

**Impacts of Child Food Insecurity and Hunger on Health and Development in Children;  
Implications of Measurement Approach**

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## **Introduction and Background**

The current officially recognized measures of food security, food insecurity and hunger for the U.S. population were mandated under the National Nutrition Monitoring and Related Research Act of 1990.<sup>1</sup> The conceptual framework and measurement approach used to develop the measures were built on a foundation of federal interagency activity with input from research conducted by public and private institutions. An extensive collection of historical documents and excellent overall summary of the history of development of the U.S. Food Security Scale, and the subsequent Food Security Survey Module, are available on the USDA Economic Research Service's Food Security in the U.S. website at <http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us.aspx#.UaGExdgzT1V> .

### ***The Food Security Scales***

The eighteen-item U.S. Household Food Security Scale (HFSS) was initially developed by the Food Security Measurement Project in 1995-1997, using data from a preliminary household survey instrument that received cognitive assessment and field testing by the Census Bureau, and was administered in its April 1995 Current Population Survey. Results of scale development by the Food Security Measurement Project team were published in three reports released in 1997.<sup>2,3,4</sup>

The HFSS was developed for use with either a twelve-month reference period (the twelve months prior to the interview date), or a thirty-day reference period (the thirty days prior to the interview date). In addition to the eighteen-item HFSS, the Food Security Measurement Project also developed an abbreviated six-item version of the HFSS for use in surveys in which a measure of food security is needed but it is not possible or convenient to include all eighteen scale questions.<sup>3</sup>

In the years immediately following release of the Food Security Measurement Project reports, USDA/ERS continued testing the scale and made several refinements and revisions. These included placing the scale within the structure of a three-stage U.S. Food Security Survey Module with optional screening procedures to identify (and not interview) respondents unlikely to have experienced any level of food insecurity during the relevant time period.<sup>5,6</sup> These structural changes aimed to facilitate use of the scale by other survey researchers, shorten interview time and reduce respondent burden. Substantive revisions improved the validity, reliability and overall effectiveness of the measures.

As part of their revisions, ERS analysts also tested and validated distinct adult and child Food Security Scales formed by separating the adult and household-referenced questions from the child-referenced questions. The eight child-referenced questions became the Child Food Security Scale (CFSS), administered only to households with at least one child present. The three household and seven adult referenced questions were combined into a ten-item Adult/Household Food Security Scale (A/HFSS) for separate determination of food security status of adults in households with children, and for administration to households with no children. Further examination of data from the Child Food Security Scale also revealed important differences between child hunger results obtained by scoring and scaling data from the full eighteen-item scale compared to those obtained when data from the Child Food Security Scale was used separately.<sup>7</sup>

Estimating child hunger prevalence (later referred to as very low food security in children) using data from the eighteen-item scale resulted in underestimation of its prevalence, particularly among households with children of broadly different ages. Separation of the

eighteen-item U.S. Food Security Scale into two distinct scales, one used in households with no children present (including elderly adult-only households), and a second used in households with at least one child (ages <18 years), along with the other revisions made, improved the validity and reliability of the food security measures and the accuracy of prevalence estimates obtained using data from the scales.<sup>7</sup>

In addition to the adult and child food security scales, and the six-item abbreviated household-level scale, ERS analysts also developed a survey module that can be self-administered by youth ages  $\geq$  twelve years. To accommodate the large and growing Latino population in the U.S. a Spanish translation of the USFSSM was also completed and validated.

### ***Nature of the U.S. Food Security Measures***

The U.S. Household Food Security Survey Module and its associated scales were developed using Item Response Theory (IRT) methods similar to those used to develop national standardized tests.<sup>3</sup> The statistical procedures and models comprised by IRT methods<sup>‡</sup> can be used to assess candidate scale items based on their psychometric and statistical characteristics and overall patterns of responses to the items, to gauge the relative severity of candidate items, and to determine how completely the underlying condition being measured is “covered” by the set of items being considered for inclusion in the scale.

IRT methods can guide and inform selection of questions for inclusion in a final scale, and decisions about thresholds and categories based on levels of severity of the condition. However, the IRT methods alone cannot determine severity categories or thresholds indicating transitions from one category into another. Decisions about the number of categories appropriate for a scale, and where to set thresholds defining transitions from one category to another, have to be made by people. Those decisions require knowledge of the phenomenon or condition being measured, an understanding of the IRT methods, and informed judgments.

