This was partially offset by 78,300 households with severe hunger that denied the "child hungry" item.

Assessing Differences in the Households Identified as Having Children's Hunger by the Two Scales

Differences between the prevalence rates of households with children's hunger (based on the child-specific scale) and household-level severe hunger (based on the full 18-item scale) varied among demographic and economic categories of households, and the differences shed some light on why the two measures differ. The most notable variation is across categories based on age of oldest child (table 5). The difference in prevalence rates (households with children's hunger less households with household-level severe hunger) was greatest for households with older children and was actually negative for households in which all children were age 6 and under. This indicates that younger children are protected from hunger, even at the cost of rather serious adult hunger, to a greater extent than are older children. Compared with young children, older children experience hunger when adult hunger in the household is at lower levels of severity. Even among households with older children, however, the children registered hunger on the child-specific scale in only about one-fourth of the households with adult hunger (i.e., moderate or severe household-level hunger).[11]

Single-parent families and larger families also had greater differences between child-hunger and household-level severe hunger prevalences. Households with a lower ratio of adults to children are, arguably, less able to protect the children from hunger by reducing adult consumption. Also, these households are more likely to be in poverty over longer periods of time. If periods of economic stress and food insufficiency are relatively short, adults may be better able to maintain adequate food supply to the children by stinting themselves. But this becomes less achievable over long periods of time. The somewhat greater difference observed for low-income households than for higher income households also suggests this process.

Differences between the two prevalence rates were greater for black and Hispanic households than for non-Hispanic whites. In part, these differences may be due to the substantially higher poverty rates and longer term character of the poverty of blacks and Hispanics. Additionally, blacks have a substantially larger share of single-

[10]The higher prevalence estimate for children's hunger based on the the child-hunger scale could result, in part, from the higher measurement error inherent in that scale. The child-hunger threshold is well out in a tail of the distribution, so a measure with random measurement error will misclassify more nonhungry households as hungry than vice versa because there is a larger population share within a given severity distance below the threshold than within the same distance above it. This upward bias of prevalence estimates affects the 18-item scale also, but since the bias increases as measurement error increases, the bias on the child-hunger-scale-based prevalence estimate is greater than that on the 18-item-scale-based estimate. Preliminary work by Nord (1999) estimated the size of the bias at about 12 percent for the 18-item scale at the severe-hunger threshold. Similar analysis for the child-hunger scale suggests an upward bias of 15 to 18 percent. The difference in bias, then, accounts for, at most, about one-fifth of the difference in prevalence estimates. It should be emphasized that these bias estimates are based on rather crude methods and that much more work remains to be done in this area.

[11]The statistics for this comparison are not shown in the table. Among households with older children, 5.7 percent registered adult hunger—i.e., moderate or severe household hunger—while only 1.3 percent registered child hunger on the child-specific scale.

parent families, and Hispanics have, on average, more children. Both of these factors are associated with larger differences between child hunger and severe adult hunger. There may also be cultural differences among racial and ethnic groups either in the way household resources are managed or in the way hunger and food insufficiency are described. In nonmetro areas, the prevalence of children's hunger was virtually identical to the prevalence of severe adult hunger and was much lower than the prevalence of children's hunger in metro areas. This may result, in part, from the smaller share of racial and ethnic minorities in rural areas, but further research is needed to account fully for the rural-urban difference.

Reduced Diet Quality for Children

The child-specific scale provides the basis for another potentially meaningful classification. Households affirming two or more child-specific items, typically that they fed the children a few kinds of low-cost foods and that they could not feed the children balanced meals, may be classified as providing reduced quality diets to the children.[12] The estimated prevalence of such households is 3.51 million, or 9.2 percent of all households with children. This threshold falls in the "food insecure with no hunger evident" range of the household-level scale, about two-thirds of the distance from the threshold of that range to the threshold of the "food insecure with moderate hunger evident" range. It coincides closely in severity with the first two items, indicating that adults reduce their food intake. "Adults cut size of meals or skipped meals" falls just below it, and "adult ate less than felt he/she should" lies just above it in severity. If this is an appropriate threshold for the phenomenon, then its prevalence is not adequately represented by any of the thresholds on the household-level measure. All households with children that registered severe hunger and the vast majority (83.2 percent) of those with moderate hunger registered reduced quality of children's diets by this measure. Thirty-eight percent of households with children that registered food insecurity short of hunger also provided reduced quality diets to the children, and these households comprised 50 percent of the households with reduced quality of children's diets. The proportion of food secure households that reduced the quality of children's diets was negligible.

[12]It is important to keep in mind that this is perceived quality/variety/desirability of diet as reported by an adult member of the household. Whether it also indicates a reduction in the nutritional quality of the children's diet is an empirical question.

Confirmation From 1998 CPS Food Security Supplement Data

The findings reported above were all based on the 1995 CPS Food Security Supplement. We replicated the entire analysis using the unedited 1998 CPS Food Security Supplement data. In part, this was done simply to verify our findings with an additional year of data. But also, there are two reasons why the 1998 data might produce different results than the 1995 data. First, in 1998, the order of administration of the items was changed to approximate the order of severity of the items, and three internal screeners imputed negative responses to further questions if all questions up to the screener were denied. Since the more serious items, including most of the child items, were administered earlier in the 1995 instrument and without any screeners beyond the initial entry screener, the relationship between child and adult items could have changed in 1998. Second, in 1995, for households with only one child, the child's name was inserted into the child-referenced questions, whereas in 1998 the child was referred to as "your child." Analysis by the authors (unpublished) revealed that naming the child (as in 1995) depressed the proportion of affirmative responses for households at the same overall level of food security. This could account for some of the lack of congruence between the child-specific and household-level scales.

In spite of these questionnaire differences, the 1998 findings were in all important respects completely consistent with those based on the 1995 data. The factor extracted from the item residuals was nearly identical in strength and character to that observed in the 1995 data, the scaling of the child-specific items was essentially the same, the

difference in prevalence estimates was the same, the cross-tabulation was the same, and the patterns across household categories was substantially the same. We do not report the 1998 results in detail here, because they are based on unedited data (using core CPS household weights in the absence of supplement weights) and the results are so similar that the additional material would be redundant.

Conclusions

There is convincing evidence that a nontrivial, second dimension exists in the items in the food security and hunger scale, a dimension that corresponds with the extent to which children are protected from hunger at the expense of more severe adult hunger. As a result, estimates of the prevalence of children's hunger based on the household-level severe-hunger category understate the actual prevalence of hunger among children. A Rasch-based scale using only the child-specific items in the Food Security Supplement produces a prevalence estimate of households with children's hunger that is about 29 percent higher than the estimate based on the "food insecure with severe hunger" category of the household-level 18-item food security scale (1.12 percent compared with 0.87 percent). Differences between prevalence estimates based on the two scales were greatest for households with older children. In fact, for households in which all children were age 6 or younger, children's hunger was less prevalent than household-level severe hunger, indicating that young children are more effectively shielded from reduced food intake—even at the cost of more severe stinting by adults—than is true for older children. Differences between prevalence estimates from the two scales were also greater, although less dramatically so, for single-parent families and for households with more children, presumably because households with a higher ratio of children to adults are less able to shield the children from hunger by adult stinting.

The child-specific scale also suggests that in about 9 percent of all households with children, the quality or variety of children's diets is reduced due to inadequate household resources. The appropriate threshold for identifying these households does not correspond with any of the thresholds identified on the household-level measure.

These findings raise the question of whether the U.S. Department of Agriculture should consider creating a second, child-specific scale for estimating the prevalence of children's hunger, rather than basing those estimates on the household-level scale. There are advantages in supporting only a single scale. However, given the strong national interest in children's nutritional and developmental well-being, the value of improving the accuracy of prevalence estimates for children's hunger and reduced diet quality by basing them on a child-specific scale may well outweigh the costs of supporting the additional scale.

Further research is needed to determine whether one or more of the household-level items that are not adult-specific should be included along with the child-specific items in a full range food insecurity-hunger scale for children. Although these do not ask specifically about children, they register household experiences that may affect children. Whether they do so consistently enough to add to the accuracy of a child-specific scale is an empirical question. It is not likely that they would improve classification accuracy much at the child-hunger threshold, but they might substantially improve the "reduced quality of children's diet" classification accuracy.

For research purposes, too, it is likely that the more accurate identification of households with children's hunger (and, perhaps, with reduced quality of children's diets) that can be achieved by using a child-specific scale will improve the fitting of models of determinants and outcomes of children's hunger. These issues will be one dominant focus of the next major phase in food security research as surveys that study children's development, health, well-being, and behavior also carry the food security and hunger items. Establishing a standard child-specific scale early will improve the consistency and comparability of the many research efforts that will address these important issues.

References

Carlson, Steven J., Margaret S. Andrews, and Gary W. Bickel. 1999. "Measuring Food Insecurity and Hunger in the United States: Development of a National Benchmark Measure and Prevalence Estimates," *Journal of Nutrition*. Vol. 129, pp. 1S-7S (February, Supplemental Issue).

Hamilton, William L., John T. Cook, William W. Thompson, Lawrence F. Buron, Edward A. Frongillo, Jr., Christine M. Olson, and Cheryl A. Wehler. 1997a. *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project*. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA.

Hamilton, William L., John T. Cook, William W. Thompson, Lawrence F. Buron, Edward A. Frongillo, Jr., Christine M. Olson, and Cheryl A. Wehler. 1997b. *Household Food Security in the United States in 1995: Technical Report of the Food Security Measurement Project.* U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA.

Nord, Mark. 1999. "Upward Bias on Food Insecurity and Hunger Prevalence Estimates Due to Measurement Error." Working Paper No. FS-8. Unpublished—available from the author at U.S. Department of Agriculture, Economic Research Service.

Table 1—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
Adult ate less than felt he/she should	.30
Adults cut size of meals or skipped meals in 3 or more months	.40
Adult hungry but didn't eat	.38
Adult lost weight	.33
Adults did not eat whole day	.62
Adults did not eat whole day in 3 or more months	.60
Child-specific items:	
Children fed few low-cost foods	-.26
Couldn't feed children balanced meals	-.57
Children not eating enough	-.56
Cut size of children's meals	-.35
Children hungry	-.31
Children skipped meal	-.43
Children skipped meal in three or more months	-.38
Children did not eat whole day	-.03

Note: 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 2.74 times the proportion of shared variance expected under random conditions, or about 15 percent of the total shared variance. Item wording is abbreviated. For complete wording of child-specific items see table 2; for complete wording of other items, see Hamilton et al., 1997a.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Table 2—Proportion of households with children who affirmed child-specific items in the food security supplement

Item	Percent affirming
"We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food." Was that often, sometimes or never true for you in the last 12 months? (Often or sometimes = yes)	13.6
"We couldn't feed the children a balanced meal because we couldn't afford that." Was that often, sometimes or never true for you in the last 12 months? (Often or sometimes = yes)	8.6
"The children were not eating enough because we just couldn't afford enough food." Was that often, sometimes or never true for you in the last 12 months? (Often or sometimes = yes)	4.6
In the last 12 months, did you ever cut the size of any of the children's meals because there wasn't enough money for food?	1.8
In the last 12 months, were the children ever hungry but you just couldn't afford more food?	1.6
In the last 12 months, did any of the children ever skip a meal because there wasn't enough money for food?	.8
(If yes), how often did this happen—almost every month, some months but not every month, or in only 1 or 2 months? (Almost every month or some months but not every month = yes)	.5
In the last 12 months, did any of the children ever not eat for a whole day because there wasn't enough money for food?	.2

Note: The sample for this analysis consisted of all households with children that gave valid responses to at least half of the 18 core-module questions (n = 16,914). Wording of items was modified as appropriate for households with only one adult and for households with only one child.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Table 3—Prevalence of children's hunger in households with children—comparison of three measures

Measure	Number of households	Percent of households
	Thousands	*Percent*
Severe household-level hunger based on 18-item scale	331.9	0.87
Child hunger based on child-items-only scale	425.2	1.12
Child hunger based on response to single question	670.7	1.76

Note: Tabled values are population estimates based on household weights prepared by the U.S. Bureau of the Census for the Food Security Supplement. The estimated total number of households with children is 38,115,000. The unweighted number of cases is 16,914.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Table 4—Cross-tabulation of alternative household measures of child hunger

Number of households	Unit	Severe hunger based on 18-item scale: No	Yes	Total
Child hunger based on child-items-only scale:				
No—	*Thousands*	37,609.6	80.2	37,689.8
	Row percent	(99.79)	(0.21)	(100.00)
	Column percent	(99.54)	(24.16)	(98.88)
Yes—	*Thousands*	173.5	251.7	425.2
	Row percent	(40.80)	(59.20)	(100.00)
	Column percent	(0.46)	(75.84)	(1.12)
Total—	*Thousands*	37,783.1	331.9	38,115.0
	Row percent	(99.13)	(.87)	
	Column percent	(100.00)	(100.00)	
Child hunger based on single child-specific item:[1]				
No—	*Thousands*	37,366.0	78.3	37,444.3
	Row percent	(99.79)	(.21)	(100.0)
	Column percent	(98.90)	(23.59)	(98.24)
Yes—	*Thousands*	417.1	253.6	670.7
	Row percent	(62.19)	(37.81)	(100.00)
	Column percent	(1.10)	(76.41)	(1.76)
Total—	*Thousands*	37,783.1	331.9	38,115.0
	Row percent	(99.13)	(.87)	
	Column percent	(100.00)	(100.00)	

Note: Tabled values are population estimates based on household weights prepared by the U.S. Bureau of the Census for the Food Security Supplement. The estimated total number of households with children is 38,115,000. The unweighted number of cases is 16,914.

[1]"In the last 12 months, were the children ever hungry but you just couldn't afford more food?"

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Table 5—Difference in prevalence of children's hunger and household-level severe hunger in households with children, by demographic and economic characteristics of households

Household demographic and economic characteristics	Prevalence rate of child hunger	Prevalence rate of household-level severe hunger	Difference in child hunger less household-level severe hunger	Difference in child hunger less household-level severe hunger
	---------*Percent*---------		*Percentage points*	*Percent*
Family structure:				
Two-parent family	0.52	0.42	0.10	23.0
Single-parent family	2.70	2.02	.68	33.6
Other[1]	1.38	1.14	.24	21.6
Number of children:				
One	.71	.61	.10	17.2
Two	1.07	.89	.18	20.2
Three or more	1.76	1.21	.55	46.3
Age of oldest child:				
0-6	.55	.64	-.09	-14.7
7-14	1.34	.97	.37	37.4
15-17	1.31	.87	.44	49.7
Sex of children:				
Boys only	.79	.69	.10	14.9
Girls only	.97	.84	.13	14.9
Both	1.48	1.00	.48	47.6
Race/ethnicity of reference person:				
White non-Hispanic	.69	.63	.06	8.8
Black	2.22	1.63	.59	36.4
Hispanic	2.27	1.30	.97	73.9
Income of household:				
Below 130% of poverty line	3.18	2.46	.72	29.4
Above 130% of poverty line	.38	.31	.07	24.3
Residence:				
Metro	1.29	.96	.33	33.4
Nonmetro	.56	.57	-.01	-1.3

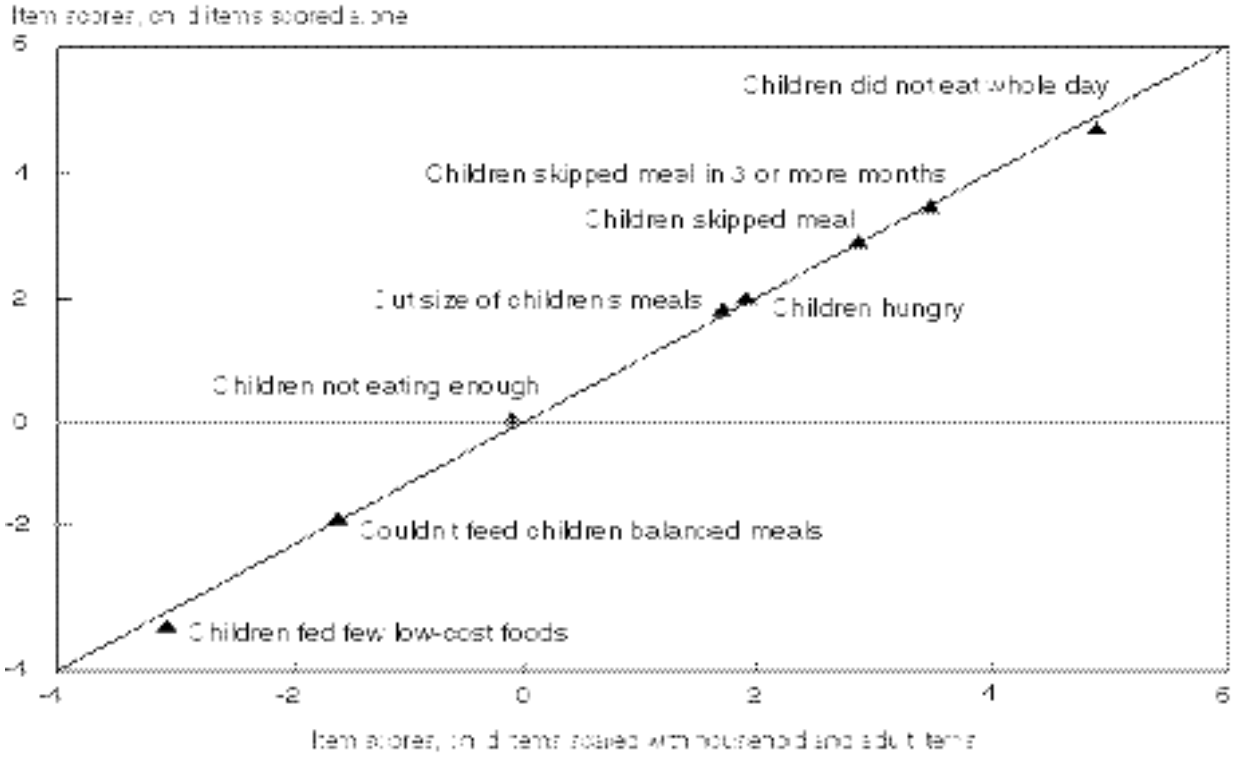
Note: Tabled values are population estimates based on household weights prepared by the U.S. Bureau of the Census for the Food Security Supplement, April 1995. The unweighted number of cases is 16,914.

[1]"Other" households have children living in them not related to the reference person. These include children of an unmarried housemate or partner, foster children, and other unrelated children.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Figure 1

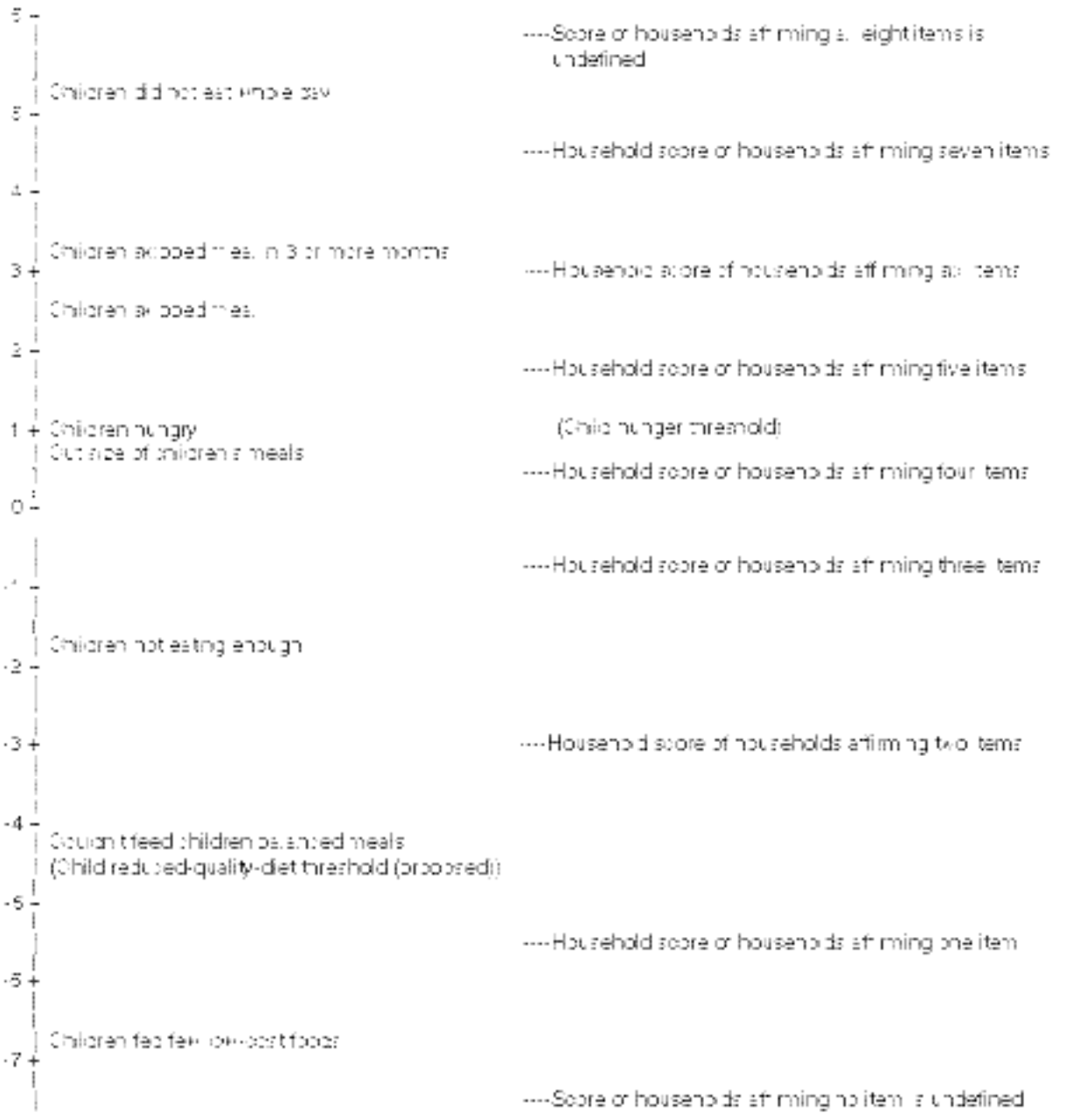
Comparison of item scale scores for child items scaled alone versus child items scaled along with household and adult items, households with children, 1995



Note: Item scores were normalized by specifying the same means and standard deviation for the child items.

Source: Prepared by USDA, ERS, using data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Figure 2
Rasch model item scores and household scores as calculated by Bigsteps software based on child-specific items only



Notes: The sample for this analysis consisted of all households with children that gave valid responses to at least half of the 18 core module questions (n = 15,914). Rasch model estimates are based on 2,738 nonextreme households, i.e., households that affirmed at least one but not all items. Household scores shown are for households with no missing child-specific items.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Appendix table 1—Bigsteps household and item summaries for households with children: All 18 core items scaled

SUMMARY OF 4,333 MEASURED (NONEXTREME) HHLDS

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	4.4	18.0	-2.66	0.90	0.99	-0.2	0.76	-0.1
S.D.	3.4	.3	2.12	.19	.55	1.1	1.32	.4
MAX.	17.0	18.0	4.98	1.34	4.39	5.2	9.90	4.1
MIN.	1.0	10.0	-5.23	.70	.24	-2.3	.08	-1.1

REAL RMSE	1.02	ADJ. SD	1.87	SEPARATION	1.84	HHLD RELIABILITY 0.77
MODEL RMSE	.92	ADJ. SD	1.92	SEPARATION	2.09	HHLD RELIABILITY .81
S.E. OF HHLD MEAN	.03					
WITH 12,581 EXTREME HHLDS =	16,914			HHLDS MEAN	-5.26	S.D. 1.88
REAL RMSE	1.45	ADJ. SD	1.20	SEPARATION	.82	HHLD RELIABILITY .40
MODEL RMSE	1.43	ADJ. SD	1.22	SEPARATION	.85	HHLD RELIABILITY .42

MAXIMUM EXTREME SCORE: 6 HHLDS
MINIMUM EXTREME SCORE: 12,575 HHLDS
VALID RESPONSES: 99.9%

SUMMARY OF 18 MEASURED ITEMS

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	1,068.4	4,328.4	0	0.07	0.99	0.1	1.23	-0.3
S.D.	1,023.2	3.6	2.69	.04	.09	2.8	1.22	1.6
MAX.	3,582.0	4,333.0	4.89	.21	1.15	7.0	6.08	3.5
MIN.	29.0	4,322.0	-5.29	.04	.83	-3.6	.27	-2.6

REAL RMSE	0.08	ADJ. SD	2.69	SEPARATION	32.31	ITEM RELIABILITY 1.00
MODEL RMSE	.08	ADJ. SD	2.69	SEPARATION	32.92	ITEM RELIABILITY 1.00
S.E. OF ITEM MEAN	.65					

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Appendix table 2—Bigsteps item statistics for households with children: All 18 core items scaled

ITEMS STATISTICS: MEASURE ORDER

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTBIS CORR.	ITEMS
18	29	4,333	4.89	0.21	1.08	0.5	6.08	1.9	0.18	chwhlday
16	87	4,331	3.47	.13	.83	-1.9	.27	-1.6	.34	chskipf
15	135	4,332	2.85	.10	.87	-1.8	.74	-.6	.37	chskip
13	191	4,332	2.34	.09	.97	-.4	.51	-1.6	.40	whldayf
17	257	4,333	1.89	.08	.92	-1.5	.93	-.2	.44	chhungry
12	288	4,333	1.71	.07	1.03	.6	1.07	.3	.43	whlday
14	290	4,332	1.69	.07	1.00	0	1.29	1.0	.44	chcut
11	317	4,322	1.54	.07	1.05	1.1	.86	-.6	.44	losewt
10	652	4,328	.25	.06	.94	-2.0	.80	-1.7	.56	hungry
6	779	4,324	-.11	.05	1.06	1.8	.85	-1.4	.53	chenuf
8	971	4,329	-.60	.05	.97	-1.2	.79	-2.6	.57	cutskipf
9	1,437	4,328	-1.57	.04	.96	-1.7	.94	-1.0	.58	eatless
5	1,453	4,325	-1.60	.04	1.08	3.1	.93	-1.2	.54	chbal
7	1,461	4,332	-1.61	.04	.94	-2.5	.96	-.7	.59	cutskip
4	2,295	4,324	-3.06	.04	1.15	7.0	1.30	3.5	.43	chfewfd
3	2,314	4,324	-3.09	.04	.93	-3.6	.88	-1.5	.52	balmeal
2	2,694	4,324	-3.71	.04	.95	-2.6	1.04	.4	.45	fnotlast
1	3,582	4,326	-5.29	.05	1.14	6.1	1.90	3.1	.22	worried
MEAN	1,068	4,328	0	.07	.99	.1	1.23	-.3		
S.D.	1,023	4	2.69	.04	.09	2.8	1.22	1.6		

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Appendix table 3—Bigsteps household and item summaries for households with children: Only specifically child-referenced items scaled

SUMMARY OF 2,588 MEASURED (NONEXTREME) HHLDS

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	2.0	8.0	-0.94	1.02	0.89	-0.6	0.72	-0.1
S.D.	1.3	.1	1.73	.12	1.28	1.1	1.92	.3
MAX.	7.0	8.0	4.33	1.70	8.39	5.2	9.90	2.9
MIN.	1.0	6.0	-2.46	.73	.08	-1.5	.03	-.4

REAL RMSE	1.24	ADJ. SD	1.21	SEPARATION	.97	HHLD RELIABILITY .48
MODEL RMSE	1.03	ADJ. SD	1.40	SEPARATION	1.36	HHLD RELIABILITY .65
S.E. OF HHLD MEAN	.03					
WITH 14,326 EXTREME HHLDS =	16,914			HHLDS MEAN	-3.05	S.D. 1.15
REAL RMSE	1.22	ADJ. SD	0	SEPARATION	0	HHLD RELIABILITY 0
MODEL RMSE	1.19	ADJ. SD	0	SEPARATION	0	HHLD RELIABILITY 0

MAXIMUM EXTREME SCORE: 10 HHLDS
MINIMUM EXTREME SCORE: 14,316 HHLDS
VALID RESPONSES: 100.0%

SUMMARY OF 8 MEASURED ITEMS

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	661.6	2,587.1	1.25	0.07	0.94	-1.8	4.22	2.2
S.D	759.7	.5	2.50	.04	.20	3.4	3.47	2.5
MAX	2,291.0	2,588.0	4.70	.15	1.33	2.1	9.90	4.7
MIN	25.0	2,586.0	-3.27	.04	.72	-8.1	.56	-2.8

REAL RMSE	0.09	ADJ. SD	2.50	SEPARATION	28.59	ITEM RELIABILITY 1.00
MODEL RMSE	.08	ADJ. SD	2.50	SEPARATION	30.72	ITEM RELIABILITY 1.00
S.E. OF ITEM MEAN	.94					

DELETED: 10 ITEMS

Note: Mean and standard deviation of item scores were specified equal to those of the child-specific items in the full 18-item model.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Appendix table 4—Bigsteps item statistics for households with children: Only specifically child-referenced items scaled

ITEMS STATISTICS: MEASURE ORDER

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTBIS CORR.	ITEMS
18	25	2,588	4.70	0.15	1.33	2.0	9.90	1.7	0.15	chwhlday
16	83	2,586	3.44	.10	.75	-2.7	.56	-.5	.43	chskipf
15	131	2,587	2.87	.08	.77	-3.1	3.65	2.2	.47	chskip
17	253	2,588	1.98	.06	1.00	0	3.91	4.6	.45	chhungry
14	286	2,587	1.80	.06	1.03	.6	2.89	3.9	.44	chcut
6	775	2,587	.05	.04	.72	-8.1	.72	-2.8	.53	chenuf
5	1,449	2,586	-1.55	.04	.85	-5.0	2.24	3.9	.27	chbal
4	2,291	2,588	-3.27	.04	1.08	2.1	9.90	4.7	-.03	chfewfd
MEAN	662	2,587	1.25	.07	.94	-1.8	4.22	2.2		
S.D.	760	0	2.50	.04	.20	3.4	3.47	2.5		

Note: Mean and standard deviation of item scores were specified equal to those of the child-specific items in the full 18-item model.

Source: Prepared by USDA, ERS, based on data from the U.S. Bureau of the Census, Current Population Survey, Food Security Supplement, April 1995.

Lessons Learned From an Assessment of the Individual-Level Core Food Security Module[1]

Joda P. Derrickson, Anne G. Fisher, and Jennifer E.L. Anderson

In an attempt to meet the demand for individual-level indicators of hunger among adults and children, national experts in food security measurement created the Individual-Level Core Food Security Module (ICFSM). The ICFSM consists of the 18 original questions in the Core Food Security Module (CFSM), 10 new individual-level questions asked to assess the extent of hunger among the individual respondent or an individual child, and three additional temporal duration questions asked in attempt to fill gaps in the CFSM scale measure. Our objective was to assess the construct validity of the ICFSM scale measure. Comments from respondents and interviewers were recorded and analyzed for common themes. Despite a total sample size of 1,664, item fit of the individual items could not be adequately assessed. Interviewers found the ICFSM questions to be threatening and demeaning to the respondents, particularly the series of questions about hunger among children. The additional temporal duration questions did not improve the CFSM scale measure. Clarification is recommended of measurement needs and consideration of food security measures that to the extent possible are simple, meaningful, and maintain the dignity of the respondent.

Introduction

The CFSM is used by the Federal Government to assess the extent and severity of household food insecurity in the preceding 12 months due to inadequate money for food (Carlson et al., 1999). Both the CFSM scale measure and its corresponding categorical algorithm were developed from a national sample to monitor household food security status (Hamilton et al., 1997a; and Hamilton et al., 1997b). A complete description of Rasch scale validation methods (Wright and Stone, 1979), technical description of the CFSM scale measure and categorical algorithm (Hamilton et al., 1997b), and our primary validation effort with the CFSM with Asians and Pacific Islanders can be found elsewhere (Derrickson, 1999).

The CFSM was not designed to determine the number of individuals actually affected by hunger, only the upper bounds of the number of people in households experiencing hunger (Carlson et al., 1999). Yet, policymakers and advocates (Personal communications: N. Kuntz, Director of the Family Health Services, Hawaii State Department of Health, Honolulu, HI, July 1998; and J. Baldwin, Executive Director of the Hawaii Foodbank, Inc., Honolulu, HI, February 1998) are very interested in the actual number of hungry adults and hungry children that the CFSM does not provide. Furthermore, gaps between the items along the CSFM scale measure have been identified as a weakness of the scale measure (Derrickson, 1999).

Individual–Level Core Food Security Measure (ICFSM)

To attempt to meet the demand for individual-level indicators of hunger among adults and children, U.S. Department of Agriculture experts in food security measurement created the ICFSM from the original CFSM (USDA, FNS, and ERS, 1999). As depicted in table 1, ICFSM contains three types of questions:[2]

(1) The 18 original CFSM questions (Q): Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q8a, Q9, Q10, Q11, Q12, Q12a, Q13, Q14, Q15, Q15a, and Q16, which in themselves were found to create a valid and reliable scale measure of food security status (Hamilton et al., 1997b);

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[2]Tables are at the end of this paper.

(2) Ten new individual-level questions: Q8I, Q8Ia, Q12I, Q12Ia, Q13I, Q14I, Q14Ia, Q15I, Q15Ia, and Q16I (Hamilton et al., 1997b); and

(3) Three new follow-up or temporal duration questions, i.e., "How often did this happen?" based on three original CFSM questions (Q9a from Q9, Q10a from Q10, and Q14a from Q14) asked in an attempt to narrow gaps between item calibrations of key hunger indicators in the CFSM scale measure.

Q1 was a four-part food-insufficiency question not included in the CFSM.

Households containing two or more adults and children answered a maximum of 31 ICFSM questions. Households without children answered a maximum of 16 ICFSM questions. As with the CFSM (Price et al., 1997), the ICFSM questions were preceded by the Q1, four-part food-insufficiency question (Rose et al., 1995). This study represents the first time the ICFSM was used in applied research.

Development of the CFSM Scale Measure Using the Rasch Model

The CFSM scale measure was developed using a log-linear measurement model called the Rasch model (Hamilton et al., 1999a; Hamilton et al., 1997b; and Wright and Stone, 1979). Applied to the CFSM, the assertions of the simple Rasch model are:

- The more food secure a respondent, the more likely she/he is to respond negatively to easier items, e.g., those indicating food security would answer "almost never" to Q2 "Worried that food would run out"; and

- Food insecurity items (Q2-Q6) are more likely to be answered affirmatively than the hunger items (Q7-Q16), e.g., more respondents will respond affirmatively to the least severe Q2, than the more severe Q10, in which the respondent indicates that they had hunger in the last 12 months.

Rasch computer programs such as the FACETS model mathematically impose these assertions (Linacre, 1986-94) while transforming raw item scores into equal-interval scales (Wright and Stone, 1979). The item calibration values represent the position of the item along the constructed food security measurement scale. As can be seen in table 2, an item such as Q16, with a high positive item calibration value (4.19), indicates a greater degree of insecurity and hunger, while an item with a low negative calibration value, e.g., Q2: -4.31, indicates more food security. Also note at times that the difference in item calibration values between adjacent indicators is smaller (Q3: -3.55, Q4: -3.19, difference of 0.36), while other times the difference is larger (Q2: -4.31, Q3: -3.55, difference of 0.76).

An inspection of the ordering of the items by calibration values can be used to evaluate the conceptual validity of the scales. Mean square residuals (MnSq), ratios of the observed versus the expected scores, are used to assess the goodness-of-fit of each item, compared with the assertions of the Rasch model. In the development of the CFSM, MnSq values > 1.2 were judged indicative of a poorly fitting or erratic item, especially when values of z, the standard residual, were ≥ 2. MnSq values < 0.8 indicate that the item was redundant with respect to the information it shares with another item (Hamilton et al., 1997b, p. 15), particularly when values of z, the standardized residual, were ≤ -2 (Wright and Stone, 1979).

Objective

Our original purpose was to determine whether the ICFSM scale measure is a valid and stable instrument to use in Hawaii, where at least 50 percent of the population is of Asian or Pacific Islander descent (Derrickson, 1999). However,

findings in this paper are limited to assessment of construct validity of the ICFSM scale measure and preliminary qualitative reports of content validity. Thus, this study represents the first independent assessment of the robustness of the ICFSM scale measure with Asians and Pacific Islanders in Hawaii. We originally hypothesized that the ICFSM would not be an adequate scale measure to use with ethnically diverse samples in Hawaii.

Methods

Samples

To validate the full range of food insecurity in a State where 9.2 percent of the population is thought to have experienced some degree of food insecurity (Hamilton et al., 1997b), three samples were surveyed over the phone (n = 1,664):

(1) A convenience sample of 144 food pantry recipients;

(2) A retest sample that included 61 of the initial 77 food pantry respondents who completed the ICFSM a second time, a mean of 11 days later; and

(3) A statewide random sample of 1,469 respondents gathered through the Hawaii Health Survey (HHS).

Data Collection

We used the *Guide to Implementing the Core Food Security Module* (Price et al., 1997) to direct data collection and survey design. Data collection methods previously described to validate the CFSM (Derrickson, 1999) are applicable to this study. All data were collected in Hawaii between June and November 1998, using the same ICFSM instrument and similar data collection methods (Price et al., 1997).

Survey Instrument

To expedite appropriate survey administration, basic demographic information (sex, household composition, and ethnic disposition) was queried prior to the food security questions. Thus, questions that did not apply to households without children were not asked, and the terminology of "I" or "we" was appropriately used. The question "With what ethnic group do you identify with most?" was used to assess ethnicity. A total of 19 ethnic response categories were collected, including one for no response and another for mixed ethnicity.

As outlined in the guidelines (Price et al., 1997), the 18 food security questions were preceded by the four-part food insufficiency question (Rose et al., 1995). Exact wording of the questions and responses was maintained, and suggested skip patterns were employed to decrease response burden (Price et al., 1997; and USDA, FNS and ERS, 1999). The adult individual-level items, by design, were asked of the participant only after she/he had responded affirmative to the previous relevant indicator, e.g., if "yes" to Q8 "Adults cut the size or skip meals," then Q8I "Did you cut the size of your meals or skip meals" was asked. Subsequently, all temporal duration questions were asked only if the response to the preceding question was affirmative, e.g., Q8Ia asked only if Q8I was affirmative. Questions pertaining to individual-level child hunger were asked about the child who most recently had a birthday, although the name of the child was not discussed or recorded.

Quantitative Data Analysis

Food security responses were coded as zero (0) = negative response and one (1) = affirmative response (Price et al., 1997). However, instead of assuming negative responses for questions not answered because the participant was screened out, responses to questions not asked were left blank. If a participant responded negatively when asked a question that also had a temporal

duration follow-up question (Qs.8 to 8a, Qs.9 to 9a, Qs.10 to 10a, Qs.12 to 12a, Qs.14 to 14a, and Q15 to Q15a), a negative response was assumed for the follow-up question as well.

Analysis was completed with the FACETS Rasch computer program (Linacre, 1986-94). Three separate Rasch scale analyses were run for:

(1) the 18 CFSM items and 6 key ICFSM indicators (8I, 12I, 13I, 14I, 15I, and 16I);

(2) the 9 ICFSM items without Q16I; and

(3) the 18 CFSM items and 3 additional questions (Q9a, Q10a, and Q14a).

Including the 61 food pantry survey responses that comprised the retest sample was not viewed as a threat to validity (Derrickson et al., 1999).

In addition, comments from interviewers about the questions and respondents' reactions were handwritten on surveys during the stability study (n = 77: Derrickson, 1999). After all data were collected, the interviewers were queried by a project investigator in an informal group format regarding their thoughts on the questions and interviewee's reactions to the 31 ICFSM items. Both sources of information were entered into a word processing file and analyzed by hand for common themes across food security questions, using standard qualitative data analysis methods (Miles and Huberman, 1994).

Results and Discussion

Overall, 1,411 (84.8 percent) households were classified by the CFSM categorical algorithm as food secure, 158 (9.5 percent) as food insecure without hunger, 64 (3.8 percent) as food insecure with moderate hunger, and 31 (1.2 percent) as food insecure with severe hunger (Price et al., 1997). Fifty-five percent of the 1,664 respondents identified themselves as an Asian or Pacific Islander. Fifty-seven percent identified themselves as a household without children, and 43 percent had one or more children.

If a household responded to the CFSM items but not to any of the individual items, the data would not contribute to the evaluation of the CSFM, and thus the responses were excluded from the evaluation of the individual items. Furthermore, 61 respondents who had one or more responses to individual indicators were also excluded in Rasch analysis because these participants responded affirmatively to all individual indicators asked of them (Wright and Stone, 1979). Thus, despite a total sample size of 1,664, responses from only 29 respondents who were asked one or more of the individual indicators could be used in Rasch analysis of the ICFSM. Because of the inadequate number of available responses to the individual indicators, scale validity assessment of neither the 18 CFSM indicators with the 10 individual indicators nor the subset of 10 individual items by themselves could be adequately assessed.

The results of the goodness-of-item fit of the Rasch analysis of the 18 CFSM items and the three additional temporal duration items (Q9a, Q10a, and Q14a) are presented in table 2. A comparison of item calibration values confirms the conceptual validity of the additional questions: the item calibration of Q9 was -1.38 versus -0.48 for Q9a. Likewise, Q10a was more severe than Q10, (0.89 versus 0.36) and Q14a was more severe than Q14 (1.77 versus 1.28), respectively. The item calibration value of Q9a is similar to that of Q8a (-0.48 versus -0.44), Q10a similar to Q11 (0.89 versus 0.79), and Q14a similar to Q12 (1.77 versus 1.64).

Based on standard Rasch goodness-of-fit criteria used previously to develop and test the CFSM (Hamilton et al., 1997; and Derrickson et al., 1999a), the three additional items resulted in a poor fit of several original items:

- Q12 "Any adult did not eat whole day" (Outfit MnSq = 2.2, z = -2) and Q4 "(Un)able to eat

balanced meals" (Outfit MnSq = 2.5, z = 3) were both deemed erratic; and

- Q8, Q8a, Q9a, Q10, and Q10a, all had outfit MnSq ≤ 0.7 indicative of redundancy.

Therefore, the additional indicators seemed to fall in the right places conceptually along the food security scale measure continuum, but they did not enhance the goodness-of-fit of the scale or the scale's ability to differentiate food security status. If improving the ability of the CFSM to differentiate stages of early food insecurity is a top priority, findings suggest that the value of additional less severe food insecurity indicators would be valuable. In particular, indicators less severe than Q2, between the severity levels of Q2 and Q3, and between Q4 and Q9 may be useful in closing the gaps in indicators and should be evaluated in future studies of this nature (Derrickson, 1999).

Qualitative Reports of the ICFSM

Overall, both interviewers and interviewees reported that the extensive list of child hunger indicators felt threatening and demeaning to the respondents (Q13 to Q16I). It is not clear whether this was only due to additional individual questions, or simply the perceived repetition of sensitive questions. Parents repeatedly complained, "Why are you asking me this again?" A few of the more hungry respondents appeared to be near tears; and a few were annoyed by the perceived repetition. Completion of the entire ICFSM took up to 15 minutes, an estimated 5 minutes longer than answering only 18 questions, and often emotionally drained interviewers.

Perceptions to individual indicators varied with each set of indicators. In general, Q8I and Q8Ia were thought to be fair and well-received questions with responses that were likely to be true; respondents generally did not complain about these questions. On the other hand, because Q12I and Q16I were so infrequently asked (n = 4/14 affirmative responses for Q12I), the utility and face validity of these questions could not be assessed. Alternatively, it would appear that these severely hungry questions would not be useful in many samples.

The individual-level questions of severe hunger among children (Q13I, Q14I, and Q15I) were problematic for several reasons:

- These questions appeared to cross the threshold of parental comfort and indirectly judge a parent. Despite good interviewer rapport, many parents felt uncomfortable discussing this severe degree of hunger and may have underreported the truth because of their pride and embarrassment.

- The questions are quite repetitive; it is not clear to some respondents why so many similar questions were repeatedly asked.

- Many parents who answered either Q13I, Q14I, or Q15I indicated that the child who most recently had a birthday was their youngest, was often still bottle-fed, and was thus protected from the nutritional shortfalls other household members had to experience, although it was clear from other responses that other children did experience inadequate intake. Therefore, responses based on an infant may underestimate severity of hunger among other children in the household.

- Some households answered Q14 "children hungry" affirmatively, after negatively responding to Q13 "children skip meals." Thus, contrary to the design of the ICFSM, the question about which child most recently had a birthday had to be asked after Q14, which altered the original data collection protocol for this question. Given that our previous work demonstrated that the item calibration value of Q14 (1.37) was lower than the item calibration of Q13 (1.72) (Derrickson, 1999), switching the order of

these questions may be warranted if the ICFSM is used again.

- Questions Q14 and Q14I, despite the subjective vagueness of "being hungry," appeared to have high face validity for respondents. Interviewees usually responded immediately to Q14 and Q14I, but considered factors that affect cutting the size or skipping meals (desired weight loss, busy schedule) prior to answering Q13, Q13I, Q15, and Q15I. Although it was made clear that an affirmative response was appropriate only if the cause was "inadequate resources for food."

Based on our quantitative and qualitative findings, we do not recommend that the individual-level items be added to the CFSM. Rather since Q9 "Respondent ate less than she/he should" and Q10 "Respondent hungry" are current CFSM indicators that are asked of the respondent rather than for the entire household, we recommend using these items as the basis of an adult individual-level hunger measure. Based on our experience, we believe that children age 8 and above, with grade-level reading ability, may be able to adequately respond to simple questions pertaining to adequate intake of food because of perceived resource constraints. Investigation of a child individual-level hunger measures for school-age children could be considered an alternative to parent report of food security status (Q13 to Q18 of the CFSM).

Implications

This is the first study to report results based on the ICFSM with an ethnically diverse sample. Preliminary findings and implications shared in a preliminary form at the Second Food Security Measurement and Research Conference (Derrickson et al., 1999) have been identified as priority areas for food security research (USDA, ERS, 1999). In summary, findings do not support the incorporation of the ICFSM indicators into the CFSM. Furthermore, the additional items, tested to improve the scale, failed to do so because they did not eliminate gaps between items with a large spread in item severity. Moreover, importantly, we believe that interviewers and respondents found the survey experience threatening and redundant. It is not clear whether this survey burden was only a function of the additional individual-level questions, or if it is because the child hunger items in the CFSM are repetitive and cross a threshold of parent discomfort.

Since respondent burden should be an important consideration in survey design (Perkin, 1992), we recommend that food security measurement experts clarify the purpose and use of food security measures in clinical and food security monitoring situations prior to widespread use of the ICFSM or CFSM measure. To the extent possible, we suggest striving for household and individual-level measures of food security status that are simple, reliable, and consistent with the conceptual understanding of food insecurity (Radimer, 1990; and Derrickson and Anderson, 2000) and that maintain the dignity of all respondents.

References

Carlson, S.J., M.S. Andrews, G.W. Bickel. (1999) "Measuring Food Insecurity and Hunger in the United States: Development of a National Benchmark Measure and Prevalence Estimates," *Journal of Nutrition*. Vol. 129. pp. 510S-516S.

Derrickson, J.P., J.A. Anderson, and A. Fisher. (1999) "Assessment of Food Insecurity Among Asians and Pacific Islanders." Second Food Security Measurement and Research Conference, Alexandria, VA. February 22-24.

Derrickson, J.P., A.G. Fisher, J.A. Anderson. (2000) "Core Food Security Module Scale Measure Demonstrates Validity and Reliability When Used With Asians and Pacific Islanders," *Journal of Nutrition*. Vol. 130. pp. 2,666-2,675. 2000.

Derrickson, J.P, and J.A. Anderson. (2000) "Face Validity of the Core Food Security Module

with Asians and Pacific Islanders," *Journal of Nutrition Education*. Vol. 32. pp. 21-30.

Hamilton, W.L., J.T. Cook, W.W. Thompson, L.F. Buron, E.A. Frongillo, Jr., C.M. Olson, and C.A. Wehler. (1997a) *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project*. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA.

Hamilton, W.L., J.T. Cook, W.W. Thompson, L.F. Buron, E.A. Frongillo, Jr., C.M. Olson, and C.A. Wehler. (1997b) *Household Food Security in the United States in 1995: Technical Report of the Food Security Measurement Project*. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA.

Miles, M.B., and A.M. Huberman. (1994) *Qualitative Data Analysis: An Expanded Sourcebook*. Sage Publications, Thousand Oaks, CA.

Perkins, J. (1992) "Design and Use of Questionnaires in Research," *Research: Successful Approaches*. (E.R. Monsen, ed.) American Dietetic Association.

Price, C., W.L Hamilton, and J.T. Cook. (1997) *Household Food Insecurity in the United States: Guide to Implementing the Core Food Security Module*. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Alexandria, VA.

Radimer, K.L. (1990) "Understanding Hunger and Developing Indicators To Assess It." Doctoral dissertation. Cornell University, Ithaca, NY.

U.S. Department of Agriculture, Economic Research Service. (1999) *Food Security: Measurement and Research Priorities Identified: Second Food Security Research and Measurement Conference*. Downloaded May 21, 1999 from http://www.econ.ag.gov/briefing/foodasst/fsresearch.htm

U.S. Department of Agriculture, Food and Nutrition Service and Economic Research Service. (1999) *Food Security/ Hunger Core Module: Three-Stage Design, with Screeners*. Downloaded June 23, 1999 from http://www.ers.usda.gov/briefing/foodsecurity/surveytools/core0699.pdf

Wright, B.D., and M.H. Stone. (1979) "Best Test Design," *Rasch Measurement*. Mesa Press. University of Chicago, Chicago, IL.

Table 1—Individual-Level Core Food Security Module (CFSM, individual and additional items)

Indicator type	Essence of Indicators: In the last 12 months. (Question)…because there wasn't enough money for food/couldn't afford it?
CFSM	2.[a] Worried about whether food would run out, etc.[b]
CFSM	3. The food we bought just didn't last, and we didn't have money to get enough more.[b]
CFSM	4. We couldn't afford to eat balanced meals.[b]
CFSM	5. We relied on only a few kinds of low-cost foods to feed our children.[b]
CFSM	6. We couldn't feed our children a balanced meal.[b]
CFSM	7. Children were not eating enough because couldn't afford enough food.[b]
CFSM	8. Any adult in household ever cut the size of meal or skip meals?[c]
CFSM	8a. How often?[d]
Individual	8I. Did you ever cut size of your meals or skip meals?[c]
Individual	8Ia. How often?[d]
CFSM	9. Did you ever eat less than you felt you should?[c]
Additional	9a. How often?[d]
CFSM	10. Were you ever hungry but didn't eat?[c]
Additional	10a. How often?[d]
CFSM	11. Did you lose weight?c
CFSM	12. Any adult ever not eat for a whole day?[c]
CFSM	12a. How often?[d]
Individual	12I. Did you ever not eat for a whole day?[c]
Individual	12Ia. How often?[d]
CFSM	13. Did you ever cut the size of any of your children's meals?[c]
Individual	13I. For child with most recent birthday. Did you ever have to cut the size of this child's meals?[d]
CFSM	14. Were the children ever hungry, but you could not afford more food?[c]
Additional	14a. How often?[d]
Individual	14I. For child with most recent birthday was he/she ever hungry?[c]
Individual	14Ia. How often?[d]
CFSM	15. Did your children ever skip meals?[c]
CFSM	15a. How often? Three or more months.[d]
Individual	15I. For child with most recent birthday did he/she ever skip meals?[c]
Individual	15Ia. How often?[d]
CFSM	16. Did any child ever not eat for a whole day?[c]
Individual	16I. For child with most recent birthday, did he/she ever not eat for a whole day?[c]

Notes:

a. The four-part food insufficiency question is not part of the CFSM, but is the first question used for screening households: Which of these statements best describes the food eaten in your household in the last 12 months, that is, since July 1997? (1) We always have enough and the kinds of foods we wanted; (2) We have enough to eat but not always the kinds of foods wanted; (3) Sometimes we don't have enough to eat; or (4) Often we don't have enough.

b. Affirmative responses are "often true" or "sometimes true." A negative response is "never true."

c. An affirmative response is "yes."

d. An affirmative response is "almost every month" or "some months but not every month." A negative response is "in only 1 or 2 months."

Source: USDA, ERS and FNS, 1999.

Table 2—Hawaii item measurement report of the CFSM with three additional items (9a,10a, and 14a)

	Question/Item: In the last 12 months have . . .(item) because of not enough money for food	Item responses: Number of affirmative responses	Item sample size[a]	Rasch item calibration (logits): Value[b]	SE	Goodness-of-fit statistics: Infit[c] MnSq	Infit z	Outfit[d] MnSq	Outfit z
2	Worried food would run out	289	359	-4.31	0.17	1.2	2[f]	1.8	1
3	Food did not last	256	361	-3.55	.14	1.0	0	1.2	0
4	Adults eat unbalanced meals	235	357	-3.19	.15	1.1	1	2.5	3[f]
5	Children rely few foods	159	251	-2.90	.17	1.0	0	1.0	0
6	Children unbalanced meals	120	250	-1.85	.18	1.1	1	1.0	0
7	Children not eat enough	60	245	.07	.21	1.1	0	.9	0
8	Adults cut size meals	126	354	-1.00	.17	.8	-3[f]	.6	-2[f]
8a	Adults cut size meals, often[e]	102	353	-.44	.18	.8	-2[f]	.5	-2[f]
9	Respondent eat less[e]	143	355	-1.38	.16	.9	-1	.7	-1
9a	Respondent ate less, often[e]	103	355	-.48	.17	.9	-1	.7	-1
10	Respondent hungry[e]	73	356	.36	.19	.9	-1	.6	-1
10a	Respondent hungry, often[e]	57	355	.89	.21	.8	-1	.5	-1
11	Respondent lost weight[e]	59	353	.79	.19	1.0	0	1.0	0
12	Adults not eat for a whole day	37	182	1.64	.23	1.1	0	2.2	2[f]
12a	Adults not eat for a whole day, often[e]	25	179	2.32	.26	.9	0	1.7	1
13	Children cut size meals	28	122	1.62	.26	1.0	0	.8	0
14	Children hungry	33	121	1.28	.26	.9	0	1.1	0
14a	Children hungry, often[e]	26	121	1.77	.28	.9	0	1.4	0
15	Children skip meals	23	120	1.97	.30	.9	0	.8	0
15a	Children skip meals, often[e]	19	119	2.21	.31	.9	0	.9	0
16	Children not eat for a whole day	5	123	4.19	.53	.9	0	.3	0

Notes:
a. Total number indicates the number of respondents who were asked the question.
b. Item calibration value is the Rasch model scale value indicating item severity.
c. Infit Mnsq = Infit mean square residual goodness-of-fit statistic, and standardized z.
d. Outfit MnSq = Outfit mean square residual goodness-of-fit statistic, and standardized z.
e. Often indicates more frequently than in only 1 or 2 months of the last 12 months.
f. Items failed to demonstrate adequate goodness-of-fit statistics.

Dietary Factors Associated With Reported Food Insecurity

Valerie Tarasuk

Since the 1980s, extensive work has been undertaken to clarify the meaning of food insecurity in a U.S. or Canadian context and to develop survey instruments to measure the extent of this problem. Quantitative, qualitative, psychological, and social or normative dimensions of food insecurity have been described at the individual and household levels *(1)*, but measurement work has largely focused on the qualitative and quantitative compromises in food intake that arise with declining household resources *(2 and 3)*. (Italicized numbers in parentheses refer to citations at the back of this paper.) Dietary intake data have often been compared with measures of food sufficiency or food security as a means to validate these measures *(3 to 5)*, but there has been little detailed examination of the interrelationships between food security status measures and individuals' dietary intake patterns.

In this paper, specific food intake behaviors related to the severity of household food insecurity are described, and their representation in conventional descriptors of individuals' dietary intakes is explored, using data from a Canadian study of food insecurity and nutritional vulnerability among women in families using charitable food assistance programs *(6 and 7)*. Although limited in sample size, the study is useful in that it includes contemporaneous measures of household food security and women's dietary intakes. Further, the high levels of deprivation in this sample enable exploration of intake behaviors in the context of varying levels of food insecurity.

Study Design and Methods

A full description of the study methods has been published elsewhere *(6 and 7)*. In 1996-97, participants were recruited from a stratified random sample of 21 emergency food hamper programs in Toronto. Women were eligible to participate if they were 19 to 49 years old, had at least one child under the age of 15 living with them, were not pregnant, had received emergency food relief at least one other time in the past 12 months, and spoke sufficient English to participate in oral interviews. Participation was voluntary and confidential.

Three interviews were conducted with each participant, on nonconsecutive days and typically on different days of the week, spanning the 3 weeks following recruitment. At each interview, the participant completed an interviewer-administered 24-hour dietary intake recall and questionnaire. The dietary recall interviews followed a multiple-pass approach, with portion size models used to prompt accurate recall of food quantities. Interviewers were instructed to record the circumstances associated with any extreme (low or high) intakes reported. Height and weight were measured at the first interview. Food insecurity was assessed at the third interview, using the 12-month and 30-day scale items from the U.S. Department of Agriculture's (USDA) Food Security Module *(8)*, but with the omission of one question about perceived weight loss attributed to lack of food. Data on household demographics, perceived health, health-related behaviors, and food acquisition and provisioning practices were also collected. A final sample of 153 women was achieved, but the analyses presented in this paper include only data from the 145 women (95 percent of the sample) who completed all three interviews within a 31-day window, thus providing contemporaneous data on food security and dietary intake.