The initial measurement framework guiding scale development called for identification of four food security categories, including three levels of severity of food insecurity; food secure, food insecure without hunger, food insecure with moderate hunger (hunger in adults only), and food insecure with severe hunger (hunger in adults and children when children are present in the household, more severe hunger in adults when children are not present).<sup>8,3</sup> Previous research indicated that adults in U.S. households with children normally attempt to spare children from experiencing hunger, and when children do experience hunger as measured by the scale, it is indicative of conditions so severe that adults are unable to successfully prevent children from experiencing hunger.<sup>7</sup> With separate adult and child food security scales, child hunger, though still indicative of more severe hunger, is conceptualized and measured somewhat distinct from adults’ experiences of food insecurity or hunger.

Researchers and others refer to “household food security”, “adult food security”, and “child food security”, however it is necessary to note that the Committee on National Statistics declared in its ten-year review of the module and associated scales that, since the U.S. HFSSM is a household-level survey instrument, it and its component scales do not measure individual-level experiences.<sup>9</sup> Except in the relatively small proportion of households with one adult and/or one child, it is not considered appropriate to assign food security status to individuals in households. Thus all of the U.S. food security scales yield results that pertain to the household as a whole.

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<sup>‡</sup> The model used to develop the U.S. Food Security Scale was a Rasch model, a type of unidimensional non-linear factor analytic model.

This sometimes leads to an unavoidable necessity to use somewhat eccentric language and terminology when describing households' food security status, especially in discussing households' status with respect to adults or children separately. For example, it is not considered appropriate to state that "N children in the U.S. experienced very low food security in a given year". Instead, current convention requires one to state that "N children were living in households with children in which at least one child experienced very low food security in children in that year, based on results of the CFSS."

### ***Food Security Categories and Thresholds***

The eighteen questions comprising the original U.S. Food Security Scale (FSS) address three main conceptual domains corresponding to successively higher levels of severity of food insecurity. Those domains are: i) concerns about the present or future adequacy of household food supplies and resources needed to replenish them, leading to negative affective states such as anxiety or worry among some household members, ii) reductions in the quality and/or variety of foods available in the household to an extent that some household members experience (and the respondent reports) dissatisfaction with these aspects of available foods, and iii) reductions in the quantity of foods available, in addition to reductions in their variety and/or quality, to an extent that food intake is reduced in some household members below usual levels. Such reductions in food intake below usual levels, if substantial and/or prolonged, can provide the basis for inferring that hunger has been experienced by some household members.

Since the FSS necessarily contains more than one question about conditions consistent with each of the three conceptual domains of food insecurity, informed judgments were necessary to make decisions regarding which questions to designate as threshold or cut-point questions. Information brought to bear in making those decisions included; results from the IRT modeling, the best available scientific evidence on the adequacy of food in the U.S. population, the purposes for which the scale was being developed, and the policy environment in which the scale and its results were to be used.<sup>1,3</sup> Though mandated to be scientifically valid and reliable, developing the measures was not merely an academic exercise. They were intended and developed to serve nutrition monitoring and research needs of the academic/scientific community (both public and private), state and federal government agencies, and the U.S. public.

The FSS is "very well ordered", meaning that if a particular scale question is affirmed by a respondent, it is almost certain (or very likely) that all prior scale questions were also affirmed. This characteristic of the scale (together with other statistical properties) means that the number of questions affirmed can be a valid indicator of the severity of food insecurity experienced by household members. The more scale questions affirmed, the higher the level of severity of food insecurity experienced by household members.

Considered in light of the three conceptual domains described above, this property suggests logical points on the scale (indicated by specific questions), at which the severity of household food security changes. These transition questions become candidates for thresholds beyond which the severity of food insecurity changes to the adjacent category. The present threshold questions for the CFSS are question CH1 and question CH4 (Table 1). The thresholds for the A/HFSS are questions HH3 and AD1 (Table 2).

A shortcoming arising when the child-referenced items were separated from the adult-referenced items and re-scaled as a separate scale is that there are no questions in the child scale asking about the affective (worry, anxiety) component of food security. Thus, while households with children in which the respondent affirms 0-1 item only are typically considered to have high

(0 items affirmed) or marginal (1 item affirmed) food security among children, if the respondent affirms 0 items, it is not possible to rule-out the presence of this affective component. The A/HFSS was formed by combining three of the four household-referenced items with the adult-referenced items from the original eighteen-item scale. This scale is appropriate for assessing overall food security at the household level, and for measuring adult food security. It begins with a question about the “worry/anxiety” or affective component of food security, then moves into questions about the quality and variety of food available in the household, and finally into questions about the quantity of food available. Researchers interested in determining overall food security status of households with children, including food security status of both adults and children in the household, administer the A/HFSS and CFFS, comprising all eighteen scale items.