The 24-hour dietary recall data were converted into total energy and nutrient intakes, using the 1996 version of the Canadian Dietary Information System for food intake analysis *(9)*. Although nutrient intakes from supplements were recorded, these data were not included in the analyses of nutrient intakes because supplement use was only reported by 19 women and use appeared inconsistent. Categorical variables were constructed to denote the severity of household food insecurity over the past 12-month and 30-day periods, using scaling methods developed by Hamilton et al. *(10)* for analysis of the USDA Food Security Module. Statistical analyses were

conducted using SAS/PC versions 6.10 and 6.12 for Windows (SAS Institute, Cary, NC).

Analysis of variance approaches (PROC GLM) were used to initially explore relationships between intake variables and household food security status. To examine the quantitative effect of hunger in the household on women's intakes while controlling for other possible influences on dietary intake, single-equation multivariate regression analyses were performed using PROC REG. In these analyses, 3-day mean energy and nutrient intakes were the dependent variables. The independent variables included a dichotomous variable to differentiate between households reporting hunger (moderate or severe) and those where no hunger was apparent (the reference category) over the past 30 days. Independent variables also included household-level disposable income for the month and characteristics of the individual woman found to have some association with at least one of the intake variables in prior univariate analyses, such as the woman's educational level, ethnoracial identity, smoking behavior, presence of employment income, and presence of a partner in the household. To elucidate the effect of controlling for these variables on the apparent effect of hunger on intake, a simple regression model was run, omitting all independent variables except hunger, and the resultant coefficients were compared with those from the multivariate models. (A detailed discussion of these regression analyses can be found in *(7)*.)

To examine differences in the nutrient composition of women's intakes while controlling for differences in total food intake, nutrient intakes were expressed as nutrient densities, i.e., nutrients per megajoule—first calculated for each 24-hour recall, then averaged over 3 days—and then analyzed following the analysis of variance and regression methods described earlier. To explore the effect of the energy-adjustment method of these results, selected nutrient intake variables were also adjusted for total energy intake, using the regression technique described by Willett and Stampfer *(11)*. The nutrient variables were first log-transformed to improve normality. Then separate regression models were constructed for each nutrient variable, with total energy intake as the independent variable and absolute nutrient intake as the dependent variable. Residuals were extracted from the regression models and used in analyses of variance to examine differences in nutrient composition by 30-day food security status. As well, the analyses of variance were run with absolute nutrient intakes as the dependent variable, but with energy intake included as a covariate (the standard multivariate method of energy adjustment).

To further explore the relationship between the reporting of dietary intake and household food insecurity status over a 30-day period, women's reported mean energy intakes (EI) were expressed as a ratio of their estimated basal metabolic rate (BMRest) *(12)*, and these ratios were compared across groups defined by 30-day food security status. Using this ratio (EI:BMRest), Goldberg et al. have proposed a method to estimate minimum plausible levels of intakes among normal, healthy, free-living adults for use in evaluating self-reported energy intake data *(13)*. Following their method, the Goldberg cut-off value for EI:BMRest for individuals in this study was calculated to be 1.04 *(13)*. The odds of falling below this cut-off value, given reported household food insecurity with hunger (grouping moderate and severe hunger classifications together) was calculated using PROC LOGISTIC.

Sample Characteristics

A full description of the study sample is presented elsewhere *(6 and 7)*. Briefly, participants ranged in age from 19 to 48 years, with the mean age 33 ± 7 years. The mean body mass index (BMI) of women in this study was 27.7 ± 6.74 kg/m^2 (median 26.9 kg/m^2), and 49 percent of the sample had BMI's in excess of 27 kg/m^2. Forty percent reported a long-standing health condition, illness, or disability, and two-thirds of these (26 percent of the sample) described the condition as activity-limiting.

The sample was heterogeneous with respect to ethnoracial identity, education, and household

composition, but remarkably similar in their poverty. Forty-six percent of women were white, 27 percent black, 11 percent Latin American, 10 percent Asian, 3 percent aboriginal Canadians, and 2 percent undefined. Most (65 percent) women had completed high school, and 41 percent had at least some post-secondary training. Sixty-five percent of the sample were presently lone parents. Household size ranged from 2 to 10, with a median of 3 persons per household. The median number of children was two. Most (69.9 percent) households were supported by social assistance programs (welfare); an additional 14.4 percent of households relied on a combination of welfare payments and employment income. Only 9.8 percent of households relied solely on employment incomes. The remaining 5.9 percent of households were reliant on savings or received income from student loans, unemployment insurance, or other sources. As a means to interpret household income relative to Canadian standards, reported income for the month was expressed as a percentage of the 1995 Statistics Canada Low-Income Cut-offs,[1] commonly referred to as "poverty lines" *(14).* Household incomes were, on average, 52.8 percent ± 0.13 percent of the poverty line, and 90 percent of households had incomes which were less than two-thirds of the poverty line.

Although the extent of reported food deprivation varied widely among households, 93.5 percent reported some degree of food insecurity over the past 12 months *(6)*. Fifty-two (36 percent) of the 145 women who comprise the analytic sample reported food insecurity with moderate hunger and 31 (21 percent) reported food insecurity with severe hunger, over the past 30 days.

[1]The Statistics Canada Low-Income Cut-offs define "low income" in relation to average household expenditure patterns, and are adjusted for household size and degree of urbanization. In 1995, the cut-offs were set at dollar values below which households spent 56.2 percent or more of their gross income on the basic necessities of food, clothing, and shelter.

Evidence of Food Insecurity in Women's Dietary Intake Data

Food intake behaviors associated with food insecurity, by definition, include compromises in the selection and quality of foods consumed and reductions in the quantity of food consumed as resources become more constrained. The behaviors should, to some degree, be observable in individuals' intake data, depending on the nature of the dietary data collection and analysis and depending on intrahousehold food distribution practices. Even when households are under no apparent economic constraints, foods and nutrients are not allocated in proportion to individual members' needs; some members are more privileged than others *(15 to 18)*. Inequities in intrahousehold food distribution appear to increase in the context of food insecurity. Poor women typically report that they deprive themselves of food so as to leave more for their children during periods of severe food shortages *(19 to 23)*. This behavior is also suggested by studies reporting poor-quality dietary intakes among low-income women in comparison with their children *(20, 24, and 25)*. Thus, women's intakes may be particularly sensitive to deteriorations in household food security.

Reductions in Total Food Intake

Comparing women's 3-day mean intakes with a concurrent measure of 30-day household food security status, group mean intakes for energy and most nutrients fell in a stepwise fashion as severity of household food insecurity increased (table 1).[2] Statistically significant differences between group means were observed for energy, protein, vitamin A, iron, magnesium, and zinc. The prevalence of inadequacy in this sample was estimated to be at or in excess of 15 percent for protein, vitamin A, folate, iron, and magnesium, suggesting that the low levels of intake associated with severe household food insecurity are in a range that could put women at risk of nutrient deficiencies *(7)*.

[2]Tables are at the end of this paper.

When women's reported energy and nutrient intakes were considered in relation to the presence or absence of hunger in the household, while controlling for other economic, socio-cultural, and behavioural influences on diet, systematically lower intakes (indicated by the negative direction of the partial regression coefficients in table 2) were observed among women in households reporting moderate or severe hunger, compared with those where no hunger was apparent. The differences in mean intake levels were significant ($p < 0.05$) for energy and all nutrients examined except fat, vitamin C, and calcium. The partial regression coefficients derived from the multivariate model diminished only slightly for energy and most nutrients, when compared with those derived from the simple (uncontrolled) regression model, suggesting that the negative effect of household food insecurity with moderate or severe hunger on the food intakes of women is independent of many other influences on diet. It is noteworthy, however, that the association of hunger with two nutrients (fat or vitamin C) lost statistical significance once other dietary influences were included in the model.

Expressing individuals' mean energy intakes as a ratio of their estimated basal metabolic rates (EI:BMRest) provides another means to explore reported intakes for indications of food deprivation. Women reporting household food insecurity with severe or moderate hunger had a group mean EI:BMRest of 0.975 ± 0.411, whereas the mean ratio for women not reporting food insecurity with hunger was 1.21 ± 0.603. Further, the odds of having an EI:BMRest below the estimated minimum plausible level of intakes among a normal, healthy, free-living sample of adults (i.e., the calculated Goldberg cut-off level) was 2.58 (95 percent confidence interval: 1.31, 5.07) for women in households characterized by food insecurity with moderate or severe hunger when compared with those in households where no hunger was evident *(7)*.

The observed associations between intake and household food security status, although cross-sectional in nature, imply that some women's reports of low intakes reflect reductions in food intake and/or episodes of absolute food deprivation in the context of scarce household resources. This is further borne out by the heightened probability of low EI:BMRest among women in households with hunger. The intake data would appear to simply be mirroring the behaviours women have described on the Food Security Module, i.e., cutting meal sizes, skipping meals, going hungry, and going whole days without eating. The interviewers' records of the women's descriptions of extenuating circumstances in association with their reports of extreme intakes lend further credence to this interpretation. Women's subjective appraisals of household food security appear reflected in the adequacy of their own dietary intakes.

Interpretation of the associations presented here is complicated, however, by the problem of underreporting in dietary intake surveys. Underreporting has been repeatedly observed when self-reported energy intakes (assessed with 24-hour recall or food record methods) have been contrasted to biological markers of intake (e.g., the doubly labeled water technique) *(26 to 30)* or to calculated estimates of energy expenditure *(27, 28, and 31 to 33)*. Further, a recent United Kingdom study has suggested that the prevalence of underreporting is inversely related to socioeconomic status *(34)*. Among low-income women, underreporting has been found to relate to low levels of literacy and high levels of body fatness *(35)*. Although the issue of underreporting is typically discussed in terms of reported low levels of energy intakes, in fact, people must underreport food intake. Thus, problems of underreporting can confound the interpretation of observed low levels of nutrient intakes as well as energy intakes.

The low levels of food intakes reported by some women in this study and the comparison of reported energy intakes with estimated basal energy expenditures raise the question of whether the results presented here can be explained by underreporting. However, there are serious problems with the application of standard cut-off values of EI:BMRest to identify underreporting among individuals in specific population subgroups that differ markedly from the general population *(7)*. In particular, calculation of the basal

metabolic rate (BMR) may overestimate true BMR for obese individuals. Further, the assumptions about normal levels of physical activity may be unrealistic in impoverished samples where activity limitations are likely more prevalent and opportunities for physical recreation less common. Lastly, the proposed evaluation criteria assume that habitual intake is being assessed and individuals are in energy balance during the time frame of observation. This is not a reasonable assumption in studies of dietary intake in the immediate context of severe household food insecurity.

Given evidence of the pervasiveness of underreporting in dietary surveys, it would be naive to suggest that studies of dietary intake in the context of resource constraints are somehow immune to this problem. However, additional factors underlie the reporting of low levels of energy intakes in these settings, making the application of standard population-level assumptions about energy expenditure and energy balance an inappropriate means to differentiate reporting effects in these data. Regrettably, we lack a means to differentiate underreporting from true low intakes.

Altered Food Selection Practices

Qualitative compromises in dietary intake in response to resource constraints may entail the restriction or omission of specific food items or whole classes of foods from the diet because, although desirable, the foods are deemed unaffordable. Additionally, the use of food items of substandard quality, e.g., damaged packaged goods, stale baked goods, and fresh produce that is aged or otherwise sub-optimal may increase. Insofar as household food insecurity is a managed process, qualitative compromises may precede quantitative changes in individuals' intakes, denoting less severe stages of food insecurity *(36 and 37)*. However, as food insecurity worsens and reductions in food intake occur, the selection of foods consumed must become even more restricted. Reports of meals comprised of fried potatoes, rice, or bread with little else are not uncommon among families facing extreme constraints *(21 and 23)*. Studies of dietary intakes in the context of food insecurity have typically not differentiated between qualitative and quantitative compromises in intake, but the distinction is important in the formulation of effective intervention strategies.

To explore differences in the nutrient composition of women's diets, depending on their household food security status, women's nutrient intakes were first expressed in relation to total energy intake as nutrient densities and then compared across groups using analysis of variance methods (table 2). No significant difference in the macronutrient composition of women's diets was noted, and no micronutrients per megajoule (MJ) appeared to differ by food security status except vitamin A. To examine the relationship between severity of household food insecurity and nutrient density while controlling for other identified influences on dietary intake, single-equation multivariate regression analyses were rerun as described earlier, but with 3-day mean nutrient intake per MJ as the dependent variable. In examining the partial regression coefficients for hunger derived from this model, again only one significant difference in intake was observed. Women reporting food insecurity with moderate or severe hunger had a mean difference of -1,232 ± 572 Retinal Equivalent of vitamin A per MJ, when compared with those not reporting hunger (p-value = 0.0332). This low level of intake may indicate a drop in women's vegetable intake, with increasing severity of food security, although it should be noted that no similar decline in folate intake was observed. The absence of significant associations for other nutrients when expressed in relation to total energy intake suggests that the observed differences in women's nutrient intakes by household food security status primarily reflected differences in absolute intake levels, rather than differences in food selection practices.

Our inability to discern more systematic differences in food selection by food security status may partly be attributed to high overall levels of deprivation in this sample. The comparisons presented here are essentially between women in households experiencing more and less severe food insecurity. Qualitative compromises in

dietary intake were probably occurring even among the most advantaged group in this sample. Perhaps a comparison of women's intakes of specific classes of foods rather than nutrients would reveal some changes in food selection with increasing severity of food insecurity. However, the absence of observable differences in all but one nutrient per MJ by food security status suggests that differences in food selection are not what is driving the systematically lower nutrient intakes observed here. It is interesting that in 1989, the results of Campbell and Desjardins' exploratory study of low-income families' management of limited food resources led them to hypothesize that "the risk of inadequate nutrient intake is more related to total calorie intake than to specific foods selected" *(19)*. The foregoing examination of food selection practices would appear to confirm this.

The comparisons presented here may also have been affected by the particular analytic approach employed to adjust for the effect of total food intake on food selection. In the nutritional epidemiology literature, there has been considerable discussion and debate about the most appropriate analytic method to separate differences in food selection or dietary composition from differences in total food intake *(31 and 38 to 42)*. One alternative to the use of nutrient densities is the standard multivariate method of controlling for energy by simply including energy as a covariate in analyses. In addition, Howe et al. have proposed an energy partition, or energy decomposition, method *(43)*, and Willett and Stampfer have proposed the use of nutrient residuals derived from the regression of absolute nutrient intakes on total energy intake *(11)*. Different approaches to energy adjustment have been demonstrated to yield different results in examinations of particular diet-disease relationships *(39 and 41)*. Beaton has determined that the derived variables from the different procedures possess different error structures and the approaches embody subtly different assumptions about the nature of the relationship being examined *(31)*.

To explore the effect of the energy-adjustment method on the apparent relationship between food selection and food security status, analysis of variance comparisons were repeated for selected nutrients, using the residual method and the standard multivariate method to control for total energy intake. The apparent relationship of protein and vitamin A intake with household food security status changed, depending on the method of adjustment (table 3). This brief comparison highlights the importance of the choice of adjustment procedure, but leaves the question unresolved about which method is most appropriate for use in characterizing food selection practices in the present context.

Day-to-Day Variation in Intake

Individuals in households with severe resource constraints could be expected to exhibit very low intakes (absolute food deprivation) when resources are severely limited, and increased intakes with the influx of resources. Their day-to-day variation in intake might, therefore, be greater than the variation among individuals experiencing no resource constraints because of this additional pressure. Although the error associated with the estimation of true within-person variation from a limited number of days of intake data is substantial *(44)*, when more than 1 day of intake data is available per person, day-to-day variation can be estimated as the individual's standard deviation or variance in intake over the days of observation. To control for differences in mean intake, within-person variation is also expressed as the coefficient of variation.

When standard deviations or coefficients of variation derived from three 24-hour recalls per woman were considered in relation to household food security status over the same time period, there is some suggestion that women in households characterized by food insecurity with severe hunger were more likely to exhibit higher day-to-day variation in energy intake (table 4). It is emphasized that the sample is small and the variance estimates must be poor given our limited sampling of days over the month in question. Nonetheless, this very crude comparison suggests that particularly high levels of within-person variation in energy intake observed in the context of severe household food insecurity might be indicative of extreme fluctuations in intake in

response to particularly desperate situations. Further research is needed to confirm this observation.

In the nutrition literature, within-person variance has traditionally been a subject of interest because it functions as a source of error in the estimation of usual intake from limited days of observation of actual intake. However, there is some work to suggest that within-person variance may be a useful indicator of environmental pressures on intake. Working with energy and protein intake data from household samples in India and the Philippines, Bhargava *(45)* observed that the contribution of within-person variation to total observed variation declined with household income, implying a relative increase in within-person variation among individuals in households with lower versus higher incomes. The observation is intriguing and begs the question of whether comparisons of pooled estimates of within-subject variance in other samples might reflect differences in household food security.

The study of within-person variation in intake in the context of food insecurity may be of potential importance to our field for two reasons. First, an examination of within-person variation in intake may enable us to identify specific settings and circumstances associated with episodic hunger and thus inform interventions. Second, the characterization of within-person patterns of intake in the context of varying degrees of food insecurity may yield insight into the particular health consequences of food insecurity. For example, Dietz *(46)* has hypothesized that the higher prevalence of obesity among low-income groups may be related to the unique pattern of energy and macronutrient intake associated with chronic food insecurity. Pursuit of this research direction, however, would require a more thorough assessment of individuals' intakes over time and the development of additional questions to capture detailed data on the duration, frequency, and depth of food deprivation experienced.

Conclusions

The foregoing analyses indicate that the severity of household food insecurity is manifested in the dietary intake behaviors of women in these settings. These analyses also have served to reveal some methodological issues that affect the identification and interpretation of particular intake behaviours in relation to food insecurity. Given differences in intrahousehold food distribution, the particular interrelationships described here cannot be generalized to other members of these households. Research into the intake patterns of children and other adults in the context of declining household food security is clearly required.

While previous work has documented relationships between household food insufficiency or insecurity and individuals' dietary intakes (5, 24, and 47), this examination of the interrelationship between household food security status and various descriptors of women's dietary intakes points to the possibility of considering both kinds of data simultaneously as a means to better describe individuals' vulnerability. The integration of dietary and food security measures to identify specific aspects of nutritional vulnerability related to resource constraints may be particularly useful in furthering our understanding of the effect of varying experiences of food insecurity on health and well-being and in informing effective policy and program responses.

References

1. Campbell, C.C. "Food Insecurity: A Nutritional Outcome or a Predictor Variable?" *Journal of Nutrition*. Vol. 121. pp. 408-415. 1991.

2. Carlson, S.J., M.S. Andrews, and G.W. Bickel. "Measuring Food Insecurity and Hunger in the United States: Development of a National Benchmark Measure and Prevalence Estimates," *Journal of Nutrition*. Vol. 129. pp. 510S-516S. 1999.

3. Frongillo, E.A., B.S. Rauschenbach, C.M. Olson, A. Kendall, and A.G. Colmenares.

"Questionnaire-Based Measures are Valid For the Identification of Rural Households With Hunger and Food Insecurity," *Journal of Nutrition*. Vol. 127. pp. 699-705. 1997.

4. Basiotis, P.P. *Validity of the Self-Reported Food Sufficiency Status Item in the U.S. Department of Agriculture's Food Consumption Surveys*. Toronto, Canada. Proceedings, 1992 annual meeting of the American Council in the Consumer Interest. 1992.

5. Rose, D., and V. Oliveira. *Validation of a Self-Reported Measure of Household Food Insufficiency with Nutrient Intake Data*. Technical Bulletin No. 1863. U.S. Department of Agriculture, Economic Research Service. August 1997.

6. Tarasuk, V.S., and G.H. Beaton. "Household Food Insecurity and Hunger Among Families Using Food Banks," *Canadian Journal of Public Health*. Vol. 90, No. 2. pp. 109-113. 1999.

7. Tarasuk, V.S., and G.H. Beaton. "Women's Dietary Intakes in the Context of Household Food Insecurity," *Journal of Nutrition*. Vol. 129. pp. 672-679. 1999.

8. Hamilton, W., J. Cook, and W. Thompson et al. *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project*. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA. 1997.

9. Nova Scotia Heart Health Program, Nova Scotia Department of Health, and Health and Welfare Canada. *Report of the Nova Scotia Nutrition Survey.* 1993.

10. Hamilton, W., J. Cook, and W. Thompson et al. *Household Food Security in the United States in 1995: Technical Report of the Food Security Measurement Project*. U.S. Department of Agriculture. Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA. 1997.

11. Willett, W., and M.J. Stampfer. "Total Energy Intake: Implications for Epidemiologic Analyses," *American Journal of Epidemiology*. Vol. 124, No.1. pp. 17-27. 1986.

12. Schofield, W.N. "Predicting Basal Metabolic Rate, New Standards and Review of Previous Work," *Human Nutrition and Clinical Nutritio*n. Vol. 39C, Supplement 1. pp. 5-41. 1985.

13. Goldberg, G.R., A.E. Black, S.A. Jebb, T.J. Cole, P.R. Murgatroyd, W.A. Coward, and A.M. Prentice. "Critical Evaluation of Energy Intake Data Using Fundamental Principles of Energy Physiology: 1. Derivation of Cut-Off Limits to Identify Under-Recording," *European Journal of Clinical Nutrition*. Vol. 45. pp. 569-581. 1991.

14. National Council of Welfare. *Poverty Profile 1995*. Ottawa: Minister of Supply and Services Canada. 1997.

15. Bull, N.L. "The Distribution of Energy and Nutrient Intakes Within Households," *Journal of Human Nutrition and Dietetics*. Vol. 4. pp. 421-425. 1991.

16. Enns, C.W. "Comparison of Nutrient Intakes By Male Versus Female Heads of Households," *Journal of the American Dietetic Association*. Vol. 87. pp. 1,551-1,553. 1987.

17. Louk, K.R., E. Schafer, R.B. Schafer, and P. Keith. "Comparison of Dietary Intakes of Husbands and Wives," *Journal of Nutrition Education*. Vol. 31. pp. 145-152. 1999.

18. Nelson, M. "The Distribution of Nutrient Intake Within Families," *British Journal of Nutrition*. Vol 55. pp. 267-277. 1986.

19. Campbell, C.C., and E. Desjardins. "A Model and Research Approach for Studying the Management of Limited Food Resources by Low Income Families," *Journal of Nutrition Education*. Vol. 21, No. 4. pp. 162-171. 1989.

20. Dowler, E., and C. Calvert. *Nutrition and Diet in Lone-Parent Families in London*. London: Family Policy Studies Centre. 1995.

21. Fitchen, J.M. "Hunger, Malnutrition, and Poverty in the Contemporary United States: Some Observations on Their Social and Cultural Context," *Food and Foodways*. Vol. 2, No. 3. pp. 309-333. 1988.

22. National Council of Welfare. *Women and Poverty Revisited*. Ottawa, ON: Minister of Supply and Services Canada. 1990.

23. Tarasuk, V., and H. Maclean. "The Food Problems of Low-Income Single Mothers: An Ethnographic Study," *Canadian Home Economics Journal*. Vol. 40, No. 2. pp. 76-82. 1990.

24. Cristofar, S.P., and P.P. Basiotis. "Dietary Intakes and Selected Characteristics of Women Ages 19-50 Years and Their Children Ages 1-5 Years by Reported Perception of Food Sufficiency," *Journal of Nutrition Education*. Vol. 24, No. 2. pp. 53-58. 1992.

25. Lee, P. "Nutrient Intakes in Socially Disadvantaged Groups in Ireland," *Proceedings of the Nutrition Society*. Vol. 49. pp. 307-321. 1990.

26. Bandini, L.G., D.A. Schoeller, H.N. Cyr, and W.H. Dietz. "Validity of Reported Energy Intake in Obese and Nonobese Adolescents," *American Journal of Clinical Nutrition*. Vol. 52. pp. 421-425. 1990.

27. Black, A.E., S.A. Goldberg, S.A. Jebb, M.B.E. Livingstone, T.J. Cole, and A.M. Prentice. "Critical Evaluation of Energy Intake Data Using Fundamental Principles of Energy Physiology: 2. Evaluating the Results of Published Surveys," *European Journal of Clinical Nutrition*. Vol. 45. pp. 583-599. 1991.

28. Heerstrass, D.W., M.C. Ocke, H.B. Bueno-de-Mesquita, and J.C. Seidell. "Underreporting of Energy, Protein and Potassium Intake in Relation to Body Mass Index," *International Journal of Epidemiology*. Vol. 27. pp. 186-193. 1998.

29. Martin, L.J., W. Su, P.J. Jones, G.A. Lockwood, D.L. Tritchler, and N.F. Boyd. "Comparison of Energy Intakes Determined By Food Records and Doubly Labeled Water in Women Participating in a Dietary-Intervention Trial," *American Journal of Clinical Nutrition*. Vol. 63. pp. 483-490. 1996.

30. Sawaya, A.L., K. Tucker, R. Tsay, W. Willett, E. Saltzman, G.E. Dallal, and S.B. Roberts. "Evaluation of Four Methods for Determining Energy Intake in Young and Older Women: Comparison with Doubly Labeled Water Measurements of Total Energy Expenditure," *American Journal of Clinical Nutrition*. Vol. 63. pp. 491-499. 1996.

31. Beaton, G.H., J. Burema, and C. Ritenbaugh. "Errors in the Interpretation of Dietary Assessments," *American Journal of Clinical Nutrition*. 1997.

32. Briefel, R.R., C.T. Sempos, M.A. McDowell, S. Chien, and K. Alaimo. "Dietary Methods Research in the Third National Health and Nutrition Examination Survey: Underreporting of Energy Intake," *American Journal of Clinical Nutrition*. Vol. 65 (supplement). pp. 1,203S-1,209S. 1997.

33. Macdiarmid, J., and J.E. Blundell. "Dietary Under-Reporting: What People Say About Recording Their Food Intake," *European Journal of Clinical Nutrition*. Vol. 51. pp. 199-200. 1997.

34. Stallone, D.D., E.J. Brunner, S.A. Bingham, M.G. Marmot. "Dietary Assessment in Whitehall II: The Influence of Reporting Bias on Apparent Socioeconomic Variation in Nutrient Intakes," *European Journal of Clinical Nutrition*. Vol. 51. pp. 815-825. 1997.

35. Johnson, R.K., R.P. Soultanakis, and D.E. Matthews. "Literacy and Body Fatness are Associated With Underreporting of Energy Intake in U.S. Low-Income Women Using the Multiple-Pass

24-hour Recall: A Doubly Labeled Water Study," *Journal of the American Dietetic Association*. Vol. 98, No. 10. pp. 1,136-1,140. 1998.

36. Radimer, K.L., C.M. Olson, and C.C. Campbell. "Development of Indicators to Assess Hunger," *Journal of Nutrition*. Vol. 120.. pp. 1,544-1,548. 1990

37. Radimer, K.L., C.M. Olson, J.C. Greene, C.C. Campbell, and J. Habicht. "Understanding Hunger and Developing Indicators to Assess it in Women and Children," *Journal of Nutrition Education*. Vol. 24, No. 1. pp. 36S-45S. 1992.

38. Freedman, L.S., V. Kipnis, C.C. Brown, A. Schatzkin, S. Wacholder, and A.M. Hartman. "Comments on Adjustment for Total Energy Intake in Epidemiologic Studies," *American Journal of Clinical Nutrition*. Vol. 65 (supplement). pp. 1,229S-1,231S. 1997.

39. Kushi, L.H., T.A. Sellers, J.D. Potter, C.L. Nelson, R.G. Munger, S.A. Kaye, and A.R. Folson. "Dietary Fat and Postmenopausal Breast Cancer," *Journal of the National Cancer Institute*. Vol. 84. pp. 1,092-1,099. 1992.

40. Wacholder, S., A. Schatzkin, L.S. Freedman, V. Kipnis, A. Hartman, and C.C. Brown. "Can Energy Adjustment Separate the Effects of Energy From Those of Specific Macronutrients?" *American Journal of Epidemiology*. Vol. 140, No. 9. pp. 848-855. 1994.

41. Willett, W.C., G.R. Howe, and L.H. Kushi. "Adjustment for Total Energy in Epidemiologic Studies," *American Journal of Clinical Nutrition*. Vol. 65 (supplement). pp. 1,220S-1,228S. 1997.

42. Willett, W. *Nutritional Epidemiology*. 2nd edition, New York, NY: Oxford University Press. 1998.

43. Howe, G.R., A.B. Miller, and M. Jain. "Total Energy Intake: Implications For Epidemiologic Analyses," *American Journal of Epidemiology*. Vol. 124, No. 1. pp. 157-159. 1986.