**Table 1:** Child Food Security Scale questions with thresholds and categories

<b>Survey Question *</b>	<b>Question Content</b>	<b>Food Security Category</b>
CH1	“We relied on only a few kinds of low-cost food to feed our 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?”	Raw score ** 0-1; High or marginal food security **
<b><i>First Threshold - Change to Low Food Security</i></b>		
CH2	“We couldn’t feed our children a balanced meal, because we couldn’t afford that.” Was that often, sometimes, or never true for you in the last 12 months?	Raw score 2-4; Low food security among children
CH3	“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?”	
CH4	“In the last 12 months, did you ever cut the size of your children’s meals because there wasn’t enough money for food? (Yes/No)”	
<b><i>Second Threshold - Change to Very Low Food Security</i></b>		
CH6	“In the last 12 months, were the children ever hungry but you just couldn’t afford more food? (Yes/No)”	Raw score 5-8; Very low food security among children
CH5	In the last 12 months, did any of the children ever skip a meal because there wasn’t enough money for food? (Yes/No)	
CH5a	(If yes to question CH5) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?	
CH7	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? (Yes/No)	
<p>*This is the numbering order presently used in the Current Population Survey.  **“Raw score” refers to the number of scale questions affirmed by the respondent. Raw score = 1 may be considered marginal food security among children, but it is not certain that all households with raw score zero have high food security among children, because the scale does not include an assessment of the anxiety component of food insecurity.</p>		

### Who are the Respondents?

Households with more than one member often have one person who is more aware of the household’s food situation than other household members. This person has been referred to as the “household food manager”, and is often the mother (or primary female caregiver) in households with children. In local administration of the HFSSM researchers are advised to ask if the initial adult interviewee knows about the household food situation, and if possible, to interview an adult in the household who does. In administering the HFSSM in the December Current Population Survey, however, the Census Bureau follows its established protocol for identifying a reference person on the basis of the person or persons who own or rent the residence.<sup>10</sup> In all cases one person provides information for the household as a whole. When children are present the adult respondent provides information about all children as a group, not individual children. Likewise, the adult respondent provides information for all adults in the household as a group, not individual adults.

Table 2: Household and Adult Food Security Scale questions with thresholds

Survey Question *	Question Content	Food Security Category
HH2	“We worried whether our food would run out before we got money to buy more.” Was that often, sometimes, or never true for you in the last 12 months?”	Raw score ** 0, High food security; Raw score 1-2, Marginal food security
HH3	“The food that we bought just didn’t last and we didn’t have money to get more.” Was that often, sometimes, or never true for you in the last 12 months?”	
<b><i>First Threshold - Change to Low Food Security</i></b>		
HH4	“We couldn’t afford to eat balanced meals.” Was that often, sometimes, or never true for you in the last 12 months?”	Raw score 3-5; Low food security
AD1	“In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn’t enough money for food? (Yes/No)”	
AD1a*	“(If yes to question AD1) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?”	
<b><i>Second Threshold - Change to Very Low Food Security</i></b>		
AD2	“In the last 12 months, did you ever eat less than you felt you should because there wasn’t enough money for food? (Yes/No)”	Raw score 6-10; Very low food security
AD3	“In the last 12 months, were you ever hungry, but didn’t eat, because there wasn’t enough money for food? (Yes/No)”	
AD4	“In the last 12 months, did you lose weight because there wasn’t enough money for food? (Yes/No)”	
AD5	In the last 12 months did you or other adults in your household ever not eat for a whole day because there wasn’t enough money for food?”	

	(Yes/No)	
AD5a	“(If yes to question AD5) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?”	
<p>*This is the numbering order presently used in the Current Population Survey.  **”Raw score” refers to the number of scale questions affirmed by the respondent. Households with high or marginal food security are classified as “food secure”. Those with low or very low food security are classified as “food insecure”.</p>		

### **Impacts of Childhood Food Insecurity on Health, Growth and Development**

Development of the U.S. HFSSM has enabled a large and rapidly-growing body of research on the causes and consequences of food insecurity and hunger in the U.S. population, and abroad. The FSSM has been translated into a number of languages, and adapted for use in countries in North, Central, and South America, Europe, Africa, and Asia. It has also been implemented in several U.S. national surveys including the Survey of Program Dynamics (SPD), National Health and Nutrition Examination Survey (NHANES), the Early Childhood Longitudinal Survey (ECLS-K and ECLS-B), National Health Interview Survey (NHIS), Panel Study of Income Dynamics (PSID), the Survey of Income and Program Participation (SIPP), and a number of regional, state and local surveys.<sup>11</sup>

Several review articles have been published that summarize food security research related to child and adult health in the U.S. and elsewhere.<sup>12,13,14</sup> A set of reviews from an American Society for Nutrition sponsored symposium on Food Security and Health Across the Lifespan at the 2012 Experimental Biology meetings in San Diego, CA was published recently in the journal *Advances in Nutrition*.<sup>15,16,17,18</sup> In addition to these reviews, a large number of peer-reviewed journal articles and research reports are summarized and accessible at the USDA/ERS Food Security in the U.S. website.<sup>19</sup>

### ***What We Have Learned About Food Security and Health in Children***

Research on relationships of food security to health, in children and adults, indicates that food insecurity is associated with a variety of adverse physical and mental health outcomes, and that food insecurity influences health through two primary kinds of pathways; nutrition pathways and non-nutrition pathways.<sup>14,13,12</sup> Nutrition pathways involve responses to characteristics of food intake (e.g., the kinds, quality, or amounts of food eaten) that are affected by food security, whereas non-nutrition pathways involve responses to actual or anticipated characteristics of food resources or supply (e.g., stress, distress, worry, anxiety, about current or anticipated food supplies and/or resources needed to replenish them).

*Examples of nutrition pathways include:*

- Perinatal nutrition of mothers and children, including prenatal, postnatal, and inter-natal periods, sensitive and vulnerable periods during gestation and in the first 3-4 years of life
- Growth impacts of mothers’ and children’s food and nutrient intake including stunting, wasting (relatively rare in the U.S.), structural and system anomalies, metabolic system problems, obesity, and oral health problems

- Compromise of immune system functions related to mothers' and children's food and nutrient intake (increased risks for illness, and for infection-malnutrition cycle)
- Energy deficits related to food and nutrient intake, including;
  - Compromised body temperature regulation and temperature-related morbidity in infants and young children
  - Reduced environmental exploration & learning among children
  - Difficulty focusing and maintaining attention in school and other learning situations
  - Socio-behavioral problems, including externalizing and internalizing behaviors

*Examples of non-nutrition pathways include:*

- Adverse impacts on children's and mother's mental health (e.g., depression, anxiety, dysthymia, perceptions of low self-efficacy, and low health-related quality of life, suicidal ideation, behavior disorders, high allostatic load) stemming from stress, distress, anxiety, worry, fear, shame, and other negative affective states related to current or anticipated household food supplies
- Reduced and/or impaired adult-child interactions (lack of responsiveness in both adults and children, reduced "serve and return" activities) related to such adverse mental health outcomes
- Mothers' ineffective infant feeding strategies and behaviors related to adverse mental health outcomes
- Impoverished home environments, lack of appropriate stimulation and nurturing adult support
- "Toxic stress" (repetitive, persistent or inescapable acute or chronic stress; e.g., child abuse, domestic violence, recurrent or persistent hunger, correlates of poverty and food insecurity)
- Delays in and/or foregoing of needed medical care so that food can be purchased
- Non-compliance with prescribed health care treatment, including prescription medication and special diets so that food can be purchased

The influence of food insecurity on health through these two types of pathways may be precipitated by exogenous economic shocks to the household (e.g., unanticipated health care or other kinds of expenses, unanticipated loss of income due to involuntary reduction in work hours or job loss), or by cumulative effects of ongoing family economic hardships (e.g., chronically low income necessitating ongoing tradeoffs among necessary expenses such as rent, utilities, food, health care, etc.), or both.<sup>17,12,20,21</sup>

### ***Nutrition, Brain Growth, and Cognitive Development***

Nutrition pathways may involve absence of or deficiencies in needed nutrients, e.g., vitamins, calcium, magnesium, iron, selenium, iodine, copper, zinc, manganese, the 8 essential amino acids, 2 essential fatty acids, folic acid, and energy.<sup>22</sup> Of special interest are nutrition pathways that influence brain and cognitive development during the first 3 years of life, including the prenatal period. In humans the spinal column begins to differentiate and form during the third and fourth weeks of gestation, and within the first month specific areas of the