44. Tarasuk, V., and G.H. Beaton. "Day to Day Variation in Energy and Nutrient Intake: Evidence of Individuality in Eating Behaviour?" *Appetite*. Vol. 18. pp. 43-54. 1992.

45. Bhargava, A. "Malnutrition and the Role of Individual Variation With Evidence From India and the Philippines," *Journal of the Royal Statistical Society*. Vol. 155, Part 2. pp. 221-231. 1992.

46. Dietz, W.H. "Does Hunger Cause Obesity?" *Pediatrics*. Vol. 95, No. 5. pp. 766-767. 1995.

47. Kendall, A., C.M. Olson, and E.A. Frongillo. "Relationship of Hunger and Food Insecurity to Food Availability and Consumption," *Journal of the American Dietetic Association*. Vol. 96. pp. 1,019-1,024. 1996.

Table 1—Comparison of women's mean energy and nutrient intakes ± SD with their 30-day household food security status (n = 145)[1]

Nutrient Intake/MJ	No hunger evident	Food insecure with moderate hunger	Food insecure with severe hunger	F value[2]
	n = 62	*n = 52*	*n = 31*	*2 df*
Energy, kJ/d	7,182.58 ± 3,207.33	6,164.08 ± 2,370.20	5,696.84 ± 2,388.81	3.29[3]
Protein, g/d	67.78 ± 31.78	55.78 ± 22.17	47.56 ± 20.49	6.28[3]
(g/MJ)	(168.48 ± 46.42)	(160.74 ± 45.43)	(152.42 ± 49.00)	
Carbohydrate, g/d	242.61 ± 113.56	203.81 ± 76.97	203.07 ± 94.46	2.46
(g/MJ)	(599.46 ± 99.02)	(600.89 ± 105.79)	(625.11 ± 105.52)	
Total Fat, g/d	54.33 ± 31.62	46.51 ± 26.91	41.68 ± 21.25	2.27
(g/MJ)	(127.54 ± 34.27)	(124.04 ± 39.41)	(125.12 ± 34.90)	
Vitamin A, RE/d	1,339.40 ± 1,683.93	594.97 ± 528.67	732.18 ± 641.97	6.80[3]
(RE/MJ)	(3,477.91±4,666.05)	(1,830.44±1,749.73)	(2,750.47±3,095.16)	
Vitamin C, mg/d	108.44 ± 82.34	84.07 ± 68.06	76.37 ± 61.57	2.10
(mg/MJ)	(299.85 ± 257.55)	(255.84 ± 186.19)	(241.17 ± 219.82)	
Folate, mcg/d	197.69 ± 116.20	156.32 ± 78.99	153.08 ± 70.38	3.02
(g/MJ)	(505.64 ± 241.28)	(490.58 ± 342.11)	(493.06 ± 206.26)	
Calcium, mg/d	560.49 ± 355.01	469.05 ± 289.10	440.77 ± 231.19	1.91
(mg/MJ)	(1,361.25 ± 469.46)	(1,354.95 ± 588.00)	(1,421.44±647.81)	
Iron, mg/d	11.52 ± 6.90	9.18 ± 3.73	8.25 ± 3.53	4.30[3]
(mg/MJ)	(27.77 ± 6.75)	(27.64 ± 9.62)	(26.72 ± 7.90)	
Magnesium, mg/d	237.49 ± 99.50	194.13 ± 81.66	187.99 ± 89.92	4.55[3]
(mg/MJ)	(610.42 ± 155.41)	(586.50 ± 224.08)	(619.30±183.49)	
Zinc, mg/d	9.37 ± 4.78	7.24 ± 3.11	6.30 ± 3.25	7.27[3]
(mg/MJ)	(23.01 ± 6.67)	(21.04 ± 6.98)	(19.97 ± 6.72)	

[1]Table from (*7*).

[2]Based on analysis of transformed data in cases where the original distribution failed to approximate normality.

[3]Indicates statistically significant ($p < 0.05$) difference between groups defined by food security status. No significant difference was detected for the nutrient per MJ intakes (except vitamin A).

Table 2—Differences in energy and nutrient intake between women in households reporting hunger over the past 30 days and those reporting no hunger (n = 145)[1]

		Model adjusted for other influences on intake		Unadjusted model	
Nutrient	Unit[2]	Intake difference[3] (S.E.)	p-value[4]	Intake difference[5] (S.E.)	p-value[4]
Energy	kJ/d	-1,058.00 (484.20)	0.0307	-1,193.01 (463.32)	0.0110
Protein	g/d	-13.58 (4.65)	.0041	-15.07 (4.45)	.0009
Carbohydrate	g/d	-34.64 (16.96)	.0431	-39.08 (16.35)	.0181
Total fat	g/d	-8.45 (4.91)	.0876	-9.62 (4.70)	.0423
Vitamin A	RE/d	-634.51 (195.84)	.0015	-693.18 (198.49)	.0006
Vitamin C	mg/d	-20.29 (12.40)	.1042	-27.25 (12.28)	.0280
Folate	m/d	-35.43 (15.59)	.0247	-42.58 (15.95)	.0085
Calcium	mg/d	-73.59 (53.46)	.1071	-101.98 (51.71)	.0505
Iron	mg/d	-2.35 (.93)	.0122	-2.68 (.89)	.0030
Magnesium	mg/d	-39.02 (15.88)	.0082	-45.65 (15.30)	.0033
Zinc	mg/d	-2.23 (.69)	.0153	-2.49 (.66)	.0002

[1]Table from (*7*).

[2]kj/d is the abbreviation for kilojoules for each day, g/d is grams for each day, RE/d is retinol equivalents for each day, and mg/d is milligrams for each day.

[3]Differences in 3-day mean intakes between women in households with hunger and those without, while controlling for other factors affecting diet. These are partial regression coefficients estimated from a single-equation multivariate regression model in which each intake variable was regressed on an indicator of household food insecurity with hunger, disposable income (adjusted for family size and composition), presence of employment income in the household, presence of a partner in the household, and woman's level of education, smoking status, and ethnoracial identity.

[4]p-value represents the probability of these results occurring under the null hypothesis that there is no difference in intakes between women categorized by household hunger status. A p-value of 0.05 or less is generally considered grounds for rejection of the null hypothesis.

[5]Differences in 3-day mean intakes between women in households with hunger and those without, derived from a simple linear regression model in which intake was regressed on an indicator of household food insecurity with hunger.

Table 3—Results of analysis of variance to assess the relationship between women's 3-day mean intakes of selected nutrients and 30-day household food security status as a function of the method of adjustment for total energy intake (n = 145)

Nutrient	Method of energy adjustment		
	Nutrient density F value[1] (Pr > F)	Nutrient residual F value[1] (Pr > F)	Standard multivariate F value[1] (Pr > F)
Protein	1.46 (0.2352)	3.18 (0.0446)	2.83 (0.0625)
Vitamin A	4.03 (.0198)	.38 (.6850)	4.98 (.0082)
Iron	0.27 (.7649)	.40 (.6702)	.80 (.4536)

[1]F value with 2 degrees of freedom, derived from analysis of variance (PROC GLM), comparing 3-day mean intakes by 30-day household food security status. In cases where the distribution of the nutrient variable failed to approximate normality, the data were transformed prior to this analysis.

Table 4—Observed distributions of women's standard deviations and coefficients of variation in energy intake over 3-days, by 30-day household food security status

Food security status	Percentile			Percentile		
	25th	50th	75th	25th	50th	75th
	-------- 3-Day standard deviation ----------			------ 3-Day coefficient of variation ----------		
No hunger evident (n = 62)	295.8	384.2	616.1	16.70	28.23	38.20
Food insecure with moderate hunger (n = 52)	261.0	382.4	601.8	20.54	27.19	43.68
Food insecure with severe hunger (n = 31)	242.6	449.9	699.3	18.11	37.09	54.64

Nutrition and Health Perspectives on Establishing a Food Security Research Agenda: What Can We Learn From the Past to Establish a Framework For the Future?

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Introduction

This paper reviews some advances in the state of our knowledge regarding nutrition and health over the past few decades. It briefly reviews some relevant advances in thinking about food security from a nutritional perspective, and summarizes several developments that are favorable for future progress. Finally, some suggestions for future research on food security are provided.

Historical Background

Recent Advances in Medicine, Health, and Public Health

Appendix 1 (at the end of this paper) presents some recent advances in medicine, health, and public health that have occurred since 1950. These changes have been key influences on the development of nutrition science, which is a biological as well as social science. The application of medical and public health measures has led to continuing improvement in the health and longevity of the American population in many respects over the past few decades. This very success has, however, led to many new challenges.

Advances in our understanding of growth and development, aging, and the etiology and pathogenesis of diet-related diseases and conditions have been enormous (Pollitt, 1994, and accompanying articles). These have done much to clarify the role of nutrition and other environmental factors in disease causation. Moreover, further advances can be expected. While understanding of the human genome is still in its infancy, the stage is set for enhanced understanding of how genetic and environmental factors may interact to enhance or decrease nutritional vulnerability of some individuals. At the same time, changes in health care financing and the health care industry, coupled with a growing proportion of the gross domestic product being devoted to health related expenditures, have put even greater pressure on the health care community to achieve economies in health services delivery (Angell, 1999).

Recent Advances in Nutrition Knowledge

Taking a very long-term perspective, historians trace the modern decline in mortality rates and increases in body size, which began in the 1700s, not only to advances in medicine but to increases in the food supply and other factors in the environment. Vogel and colleagues have coined the phrase “technico-physio” revolution to describe the synergy between technological and physiological improvements in the past few centuries that has produced a form of human evolution that is biological but not genetic; rapid, culturally transmitted changes that are not necessarily stable.

Developments over the last few decades in the nutrition and health sciences have greatly expanded our understanding of the associations between nutrition and health, and have provided the basis for further improvements. These are summarized in appendix 2.

Advances in Understanding by Nutritionists of the Concept of Food Security

Nutrition is a biological science that focuses on improvement of the human condition. Therefore,

nutritionists seek the psychological, social, and economic, as well as the biological determinants of malnutrition; and ways to measure them and to alter them to improve human health and well-being.

Nutritionists have attempted to develop indices of basic nutritional needs that could be used for assessing and assuring the adequacy of diets of individuals, households, and groups within the population for nearly two centuries. The lack of sufficient food or the risk of it, owing to insufficient money to buy food, was recognized early as a major determinant of malnutrition. Appendix 3 provides some historical perspectives on nutritionists' attempts to quantify and describe food insecurity over the past century.

Until the 20th century, so little was known about the nutrients in foods that such efforts focused on amounts of food and food patterns or diets known to be associated with good health and those associated with poor health. In the mid-20th century, as knowledge and quantification of nutrient needs became more secure, efforts turned to building diets from "scratch." These efforts sought to develop descriptions of the nutrient needs of groups that could be used as templates for dietary planning, and an absolute biological floor below which one could not fall and expect to remain healthy.

At the same time, it was recognized that people ate foods, not nutrients, and that if attention were not paid to factors other than nutritional adequacy, diets planned solely on the basis of fulfilling nutrient needs might be socially or culturally unacceptable. Moreover, planners who controlled resources necessary to ensure nutritional adequacy for the population often thought in terms of foods and costs, so that recommendations, while based on nutrients, ultimately had no utility until translated into recommendations for nutritionally adequate food-based dietary patterns.

One common problem that arose was that when nutritional recommendations were for dietary patterns requiring resources in excess of those deemed appropriate for basic needs, nutritionists often found their recommendations rejected or ignored (Mayer, 1969 and 1973). However, occasionally decisionmakers took their advice. Perhaps the most notable example in the 20th century was the adoption of the Recommended Dietary Allowances in this country during World War II as a basis for planning food supplies for the war effort, and the development of food rationing schemes to implement them.

Another problem was to find generally agreed upon ways to connect biological needs for nutrients with economic and social policy indicators. Until the 1980s, progress was inhibited by lack of valid, reliable measures of food security and hunger (Andrews et al., 1998).

The Situation Today

There are many reasons for optimism about the development of a broader view of nutritional status and its many contributions to sound health today.

More Adequate Science Base

The state of science in the relevant fields is sufficient to support valid and reliable indicators of food security and hunger, and to relate these to biological realities. Nutrition scientists with a biological focus, and their more social science-oriented colleagues, respect each others' perspectives and work. Both understand the need for early-warning measures of nutritional risk, and how these may be used in policy and program development to increase returns on critical private and public human capital investments (Anderson, 1990; and Thompson and Byers, 1994).

Holistic Conceptual Frameworks Relating Food Security and Hunger to Nutritional and Health Status are Being Developed and Accepted by the Scientific Research Community

Acceptable unifying conceptual frameworks that link economic and social realities to health and disease are available. The holistic picture of

nutritional needs that unites psychological/social with biological is also being accepted. The concept of food security is gaining increased respect among biomedical scientists, as are quality of life measures and other outcome measures in the health field. Economists and other social scientists are becoming increasingly aware that dietary intakes alone, without other information about the health status of groups, is insufficient. Multidisciplinary teams are working together more productively than ever before to synthesize relevant knowledge from their respective fields, develop and validate standardized indicators of food security, and link them to health and disease (Frank, 1997; and Kleinman et al., 1998).

Metrics are Available

Now that there are ways to describe and quantify some forms of food insecurity, the problem can be presented in ways that social and biological scientists, as well as policymakers and the public, understand and find useful. These conceptual frameworks also provide a platform for expanding the concept to include other specific forms of food insecurity, such as those often faced by the frail and chronically ill.

Specialized Tools for Target Groups at Special Risk are Being Developed

Specialized food-security measurement tools are being developed for the elderly and children. However, special tools are not yet available for other at-risk groups whose food insecurity has special dimensions not tapped by existing measures. Other groups that may need modified food security measures include non-English-speaking persons, especially recent immigrants, and groups with other special problems or characteristics. For example, children and adults with special developmental and health needs often have unique problems that require specialized tools for measuring the reality of the food insecurity they experience.

The frail and ill also have special characteristics that may call for special food security measurement tools, as do castaway teenagers, current and former welfare recipients, the mentally ill and developmentally delayed living on their own, the homeless, and others with double and triple social or medical disadvantages. There is, therefore, a need for expansion of research to adapt the new measures of food security and hunger to make them more appropriate to these special groups.

National Estimates of Food Insecurity and Hunger Prevalence are Beginning to be Available

Large-scale population-based surveys are also increasingly available. These provide some estimates of the magnitude and severity of food insecurity and hunger problems, and identify groups within society most at risk. Presently, there is also a small but growing literature examining variation in food and nutrient intakes across food sufficiency categories based on the U.S. Department of Agriculture's food sufficiency questions. Food sufficiency status prevalence estimates are available from responses on the Third National Health and Nutrition Examination Survey (NHANES III) interview protocols (based on prevalence of “sometimes or often not enough food”), as well as earlier implementations of the Continuing Survey of Food Intakes by Individuals (CSFII) and Nationwide Food Consumption Survey (NFCS) (Alaimo et al., 1998; Basiotis et al., 1992; Cristofar and Basiotis, 1992; and Rose and Oliveira, 1997). These provide a basis for connecting food security status to nutrient intakes, and health outcome measures of the type available in the NHANES. The NHANES/CSFII combined survey should provide further impetus for such efforts, and enable additional advances in clarifying the nutritional and health correlates of food security status.

State and Local Estimates of Food Insecurity are Being Implemented

Health care and welfare reform are progressing at different rates and taking various forms in the several States. As programs and support levels become more heterogeneous at the State and local levels, there also may be greater heterogeneity in food security, and thus greater need for

standardized and well-validated food security and hunger measures at these levels.

Food security measures are being used to provide additional data in some States and localities that can inform changes in social policies (Kasper et al., 1999; True, 1998; Hunger Action Task Force of Milwaukee, 1998; and Detroit Hunger Action Coalition, 1998). State and local efforts include the work of the Cornell group and others at the State Department of Health in New York, the work of a group at the Boston Medical Center, and groups in North Carolina, Wisconsin, California, Michigan, and elsewhere who are trying to link these concepts and apply them to various at-risk populations. However, much remains to be done, particularly among residents of areas such as rural Alaska, Puerto Rico, the Virgin Islands, and the Asian and Pacific Islands, where special situations may prevail owing to geography, culture, or other factors.

As implementations of the food security measures at State and local levels proliferate, there is a growing need for guidance, care, and oversight from the scientific research community to assure the quality of results and their interpretations. The new food security measures were intentionally designed for ready adaptation and implementation at various levels of geographic aggregation. However, adherence to strict standards of scientific research design, implementation, interpretation, and peer review are crucial to the validity and reliability of the measures at all levels. Moreover, the value of the information provided by the measures at all levels depends on the soundness and openness of their use.

Recommendations for Future Research

Expand Collaborative Efforts and Dialogue

Continued multidisciplinary collaboration among nutrition and health professionals, economists and other social scientists, social welfare and anti-hunger advocates, and policymakers is needed. We need to develop a mutually acceptable conceptual framework that unites social science/economic and biological/medical concerns. Nutrition professionals understand the importance of such measurements, whereas in the past they did not. However, many health professionals are still unaware of the concept of food insecurity and how the phenomenon may influence health outcomes for good or ill.

Expand the Conceptual Framework

Another need is to elaborate the conceptual framework to better relate food insecurity and hunger to other concepts such as economic self-sufficiency and preventive health. Efforts should be made to include individuals and families at especially high medical and/or social risk, and to expand the range of the most severe end of the food security/hunger scale. As more women enter the labor force, especially welfare recipients and women in other poverty groups, this is a matter of considerable policy importance.

The relationships of food security measures and good nutrition to other physical and mental health outcomes also need further study. Such outcomes include associations with:

- early child development (physical, cognitive, and psychological);
- mental health problems (depression, learning disabilities, school failure, learned helplessness, etc.);
- maintenance of independence and positive health outcomes, especially among those suffering from chronic degenerative diseases such as insulin-dependent diabetes, end-stage renal disease, severe cardiovascular disease, and cancer; and
- maintenance of independence in older persons, especially among the frail and sick and those undergoing rehabilitation.

All of these topics require further exploration through multidisciplinary and specialized research activities.

Capture Periodic or Occasional Acute Food Insecurity Problems More Effectively

The time frame for the food security scale is 12 months. This makes the precise nature of periodic or short-term episodes of food insecurity and hunger difficult to measure. The 30-day food security scale can illuminate some aspects of the phenomenon with finer detail, and could be useful in this regard. However, it has a "ceiling" problem; that is, it does not adequately cover the moderate (less severe) end of the food security scale.

National cross-sectional population-based surveys done periodically are not likely to achieve this objective in and of themselves. More frequent measures and specific measures for certain groups at especially high risk need to be considered for serious problems that occur only occasionally or in specific locales. Incorporating the food security measures into longitudinal surveys (e.g., the Survey of Income and Program Participation, or the Panel Study of Income Dynamics) could also address this temporal aspect of food security more effectively.

Present measures may fail to capture important realities of the food insecurity experienced by certain groups. Individuals and families suddenly faced with unemployment, or families that break up, may not show on surveys done once a decade or even once a year, even though they experience considerable hardship. Research to explore the natural histories of these events and their relationships to food insecurity and hunger is also needed.

Improve the Measures' Ability to Capture Severe Food Insecurity and Hunger

The new food security measures, while sufficient to identify household food insecurity, may not suffice for identifying households or individuals in particularly dire situations. For example, they may be too crude to identify important aspects of severe hunger and food insecurity. Items that discriminate severe food insecurity and hunger below the present "floor" in certain respects may be helpful for these purposes. It is important to consider fleshing out the most severe range on the Food Security Scale (food insecurity with severe hunger), especially for children, the elderly, the frail, and other high-risk groups.

Validate the Food Security Scale for Application Throughout North America (Canada, USA, Mexico), and in Other Continents

As we enter the 21st century, the economy is increasingly global in nature. In North America, trade and other ties between Canada, Mexico, and the United States are drawing our nations closer and closer together in many important ways. Canada and the United States share a common dietary standard, and Mexican observers have been invited to join in the development process. Perhaps we also need to think of North American standards for measuring food insecurity and hunger. In North America, Mexico suffers the most from food insecurity. We must not forget our neighbors to the South in our research and development efforts, particularly as we develop indicators of severe food insecurity and hunger.

The U.S. Agency for International Development (USAID) and researchers in other countries have shown interest in validating the food security scale for implementation in developing countries. Limited implementation has been given preliminary approval by USAID, with options available for additional mission-initiated programs. These developments point toward greater possibilities for adapting the scale in a broader range of countries and integrating household-level measures of food security with measures at more aggregated levels.

Explore Uses of Food Insecurity and Hunger as Potential Sentinel Measures

In days gone by, coal miners used canaries in coal mines to detect noxious gases and other dangerous circumstances. It may be possible to develop sentinel indicators that provide early signals of problems related to food insecurity and hunger, and to identify groups that are best to

monitor for detecting these effects. High rates of food insecurity among dependent and highly vulnerable groups such as children in poor families or the ill, frail elderly may serve as such sentinels.

In its seminal report on "Core Indicators of Nutritional State For Difficult-To-Sample Populations," the Life Sciences Research Office of the Federation of American Societies of Experimental Biology (Anderson, 1990) describes the nature and importance of sentinel groups in disease and nutrition surveillance systems. Units considered to have characteristics that make them the first units subject to disease or malnutrition in a population, and thus predictive of future events or conditions in the broader population, are often selected for monitoring. Such sentinel units or groups are clearly not representative of the entire population, but they are useful indicators of the extent of risk in the larger population, and the likelihood of malnutrition-related disease occurring.

Poor Children as a Sentinel Group

Food-insecure young children comprise such a sentinel population, in the epidemiological sense, for malnutrition, morbidity, growth retardation, psychosocial dysfunction, and other problems associated with poverty-related food insecurity and hunger. Previous research also shows that hunger among children is indicative of chronic severe food insecurity and hunger within their families, and that evidence of even moderate hunger among children provides a clear basis for inferring the existence of severe hunger among adults in their households (Hamilton et al., 1997).

There are, however, several extraordinary aspects of the sentinel nature of child hunger and its implications for nutrition and health that amplify concerns normally associated with the phenomenon. These complexities arise out of the special character of growth and development in early childhood and infancy, and the ways adult caretakers in food-insecure households tend to respond to the food and nutrition needs of children through food rationing.

Normal patterns in the managed process of food insecurity at the household level imply that adults usually experience hunger before their children. However, because of the rapid and critical nature of growth and development in early childhood and infancy, hunger tends to cause observable impairment in nutritional status, health, and cognitive and physical development among children prior to emergence of similarly observable impairments among adults in their households. Thus, observation of hunger, malnutrition, and growth impairment in young children not only signals the likelihood of serious health and developmental problems later in their own lives, it also signals the likelihood of physical and mental health problems emerging among adults in the population under consideration. Therefore, young low-income children comprise an extraordinary sentinel group highly indicative of avoidable health problems associated with poverty-related food insecurity, hunger, and malnutrition.

Monitoring Food Security Among Sentinel Poor Children to Assess Impacts of Welfare Reform on Nutrition and Health

The Children's Sentinel Nutrition Assessment Program (C-SNAP) at the Boston Medical Center is an example of food security research focusing on low-income young children. Families of children living in a poor area of South Boston are monitored in the pediatric emergency room for food security and health status and nutrition-related growth retardation. Many families in low-income communities rely on emergency rooms and acute-care facilities for primary care because they have no health insurance and lack time and resources needed for well-child visits (Lino, 1998; and Super et al., 1996). The C-SNAP project is using the Food Security Scale to assess the impacts of welfare policy changes on poor young children's food security, health, and growth (Frank, 1997).

Explore Food Insecurity in Other High-Risk Groups, Especially the Ill and Frail

The American health care system is the most expensive in the world (Angel, 1999). The

growth of managed care has slowed but not stopped the trend of increasing health care expenditures. In 1997, Federal, State, and local governments devoted 46 percent of the $507 billion spent to health care, a percentage that has risen in recent years (Igelhart, 1999). Food insecurity and hunger among the frail and ill can lead to undernutrition, disease, and health complications resulting in medical-care costs that far exceed the costs of preventing the problems in the first place. An example of a sub-population for which this is especially true is frail adults with head/neck cancers, who lack money to buy oral nutritional supplements and secondarily develop protein-calorie malnutrition and dehydration requiring hospitalization. Other examples include diabetic hemodialysis patients who are wheelchair-bound and unattended over long weekends and develop hypoglycemic attacks because of lack of food, and children at emergency rooms or other acute-care facilities who suffer from failure to thrive because their parents cannot regularly afford enough food for them.

The proportion of the U.S. population without health insurance is 16.1 percent (Igelhart, 1999). However, 31.6 percent of all poor people in the United States, and 23.8 percent of all poor children have no health insurance (Bennefield, 1998). These groups are especially likely to become food insecure if they are confronted with a medical emergency or even by expenses for chronic and recurrent medical treatment.

List-based surveys focusing on particular high-risk groups sharing common characteristics (e.g., developmental delay, and physical or mental illness, recent discharge from hospitals or institutions) might be useful. For example, surveys of poor, frail persons with diabetes who are unable to afford food needed for prescribed diets and, thus, develop hypoglycemic reactions may be useful. Existing evidence indicates that they are more likely to develop hypoglcyemic reactions than their more food-secure peers (Nelson et al., 1998).

Low-income legal immigrants comprise another subpopulation of particular interest. Many legal permanent residents, among whom food insecurity and hunger prevalence are likely to be high, may have lost eligibility for food stamps and other benefits as a result of welfare-reform changes (Kasper et al., 1999; Cook, 1998; and Cook and Martin, 1995). Health insurance is often not available to this group, and their health status is likely to be fragile for a variety of reasons. As a result, health care costs can be higher among immigrants who are food insecure, putting them and their children (many of whom are U.S. citizens) at even greater risks of nutrition-related health and growth problems. Such hypotheses need to be tested with data from well-designed, carefully implemented empirical studies.

Expand Research to Improve Sensitivity of Condition/Illness Specific Food Security Measures

It may be necessary to adapt recently developed food security measures for use in specific high-risk groups. For example, adapted food security measures may be needed for the elderly, those who are ill, the physically and mentally handicapped, and for other groups with special problems. Additional research is needed to determine how existing measures might be improved to capture data from such high-risk groups, and clarify associations of food insecurity with health outcomes among these groups. To make the Food Security Scale more useful as a screening device for such special contexts, its sensitivity needs to be carefully examined and possibly improved. The Food Security Scale is being or has been used as a screening device in a few contexts (e.g., in a small pilot study for the Special Supplemental Nutrition Program for Women, Infants, and Children, and in the C-SNAP program). The scale might also be effectively adapted for use in the Nutrition Screening Initiative.

Recent research by Nelson et al. (1998) suggests that food insecurity is a significant factor in hypoglycemic reactions among persons who are poor, frail, and suffering from insulin-dependent diabetes. This concern also highlights the need for additional research and analysis of the specificity and sensitivity of the food security scale.

That issue, addressed in another presentation in this conference, needs to include consideration of the applicability of the scale as a screening device, and the implications of its use in this manner.

Develop Studies of Health Outcomes Among the Food Insecure III

Health outcomes associated with varying levels of food insecurity need to be studied in groups with illnesses as well as those in better health. Such groups include individuals of any age recently discharged from acute or chronic health care facilities with disabilities that impair mobility, or with mental or physical limitations that impair their ability to provide for themselves, particularly if they are low-income. The implications of food insecurity for social policy, particularly among those whose health care costs are covered by the Federal Government are considerable. Such groups include frail elders whose health care costs are covered by Medicare or Medicaid and the physically and mentally handicapped covered, in part, by other portions of the Social Security Act amendments.

As mentioned above, frail low-income persons with insulin-dependent diabetes, including those on dialysis, are especially vulnerable to lack of food. Failure to obtain food can lead to morbidity, increased health care costs, and hospital admissions, most or all of which must be covered by public health insurance. Another group especially prone to the ill effects of food insecurity are those with acquired immuno-deficiency syndrome (AIDS). Research on some of these special populations may be possible with data from the combined CSFII/NHANES survey to be implemented in the near future.

A parsimonious approach to studying whether food security is associated with greater severity and/or poorer health outcomes from chronic degenerative diseases or conditions might be to incorporate the Food Security Scale into existing federally funded studies. Appropriate adaptations could be made to large-scale studies of chronic degenerative diseases and their treatments being conducted by the National Institutes of Health. Many of these studies perform periodic followups and measure various health outcomes. Adding food security measures would enrich the data and permit exploration of the extent to which these diseases and conditions are associated with food insecurity.

Examples of such studies include the Polyps Trial, followups to cardiovascular disease studies conducted by the National Heart, Lung and Blood Institute, followups of patients on dialysis in the HEMO study of the National Institute of Diabetes, Digestive and Kidney Diseases, as well as followups of the Child and Adolescent Trials of Cardiovascular Health. Large longitudinal cohort studies of aging and health—such as the Women's Health Initiative (WHI)—would also be appropriate vehicles for food security measures, as would studies of child health and nutrition—such as the Child and Adolescent Trials of Cardiovascular Health (CATCH).

Incorporate Food Security Measures into Screens for Risk of Poor Nutritional Status

Private and volunteer sector groups, such as the Nutrition Screening Initiative, and Federal groups such as the Preventive Health Services Task Force may find it useful to develop nutrition and health screening indicators that include food security. Among those screened and identified as food insecure and hungry, valid and reliable methods for further assessing their dietary intakes and nutritional status need to be applied, and the effects on food security of various interventions need to be considered. Refinements in the sensitivity of the Food Security Scale, as well as research clarifying the relationships between food security and nutritional status will help make this kind of application more effective.

Expand Research on Age and Life Cycle-Specific Food Insecurity Measurement

Children

Food security concerns related to growth and development in infants and young children differ in important respects from those related to later

periods in the life cycle; e.g., adolescence, pregnancy, lactation, and old age (Pollitt, 1994, and accompanying articles). Meaningful associations of food security with other outcome measures may also vary across the life cycle. For example, food insecurity in children may not be related solely to impairment of physical health and growth but also to psychological and mental health problems. Food insecurity is clearly associated with family economic stress and thus may influence the quantity and quality of parent-child interactions during infancy and early childhood. These, in turn, set the stage for a host of developmental achievements necessary for success later in life. Kleinman et al. (1998) provide recent evidence that food insecurity and hunger are associated with several kinds of psychosocial dysfunctionality among children. Additional research is needed to investigate the relationships of food insecurity and hunger to other mental-health problems among adult household members such as depression, alcoholism, and domestic violence.

Childhood Obesity

Another important child health issue is the association of food insecurity with development of obesity in childhood and adolescence. Dietz (1998 and 1995) summarizes the present and future health implications of this condition for children, and hypothesizes that childhood obesity may be caused in part by weight cycling resulting from periodic or chronic food shortages. Dietz (1995) also notes that increased fat content of low-cost foods eaten to prevent hunger at times when families lack money to buy food is also a likely factor in child obesity. Greenwood et al. (in Karp, 1993) discuss some psychological/emotional problems associated with obesity in low-income children and patterns of interaction among economic, cultural, and cross-generational factors that lead to its development. Further research is needed to clarify the role of food security in this increasingly prevalent child health problem. In such studies it will be important to examine food security and hunger along with other environmental factors that may be involved (e.g., physical inactivity, dieting behavior).

Among children and adolescents, food insecurity measures might also be used as a basis for ascertaining need for food assistance programs or other school-based interventions. Food security measures may be related to participation or lack of participation in school meals programs and children's views and attitudes about schools and school programs.

The Elderly

Very little research has been done on food security among the elderly since the seminal work of Burt and Cohen at the Urban Institute in the early 1990s (Burt, 1993). Additional questions about elderly people's responses to food insecurity still need to be addressed. As suggested above, food security measures may be useful to include in nutrition and health screening programs for the elderly. Associations between food insecurity and decreased intakes of calories and other nutrients, decline in sensory-specific satiety, loss of olfactory and gustatory sense acuity, decreased dietary variety, decreased relative weight or weight loss, and adverse changes in functional status need to be examined further.

According to Census Bureau projections, the number of elderly persons 65 years and older in the U.S. population will more than double between 1995 and 2030. Over this same time period, the number of elderly age 85 and older will increase by nearly 150 percent, and the number for age 100 and over will be more than eight times greater in 2030 than it was in 1995. Due to differential survival rates between males and females, elderly women make up a larger proportion of the elderly population at each higher age interval. In 2030, for example, women are projected to comprise 55 percent of the population age 65 and over, but 65 percent of those age 85 and over. Moreover, a larger proportion of elderly persons in each higher age interval live alone. According to Census Bureau estimates, in 1998, 23 percent of all persons age 65 to 74 lived alone, while 38 percent of those ages 75 to 84 lived alone, and 52 percent of all those age 85 and over (Lugaila, 1998). Together, these trends imply that the increasing elderly population resulting from aging of the "baby boom genera-

tion" will involve dramatically larger numbers of elderly women, many of whom will be living alone.

The Food Security Measurement Study of the U.S. Department of Agriculture and the U.S. Department of Health and Human Services' National Center for Health Statistics (Hamilton et al., 1997a) found that households with elderly persons and no children had the lowest prevalences of food insecurity and hunger of all household types in 1995 (5.9 percent food insecure overall, and 1.9 percent with some level of hunger). However, the prevalence of food insecurity and hunger among such households in which people lived alone were much higher. Nearly 1 of every 10 single-person elderly households (8.2 percent) was food insecure and 2.8 percent experienced hunger. These food insecurity and hunger prevalence rates are 39 and 47 percent higher, respectively, than those for all households with elderly but no children. As the number of elderly people in the population continues to increase, elderly persons living alone (especially elderly women) will present increasingly difficult challenges for nutrition and health professionals, and an increasing need for more careful measurement of food security among the elderly population.

It is, therefore, important to refine and target measures of food insecurity for the elderly, and to concentrate especially on elders who live alone and are at higher risk of food insecurity (almost 40 percent higher) than the elderly in general. These special concerns for food security measurement among the elderly are even more critical among those with chronic degenerative diseases such as end-stage renal disease, diabetes, and heart failure.

With respect to social policy, poverty thresholds for Americans age 65 and older are lower in general than those for younger persons. As a result, the numbers and proportions of elderly in poverty are underestimated (Rogers et al., 1994). This and other social, cultural, and physiological peculiarities of the elderly population suggest that the Food Security Scale may underestimate the prevalence of food insecurity among the elderly. Studies to refine estimates of the prevalence of food insecurity among the elderly might determine the extent to which this is the case. They may also clarify the associations of food insecurity with physical or mental health outcomes among the elderly, and their patterns of use of health care and other social and public services.

Among the frail elderly especially, food insecurity may be associated not only with physical health but also with mental health status and the ability to live independently. Functional status, as measured by activities of daily living and instrumental activities of daily living, is likely to interact in important ways with food security status among the elderly, both as a cause of food insecurity and as a consequence of it. In addition, food insecurity among the elderly may be related in important ways to admissions to acute or chronic care facilities.

Similar to young at-risk children, the frail elderly may be a sentinel group for many nutrition and health problems. Yet little work has been done on the elderly as sentinels for larger societal problems. The large and growing number of very old adults, e.g., over age 85, who are living in our communities may be an important group to examine. For many of these "older old," social and medical infrastructures are fragile or inconsistently available, and food insecurity is likely to be especially apparent and problematic for them.

Determine if Food Insecurity/Hunger Measures Have Predictive Value in Determining Health Outcomes in Longitudinal Studies

The new food security measures need to be validated in a wider variety of contexts. Including them in longitudinal studies may help to determine if they can function effectively as early warning signals or harbingers of later biological, psychological, or social perils. If so, it will also be important to determine whether and how interventions to improve household food security actually alleviate the potential ill effects of food insecurity and hunger on nutritional, mental, and physical health status.

The cumulative effects of food insecurity, as can best be measured in longitudinal studies, require additional attention. Food insecurity is probably an indicator of many other stresses in people's lives. However, it is possible that rather than simply being associated with adverse outcomes, food insecurity may be a critical part of the causal chain. Chronic food insecurity, assessed longitudinally, may either cause or simply be associated with adverse health or social outcomes. It is our understanding that the Food Security Scale, or a subscale of the overall scale, has been considered for inclusion in the Survey of Program Dynamics. If it has not yet been, we urge that it be included in the future.

Many unresolved research questions related to food security and hunger deserve further investigation using longitudinal or time-series designs. For example, is chronic food insecurity among children associated with poor academic achievement, even after taking other factors into account? Do children who are chronically food-insecure and who participate in school meal programs have fewer problems with school and greater academic achievement than those who do not? Do school meal program participants from food insecure families have more positive attitudes about school and themselves than nonparticipants from food insecure households?

Among adolescents and young adults, are food insecurity and hunger linked to greater or lesser likelihood of developing severe obesity? While it might seem counterintuitive, one hypothesis suggests that chronic or episodic food insecurity and hunger lead to excessive consumption when food is available, and thus that they are associated with higher risk of obesity. Another hypothesis notes that when households become food insecure, they rely on diets with less variety and more low-cost foods, which also tend to be higher in fat. These and other coping strategies pursued by food-insecure households may contribute to higher risk of obesity. Moreover, as Dietz (1995) and Greenwood et al. (1993) point out, poverty and food insecurity involve extreme stresses for all members of affected families, and these often aggravate emotional and psychological problems that contribute to overeating and obesity.

Is chronic or recurrent food insecurity or hunger among poor, frail, or ill homebound adults with such chronic conditions as renal disease, insulin-dependent diabetes mellitus, or chronic lung disease associated with increased hospital admissions? Is chronic food insecurity among elderly persons associated with institutionalization and decreased functional status, e.g., decreased Index of Independence of Activities in Daily Living (ADL) and Instrumental Activity of Daily Living (IADL)? Food insecurity measures may be useful in questionnaires used to evaluate the quality of care in board and care and other types of long-term care facilities that house the frail elderly (Burt, 1993).

Should we study food insecurity among very obese, homebound elderly persons living in rural areas? Such individuals usually have limited mobility, and when support systems are inadequate, it might be expected that they will incur major nutritional and health risks (Burt, 1993; and Greenwood et al., 1993).

"Piggy Back" Food Security Items Onto Existing Studies

It is important to "piggy back" food security measures onto existing studies so that the natural history of food insecurity among those theoretically at risk from either or both the biological and social standpoints (e.g., poor with disabilities and frail homebound) can be identified.

The newly combined NHANES/CSFII survey offers new potential for achieving a synthesis between food security measures and biological markers. The new combined survey will repeatedly sample the population on a consistent basis, so that nationally at least, timely information can be obtained if food security measures are included. However, the sampling frame for the combined survey, while nationally representative, is not so geographically. Food insecurity problems may be present in one part of the country and absent in another. Incorporation of food

security measures into additional surveys conducted at both the Federal and State levels is also needed.

To capture changes in conditions from one region to the next, either new sampling frames must be developed that are geographically representative, or substudies with State/local samples must be implemented including the Food Security Scale with other measures. When specific age/sex/health status groups, such as frail elders, are thought to be at special risk owing to changes in programs or opportunities, specific list-based samples may be needed.

Develop Standardized Methods and Tools for Measuring Food Security and Hunger that are Portable for Use in State and Local as well as National Efforts

Today, restructuring of health and social welfare infrastructure is accelerating. Yet the type and amount of changes involved vary from State to State, and from one substate locality to another. Some program changes being implemented are likely to have adverse effects on food security and hunger, while others may have positive effects. There is a need for policymakers to have early warning indicators of food insecurity so that they do not have to operate in the dark, and can take remedial actions when program changes have unanticipated negative effects.

Relate Food Security Measures to the New Dietary Standards for Nutrients, the Dietary Reference Intakes, and to Population Assessments

The Food and Nutrition Board, National Academy of Sciences, has just begun work on a series of reports on macronutrient intakes, including caloric intakes. In tandem with these efforts to revise and update the Dietary Reference Intakes (DRI), there is a parallel effort to develop guidance on the uses of the DRI. Food security measures need to be related to these concepts, since the paradigm adopted by the Board is likely to dominate thinking in nutritional biology for the early part of the 21st century. The work of other Institute of Medicine Committees may also be helpful in clarifying questions that need to be asked relevant to the associations of food security measures with other variables.

Explore Associations of Food Security Measures with Other Indices

The associations between food security measures, functional status—as measured by the ADL, IADL and disability indices—and quality of life measures, such as the Health Survey (SF-36) of the Medical Outcomes Trust, among groups such as the elderly and the ill are of interest.

Conclusions

The past is instructive. It teaches the utility of conjoint efforts, use of standardized and well-validated measures, appropriate sampling, and development of measures of social and biological manifestations of food security. Similar efforts as those devoted to groups at risk by virtue of their age now need to be extended to groups at risk owing to their physical or mental health status, or other particular circumstances that place them at high risk for both increased food insecurity and poor nutritional status. Now that valid and reliable measures of food security and hunger are available, they need to be related to other outcomes, both on cross-sectional and longitudinal bases. In addition, the effectiveness of intervention efforts to alleviate the effect of food insecurity on short- and long-term outcomes needs to be carefully assessed.

References

Aber, J.L., N.G. Bennett, D.C. Conley, and L. Jiali. "The Effects of Poverty on Child Health and Development," *Annual Review of Public Health*. Vol. 18. pp. 463-483. 1997.

Alaimo, K., R.R., Briefel, E.A. Frongillo, and C.M. Olson. "Food Insufficiency Exists in the United States: Results From the Third National Health and Nutrition Examination Survey (NHANES III), 1998," *American Journal of Public Health*. Vol. 88, No. 3. pp. 410-426. March 1998.

Anderson, S.A. (ed.). "Core Indicators of Nutritional Status For Difficult-to-Sample Populations," *Journal of Nutrition*. Vol. 120, No. 11S. pp. 1,557-1,600. 1990.

Andrews, M., G. Bickel, and S. Carlson. "Household Food Security in the United States in 1995: Results from the Food Security Measurement Project," *Family Economics and Nutrition Review*. Vol. 11. pp. 17-28. 1998.

Angell, M. "The American Health Care System Revisited—A New Series," *New England Journal of Medicine*. Vol. 48. p. 340. 1999.

Basiotis, P.P. *Validity of the Self-Reported Food Sufficiency Status Item in the U.S. Department of Agriculture's Food Consumption Surveys*. Proceedings, 38th annual conference of the American Council on Consumer Interests. Columbia, MD. March 25-28, 1992.

Basiotis, P.P., C.S. Kramer-LeBlanc, and E.T. Kennedy. "Maintaining Food and Nutrition Security: The Role of the Food Stamp Program and WIC," *Family Economics and Nutrition Review*. Vol. 11. pp. 41-48. 1998.

Bennefield, R. "Health Insurance Coverage: 1997," *Current Population Reports*. Series P60-202. U.S. Bureau of the Census. September 1998.

Bennefield, R. *Children Without Health Insurance*. Census Brief 98-1. U.S. Bureau of the Census. March 1998.

Burt, M.R. *Hunger Among the Elderly: Final Report of a National Study on the Extent and Nature of Food Insecurity Among American Seniors.* Urban Institute, Washington, DC. November 1993.

Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. "Update: Prevalence of Overweight Among Children, Adolescents, and Adults, United States 1988-94," *Morbidity and Mortality Weekly Report*. Vol. 46, No. 9. pp. 199-202. 1997.

Cook, J.T. "The Food Stamp Program and Low-Income Legal Immigrants," *Nutrition Reviews*. Vol. 56. No. 7. pp. 218-221. July 1998.

Cook, J.T., and K.S. Martin. *Differences in Nutrient Adequacy Among Poor and Non-Poor Children.* Center on Hunger, Poverty and Nutrition Policy, Tufts University School of Nutrition Science and Policy. March 1995.

Cristofar, S.P., and P.P. Basiotis. "Dietary Intakes and Selected Characteristics of Women Ages 19-50 Years and Their Children Ages 1-5 Years by Reported Perception of Food Sufficiency," *Journal of Nutrition Education*. Vol. 24, No. 2. pp. 53-58. March /April 1992.

Dalaker, J., and M. Naifeh. "Poverty in the United States: 1997," *Current Population Reports*. Series P60-201. U.S. Bureau of the Census. September 1998.

Detroit Hunger Action Coalition. *Food Security Status: A Pilot Study in a Detroit Neighborhood.* Survey and Evaluation Services, College of Urban, Labor and Metropolitan Affairs, Wayne State University, Detroit, MI. March 1998.

Dietz, W.D. "Health Consequences of Obesity in Youth: Childhood Predictors of Adult Disease," *Pediatrics*. Vol. 101, No. 3. pp. 518-525. 1998.

Dietz, W.D. "Does Hunger Cause Obesity?" *Pediatrics*. Vol. 95, No. 5. pp. 766-767. 1995.

Frank, D.A. "The Children's Sentinel Nutrition Assessment Program (C-SNAP)." Concept paper. Boston Medical Center, Department of Pediatrics, Growth and Development Program, Boston, MA. June 2, 1997.

Greenwood, M.R.C., P.R. Johnson, R.J. Karp, and P.G. Wolman. "Obesity in Disadvantaged Children," *Malnourished Children in the United States*. R.J. Karp (ed.). Springer Publishing Company, New York. pp. 115-129. 1993.

Hamilton, W.L., J.T. Cook, W.W. Thompson, L.F. Buron, E.A. Frongillo, C.M. Olson, and C.A. Wehler. *Household Food Security in the United*

States in 1995: Summary Report of the Food Security Measurement Project. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA. September 1997a.

Hamilton, W.L., J.T. Cook, W.W. Thompson, L.F. Buron, E.A. Frongillo, C.M. Olson, and C.A. Wehler. *Household Food Security in the United States in 1995: Technical Report of the Food Security Measurement Project*. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service), Office of Analysis and Evaluation, Alexandria, VA. September 1997b.

Hunger Action Task Force of Milwaukee. *Some Food for Thought: Hunger in Milwaukee*. Center for Urban Initiatives and Research, University of Wisconsin-Milwaukee. 1998.

Igelhart, J. "The American System," *New England Journal of Medicine*. Vol. 340. pp. 70-76. 1999.

Kasper, J., S.K. Gupta., P. Tran, J.T. Cook, and A.F. Meyers. "Hunger in Legal Immigrants in California, Texas, and Illinois," *Journal of the American Medical Association*. February 1999.

Kleinman, R.E., M. Murphy, M. Little, M. Pagano, C.A. Wehler, K. Rigal, and M. Jellinek. "Hunger in Children in the United States: Potential Behavioral and Emotional Correlates," *Pediatrics*. Vol. 101, No. 1. January 1998.

Lino, M. "Child Care and Welfare Reform," *Family Economics and Nutrition Review Vol. 11*. pp. 41-48. 1998.

Lugaila, T.A. "Marital Status and Living Arrangements: March 1998 Update (with associated electronic tables)," *Current Population Reports*. Series P20-514. U.S. Bureau of the Census. December 1998.

Mayer, J. (chair and ed.). *White House Conference on Food, Nutrition and Health: Final Report*. 1969.

Mayer, J. (ed.). *U.S. Nutrition Policies in the Seventies*. W.H. Freeman and Company, San Francisco, CA. 1973.

National Health Care Financing Administration. *National Health Care Expenditure Projections*. (http://www.medicaid.com/stats/NHE-Proj/). November 18, 1998.

Nelson, K., M.E. Brown, and N. Lurie. "Hunger in an Adult Population," *Journal of the American Medical Association*. Vol. 279, No. 15. pp. 1,211-1,214. April 1998.

Pearce, D. *When Wages Aren't Enough: Using the Self-Sufficiency Standard to Model the Impact of Child Care Subsidies on Wage Adequacy*. PA Family Economic Self-Sufficiency Project and the Women's Association for Women's Alternatives, with support from the U.S. Department of Labor's Women's Bureau, Philadelphia, PA. March 1998.

Pollitt, E. "Poverty and Child Development: Relevance of Research in Developing Countries to the United States," *Child Development*. Vol. 65. pp. 283-295. 1994.

Rogers, B.L., J.L. Brown, and J.T. Cook. "Unifying the Poverty Line: A Critique of Maintaining Lower Poverty Standards for the Elderly," *Journal of Aging and Social Policy*. Vol. 6, No. 1/2. 1994.

Rose, D., and V. Oliveira. *Validation of a Self-Reported Measure of Household Food Insufficiency with Nutrient Intake Data.* Technical Bulletin No. 1863. U.S. Department of Agriculture, Economic Research Service. August 1997.

Super, D.A., S. Parrott, S. Steinmetz, and C. Mann. "Supplemental Security Income for Disabled Children and Other Provisions," *The New Welfare Law*. Center on Budget and Policy Priorities, Washington, DC. Chapter 5, pp. 29-30. 1996.

Thompson, F.E., and T. Byers. "Dietary Assessment Resource Manual," *Journal of*

Nutrition. Vol. 124, No.11S. pp. 2,244S-2,317S. 1994.

Troiano, R.P., K.M. Flegal, R.J. Kuczarmarski, S.M. Campbell, and C.L. Johnson. "Overweight Prevalence and Trends for Children and Adolescents," *Archives of Pediatric and Adolescent Medicine*. Vol. 149. pp. 1,085-1,091. 1994.

True, L. "Measuring Hunger: Powerful New Tools for Community Research," Presented at the conference of the Northeast Regional Anti-Hunger Network, Boston, MA. June 12, 1998.

Appendix 1— Some Relevant Advances in the Health Sciences Since 1960

Concepts of Disease and Health:

- Solidification of the concept of disease as involving more than the presence of overt disease to one that includes environmental and social risk factors for disease.
- Broadening of the concept of health to include functional status (e.g., activities of daily living and instrumental activities of daily living) and subjectively determined indices of well-being and quality of life.
- Broadening of concepts of disease causation from a unitary focus on being predominantly genetic or environmental in their origins to one that includes interactions between multiple factors, especially in chronic degenerative diseases (e.g., BRCA1, obesity and breast cancer risk).
- Understanding that various types of disease (e.g., infectious and chronic) can occur together or lead to each other (e.g., H. pylori leading to chronic gastric ulcer disease, certain infections and thrombus formation, possibly infection and later insulin-dependent diabetes).
- Elucidation of the role of the long-lasting effects of disease and insults not only on child development but in predisposing individuals to later developmental problems (e.g., very low birth weight infants and later developmental disabilities, untreated phenylketonuria and intellectual deficits in adulthood).
- Recognition of the recursive relationships between various coexisting diseases in worsening disease severity or duration and in determining ultimate outcomes and quality of life.

Knowledge of Disease Causation and Health Promotion:

- Understanding that most chronic degenerative diseases are multifactoral, develop over years or decades, and that their prevention and control require long-term interventions.
- Recognition that some diseases that appear later in life have genetic origins, and that others have their origins during fetal life or early infancy.
- Recognition that the diseases associated with aging can be delayed with appropriate preventive measures earlier in life.
- Further clarification and quantification of disease risk factors, how they affect various bodily functions and processes, and how they vary by age, stage of life, and health status (e.g., Healthy People 2000, Preventive Health Task Force).
- Growing recognition of special vulnerabilities of cells, organs, and organ systems to specific environmental or genetic insults.
- Clarification of the special preventively oriented needs of certain age, sex, and life stage groups (e.g., Preventive Health Services Task Force Recommendations).

- Expansion of a focus that was solely on biological determinants of disease to one that includes nutritional, economic, educational, sociocultural and physical environmental factors, and the importance of interventions outside the health sector in preventing and controlling disease.

- Greater understanding of the importance of lifestyle in disease causation and health promotion (e.g., sedentary life styles, risky behaviors).

- Recognition of the importance of physical activity to health.

- Development, implementation, and refinement of randomized clinical trials for evaluating and testing preventive and curative strategies.

- Elaboration of evidence-based algorithms for the prevention and treatment of disease (e.g., Consensus Conferences of National Institutes of Health, Preventive Health Services Task Force Recommendations, Healthy People 2010, disease-specific recommendations from the work of the Agency for Health Care Policy and Research).

Greater Application of Systems for Determining the Prevalence of Disease, and Implementing Risk Factor Surveillance and Monitoring:

- Growing availability of population-based estimates of the prevalence of risk factors for disease.

- Further development of national health monitoring and surveillance programs (e.g., NHANES I, II, III, Behavior Risk Factor Surveillance Programs, National Center for Health Statistics).

- Improved surveillance and monitoring of high-risk groups and populations (e.g., people with human immunodeficiency virus (HIV), nursing home residents, etc.)

- Evolution of generally agreed upon preventively oriented national health objectives (e.g., Promoting Health, Preventing Disease, Objectives for the Nation 1980; Healthy People 1990, Healthy People 2000, and Healthy People 2010).

Continuing Progress in Age-Specific Morbidity and Mortality:

- Improved survival of the very young (e.g., low birth weight infants), pregnant women, those with chronic diseases (e.g., coronary heart disease, stroke, and certain cancers), and the elderly.

- Decreased age-specific mortality rates among many demographically vulnerable groups (e.g., very young infants, and the elderly).

Changes in Health Care Delivery Systems:

- Increased emphasis on primary prevention.

- Decreases in length of stay in acute care facilities for many acute illnesses, with increases in therapies provided on an outpatient basis or at home.

- Community treatment and care for the mentally ill, developmentally delayed, and those with many chronic diseases.

- Increasing diversification of roles among health professionals (e.g., nurse practitioners and physician assistants making diagnoses and prescribing treatments).

- Continued increases in health care costs.

- Increasing reliance on managed care.

- Increasing consolidation of institutions and facilities (e.g., within the insurance and the health care industries).

Appendix 2—
Some Relevant Advances in Nutrition Science Since 1950

Concept of Nutritional Status and Malnutrition:

- Solidification of the concept of nutritional status as a multidimensional concept measured by anthropometry, biochemical measurements, clinical observations, dietary intake, and functional measures.

- Broadening of the concept of malnutrition from a focus on deficiency disease and undernutrition to one that includes imbalances and excesses of nutrients that also contribute to chronic degenerative diseases and conditions such as obesity (e.g., coronary artery disease, hypertension, and possibly certain hormone dependent cancers).

- Understanding that various forms of malnutrition can occur together (e.g., dietary deficiency disease, diet-related chronic degenerative diseases such as noninsulin-dependent diabetes and obesity).

- Elucidation of the role of the long-lasting effects of malnutrition not only on child development, but in predisposing individuals to chronic and infectious diseases, and in age-associated illness and disease later in life.

- Recognition of the recursive relationships between malnutrition and disease; acute and chronic diseases may cause secondary undernutrition and malnutrition, which in turn may worsen disease severity or duration.

Knowledge of Nutrients and their Functions in Health and Disease:

- Further clarification and quantification of nutrient needs for bodily functions and processes, and how these needs vary depending on the function of interest, by age, stage of life, and health status. (e.g., dietary reference intakes).

- Growing recognition of special nutrient needs of cells, organs or organ systems for specific nutrients (e.g., glutamine and fiber and gastrointestinal function).

- Clarification of the special nutrient needs of certain age, sex, and life stage groups (e.g., premature and low birth weight infants, the elderly, pregnant, and lactating women).

- Discovery of new links between nutrient deficiency and disease (e.g., folic acid deficiency and neural tube defects); nutrient excesses and adverse outcomes (e.g., vitamin B-6 excess and peripheral neuropathy).

- Expansion of a focus solely on nutrients to one that includes other food constituents with healthful or harmful biological effects (e.g., dietary fiber, glutamine, and carnitine).

- Greater understanding of the importance of dietary patterns and dietary quality and interactions between nutrients on health (e.g., atherogenic dietary patterns).

- Recognition of the importance of physical activity on metabolism of nutrients and on nutritional status.

Prevalence of Malnutrition, Nutrition Monitoring, and Risk Factor Surveillance:

- Growing availability of population-based estimates of the prevalence of risk factors for malnutrition and indicators of overt malnutrition.

- Development of national nutritional status monitoring programs (e.g., NHANES I, II, and III) and dietary status monitoring (e.g., CSFII and others).

- Development of evidence-based dietary information and guidance for Americans (e.g., Dietary Guidelines, USDA Food Pyramid, and nutrient labels on foods).

- Evolution of generally agreed upon preventive-oriented national health and nutrition objectives (e.g., Promoting Health, Preventing Disease, Objectives for the Nation 1980; Healthy People 1990, Healthy People 2000, and Healthy People 2010).

Appendix 3—
Some Relevant Advances in Nutritionists' Thinking About Food Security

19th Century

British famine handbook used in Colonial India in the 19th century for very acute food insecurity. In Europe, recognition of lesser degrees of food insecurity not yet reflected in stark biology of death rates rose dramatically due to starvation was also recognized as important. In the 19th century, British and German social and public welfare concepts of food insecurity based on income was always highly charged politically, chiefly a notion of social reformers; then later piqued interests of nutrition scientists.

Early 20th Century

Early efforts in this country in the 20th century included the President's Homes Commission but no specific standards for measuring it. Rationing in World War I was somewhat of a programmatic attempt to deal with food insecurity.

Great Depression

The Great Depression, clearly the worst time in the century, and poverty food insecurity was widespread enough to concern everyone.

World War II

National food security was a concern in World War II, especially in Europe, and the U.S. rationing was a food security attempt.