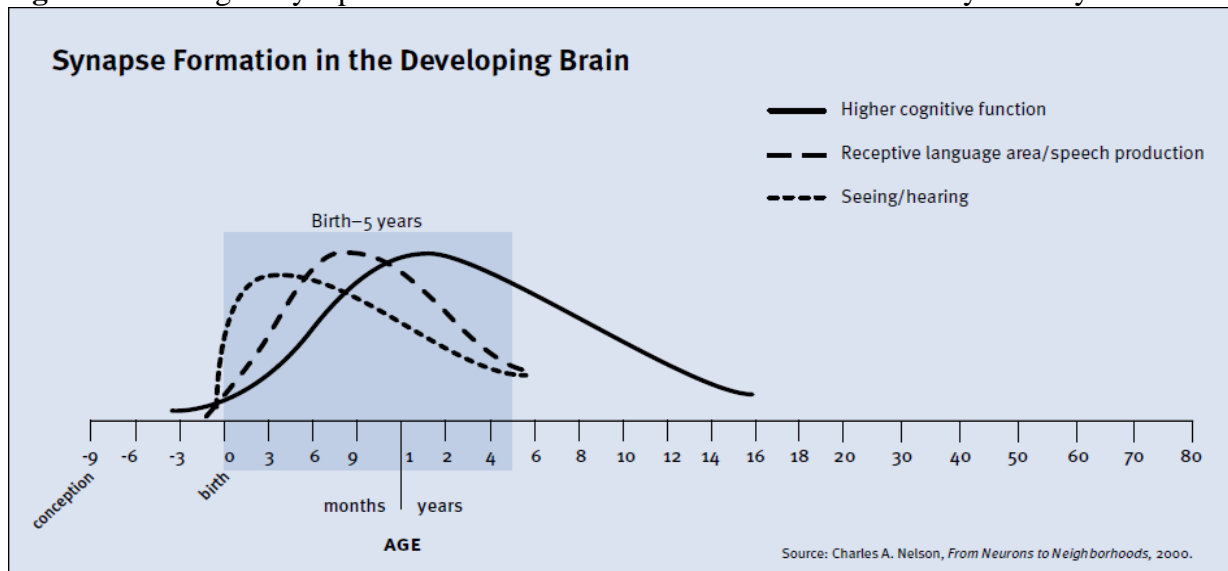
central nervous system (CNS) begin to form through neurogenesis and migration of cells in the inchoate forebrain, midbrain and hindbrain areas.<sup>23</sup>

Over the remainder of the prenatal period, there is an accelerating sequence of CNS developmental processes including proliferation and migration of cells, differentiation of cells into precursor brain structures and systems, synaptogenesis (synapse formation and proliferation), apoptosis (selective cell death or pruning away of superfluous cells), myelination (encapsulation of nerve cells in myelin sheaths), and the beginning of formation of neural networks of interconnected nerve cells.<sup>23</sup> Throughout this early developmental period, neurotransmitters are also synthesized from nutrients, playing initial important roles in organization of cell differentiation and specialization, and later assuming their primary function in neuro-transmission.

As with development of other organs, during the prenatal period the brain and remainder of the CNS are built from substances present in the mother’s diet, including vitamins, minerals, essential amino-acids, essential fatty acids including omega-3 polyunsaturated fatty acids, and other nutrients.<sup>22</sup> Availability of adequate healthful foods and proper diet for the mother during pregnancy are essential for the developing fetus, and play a critical role in determining birth outcome and health of the newborn. Even more important, the quality of mothers’ nutrition during pregnancy is a critical determinate of her baby’s brain growth and cognitive development.

The developmental processes occurring during the prenatal period accelerate and continue after birth, and are especially active and creative during the first 3 years of life (Figure 1). Commensurate needs for adequate nutrients to provide raw materials necessary for building, maintaining and elaborating the brain and other CNS structures, along with growth and development of the other organs and systems of the body (e.g., skeletal, muscular, cardiovascular, digestive, endocrine, metabolic, etc.) are ongoing, and increase as a child grows into early childhood and approaches preschool age.