Post-World War II

Food programs in post-1950 were directed against lack of food security but relied on poverty measures to determine need.

Kennedy/Johnson Great Society

Adelson's estimate based on the notion that food should be a third of total expenditures emerged in 1960s.

Nixon Administration

White House Conference on Food Nutrition and Health, 1969. Food stamps were established in place of minimal income. The Senate Select Committee on Nutrition and Hunger Needs replaced the health-related criteria (infant mortality) used by the Citizens' Board of Inquiry in 1968 to designate 280 counties as "hunger counties" with criteria based only on income.

Carter Administration

Sympathy with idea but no specific measures other than above.

Reagan and Bush Administrations

Not favorable to notion of categorical programs; attempts to block grant and consolidate programs, to give States more discretion; no specific means for monitoring progress adopted. Congressional pressure opposed to dismantling food programs. Concept of better food security measures gained momentum in the 1980's; nutrition science organizations adopted the general concept from work in international development; some States (NY and others), private advocacy groups (Food Research and Action Center) and universities tried to refine, validate and replicate measures. U.S. Department of Agriculture's Food and Consumer Service (FCS) and the National Center for Health Statistics (NCHS) were concerned about developing better measures. In the late 1980s, FCS and NCHS began to consider better ways to measure food security; then basic food security measures were developed separately by Wehler and Radimer.

Clinton Administration

The 1990s need for more specific food security measures for specific target groups became recognized in nutrition community. The Life Science Research Office's expert panel codifies consensus conceptual definitions of food security, food insecurity, and hunger under a cooperative agreement involving the American Institute of Nutrition and the U.S. Department of Health and Human Services' Office of Disease Prevention

and Health Promotion, published in the November 1990 supplement to the Journal of Nutrition as "Core Indicators of Nutritional State for Difficult-to-Sample Populations." National Nutrition Monitoring and Related Research (NNMRR) Act of 1992 mandated "a standardized mechanism and instrument(s) for defining and obtaining data on the prevalence of "food insecurity" or "food insufficiency" in the U.S. and methodologies that can be used across the NNMRR Program and at State and local levels." The responsibility for developing food security and hunger measures was jointly assigned to FCS and NCHS, which began the Food Security Measurement Project. The congressional restructuring and reinventing government efforts, with respect to food and other categorical programs, and new federalism efforts to devolve welfare programs and other programs such as health to State- and local-level added impetus to development efforts. FCS and NCHS convened the first Conference on Food Security Measurement and Research in January 1994; a consensus "Food Security Measurement Questionnaire" was developed and refined over the following year, and implemented by the Census Bureau in the April 1995 Current Population Survey.

Today

Growing acceptance of measures of food security was a result of the Food Security Measurement Study and the reports released by USDA/FCS in September 1997.

Food security and hunger measures similar to measures for poverty and quality of life, once thought to be nothing more than rhetoric, or basically impossible, are now available. Now it is recognized that reliable and valid food security and hunger measures are not only possible, but have been developed.

The Dynamic Determinants of Food Insufficiency

Craig Gundersen and Joseph Gruber

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Introduction

Households with incomes far below the poverty line face serious constraints on their income and must make choices that may result in food insufficiency. What is surprising, perhaps, is that in 1992 only 10.2 percent of households with monthly incomes below 50 percent of the poverty line sometimes or often did not get enough to eat, i.e., were food insufficient. Households above the poverty line, however, are expected in principle to have enough income, before expenses, to afford enough food to eat.[1] Despite this, 3.6 percent of households with monthly incomes between 100 and 200 percent of the poverty line were food insufficient. Previous work using static analyses has examined why a significant minority of households are food insufficient, while households with nearly identical incomes are food sufficient. These include analyses of the effect of non-income differences between households (Rose, Gundersen, and Oliveira, 1998) and the effect of food stamps on food insufficiency (Gundersen and Oliveira, 2000).

What has not been considered, however, is how the recent economic histories of food-sufficient and food-insufficient households may differ in ways not portrayed by current income. The importance of past actions and expectations of the future are incorporated into many other economic analyses, such as the effect of savings decisions on current consumption (e.g., Friedman, 1957), the influence of human capital investments on current pay (e.g., Mincer, 1958), and the effect of monetary authorities' expected actions on actors' decisions (e.g., Kydland and Prescott, 1977). In the poverty literature, the measurement of poverty has incorporated past consumption and savings decisions of households (e.g., Slesnick, 1993; and Wolff, 1990) and the welfare participation decision has been expressed in terms of past, present, and future actions (e.g., Blank and Ruggles, 1996; and Fitzgerald, 1995).

In this paper, we move beyond looking at just current economic status as an explanation for food insufficiency. Households make consumption decisions over multiple periods based on their expectations of future income, their current income, their stock of savings, and their ability to borrow. Unexpected changes to a household's budget and losses of income can adversely affect these consumption decisions and render any household susceptible to food insufficiency. This is especially true for low-income households; while middle- and high-income households have the resources to mitigate the repercussions of job loss or other unexpected shocks to a family's budget, low-income households have more limited resources to weather these shocks. By looking at current income alone, we do not accurately portray the dynamic nature of households' consumption decisions.

We begin this paper by establishing a theoretical framework that allows us to examine the influence of current, past, and future incomes on food insufficiency. Two possible hypotheses emerge out of this framework. First, households with average incomes that are sufficiently low and no savings are more likely to be food insufficient. Second, households facing liquidity constraints are more likely to be food insufficient. These theoretical explanations are then pursued empirically with the 1991 and 1992 panels of the Survey of Income and Program Participation (SIPP). Our empirical investigation does not formally test the implications from the theoretical model, rather it proceeds by comparing food-

[1]The poverty line in the United States was originally defined as three times the cost of the Thrifty Food Plan, a minimally adequate, food-sufficient diet constructed by the U.S. Department of Agriculture. Since then it has been updated annually by the Consumer Price Index. Food prices have risen more slowly than other goods so today the purchase price of the Thrifty Food Plan constitutes less than one-third of the poverty line. Therefore, households with incomes above the poverty line should be able to purchase a food-sufficient diet.

insufficient and food-sufficient households over a 9-month period. We find that, consistent with the theoretical model, food-insufficient households have relatively low average incomes, face more income shocks, and are less able to weather these shocks with saving or through borrowing than food-sufficient households.

Economic Theoretical Explanations For Food Insecurity

Because we are analyzing the dynamic determinants of food insufficiency, our theoretical model has a household maximizing its utility subject to a budget constraint over multiple periods.[2] At time *t=0*, a household solves the following problem:

$$\max E_0\left(\sum_{t=0}^{T} U(F_t, OG_t)\right),$$

subject to:

$$A_{t+1} = A_t + Y_t - p_F F_t - p_{OG} OG_t ,$$

where E is the expectations operator, T is the end of the planning horizon, U is the one-period utility, F is food consumption, OG is other goods consumption (i.e., non-food items), A is assets, Y is income, p_F is the price of food, and p_{OG} is the price of other goods. Except for income, all of the variables are known with certainty. Households know the mean of their income and the variance. They do not, however, know when income shocks (deviations from mean income) will occur. Another key assumption in this model is that households presume they can borrow against future income. For simplicity, we do not incorporate discounting or interest earned on assets into our model; this is the same as setting the interest rate and the discount rate equal to zero.

Solving this maximization problem leads to the following first-order conditions:

$$\frac{\delta U/\delta F_t}{\delta U/\delta OG_t} = \frac{p_F}{p_{OG}}, \frac{\delta U}{\delta F_t} = \frac{\delta U}{\delta F_{t+1}}, \frac{\delta U}{\delta OG_t} = \frac{\delta U}{\delta OG_{t+1}} .$$

Under the assumption of a quadratic utility function, this implies that there will be constant levels of consumption of food and other goods. Expressed in total consumption, C, at any t,

$$C_t = \frac{1}{T} E_0\left(\sum_{t=0}^{T} Y_t\right) + \frac{1}{T} A_0 .$$

Under the assumption that households know the mean income over their planning horizon, this is expressed as:

$$C_t = \bar{Y} + \frac{A_0}{T} .$$

Expressed in terms of food and other goods,

$$p_F F_t + p_{OG} OG_t = \bar{Y} + \frac{A_0}{T} .$$

For any household, let $\underline{F}$ be the minimum amount of food needed to ensure a food-sufficient diet and let $\underline{OG}$ be the minimum bundle of other goods needed to ensure nondeprivation defined over those other goods.[3] A household is food insufficient in any period t if $F_t < \underline{F}$ and is other good deprived in any period t if $OG_t < \underline{OG}$. Let $\underline{Z} = p_F \underline{F} + p_{OG} \underline{OG}$ be the minimum expenditure needed to maintain food sufficiency and other goods sufficiency. A graphical depiction of $\underline{Z}$ is in figure 1.[4] Within this general framework, we analyze two possible reasons for why households may be food insufficient.

Average Income and Initial Assets are Too Low

The possibility of food insufficiency and other-goods insufficiency exists if:

$$\bar{Y} + \frac{1}{T} A_0 < \underline{Z} .$$

For this household, a choice must be made between food insufficiency and deprivation over

[2] In this section, we provide two theoretical explanations for how food insufficiency can occur in a dynamic context. In the appendix is a third theoretical explanation.

[3] For example, a household should be adequately sheltered. For more on conceptions of deprivation over other dimensions of well-being, see, e.g., Gundersen, 1996.

[4] Figures follow tables at the end of this paper.

other goods; its choice set based on its current income and average initial assets does not include food sufficiency and nondeprivation over other goods. In what follows, we only discuss the food insufficiency outcome—it is presumed that a household can always avoid food insufficiency when income plus average initial assets are less than $\underline{Z}$, but only if it accepts deprivation over other goods. There is nothing in the general utility function that we have specified, of course, that would imply such a choice. While households can presumably borrow against future income, even with borrowing they cannot avoid food insufficiency in every period because their average income is too low. For such households, food insufficiency is an inevitable outcome in at least some periods.

There are two related explanations for food insufficiency. First, households may face higher prices on food and/or other goods than the prices used to establish $\underline{Z}$. For example, households living in central cities may face higher housing prices than someone in a rural area. Second, some households may have a higher other-goods deprivation level than other households. For example, a household with a disabled child faces higher medical expenditures than one without a disabled child. If either of these explanations holds, the value of $\underline{Z}$ will be higher.

Another explanation for food insufficiency is choice. Some households, even when food sufficiency and other-goods sufficiency is an option, may choose food insufficiency. For example, parents may forgo food for themselves to buy a small present for their child's birthday. These three explanations are in figure 2.

Negative Income Shock, Lack of Savings, and Liquidity Constraints

We now consider households for which average income is at a level that the choice of food sufficiency is seemingly possible in every period, i.e., where $\overline{Y} + \frac{1}{T} A_0 \geq \underline{Z}$. In the absence of negative income shocks, these households need not become food insufficient. However, the existence of income shocks, their timing, their magnitude, and liquidity constraints may place households in danger of food insufficiency.

Consistent with the maximization of utility discussed earlier (which implies that $A_T = 0$), a household has the following asset accumulation equation:

$$A_j = A_0 + \sum_{t=0}^{j} Y_t - \sum_{t=0}^{j} C_t = A_0 + \sum_{t=0}^{j} Y_t - j\overline{Y} - \frac{j}{T} A_0 .$$

The change in assets from one period to the next is then:

$$A_j - A_{j-1} = Y_j - \frac{A_0}{T} - \overline{Y} .$$

If there is a negative income shock (i.e., $Y_j < \overline{Y}$) such that:

$$A_{j-1} < -Y_j + \frac{A_0}{T} + \overline{Y} ,$$

then $A_j < 0$. In other words, a household does not have sufficient savings to maintain its desired consumption level. This is not a problem insofar as we assume households can borrow to sustain their desired consumption level. Suppose instead that these households suffer both an income shock and a credit rejection shock (i.e., they find that they are liquidity constrained).[5] Liquidity-constrained households have $A_j \geq 0$ for all j. This implies that the following must hold:

$$A_{j-1} \geq -Y_j + \frac{A_0}{T} + \overline{Y} = \overline{C} - Y_j ,$$

where $\overline{C}$ is the household's desired consumption level. If a household is liquidity constrained, and the income draw is such that:

$$A_{j-1} < \overline{C} - Y_j ,$$

then the household must deviate from the desired consumption to a level such that:

$$C_j \leq A_{j-1} + Y_j .$$

If this new level of consumption is less than the minimum income level needed to maintain food sufficiency and other-goods sufficiency, food

[5]For more on liquidity constraints, see, e.g., Deaton, 1991; and Deaton, 1992, pp. 194-213.

insufficiency is one consequence of this income shock. In other words, if:

$$C_j < \underline{Z} = p_F \underline{F} + p_{OG} \underline{OG}.$$

In the empirical section, we analyze these two explanations for food insufficiency by comparing food-sufficient and food-insufficient households. The data set we use for these comparisons is first described.

Data and Descriptive Results

This paper uses the 1991 and 1992 panels of the SIPP, a multipanel longitudinal survey of the noninstitutional population of the United States administered by the U.S. Department of Commerce, Bureau of the Census. The panel is constructed from a group of addresses selected for interviews at the start of the year. All individuals living at these addresses over the age of 15 are then interviewed every 4 months (each 4-month segment constitutes a wave) for 2½ years. These individuals are followed even if they change addresses, move into an existing household, or form a new household. Monthly information is collected on earnings, hours of work, health insurance coverage, school enrollment, asset income, participation in government programs (e.g., Medicaid, AFDC, and food stamps), and numerous other demographic variables. In each wave, a Core Module and Topical Module are administered; the Core Module is the same in every wave, but the Topical Module changes.

The Well-Being Topical Module, administered in Wave 6 of the 1991 panel and Wave 3 of the 1992 panel, has a series of questions on food insufficiency. Respondents are asked to describe their households' recent food intake in terms of the U.S. Department of Agriculture (USDA) food sufficiency question: "Which of these statements best describes the food eaten in your household in the last four months?" They have four choices: "enough of the kinds of food we want to eat; enough but not always the kinds of food we want to eat; sometimes not enough to eat; or often not enough to eat." Those households reporting that they sometimes or often do not get enough to eat are considered food insufficient and are asked a further question: "In what month(s) did your household not have enough to eat?"

Several studies have confirmed the validity of this USDA food sufficiency question as a measure of decreased food intake. Basiotis (1992) used national-level data to show that classification of respondents using this question was consistent with consumer theory regarding the demand for calories and food. Using data from the 1985-86 Continuing Survey of Food Intake by Individuals (CSFII), Cristofar and Basiotis (1992) found that usual food expenditures were lower in households reporting food insufficiency. The same study found that the mean food intake of women from food-insufficient households was lower than for food-sufficient women for 13 food groups, while the mean food intake of children from food-insufficient households was lower than for food-sufficient children for five food groups. Rose and Oliveira (1997) used the 1989-91 CSFII to show that after controlling for other factors that affect diet, food insufficiency was significantly related to decreases in nutrient intake at the household level. Calorie intake was 13 percent lower for food-insufficient households and the decrease in intake of 13 other nutrients ranged from 8 to 18 percent of consumption levels in food-sufficient households.

We examine households in the 8 months leading up to the first month of food insufficiency and their first (and perhaps only) month of food insufficiency. Figure 3 shows the structure of the breakdown. Waves 4, 5, and 6 of the 1991 panel and Waves 1, 2, and 3 of the 1992 panel are used in this analysis and these cover the identical time period. More precisely, Waves 6 and 3 cover the identical time period, and so forth. Households reporting that they were food insufficient for the first time in the first month of Wave 6 of the 1991 panel (Wave 3 of the 1992 panel) are examined in months one through nine; households reporting that they were food insufficient in the second month of Wave 6 (Wave 3) are in the sec-

ond category, etc.[6] The breakdown is as follows: 63 percent in the first 9 months, 9 percent in the second, 14 percent in the third, and 14 percent in the fourth. We assign food-sufficient households such that the percentage of food-sufficient households is 63 percent in the first 9 months, 9 percent in the second, etc. Through this assignment, rather than just, say, placing all food-sufficient households in months 1 through 9, we correct for any time-structured bias that may be present in the data. Unfortunately, the food insufficiency question is only asked in Wave 3 (Wave 6). The months for which we have information about food insufficiency are displayed in the banded portion of figure 3.

Our sample is confined to households with average incomes in Wave 3 (Wave 6) below 200 percent of the poverty line. Eighty percent of food-insufficient households are in this category, and only 0.06 percent of households above 200 percent of the poverty line are food insufficient.

Food-insufficiency rates for selected variables are presented in table 1.[7] These are broken into three categories: all households with monthly incomes below 200 percent of the poverty line; households below the poverty line; and households between 100 and 200 percent of the poverty line. The variables are all from the final month of the 9-month categories discussed above. Current income clearly mattered in predicting who was food insufficient; 10.2 percent of households with incomes less than 50 percent of the poverty line were food insufficient, while 2.6 percent of households with incomes more than 150 percent of the poverty line were food insufficient. In the ensuing discussion, the results for all households are discussed—the ordering of categories is roughly similar for households below and above the poverty line, though the food-insufficiency rates are always higher for those below the poverty line. Homeowners are much less likely to be food insufficient than renters: 8.3 versus 3.1 percent. Transfer recipients (Aid to Families with Dependent Children, Supplemental Security Income, and/or food stamps) are more likely to be food insufficient than nonrecipients.[8] Food insufficiency was lower in households headed by a senior citizen than those headed by others, 1.9 percent versus 7.8 percent. Food-insufficiency rates generally increased with household size, ranging from 4.0 percent in one-person households to 8.0 percent in six-person households. Household composition is broken into four categories: wife and husband with children, wife and husband without children, single person with children, and single person without children. Wife and husband with no children had the lowest food insufficiency rates (2.8 percent), while single-parent households had the highest (10.4 percent). Households are classified into four race-ethnicity categories: non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other. Non-Hispanic white, non-Hispanic black, and non-Hispanic other households had similar food insufficiency rates (5.0, 5.7, and 6.3 percent), while Hispanics had higher rates (9.3 percent).[9]

[6]Because each wave has four rotation groups, each with different interview months, the calendar months will differ between households even for households reporting that they were food sufficient in the first month. The months in Wave 6 (Wave 3) range from September to December 1992.

[7]Tables are at the end of this paper.

[8]This does not imply, of course, that households receiving transfers are worse off than if they did not receive the transfers. For more on the relation between food stamps and food insufficiency, see Gundersen and Oliveira, 2001.

[9]These bivariate results give us a useful description of the relation between various variables and the extent of food insufficiency. While illustrative, these do not give us information about the relative influence of the variables. Previous work using a sample of all households in the SIPP found that, after controlling for other factors in the preferred model, low-income households, larger households (with economies of scale), single-person households without children, single-parent households with children, non-high school graduates, and renters were all more likely to be food insufficient (Rose, Gundersen, and Oliveira, 1998, table 3, column 6). Previous work using a sample of households eligible for the Food Stamp Program found that after controlling for the simultaneity of the food stamp participation decision and food insufficiency status, households without a senior or a disabled person and households losing a job were more likely to be food insufficient (Gundersen and Oliveira, 2001, table 4, column 2).

Empirical Results

We now empirically examine the theoretical explanations discussed above for why households may be food insufficient through a comparison of food-insufficient and food-sufficient households in the 9 months leading up to their first spell (possible spell) of food insufficiency.[10] We begin by considering the importance of low average income and high minimum income levels to the food insufficiency outcomes. We then look at the influence of income shocks, lack of savings, and liquidity constraints on the food insufficiency outcomes.

Average Income and Initial Savings are Too Low

Food-insufficient households have lower average monthly incomes than food-sufficient households. Average monthly income is calculated by summing over the 12 months of Waves 1, 2, and 3 (Waves 4, 5, and 6) and dividing by 12. Out of households with incomes below 50 percent of the poverty line, 9.8 percent were food insufficient; with incomes between 50 and 100 percent of the poverty line, 8.6 percent; with incomes between 100 and 150 percent, 5.3 percent; and with incomes more than 150 percent, 3.2 percent. With the exception of the first two categories, the higher food-insufficiency rates due to lower income is statistically significant.

There is also some evidence that average monthly income is a more important determinant of food insufficiency than current monthly income. The average monthly income for food-sufficient households is $1,365 and for food-insufficient households is $1,130, a difference of 17.2 percent. The average income in the first month of food insufficiency (or the first month assigned to food-sufficient households) is $1,141 for food-sufficient households and $996 for food-insufficient households, a smaller difference of 12.7 percent.[11] A low average income will have its largest effect on households without savings. We consider the evidence on lack of savings in the "Lack of Savings" section below.

We find some evidence to support differences in prices, in minimum expenditures needed for other goods sufficiency, and in preferences as explanations for food insufficiency. As seen in table 2, 8 percent of food-sufficient households have a non-senior, disabled person, while 13 percent of food-insufficient households have a non-senior, disabled person.[12] Expenditures needed for disabled persons (e.g., in-home care if the disability is serious enough) but not for nondisabled persons leads to a higher other-goods sufficiency line. A similar explanation holds for household composition. Single-parent households with children are more likely to be among food-insufficient households (35 versus 18 percent), while single-person households without children are less likely to be among food-insufficient households (33 versus 43 percent). Households with children face certain expenditures (e.g., school costs and additional clothing) that households without children do not face leading to higher other-goods sufficiency lines. The slightly higher percentage of food-insuffi-

[10]Three limitations with the SIPP prevent a more formal treatment of our theoretical model. First, there is information on food-insufficiency status only in Wave 3 (Wave 6). Thus, we do not know if, say, an income shock in month 2 has an immediate effect or only an effect in month 9. Second, the timeframe of the SIPP is relatively short: 12 months in the 1992 panel and 18 months in the 1991 panel. Because savings and consumption decisions often occur over many years, we cannot adequately incorporate these into a model using the SIPP. Third, the SIPP only has limited information about consumption. Thus, we do not precisely know the trade-offs households are making between food consumption and other consumption.

[11]The average monthly income will by definition be substantially higher than the average income in the first spell of food insufficiency due to the sample selection method. Households with average monthly incomes less than 200 percent of the poverty line in Wave 3 (Wave 6) were selected into the sample. Households whose incomes were lower in previous waves but rose to above 200 percent of the poverty line in Wave 3 (Wave 6) were not included, but households whose incomes were higher in previous waves but fell to below 200 percent of the poverty line were included.

[12]Persons are defined as disabled in the SIPP if they have "...a physical, mental or other health condition that limits the kind or amount of work..." that they can do. Disability status is assigned to all members of the household between the ages of 15 and 69.

cient households paying for child care (3.2 versus 2.0 percent) is consistent with this explanation.

Food-insufficient households pay nearly one-third more for housing than food-sufficient households ($302 versus $232 in rent or mortgage payments), although this difference is not statistically significant at usual confidence levels. The rent statistics are for only the 1991 panel and, therefore, draw upon a smaller sample size than other statistics. This higher expenditure on housing could be due to higher housing prices in an area and/or a choice by food-insufficient households to live in better quality housing.

Negative Income Shocks, Lack of Savings, and Liquidity Constraints

Low average income is one explanation for food insufficiency, but the large number of households with even average incomes above the poverty line (and hence, supposedly able to choose food sufficiency) means other explanations are needed. We now turn to these other explanations.

Negative Income Shocks

Within our dynamic framework, a negative income shock is one explanation for why households face the possibility of food insufficiency. For our purposes, a "negative income shock" is defined as any event that causes a decline in the resources available to a household to purchase food. The effect of this negative income shock may have negative consequences beyond the first month it is experienced; in fact, the full effect may be felt only once households drain their available savings.[13] Previous studies have noted the importance of recent economic changes on the probability of food insufficiency. For example, Campbell and Desjardins (1989, footnote 53) found that 85 percent of food-insecure households experienced a major event in their household in the past 12 months, the most common being a loss of employment. Other major factors influencing the resources available to a household include spouse leaving, birth of a baby, and moving. We say a household has experienced a negative income shock if one has occurred in any of the 9 months. The effects of two income shocks—loss of earnings and loss of food stamps—were influential on food insufficiency and were significant at the 95-percent confidence level. The results discussed in this section are in table 3.

Loss of earnings. For each month for every household member, SIPP has information on earnings from wage and salary work and self-employment. This information is summed across household members to arrive at a household earnings measure. We say a loss of earnings was determined to have occurred when a month in which income was earned is immediately followed by one in which there is no earned income. This definition of earnings loss would include a scenario in which a steady stream of earned income is interrupted by a single zero-income month. Thus, the loss of earnings need not be permanent to be recorded, using the rationale that even a temporary loss of income constitutes a negative shock. However, a period without work that straddles 2 calendar months could slip through this definition of earnings loss without detection. For example, a household that has no earnings one week into the calendar month and then has earnings in the last week of the next calendar month would appear to have had continuous earned income when in actuality the household experienced a 6-week period without earned income. A household without earnings does not necessarily mean that everyone is unemployed; a self-employed person without any sales, in the past month, for example, could still be employed but not earning any money.

Food-insufficient households are more likely to have lost earnings than food-sufficient households. Out of all households, 15.3 percent went from some earnings to zero earnings in the previous 9 weeks. Food-insufficient households had an earnings-loss rate of 23.6 percent, while food-

[13]Due to the data limitations discussed above, we do not necessarily know households' food-insufficiency status in every month following the income shock and thus do not know when the full effect is felt.

sufficient households had an earnings-loss rate of 14.8 percent.

Loss of food stamps. Following the method outlined earlier for determining loss of employment, a loss of food stamp benefits is said to occur when a month of positive benefits is followed by a month in which no benefits are collected. Thus, as with loss of earnings, a single month of zero food stamp income within an otherwise positive stream of benefits would constitute a loss.

To be eligible for food stamps, a household must have a gross income less than 130 percent of the poverty line; a net income (after various deductions) less than 100 percent of the poverty line; and assets less than $2,000 ($3,000 for elderly households). Because the gross income cutoff in our paper is 200 percent of the poverty line, not everyone in our sample had the possibility of receiving food stamps. As seen in table 2, 20 percent of food-sufficient households received food stamps, while 39 percent of food-insufficient households received food stamps.

A loss of food stamps may have an even larger effect on food insufficiency than a loss in earnings. Numerous studies based on experiments where food stamp recipients received cash instead of food stamps have shown that a dollar of food stamps has a larger influence on the marginal propensity to consume out of food stamps than out of cash (for recent articles, see Breunig et al., 2001; and Levedahl, 1995). The effect of losing food stamps may thus produce a larger increase in the probability of food insufficiency, in comparison with the same dollar loss in earnings.

Food-insufficient households are almost three times as likely to have lost food stamp benefits as food-sufficient households. Out of all households, 5.9 percent lost their food stamp benefits. Food-insufficient households had a food stamp-loss rate of 14.8 percent, while food-sufficient households had a food stamp-loss rate of 5.4 percent. In a study of hunger among adult patients receiving medical care, Nelson, Brown, and Lurie (1998) also found that loss of food stamps was a significant determinant of food insufficiency.

One reason households lose their food stamps is because their gross income increased enough to render them ineligible. If this were the case, the negative effect of losing food stamps may be mitigated by their increased income. This situation does not appear to be the case for most households. Only 13.8 percent of food-insufficient and 12.3 percent of food-sufficient households lost food stamps because their gross monthly income rose to above 130 percent of the poverty line.[14] A large percentage of households losing their food stamps, however, do have incomes above 130 percent of the poverty line before and after they receive food stamps. Among food-insufficient households, 26.2 percent have incomes that are too high, while 21.0 percent of food-sufficient households have incomes that are too high. This percentage of seemingly ineligible households is roughly consistent with other analyses that have used more precise measures of eligibility (e.g., Cody and Trippe, 1997).

Variability of income may also be a determinant of food insufficiency. Households with higher variability of income experience more shocks and/or larger shocks than households with lower variability of income.

We constructed income variances as a proportion of deviation from the mean monthly income for all households. Strict numerical variance, however, obscures the magnitude of the difference in the severity of income shocks experienced by food-sufficient and food-insufficient populations. High mean income on the part of food-sufficient households (see table 2) allows the appearance of greater variance than low mean income food-insufficient counterparts. Adjusting for the difference in mean incomes between the two populations, however, reveals that as a proportion of income, food-insufficient households have a

[14]There are other reasons why households could become ineligible. Two of the more common explanations would be a decrease in household size or an increase in a household's assets. We did not find either of these to be explanations in any case.

higher variance. For food-sufficient households, there was a variance of 18 percent around mean income, while for food-insufficient households, the variance was 31 percent.

Other possible shocks to the resources used to avoid food insufficiency include a change in household composition (e.g., a divorce or birth of child), moving, and loss of transfer payments (AFDC and SSI). There were no statistically significant differences between food-sufficient and food-insufficient households in these factors.