**Figure 1:** Timing of Synapse and Neural Network Formation in Humans by Primary Function



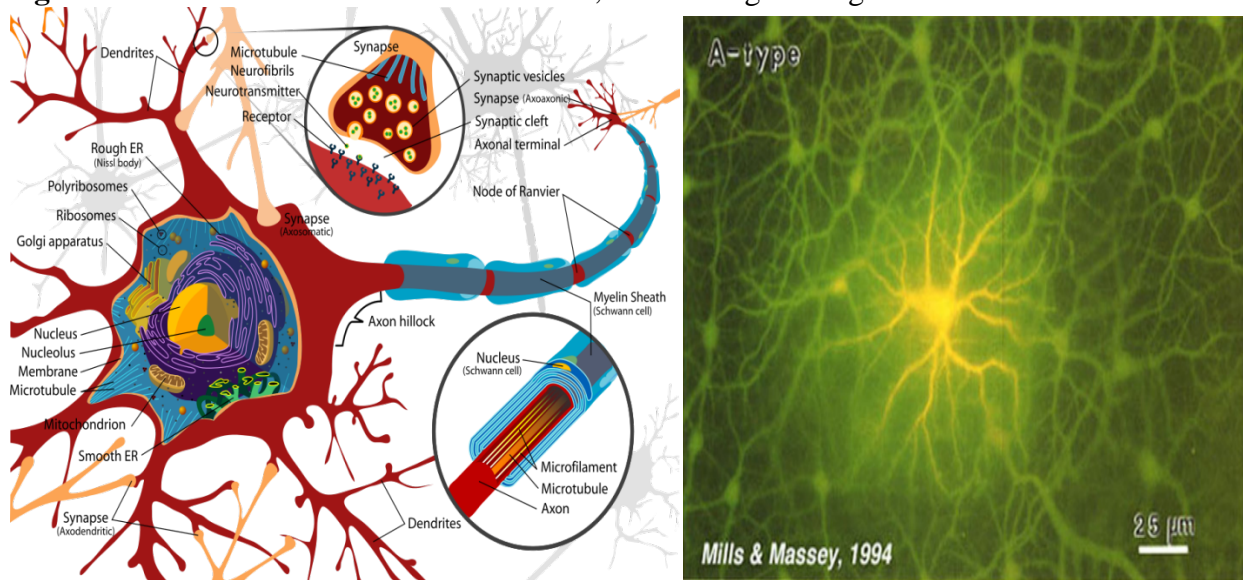
Food insecurity can make it extremely difficult, or impossible, for pregnant mothers to maintain the quality of their own diet and nutrition, and to provide consistently good nutritional materials for their babies’ growth and development.<sup>24</sup> Consequently, perinatal nutrition of

mothers and their babies are among the most critical nutrition pathways through which food insecurity can adversely impact children’s health, growth and development, with consequences that last throughout their lives.<sup>25,26,27</sup> Once the child is born, the mother’s nutrition continues to influence her health, and her baby’s health, growth and development, and food insecurity continues to pose serious risks to both the mother’s and the child’s health.

Mothers’ decisions to breastfeed or not have major consequences for their babies’ food and nutrient needs. If a mother breastfeeds her baby, her food and nutrient needs take on particular importance in support of lactation and nursing. If she is unable to breastfeed, or decides against it, her baby’s nutrition becomes oriented around nutritious formula, which is costly. In either case, even after other foods are introduced into the baby’s diet, the mother’s and child’s food and nutrient needs remain a primary factor in the child’s health, growth and development, and food insecurity remains a major potential risk factor.

During the first three years of life a child’s brain is developing very rapidly, building neural networks through synaptic connections among billions of interconnected neurons (Figure 2).<sup>28</sup> Dendritic arborization provides potential for interconnecting very large numbers of cells into networks that function in perception, memory, thought, language, and other higher-order cognitive processes. All parts of neurons are formed from raw materials in foods and nutrients.

**Figure 2:** Schematic of Individual Nerve Cell, with Enlarged Image of Interconnected Cells



Source: (LHS image) Wikimedia Commons, by Mariana Ruiz Villarreal (LadyofHats), Hamburg, Germany, used with gratitude. (RHS image) [webvision.med.utah.edu](http://webvision.med.utah.edu) .

The myelin sheath that encapsulates the axon of each neuron is critical to effectiveness of signal transmission along the axon. Development and deposition of myelin requires availability of lipids and fatty acids found in certain foods, making myelination particularly vulnerable to malnutrition during the later gestational period.<sup>23</sup> Exposure to malnutrition during this vulnerable period can have adverse consequences that limit a child’s cognitive potential for life. This also means that food insecurity during the later period of a pregnancy poses an especially serious threat to brain growth and cognitive development.

Synapses are the neurobiological substrate for almost all nerve cell to nerve cell communication. Synaptogenesis, the development of synapses, is also vulnerable to malnutrition

and exposure to environmental toxins. Synapses develop at different times in different parts of the brain, with the process of synaptogenesis continuing into adolescence in humans, lengthening the time period of vulnerability of this very important developmental process.<sup>22,23</sup>

### ***Learning***

Optimally, human infants and toddlers are well prepared for learning, which will be an important activity for their entire lives. Learning brings all parts of the CNS together in a complex interaction of activities. In human toddlers learning is a dynamic interplay of attention, perception, thought, language, memory and feelings, made all the more remarkable by the rapid changes occurring in those processes, and in the neurochemistry and neurobiology of the child's developing brain. Learning is the core activity of human capital accumulation, and it largely determines the trajectory of children's lives. Humans' capacity to learn is literally built on a foundation and infrastructure made from nutrients in the food we and our mothers eat.<sup>23</sup>

Human's initial genetic endowment expresses through early gene-environment interactions, providing the foundation on which life-long human capital accumulation will build. Food and nutrition, beginning with mothers' nutrition in the internatal period before conception, increases in importance during prenatal life *in utero*, providing the building materials with which brain architecture is laid down, and on which learning capacity is built. Food insecurity threatens this process from its very beginnings, and is a potential threat to the successful development of learning capacity, and to learning itself. Food insecurity is incompatible with successful human capital accumulation, and its costs to individuals, families and society are very large.

### ***Food Security Research Across the Phases of Childhood***

#### ***The Internatal or Preconception Period***

Recently the internatal period, before and between pregnancies, has received growing attention among child and maternal health researchers and practitioners in recognition of the importance of both mothers' and fathers' health at the time of conception to successful pregnancies, pregnancy outcomes, and healthy babies.<sup>29,30,31,32,33</sup> A key element of preconception care is ensuring the nutritional status of women of childbearing age, with special emphasis on nutrients known to play important roles in preventing congenital birth defects such as *spina bifida* and other neural tube defects.<sup>34,29</sup> Specific concerns have been raised about adequacy of intakes of Vitamins A, C, B6, and E, folate, calcium, iron, zinc, and magnesium among U.S. women.<sup>35</sup> While no research has specifically examined relationships between food insecurity and internatal health, it is recognized as a dietary risk factor and the six-item abbreviated Household Food Security Scale has been recommended as part of overall screening for nutritional risks during preconception care.<sup>29</sup>

#### ***The Prenatal Period***

Mothers' nutritional status during pregnancies can have major impacts on their and their babies' health during the pregnancy and *post partem*. High prevalence of overweight and obesity among U.S. women overall leads to serious concerns for mothers' weight status during pregnancy.<sup>36</sup> Obesity has been associated with a number of poor pregnancy outcomes, including gestational diabetes mellitus, pregnancy-induced hypertension, preterm delivery, stillbirth, macrosomia, and congenital anomalies.<sup>35,37</sup> Women who are overweight or obese during pregnancy have also been found to have higher health care utilization during the pregnancy and longer hospital stays after birth, resulting in higher pregnancy and birth-related health care

costs.<sup>38</sup> Several studies have found food insecurity associated with some of these adverse pregnancy outcomes, including gestational weight gain, low birth weight and other pregnancy complications.<sup>39,40,41</sup>

It is not known how many pregnancies nationwide occur among women living in food-insecure households. However, in the California Maternal and Infant Health Assessment (MIHA) data for 2002-2006, 18.3% of all pregnancies statewide involved women in food-insecure households, with 34.7% of pregnancies among women whose household incomes were below 100% of the Federal Poverty Line (FPL) occurring in food-insecure households.<sup>42</sup> The overall average food insecurity prevalence among California households from 2004-2006 was 10.9%.<sup>43</sup>

It seems clear that food insecurity poses risks to the nutritional well-being of pregnant mothers and their babies. The importance of this period to brain and cognitive development, and other aspects of children's health makes it a particularly vulnerable period. Yet there is still much that we need to discover about the implications of food insecurity for the mother and her baby during the prenatal period.

### *Early Childhood*

Food insecurity during early childhood has been associated with a variety of adverse health outcomes in children, including increased hospitalizations,<sup>44</sup> poor health status,<sup>45</sup> iron deficiency anemia,<sup>46</sup> behavior problems (e.g., aggressiveness, inattention/hyperactivity),<sup>47</sup> and developmental concerns.<sup>48</sup> The first 3-4 years of life comprise a period of rapid development in which language and many of the precursors of formal learning are established. This is also a period during which exploration of the environment and positive adult-child interactions are very important for establishing self-confidence and efficacy, and developing trust in supportive adults.