Lack of Savings

Households experiencing a negative income shock and/or unexpected new expenses can avoid the problem of decreased consumption if they have alternative sources of funds available. In this section, we consider three statistically significant differences (at a 95-percent confidence level) between food-insufficient and food-sufficient households in terms of savings stocks. Evidence about lack of savings is relevant for households with income shocks, but it is also relevant for households with low average income. As discussed in the theoretical section of this paper, households with low average incomes can avoid food insufficiency if they have high enough initial savings level.

Liquid assets. For each wave, SIPP collects information on whether a household receives interest (reinvested or distributed) from a wide variety of liquid assets. Assets include passbook savings accounts, money market deposit accounts, certificates of deposit, interest-earning checking accounts, money market funds, U.S. Government securities, municipal or corporate bonds, stocks, and mutual funds. A household is said to have positive savings if they receive interest from one or more of these assets. Uninterrupted positive returns throughout the entire sample period were required for a household to be marked as having access to liquid assets.

There is a sharp disparity in the amount of savings available to food-sufficient and food-insufficient households. Only 3.6 percent of food-insufficient households have savings, while 26.7 percent of food-sufficient households have savings. These figures, though, should be considered a lower-bound estimate on the number of households with access to liquid assets, because money in the form of cash or noninterest-bearing checking accounts are not included in this measure.

Homeownership. Owning a home provides households with three main ways to prevent food insufficiency from occurring in face of an income shock. First, households without mortgages and households with mortgage payments less than the rental value of their homes have more money available for food than if they were renting. Second, homeowners can avoid making needed repairs to their houses whereas renters needing the same repairs may find their rent increased. This is akin to liquidating an asset. Third, homeowners can borrow against the equity present in a house. Instead of drawing down a liquid stock of savings, homeowners can draw down the equity in their homes. Households, primarily seniors, receiving a monthly payment in exchange for the equity in their house (reverse mortgages) collect a similar flow from their housing asset.

As with savings, to be considered a homeowner, a household was required to maintain home ownership throughout the sample period. Almost twice as many food-sufficient households own their home in comparison with food-insufficient households: 46.8 to 24.0 percent, respectively.

Health insurance. A household does not draw upon insurance as they draw upon a liquid asset or a home, but the effect can be similar. Insurance enables a household to afford unexpected expenditures for other goods, avoiding the possibility of food insufficiency. Because health care costs can be especially extreme for some households, we look at whether households have health insurance.

Households covered by health insurance for the entire sample period were counted as having health insurance. Health insurance includes private health insurance, employer-provided health insurance, Medicaid, and Medicare. Food-

insufficient households are significantly less likely to be covered by health insurance than their food-sufficient peers (69.6 to 56.7 percent).

While we observe income shocks, we do not observe unexpected increases in expenses, e.g., a major appliance or an automobile needing repairs. These three forms of savings help to alleviate the consequences of both income shocks and unexpected increased expenses. In table 4, for the observed income shocks discussed earlier, we further examine the households losing food stamps and households losing earnings by types of savings available.

Not only are food-insufficient households more likely to experience observed income shocks, those suffering from income shocks are less likely to have the resources to ameliorate those shocks. Food-insufficient households losing earnings are especially ill-suited to weather these shocks, compared with food-sufficient households losing earnings. Only 2.3 percent of food-insufficient households losing earnings have liquid savings (compared with 20.2 percent for food-sufficient households); 23.0 percent are homeowners (compared with 42.1 percent); and 45.6 percent have health insurance (compared with 51.7 percent). Similar differences between food-sufficient and food-insufficient households, although less stark, exist for households losing food stamps.

Liquidity Constraints

Households experiencing negative income shocks can avoid food insufficiency if they have enough savings and/or if they can borrow. While evidence of savings differences between food-insufficient and food-sufficient households exists (as discussed earlier), we are unable to ascertain directly from the SIPP whether households are liquidity constrained. The SIPP does not include questions about whether loans were applied for and rejected nor are there questions about borrowing levels. Moreover, the short time length of the SIPP and the lack of consumption questions prevents an analysis of liquidity constraints similar to that of, e.g., Zeldes (1989).

Previous research, however, has shown that liquidity-constrained households are more likely to have the characteristics of food-insufficient households. Zeldes (1989) showed that households with less than 2 months worth of average income in liquid savings were liquidity constrained.[15] As seen in table 3, food-insufficient households have lower savings rates. Jappelli (1990, table III) examined the factors that differentiated "unconstrained households" from "rejected applicants" and "discouraged borrowers" (i.e., households answering "yes" to the question: "Was there any time in the past few years that you (or your husband/wife) thought of applying for credit at a particular place but changed your mind because you thought you might be turned down?"). The probability of receiving credit was greater with high income and high wealth, and white households and homeowners were more likely to receive credit. Food-sufficient households are more likely than food-insufficient households to have these characteristics (tables 2 and 3).

Conclusion

In studying the dynamic determinants of food insufficiency, we have sought to go beyond simple, and not completely satisfying, mean income level explanations of food insufficiency to consider how the actual time-path of income can affect a household's food consumption decisions. Whereas low average income is an intuitively appealing explanation for food insufficiency, the data do not wholeheartedly support such a conclusion. The coexistence of food-sufficient households with incomes below 50 percent of the poverty line and food-insufficient households with incomes above 150 percent of the poverty line is evidence that mean income and food insufficiency are not perfectly correlated.

Further insight into the determinants of food insufficiency is provided by our study of income

[15] A household is liquidity constrained in Zeldes (1989) if, in comparison with the unconstrained case, the marginal utility of consumption in the current period is higher relative to the next period.

dynamics. We have shown that food-insufficient households are disproportionately likely to suffer from income shocks associated with the loss of earnings and food stamps. Additionally, food-insufficient households were calculated to experience a greater variance of income, measured as a proportion of mean income, than their food-sufficient peers, lending further credibility to the conjecture that the path of income and income shocks are important components for determining food insufficiency.

The amount of savings available to a household in the event of a negative income shock is an important determinant of food insufficiency. Only a small number of food-insufficient households possess any savings to fall back on in the event of a negative income shock. Low rates of food-insufficient homeownership and health insurance coverage also indicate vulnerability to negative income shocks, since these households do not have options to borrow against their homes or use health insurance to smooth consumption over health crises. A household with the ability to borrow can smooth consumption over any temporary drop in income through the assumption of debt. However, we have shown (indirectly) that food-insufficient households are often liquidity-constrained households. Liquidity constraints are an important aspect of constructing a hypothesis of income shock-initiated food insufficiency.

This paper informs policy in three primary ways. First, we emphasize the influence of savings and access to credit on the well-being of low-income households. At least in terms of food insufficiency, policymakers may wish to seek ways to improve the ability of low-income households to weather negative income shocks. Efforts to make credit more readily available for low-income households with low credit risks, improve their credit-worthiness, and encourage savings can help to improve low-income households' well-being in instances of negative income shocks. Second, we provide some support for using asset tests as part of the eligibility criteria for the Food Stamp Program. Currently, households with liquid assets above $2,000 ($3,000 for seniors) are ineligible for food stamps, even if they are income eligible. Given the results here, insofar as having some assets is a very imperfect method of ascertaining food stamp eligibility, asset ineligible households appear to be at less risk of food insufficiency then asset eligible households. Third, we show how important maintaining receipt of food stamps is to the food-insufficiency status of eligible households. As analysis of the effects of welfare reform on low-income households continues, one aspect that might be considered is how loss of food stamps (or other programs) affects the well-being of households over more direct measures such as food insufficiency. In particular, these analyses may wish to consider the effects of limited food stamp eligibility on able-bodied adults without dependents (ABAWD's) and on the still-eligible former recipients of Temporary Assistance for Needy Families who no longer receive food stamps.

References

Basiotis, P. Peter. "Validity of the Self-Reported Food Sufficiency Status Item in the U.S. Department of Agriculture's Food Consumption Surveys," *American Council on Consumer Interests 38th Annual Conference: The Proceedings.* V.A. Halderman (ed.). 1992.

Blank, Rebecca, and Patricia Ruggles. "When Do Women Use Aid to Families with Dependent Children and Food Stamps? The Dynamics of Eligibility Versus Participation," *The Journal of Human Resources.* Vol. 31, No. 1. pp. 57-89. 1996.

Breunig, Robert, Indraneel Dasgupta, Craig Gundersen, and Prasanta Pattanaik. *Explaining the Food Stamp Cash-Out Puzzle.* Food Assistance and Nutrition Research Report Number 12. U.S. Department of Agriculture, Economic Research Service. April 2001.

Campbell, Cathy, and Ellen Desjardins. "A Model and Research Approach for Studying the Management of Limited Food Resources by Low Income Families," *Journal of Nutrition Education.* Vol. 21, No. 4. pp. 162-170. 1989.

Cody, Scott, and Carole Trippe. *Trends in FSP Participation Rates: Focus on August 1995.* Mathematica Policy Research, Inc. Washington, DC. 1997.

Cristofar, Sharron P., and P. Peter Basiotis. "Dietary Intakes and Selected Characteristics of Women Ages 19-50 Years and Their Children Ages 1-5 Years by Reported Perception of Food Sufficiency," *Journal of Nutrition Education.* Vol. 24, No. 2. pp. 53-58. 1992.

Deaton, Angus. "Saving and Liquidity Constraints," *Econometrica.* Vol. 59, No. 5. pp. 1,221-1,248. 1991.

Deaton, Angus. *Understanding Consumption.* Oxford: Clarendon Press. 1992.

Dow, James P., Jr., and Lars J. Olson. "An Analytic Solution to a Stochastic Consumption/Saving Problem with Liquidity Constraints," *Southern Economic Journal.* Vol. 58. pp. 459-464. 1991.

Fitzgerald, John. "Local Labor Markets and Local Area Effects on Welfare Duration," *Journal of Policy Analysis and Management.* Vol. 14, No. 1. pp. 43-67. 1995.

Friedman, Milton. *A Theory of the Consumption Function.* Princeton, New Jersey: Princeton University Press. 1957.

Gundersen, Craig. "Direct Measures of Poverty and Well-Being: A Theoretical Framework and an Application to Housing Poverty in the United States." Ph.D. thesis. University of California, Riverside. 1996.

Gundersen, Craig, and Victor Oliveira. "The Food Stamp Program and Food Insufficiency," *American Journal of Agricultural Economics.* 2001. Forthcoming.

Jappelli, Tullio. "Who is Credit Constrained in the U.S. Economy?" *The Quarterly Journal of Economics.* Vol. 105. pp. 219-234. 1990.

Kydland, Finn, and Edward Prescott. "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy.* Vol. 85, No. 3. pp. 619-637. 1977.

Levedahl, J. William. "A Theoretical and Empirical Evaluation of the Functional Forms Used to Estimate the Food Expenditure Equation of Food Stamp Recipients," *American Journal of Agricultural Economics.* Vol. 77. pp. 960-968. 1995.

Mincer, Jacob. "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy.* Vol. 66. pp. 281-302. 1958.

Nelson, Karin, Margaret Brown, and Nicole Lurie. "Hunger in an Adult Patient Population," *Journal of the American Medical Association.* Vol. 279, No. 15. pp. 1,211-1,214. 1998.

Rose, D., and V. Oliveira. *Validation of a Self-Reported Measure of Household Food Insufficiency with Nutrient Intake Data.* Technical Bulletin Number 1863. U.S. Department of Agriculture, Economic Research Service. 1997.

Rose, Donald, Craig Gundersen, and Victor Oliveira. *Socio-Economic Determinants of Food Insecurity in the United States: Evidence from the SIPP and CSFII Datasets.* Technical Bulletin Number 1869. U.S. Department of Agriculture, Economic Research Service. 1998.

Slesnick, Daniel. "Gaining Ground: Poverty in the Postwar United States," *Journal of Political Economy.* Vol. 101, No. 1. pp. 1-38. 1993.

Wolff, Edward. "Wealth Holdings and Poverty Status in the U.S.," *Review of Income and Wealth.* Vol. 36, No. 2. pp.143-165. 1990.

Zeldes, Stephen. "Consumption and Liquidity Constraints: An Empirical Investigation," *Journal of Political Economy.* Vol. 97, No. 2. pp. 305-346. 1989.

Table 1—Food-insufficiency rates by selected variables[1]

Variable	All households below 200 percent of the poverty line	Households below the poverty line	Households between 100 and 200 percent of the poverty line
		Percent food insufficient, weighted	
All households	5.7	9.2	3.6
Income of household, percent of poverty line:			
≤50 percent	10.2	10.2	—
> 50 and ≤ 100 percent	8.7	8.7	—
> 100 and ≤ 150 percent	4.6	—	4.6
> 150	2.6	—	2.6
Education of household head:			
Did not complete high school	6.0	9.8	3.0
High school graduate	5.5	8.7	3.9
Homeownership status:			
Owners	3.1	5.5	2.1
Renters	8.3	11.4	5.4
Transfer recipiency status:			
Household receives AFDC or SSI[2]	9.7	12.0	4.8
Household does not receive AFDC or SSI[2]	4.6	7.5	3.4
Food stamp recipiency status:			
Household receives food stamps	10.3	11.4	6.8
Household does not receive food stamps	4.4	7.5	3.3
Senior citizen status:			
< 65 years of age	7.8	11.1	5.4
> 65 years of age	1.9	4.4	.9
Disabled nonsenior citizen in household:			
Non-disabled	4.8	8.1	3.0
Disabled	8.5	12.2	5.7
Household size:			
1 person	4.0	6.0	2.6
2 persons	5.1	9.1	3.3
3 persons	7.6	12.1	4.9
4 persons	7.5	12.8	4.3
5 persons	7.1	12.4	4.1
6 persons	8.0	9.2	6.8
7 or more persons	7.1	9.9	4.0
Household composition:			
Wife and husband with child(ren)	6.0	9.3	4.5
Wife and husband without children	2.8	6.8	1.7
Single person with child(ren)	10.4	13.8	5.9
Single person without children	4.4	6.5	3.1
Race-ethnicity of the household head:			
Non-Hispanic white	5.0	8.5	3.4
Non-Hispanic black	5.7	8.5	2.6
Hispanic	9.3	12.9	5.9
Non-Hispanic other	6.3	8.2	5.0

[1]Data are from the 1991 and 1992 panels of the Survey of Income and Program Participation. These figures are for the month of a household's first spell of food insufficiency. For food-sufficient households, these figures are for the "first month" as described on pages 95-96.

[2]AFDC is the abbreviation for Aid to Families with Dependent Children, and SSI is the abbreviation for Supplemental Security Income.

Table 2—Sample means for selected variables[1]

Variable	All households below 200 percent of the poverty line	Food-sufficient households	Food-insufficient households
		Mean, weighted (standard deviation)	
Income	1,075.02 (709.21)	1,085.46 (713.06)	902.27 (616.67)
High school graduate	.61	.61	.58
Homeownership	.48	.50	.26
Household receives AFDC or SSI[2]	.21	.20	.36
Household receives food stamps	.22	.20	.39
Household head more than 65 years of age	.36	.37	.12
Disabled nonsenior citizen in household	.09	.08	.13
Household size	2.65 (1.75)	2.63 (1.75)	3.0 (1.79)
Wife and husband with child(ren)	.24	.24	.25
Wife and husband without children	.14	.14	.07
Single person with child(ren)	.19	.18	.35
Single person without children	.42	.43	.33
Non-Hispanic white	.68	.68	.59
Non-Hispanic black	.17	.17	.17
Hispanic	.13	.12	.20
Non-Hispanic other	.03	.03	.03

[1]Data are from the 1991 and 1992 panels of the Survey of Income and Program Participation. These figures are for the month of a household's first spell of food insufficiency. For food-sufficient households, these figures are for the "first month" as described on pages 95-96.

[2]AFDC is the abbreviation for Aid to Families with Dependent Children, and SSI is the abbreviation for Supplemental Security Income.

Table 3—Income shocks and savings by food-insufficiency category[1]

Variable	All households below 200 percent of the poverty line	Food-sufficient households	Food-insufficient households
		Percent	
Income shocks:			
Households losing earnings	15.3	14.8	23.6
Households losing food stamps	5.9	5.4	14.8
Savings:			
Households with liquid savings	25.4	26.7	3.6
Homeowners	45.5	46.8	24.0
Households with health insurance	68.8	69.6	56.7

[1]Data are from waves 1 to 3 of the 1992 panel of the Survey of Income and Program Participation (SIPP) and waves 4 to 6 of the 1991 panel of the SIPP.

Table 4—Savings of food-sufficient and food-insufficient households experiencing income shocks[1]

Variable	With liquid savings	Homeowners	With health insurance
		Percent	
Food sufficient households:			
Households losing earnings	20.2	42.1	51.7
Households losing food stamps	3.5	33.0	47.2
Food insufficient households:			
Households losing earnings	2.3	23.0	45.6
Households losing food stamps	0	19.6	39.9

[1]Data are from waves 1 to 3 of the 1992 panel of the Survey of Income and Program Participation (SIPP) and waves 4 to 6 of the 1991 panel of the SIPP.

Figure 1
Minimum expenditures needed for food sufficiency and other goods sufficiency

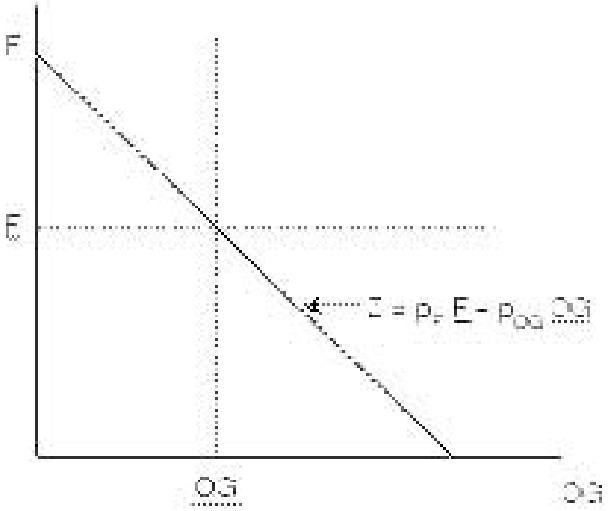


Figure 2
Examples of how food insufficiency can occur with seemingly sufficient income levels

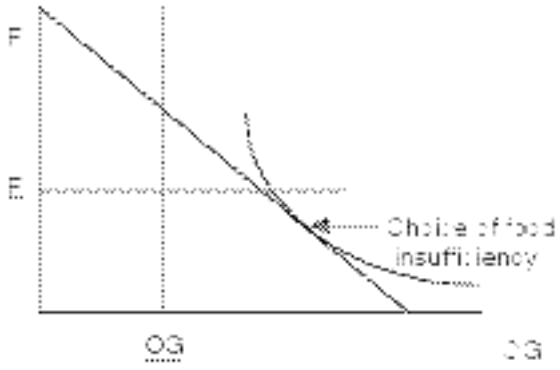


Figure 2(a)

Figure 2(b)

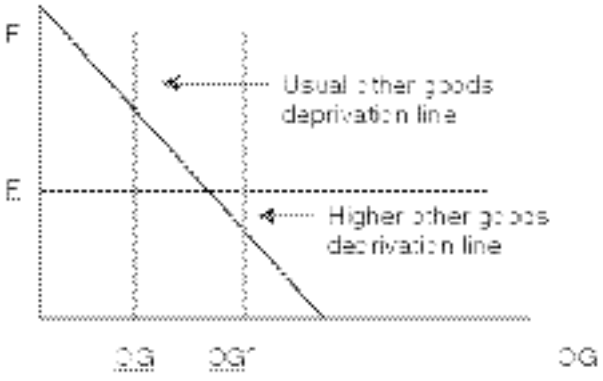
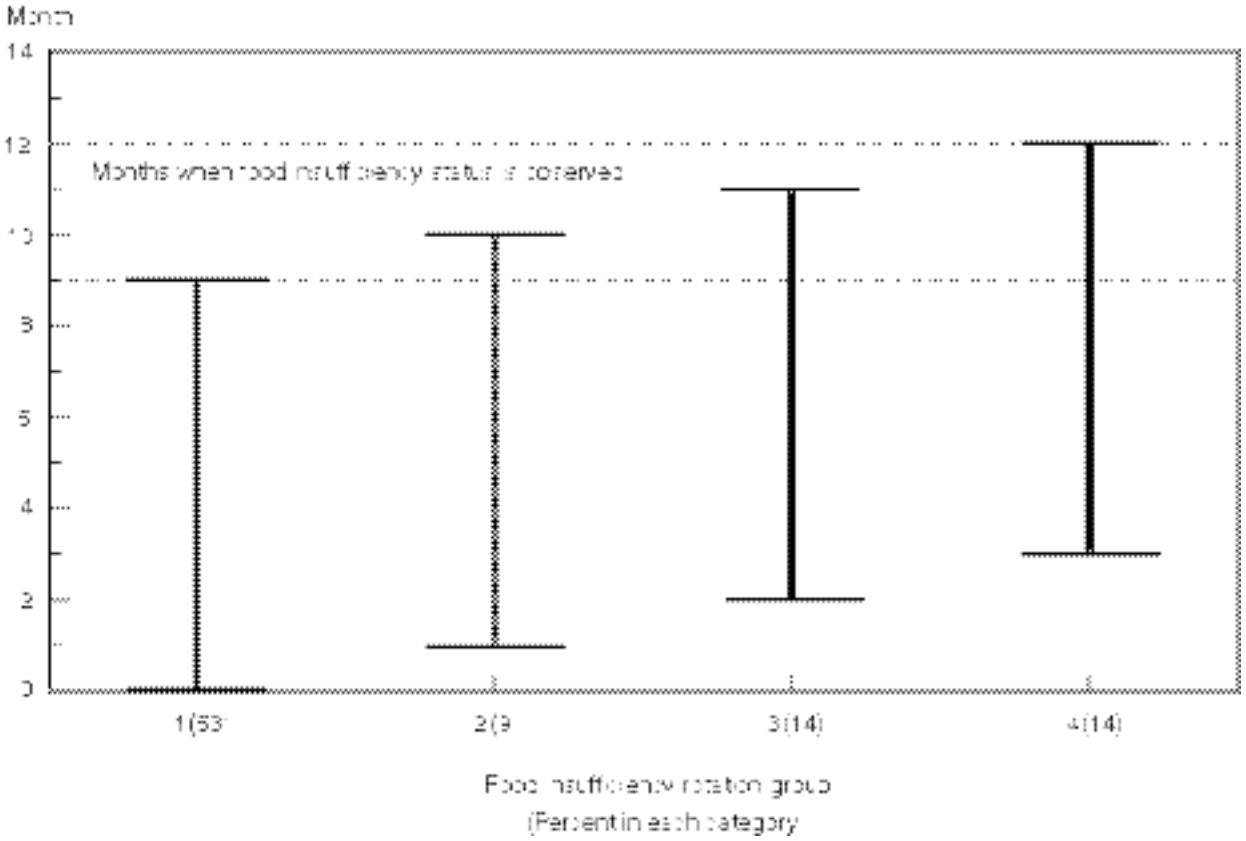


Figure 2(c)

Figure 3
Assignment of households to 9-month time periods



Appendix

An Alternative Dynamic Model of Food Insufficiency

In this appendix, we formally demonstrate, using a different model than in the text, how a household can be both food insufficient and above the poverty line. In this model, a household maximizes the sum of future expected utility defined over the consumption of two categories of goods, C_t and D_t. Food consumption is subsumed under C_t, and other-goods consumption is subsumed under both C_t and D_t. (In order to more fully concentrate on food insufficiency, below we assume that C_t consists only of food consumption.) Goods are distinguished by the timing of their purchase decisions: C_t goods are chosen and consumed within the period, while D_t requires a purchasing decision one period prior to consumption. We impose two conditions on the model that distinguish it from earlier models. First, we do not allow savings and we impose complete liquidity constraints. As discussed in the empirical section, these assumptions are consistent with the experiences of the vast majority of food-insufficient households. Second, decisions regarding the consumption of good D_t must be made in the period prior to the purchase and consumption of the good. D_t can be thought of as any consumption that might involve a degree of planning or preparation, such as rent, commuting costs, and cable TV. D_t consumption is not quite durable goods, but rather contractual consumption. Income is not known at the time contractual consumption is chosen. Whereas standard intertemporal consumption models introduce their temporal element through the budget constraint and the ability to borrow and lend consumption, our model is intertemporal as a result of the consumption decisionmaking process. There is not temporal dependence in the budget constraint or the utility function, so that on the surface the model seems to be a collection of stand-alone static optimization problems. The model is made dynamic through the existence of contractual consumption. Expected utility is maximized subject to a series of period-specific budget constraints equating current income to current C_t and D_t expenditures:

$$Max_{C_{t+1}, D_{t+1}} \; U = E_t\left(C_{t+1}, D_{t+1}\right)$$
$$s.t.\; Y_t = C_t + D_t$$
$$E_t\left(Y_{t+1}\right) = E_t\left(C_{t+1}\right) + D_{t+1}\,,$$

where $u(\bullet)$ is a generic utility function and Y_t is income. Without loss of generality, we set the prices of C_t and D_t to 1. Note that at time t, the consumption of D_t was chosen in t-1 based on expectations of income and consumption at time t, and the resulting consumption of C_t is the residual after the realization of income in time t. At time t, the agent also makes a decision about the consumption of D_{t+1} based on expectations in time t of income and consumption in time $t+1$.

The First-Order Conditions

Substituting C_t out of the utility function using each period's budget constraint then solving results in the following first-order condition :

$$E_t\left(\delta u \big/ \delta C_{t+1}\right) = \left(\delta u \big/ \delta D_{t+1}\right).$$

There is no first-order condition for period t because when we substitute out C_t, there is no choice variable to maximize over. The predetermination of D_t implies a value for C_t and period t utility before that period actually arrives. The first-order conditions relate the marginal utility of C_t and D_t consumption within each period. There is no relation between marginal utilities across time as a result of our assumptions regarding the budget constraint.

The Utility Function

To proceed any further in analyzing consumer behavior in our model, a functional form must be imposed on utility:

$$u = C_t - \frac{1}{2}C_t^2 + D_t - \frac{1}{2}D_t^2\,.$$

Thus, utility is quadratic is both its arguments, which are then simply summed. The first-order equations can now be rewritten:

$$E_t\left(C_{t+1}\right) = D_{t+1}\,.$$

The consumer chooses D_{t+1} to equal C_{t+1} in expectation. Solving for D_{t+1} through the budget constraint reveals:

$$D_{t+1} = \frac{E_t\left(Y_{t+1}\right)}{2}.$$

The Income Process

To reveal the dynamics of the specified model, it is necessary to make some assumptions regarding the nature of the income process. A convenient assumption is that income follows a random walk so that next period's income is current income plus a normally distributed mean-zero error and current income is the best predictor of future income:

$$Y_{t+1} = Y_t + \varepsilon_{t+1}.$$

Thus,

$$E_t\left(Y_{t+1}\right) = Y_t,$$

$$D_{t+1} = \frac{Y_t}{2},$$

and

$$C_{t+1} = \frac{Y_t}{2} + \varepsilon_{t+1}.$$

Consumption of good D in period $t+1$ is determined by the consumer's best guess of next period's income. The variation from this expectation, ε_{t+1}, must be fully borne by C_{t+1} due to the pre-committed contractual nature of D_{t+1}. Income innovations only affect C_t in the period that they occur.

Poverty Line Defined Over Food Insufficiency

Hereafter, to concentrate on food sufficiency outcomes, we restrict C_t to include food alone. Akin to our earlier models, suppose now that there is a minimum sufficient level of C_t and D_t consumption that sum to the minium sufficient income,

$$\underline{C} + \underline{D} = Z.$$

Allow γ to represent the proportion of this minium budget that must be spent on food, so that:

$$\underline{C} = \gamma Z,$$

and then,

$$\underline{D} = \left(1 - \gamma\right) Z$$

When Food Insufficiency and Above Poverty Line Income Occur Simultaneously

A household is food sufficient in period $t+1$ if $\underline{C}$ exceeds C_{t+1}, which implies:

$$\gamma Z - \frac{1}{2} Y_t > \varepsilon_{t+1}.$$

A household's income is above the poverty line if Y_{t+1} exceed Z, which implies:

$$\varepsilon_{t+1} > Z - Y_t.$$

Together the two inequalities imply a range of ε_{t+1} over which period $t+1$ income exceeds the poverty level simultaneously with C_{t+1} being below its sufficient level $\underline{C}$:

$$\gamma Z - \frac{1}{2} Y_t > \varepsilon_{t+1} > Z - Y_t.$$

Food Insufficiency and Children's Health Status in the United States: Findings From NHANES III[1]

Katherine Alaimo, Christine M. Olson, and Edward A. Frongillo, Jr.

This study investigates the association between food insufficiency, poverty, and proxy-reported health status for U.S. school-age children, 6 to 11 years of age. A conceptual model was developed to describe the relationships between poverty, food insufficiency, and other factors to children's health status. Using this model, data were analyzed from the Third National Health and Nutrition Examination Survey (NHANES III), a cross-sectional representative sample of the civilian non-institutionalized U.S. population living in households. Children were classified as food insufficient if a family respondent reported that their family sometimes or often did not get enough food to eat. Health status was coded as an ordinal variable ranging from excellent health to fair or poor health. Ordinal logistic regression was conducted with health status as the outcome variable. Odds ratios for food insufficiency are reported controlling for poverty status, other demographic variables, and other variables potentially related to children's health. The prevalence of fair or poor health was 13.8 percent (standard error: 2.3) for children living in food-insufficient families versus 3.4 percent (standard error: 0.5) for children living in food-sufficient families. Controlling for potential confounders including poverty status, food-insufficient children were significantly more likely to have poorer health than food-sufficient children (odds ratio: 1.60; 95 percent confidence interval: 1.04, 2.46). Food insufficiency is a health concern for U.S. school-age children. Children who live in families that do not get enough food to eat are more likely to have poorer health status than food-sufficient children.

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Introduction

Although a wealthy nation, the United States is not immune to poverty and hunger. In 1994, 38 million Americans lived in poverty, the majority of whom were children (U.S. Bureau of the Census, 1996). Over 20 percent of children were poor, and in 1995, more than 9 million children under the age of 18 lived in food-insecure households—households where there is "limited or uncertain availability of nutritionally adequate or safe foods" (U.S. Department of Agriculture, 1997).

The poverty rate for children in the United States has not always been as high as one in four. From 1970 to 1993, children's poverty increased more than 50 percent and welfare reform has increased the vulnerability of low-income groups to negative income shocks (U.S. Department of Commerce, 1998; Crooks, 1995; Porter, 1998; and Zedlewski, 1996). The child poverty rate is dramatically higher than any other developed country around the world, the closest nations being Australia and Canada at approximately 14 percent (Rainwater and Smeeding, 1995).

But while these numbers demonstrate the magnitude of this social problem, they do not expose the real consequences of poverty and hunger for children. The relationship between poverty and adverse health outcomes in children is well-documented (Newacheck et al., 1994; Starfield, 1982; Montgomery et al., 1996; and Dutton, 1985). Hunger has long been suspected to lead to poor health in children, over and above the effects of poverty, but until recently, empirical studies to test this suspicion have been sparse. One study, the Community Childhood Hunger Identification Project, conducted from 1992-94, found that poor, hungry children were more likely than poor, but not hungry, children to suffer from health problems such as frequent colds, ear infections, anemia, asthma, and frequent headaches (Wehler, 1995).

This paper examines the relationships between poverty, family food insufficiency, and proxy-

reported health status in U.S. children, using data from the Third National Health and Nutrition Examination Survey (NHANES III). It demonstrates once again that there are health consequences to living in poverty for children, and further shows that at least a portion of these consequences are attributable to a lack of food.

Methods

NHANES III Data

Data for children ages 6 to 11 years of age (n = 3,028) were analyzed from NHANES III, a cross-sectional representative sample of the civilian non-institutionalized, non-homeless population living in households. The survey was conducted from 1988-94. Mexican Americans and black Americans were oversampled to provide reliable estimates for these groups. Detailed descriptions of the sample design and operation of the survey have been published elsewhere (National Center for Health Statistics, 1994).

NHANES III included medical examinations and interviews conducted with survey participants and proxies. For this analysis, we used data from the Household Family and Household Youth Questionnaires (proxy interviews) conducted in the home, Youth and Proxy Questionnaires conducted in the Mobile Examination Centers, and blood analysis.

Socio-Demographic and Family Characteristics

For each child in the survey, information about sex, age, race-ethnicity, health insurance status, family size, and family income, as well as employment status and education of the family head were provided by a responsible adult living in their home. The family head was a person who owned or rented the home where the child lived.

Total family income for the previous 12 months was collected in categories ranging from "less than $1,000" to "$80,000 and over," in $1,000 increments below $19,999, in $5,000 increments between $20,000 and $49,999, and in $10,000 increments between $50,000 and $79,999. A poverty index ratio (PIR) was then calculated, using the mid-point of the category and the child's family size (U.S. Department of Health and Human Services, 1995). These analyses use three income categories: low income, defined as PIR less than or equal to 130 percent of the poverty line, which is the Federal cut-off point for the Food Stamp Program; middle income (131 to 350 percent of the poverty line); and high income (greater than 350 percent of the poverty line). A child was defined as insured if she or he was covered by private health insurance, military health care insurance, or Medicaid, and if the coverage paid for more than accidents.

Controlling for language of interview is important for the analysis of proxy-reported health status. Previous research has demonstrated that due to the translation of the question, Spanish-speakers may answer this question differently than English speakers (Angel and Guarnaccia, 1989; Angel and Worobey, 1988; and Idler and Benyamini, 1997). Therefore, information on race, ethnicity, and the language used during the proxy interview were used to classify children into four race-ethnic categories: (1) all non-Hispanic white children and other children with an interview conducted in English, (2) all non-Hispanic black children, (3) Mexican American children with an interview conducted in English, and (4) Mexican American children or other children with an interview conducted in Spanish.

Location

Metropolitan and non-metropolitan areas were assessed based on the U. S. Department of Agriculture rural and urban continuum codes. Central or fringe counties of metropolitan areas of 1 million people or more were classified as metropolitan and all other areas were classified as non-metropolitan (National Center for Health Statistics, 1996).

Health Care/Environmental Risk

For all children, information was collected on whether they had a regular source of health care,

if they had ever attended a day care center or nursery school where there were six or more children before they were 4 years old, their blood lead level, their mother's age at the child's birth, the presence of birth complications, low birth weight (birth weight below 2,500 g), and if they were exposed to any smoke prenatally.

Food Insufficiency

For the purpose of the NHANES III survey, food insufficiency was defined as "an inadequate amount of food intake due to a lack of resources." A child was classified as food insufficient if the respondent to the family questionnaire reported that the family sometimes or often did not get enough food to eat. This question has undergone cognitive testing and has been shown to be valid (Alaimo, 1997; Alaimo et al., 1998; Alaimo et al., 1999; Briefel and Woteki, 1992; Findlay et al., 1994; and Carlson and Briefel, 1995), and has also been demonstrated to be associated with food expenditure and nutrient intake (Basiotis, 1992; Cristofar and Basiotis, 1992; and Rose and Oliveira, 1997).

Proxy-Reported Health Status

We chose proxy-reported health status as an indicator because it provides a general summary of children's health. Proxies for the household youth questionnaire were asked to describe the child's health as excellent, very good, good, fair, or poor. For this analysis, the categories fair and poor were combined.

Extensive study has shown self-reported health status to be valid and reliable in adult populations (Lundberg and Manderbacka, 1996), and to predict mortality and disability (Idler and Benyamini, 1997). Self-rated health has been found to form a continuum from poor to good health (Manderbacka et al., 1998), and although qualitative studies have revealed that the question is not always interpreted similarly by respondents, "this emerging body of research reaffirms that the global health status item functions largely as intended because it pulls together or summarizes the various components that make up the health status domain" (Krause and Jay, 1994, p. 940).

Research on proxy-reports for children has been much more limited, but comparisons between child health status as reported by their parent and by the child has been shown to be consistent (Theunissen et. al, 1998). One study of pre-term low-birth-weight infants showed that the mother's assessment of her infant's health status was significantly related to outpatient use and behavior problems (Scholle et al., 1995).

To confirm that proxy-reported health status correctly identified children's health status, we ran ordinal logistic regression models with health status as the outcome and selected other measures of health as the determinants. One determinant was included in each model. The results from these analyses are shown in table 1.[2] Proxy-reported health status was significantly related to almost all other health status measures, including physician-reported health status, number of colds in the past 12 months, frequency of stomach aches and head aches, iron deficiency (as measured by transferrin saturation, serum ferritin, and erythrocyte protoporphyrin according to expert panel guidelines) (Looker, 1997), blood lead levels, the presence of a persistent cough in the past 12 months, infections in the past 4 weeks, and the presence of an impairment or health problem that keeps the child from attending school. Proxy-reported health status was not related to the number of ear infections the child had experienced in their lifetime.

Conceptual Model

The conceptual model shown in figure 1 was adapted from Crooks for use with the NHANES III data (Crooks, 1995).[3] Summarizing available research, the model hypothesizes that the environment of poverty, along with certain child, location, and family factors, put children at risk for conditions that can lead to poor health, including food insufficiency and environmental

[2]Tables are at the end of this paper.

[3]Figures follow tables at the end of this paper.

or health care risk. Past health risk can also affect current health status.

Statistical Methods

Weights were created for the NHANES III data to take into account the survey cluster design, oversampling of certain groups, such as black Americans and Mexican Americans, and nonresponse. For these analyses, NHANES III weighted data were analyzed using the *svy* commands available in STATA Statistical Software (Statacorp, 1997). These commands use the weights and complex survey design to calculate point estimates and variance.

Ordinal logistic regression models were created to test the hypothesis that food insufficiency is a predictor of poorer health, independent of 17 other potential confounders. Ordinal logistic regression calculates odds ratios for outcome categories, taking into account the ordering of outcome categories. Odds ratios compare a set of categories of health status with those categories above it: fair or poor health versus good, very good, and excellent; fair or poor and good health versus very good and excellent, and fair or poor, good and very good health versus excellent. The overall odds ratio represents the likelihood that a child had a poorer health status.

Results

Socio-demographic and family characteristics of food-sufficient versus food-insufficient children are shown in table 2. Almost 83 percent of food-insufficient children lived in low-income families, compared with only 29.1 percent of food-sufficient children. As compared with food-sufficient children, food-insufficient were more likely not to be covered by health insurance (19.7 and 10.4 percent, respectively), to have been born to a mother who was younger than 18 years of age (8.9 and 5.4 percent, respectively), and to live in families where the family head did not have a high school diploma, was not married, or was unemployed. Notably, however, the family head was employed for 61 percent of food-insufficient children.

Food-insufficient children also differed from food-sufficient children in relation to some risk factors shown in figure 1. As shown in table 2, food-insufficient children were less likely to have a regular source of health care and to have attended day care before the age of 4 years, and were more likely to have had birth complications. They were not more likely to be low-birthweight or to have been exposed to prenatal smoke.

Figures 2 and 3 show the prevalence of children who were reported to have fair/poor health status for each of the poverty categories and for food-insufficient versus food-sufficient children. Overall, food-insufficient children were more than four times more likely to have fair/poor health than food-sufficient children (13.8 versus 3.4 percent). Low-income children were more likely to have fair/poor health, which was much more prevalent among the food-insufficient—14.4 versus 6.8 percent for low-income children and 9.4 versus 2.3 for middle income children.

Because food insufficiency is closely related to poverty status, ordinal logistic regression analysis was performed to determine whether food-insufficient children had poorer health status when poverty and other potential confounders are taken into account. The results are presented in table 3. Both poverty status and food insufficiency were significantly related to health status. Low-income children were 2.6 times more likely, and middle-income children were 1.7 times more likely than high-income children to have poorer health status. Controlling for other confounders, food-insufficient children were 1.6 times more likely to have poorer health status.

Discussion

Contrary to popular belief, most food-insufficient children in the United States are non-Hispanic white, live in two-parent families, have at least one parent who is working, and are not more likely to live in a metropolitan area. Food-insufficient children are more likely than food-sufficient children to live in low-income families, and to be without health insurance and a regular

source of health care. Above and beyond these social characteristics, however, this research demonstrates that food insufficiency is independently related to children's health status.

Proxy-reported health status has been used as a general assessment of children's health in other studies. Results from several National Health Interview Surveys conducted since 1978 have consistently shown a higher prevalence of fair or poor health status for poor children as compared with nonpoor children (Newacheck, 1989; Newachek et al., 1994; Starfield, 1982; and Montgomery et al., 1996). Montgomery et al. found that from 1989 to 1991, poor children were almost three times more likely to be reported in fair or poor health status, controlling for race and family structure (Montgomery et al., 1996).

The use of proxy-reported health status is not without limitations, however, particularly when assessing its relationship to another proxy-reported variable, such as food insufficiency. For each child in the NHANES III survey, health status and food insufficiency were assessed by the same proxy, often the mother. It is possible that part or all of the association found was due to a tendency of the proxy to over-report bad outcomes. Confidence in the use of proxy-reported health status is strengthened, however, by its association with child health indicators from other sources, as shown in table 1.

Testing of the child health model shown in figure 1 is hindered by other limitations in the NHANES III data. In the regression analyses, we were unable to include other important characteristics found to be related to children's health status such as poverty status at earlier stages of the child's life, or quality of health care received. In addition, because the data are cross-sectional, it is impossible to determine if the relationship found between food insufficiency and health is causal or even if the relationship exists because children's poor health status (by necessitating high expenditures on health care) contributes to their families' inability to acquire adequate food (reverse causality). However, cross-sectional studies are important for the determination of associations when experimental designs are not possible and longitudinal studies are not available.

Demonstration of an association between food insufficiency and children's poor health status, regardless of the causal direction, once again highlights the harmful risks that poor American children face. A wise society nurtures and protects its future generations. Ensuring that all American children are adequately fed is an action that should be taken to improve the health of our Nation's children.

References

Alaimo, K. "Food Insecurity, Hunger, and Food Insufficiency in the United States: Cognitive Testing of Questionnaire Items and Prevalence Estimates From the Third National Health and Nutrition Examination Survey." Thesis. Cornell University, Ithaca, NY. 1997.

Alaimo, K., R.R. Briefel, E.A. Frongillo, and C.M. Olson. "Food Insufficiency Exists in the United States: Results From the Third National Health and Nutrition Examination Survey (NHANES III)," *American Journal of Public Health*. Vol. 88. pp. 419-426. 1998.

Alaimo, K., C.M. Olson, and E.A. Frongillo, Jr. "Importance of Cognitive Testing For Survey Items: An Example From Food Security Questionnaires," *Journal of Nutrition Education*. Vol. 31, No. 5. pp. 269-275.

Angel, R., and P.J. Guarnaccia. "Mind, Body, and Culture: Somatization Among Hispanics," *Social Science and Medicine*. Vol. 28, No. 12. pp. 1,229-1,238. 1989.

Angel, R., and J.L. Worobey. "Acculturation and Maternal Reports of Children's Health: Evidence from the Hispanic Health and Nutrition Examination Survey," *Social Science Quarterly*. Vol. 69. pp. 707-721. 1988.

Basiotis, P.P. "Validity of the Self-Reported Food Sufficiency Status Item in the U.S. Department of Agriculture Food Consumption

Surveys." Proceedings, 1992 Annual Meeting of the American Council in the Consumer Interest. March 25-28, 1992.

Briefel, R.R., and C.E. Woteki. "Development of the Food Sufficiency Questions for the Third National Health and Nutrition Examination Survey," *Journal of Nutrition Education*. Vol. 24., pp. 24S-28S. 1992.

Carlson, S., and R.R. Briefel. *The USDA and NHANES Food Sufficiency Question as an Indicator of Hunger and Food Insecurity*. Conference on Food Security Measurement and Research: Papers and Proceedings. U.S. Department of Agriculture, Food and Consumer Service (currently Food and Nutrition Service). Alexandria, VA. 1995.

Cristofar, S.P., and P.P. Basiotis. "Dietary Intakes and Selected Characteristics of Women Ages 19-50 Years and Their Children Ages 1-5 Years By Reported Perception of Food Sufficiency," *Journal of Nutrition Education*. Vol. 24, pp. 53-58. 1992.

Crooks, D.L. *American Children at Risk: Poverty and its Consequences for Children's Health, Growth, and School Achievement, Yearbook of Physical Anthropology*. Vol. 38, pp. 57-86. 1995.

Dutton, D.B. "Socioeconomic Status and Children's Health," *Medical Care*. Vol. 23, pp. 142-156. 1985.

Egbuonu, L., and B. Starfield. "Child Health and Social Status," *Pediatrics*. Vol. 69, pp. 550-557. 1982.

Findlay, J., B. Greene, C. Petty-Martin, A. Ostchega, and G. Pinder. *NHANES III Interviewer Debriefing*. Bethesda, MD: National Center for Health Statistics. October 19-20, 1994.

Idler, E.L., and Y. Benyamini. "Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies," *Journal of Health and Social Behavior*. Vol. 38, pp. 21-37. 1997.

Krause, N.M., and G.M. Jay. "What Do Global Self-Rated Health Items Measure?" *Medical Care*. Vol. 32. pp. 930-942. 1994.

Looker, A.C., P.R. Dallman, M.D. Carroll, et al. "Prevalence of Iron Deficiency in the United States," *Journal of the American Medical Association*. Vol. 277, No. 12. pp. 973-976. 1997.

Lundberg, O., and K. Manderbacka. "Assessing Reliability of a Measure of Self-Rated Health," *Scandinavian Journal of Social Medicine*. Vol. 3, pp. 218-224. 1996.

Manderbacka, K., E. Lahelma, and P. Martikainen. "Examining the Continuity of Self-Rated Health," *International Journal of Epidemiology*. Vol. 27. pp. 208-213. 1998.

Montgomery, L.E., J.L. Kiely, and G. Pappas. "The Effects of Poverty, Race, and Family Structure on U.S. Children's Health: Data From the NHIS, 1978 Through 1980 and 1989 Through 1991," *American Journal of Public Health*. Vol. 86. pp. 1,401-1,405. 1996.

National Center for Health Statistics. *NHANES III Household Youth Data File Documentation*. Catalogue No. 77550. December 1996.

National Center for Health Statistics. "Plan and Operation of the Third National Health and Nutrition Examination Survey, 1988-1994," *Vital Health Statistics*. Vol. 1, No. 32. July 1994.

Newacheck, P.W. "Improving Access to Health Services for Adolescents From Economically Disadvantaged Families," *Pediatrics*. Vol. 84. pp. 1,056-1,063. 1989.

Newacheck, P.W., W.J. Jameson, and N. Halfon. "Health Status and Income: The Impact of Poverty on Child Health," *Journal of School Health*. Vol. 64, No. 6. pp. 229-233. 1994.

Porter, K. "Improvements in Poverty and Income in 1995 Tempered By Troubling Long-Term Trends," *International Journal of Health Services*. Vol. 28, No. 1. pp. 1-12. 1998.

Rainwater, L., and T.M. Smeeding. "Doing Poorly: The Real Income of American Children in Comparative Perspective." Unpublished manuscript. Luxemburg Income Study. August 1995.

Rose, D., and V. Oliveira. "Nutrient Intakes of Individuals From Food-Insufficient Households in the United States," *American Journal of Public Health*. Vol. 87, pp. 1,956-1,961. 1997.

Scholle, S.H., L. Whiteside, K. Kelleher, et al. "Health Status of Preterm Low-Birth-Weight Infants," *Archives of Pediatric and Adolescent Medicine*. Vol. 149, pp. 1,351-1,357. 1995.

Starfield, B. "Family Income, Ill Health, and Medical Care in U.S. Children," *Journal of Public Health Policy*. Vol. 3, No. 3, pp. 244-259. September 1982.

Starfield, B. "Childhood Morbidity: Comparisons, Clusters, and Trends," *Pediatrics*. Vol. 88, pp. 519-526. 1991.

Statacorp. Stata Statistical Software: Release 5.0. College Station, TX: Stata Corporation. 1997.

Theunissen, N.C.M, T.G.C. Vogels, H.M. Koopman et al. "The Proxy Problem: Child Report Versus Parent Report in Health-Related Quality of Life Research," *Quality of Life Research*. Vol. 7, pp. 387-397. 1998.

U.S. Bureau of the Census. *Income, Poverty, and Valuation of Non-Cash Benefits, 1994*. Series P-60. No. 189. April 1996.

U.S. Department of Agriculture. *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project*. Abt Associates, Inc. September 1997.

U.S. Department of Commerce, Bureau of the Census. *1988 and 1997, Statistical Abstract of the United States: 1988 and 1997*. (108th and 117th eds.) as cited in "Federal Statistics: Children and Family Composition," *Family Economics and Nutrition Review*. Vol. 11, No. 3, pp. 74-75. 1998.

U.S. Department of Health and Human Services. "Poverty Income Guidelines; Annual Revision," *Federal Register*. Vol. 60, No. 27, pp. 7,772-7,774. 1995.

Vogels, T., G.H.W. Verrips, S.P. Verloove-Vanhorick et al. "Measuring Health-Related Quality of Life in Children: The Development of the TACQOL Parent Form," *Quality of Life Research*. Vol. 7, pp. 457-465. 1998.

Wehler, C.A., R.I. Scott, and J.J. Anderson. *Community Childhood Hunger Identification Project.* Washington, DC: Food Research and Action Center. July 1995.

Zedlewski, S. et al. *Potential Effects of Congressional Welfare Reform Legislation On Family Incomes*. Urban Institute, Washington, DC. July 26, 1996.

Table 1—Proxy-reported health status: Associations with other health indicators

Variable	Coefficient	P-value
Physician-reported health status	0.19	0.05
Colds	-.13	.01
Stomach aches	-.25	0
Headaches	-.21	.01
Ear infections	.03	.40
Problem cough	-.66	0
Iron deficiency	-.62	0
Blood lead level	-.12	0
Infections	-.31	.01
School-restricting impairment	-3.27	.08

Source: NHANES III, 1988-94, children ages 6-11 years.

Table 2—Socio-demographic characteristics, health, and environmental risk factors of children, by food sufficiency status

Item	Food-sufficient children		Food-insufficient children	
	Percent (standard error)			
Poverty index ratio:				
<130	29.1	(2.1)	82.9	(6.0)
130 - 350	49.5	(2.1)	17.1	(6.0)
>350	21.4	(1.8)	0	(0)
No health insurance	10.4	(.01)	19.7	(4.6)
Race-ethnicity:				
Non-Hispanic white	75.4	(1.7)	42.2	(7.7)
Non-Hispanic black	14.9	(1.3)	26.5	(5.2)
Mexican American, English	4.6	(.6)	11.8	(2.9)
Mexican American, Spanish	5.1	(1.0)	19.4	(4.1)
Mean age	8.5	(.1)	8.5	(.1)
Gender:				
Female	48.7	(1.3)	49.3	(4.5)
Male	51.3	(1.3)	50.7	(4.5)
Metropolitan area	48.5	(5.3)	39.3	(6.9)
Age of mother at child's birth:				
<=18 years	5.4	(.6)	8.9	(2.3)
Family head education:				
< High school	21.1	(1.5)	57.3	(6.3)
High school graduate	34.9	(1.9)	35.3	(6.6)
> High school	43.9	(2.0)	7.3	(2.6)
Family head marital status:				
Not married	20.1	(1.6)	42.3	(5.6)
Family head employed	82.7	(1.6)	61.2	(6.1)
Mean family size	4.6	(.05)	5.2	(.2)
Regular source of health care	91.8	(.9)	84.6	(3.7)
Birth complications	11.4	(1.0)	17.9	(3.0)
Prenatal smoke exposure	24.5	(1.8)	24.6	(5.3)
Day care before age 4 years	51.5	(1.8)	34.2	(3.5)
Low birth weight	5.9	(.6)	5.7	(1.4)

Source: NHANES III, 1988-94, children ages 6-11 years.

Table 3—Relationship of proxy-reported health status to socio-demograhic characteristics and risk factors in children

Item	Odds ratio	95% CI
Poverty index ratio:		
<130	2.61	(1.67, 4.14)
130 - 350	1.72	(1.51, 1.99)
No health insurance	1.34	(.87, 2.05)
Race-ethnicity:		
Non-Hispanic black	1.51	(.99, 2.31)
Mexican American, English	1.55	(1.00, 2.42)
Mexican American, Spanish	4.52	(2.92, 6.98)
Age	1.03	(.95, 1.11)
Male	1.03	(.75, 1.26)
Metropolitan area	1.04	(.76, 1.43)
Age of mother at child's birth <18y	.70	(.45, 1.11)
Family head education:		
< High school	1.87	(1.31, 2.67)
High school graduate	1.42	(.98, 2.05)
Single parent	1.11	(.82, 1.51)
Family size	1.02	(.92, 1.12)
Family head unemployed	.67	(.48, .95)
No regular source of health care	1.27	(.81, 1.99)
Blood lead level (mg/dl)	1.04	(.97, 1.11)
Birth complications	1.40	(.87, 2.25)
Prenatal smoke exposure	1.41	(.97, 2.05)
No day care before 4 years	1.61	(.83, 2.17)
Low birth weight	1.37	(.81, 2.32)
Food insufficient	1.60	(1.04, .46)

CI = confidence interval.
Note: Odds ratios are adjusted for all other variables for which odds ratios are reported.

Source: NHANES III, 1988-94, children ages 6-11 years (n = 2,274).

Figure 1
Child health model

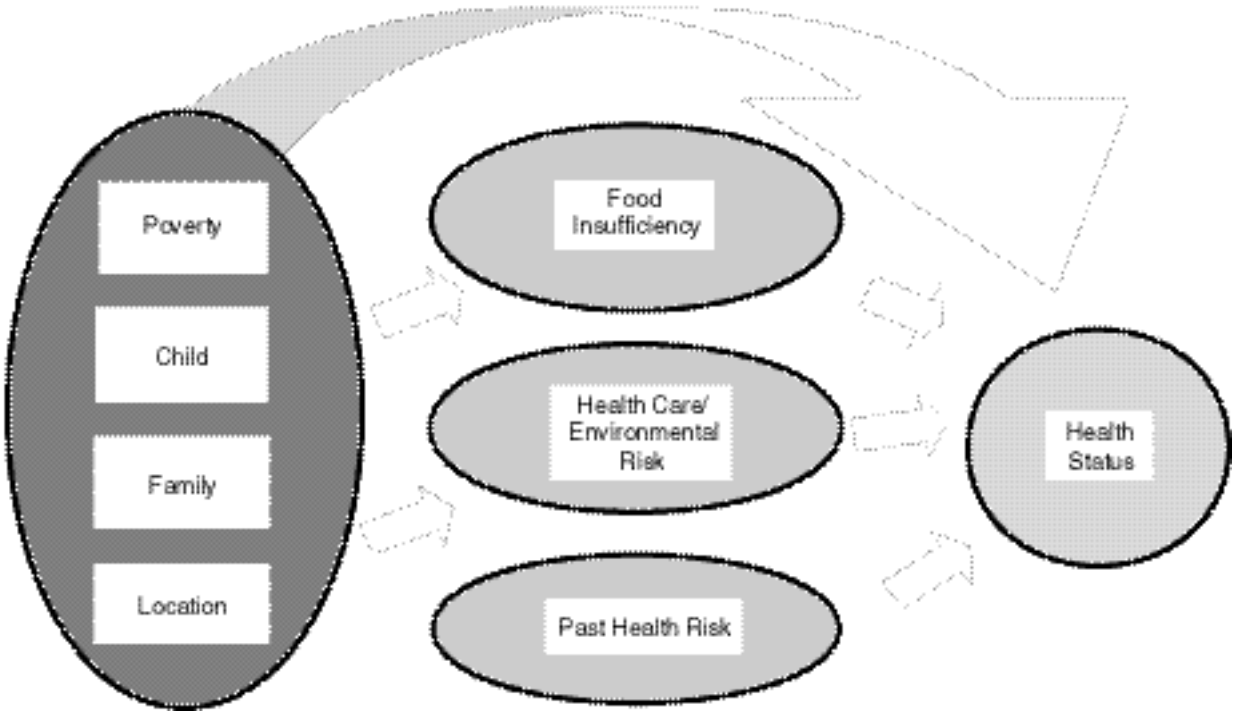

Figure 2
Prevalence of fair or poor health status by food sufficiency status: NHANES III

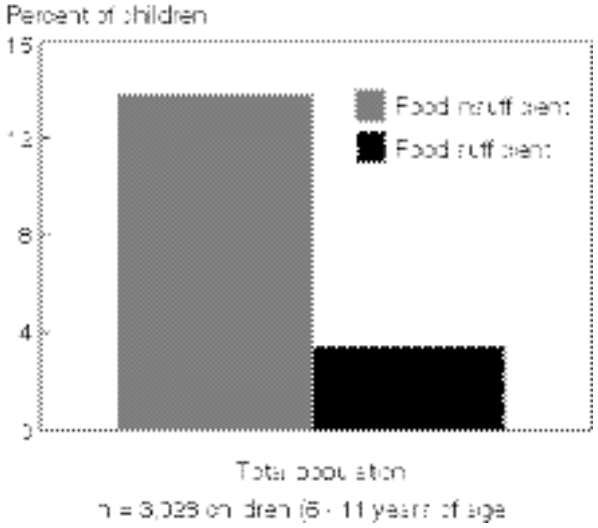

Figure 3
Prevalence of fair or poor health status by income and food sufficiency status: NHANES III