The early childhood years are also a period in which children begin to exert some degree of choice and control over their own diet and food intake. Food preferences begin to take root and patterns of healthy eating can be established. Early childhood is also a period of relative vulnerability for mothers, and food insecurity has been associated with maternal depression during this period.<sup>47,49,21</sup> Mothers' depression, and its associations with food insecurity, have been implicated in emergence of childhood obesity through adverse impacts on infant feeding behavior.<sup>50,51</sup> Similarly, food insecurity has been found to operate through maternal depression and parenting practices to affect security of attachment and mental proficiency in toddlerhood.<sup>52</sup>

### *School-Age Years*

Some of the earliest research on food insecurity's associations with child health and development covered school-age years and used precursor measures of food adequacy such as the Community Childhood Hunger Identification Project (CCHIP) hunger scale, the USDA "food sufficiency question", and early versions of some questions that were later incorporated into the USFSSM. A set of seminal studies in 1998-2002, using data from the CCHIP scale, found hunger (as measured by the CCHIP scale) strongly associated with both physical and mental health outcomes in school-age children.

Children categorized as hungry by the CCHIP scale were more likely to have clinical levels of psychosocial dysfunction on the Pediatric Symptom Checklist (PSC) than either at-risk or non-hungry children. Analysis of individual PSC items found that most behavioral, emotional, and academic problems were more prevalent in hungry children, and that aggression and anxiety had the strongest degree of association with hunger.<sup>53</sup> Children ages <12 years categorized as hungry or at risk of hunger were twice as likely as non-hungry children to be reported as having

impaired functioning by either a parent or the child her/himself. Teachers reported statistically significantly higher levels of hyperactivity, absenteeism, and tardiness among hungry/at-risk children.<sup>54</sup>

Severe hunger on the CCHIP scale was a statistically significant predictor of chronic illness among both preschool-aged and school-aged children and was statistically significantly associated with internalizing behavior problems, whereas moderate hunger was a statistically significant predictor of health conditions in preschool-aged children. Severe hunger was also associated with higher reported anxiety/depression among school-aged children.<sup>55</sup>

Using data from the NHANES III on the USDA food sufficiency question and a few other questions about food security, versions of which were later incorporated into the Food Security Scale, Katherine Alaimo and colleagues at Cornell University and the National Center for Health Statistics completed a series of very important studies on associations between food insufficiency and physical and mental health outcomes, and academic achievement, in school-age children from 2001-2002.

Food insufficiency was positively associated with higher prevalence of fair/poor health and iron deficiency, and with greater likelihood of experiencing stomachaches, headaches, and colds in children aged 1–5 years.<sup>56</sup> Children aged 6–11 years in food-insufficient families had lower arithmetic scores, were more likely to have repeated a grade, to have seen a psychologist, and to have had difficulty getting along with other children, than similar children whose families were food sufficient. Teenagers from food insufficient families were more likely than food-sufficient peers to have seen a psychologist, to have been suspended from school, and to have had difficulty getting along with other children.<sup>57</sup> Children aged 15–16 years from food-insufficient households were statistically significantly more likely to have had dysthymia, to have had thoughts of death, to have had a desire to die, and to have attempted suicide than food-sufficient peers.<sup>58</sup>

And finally, one of the most important studies on relationships between food insecurity and physical and mental health and academic achievement in school-age children was published by Jyoti and colleagues on data from the ECLS-K. This research was important partly because it used longitudinal data that enabled it to move a step farther toward demonstrating causality in the relationships it examined, and partly because of the breadth of its findings.

In lagged models, Jyoti and colleagues found food insecurity (FI) in kindergarten associated with lower math scores, increased BMI and weight gain, and lower social skills in girls at third grade, but not in boys, after controlling for time-varying and time-invariant covariates. Using difference scores and dynamic models based on changes in predictors and outcomes from kindergarten to third grade, these researchers found that children from persistently FI households (FI at both kindergarten and third grade years) had greater gains in BMI and weight than those of children in persistently food-secure households, though effects were statistically significant only for girls. Also among girls, but not boys, persistent FI was associated with smaller increases in reading scores over the period than for persistently food-secure girls.<sup>59</sup>

In dynamic models, for households that transitioned from food security to FI over kindergarten to third grade (i.e., became FI), the transition was associated with statistically significantly smaller increases in reading scores for girls and boys than for children in households remaining food secure. For children transitioning from FI to food security (i.e., becoming food secure), the transition was associated with larger increases in social skills scores for girls but not for boys. Becoming FI was associated with statistically significantly greater

weight and BMI gains for boys but not for girls and with greater declines in social skills scores for girls but not boys.<sup>59</sup>

### ***Children's Awareness and Experience of Food Insecurity***

Several recent studies have examined a dimension of child food insecurity that has not previously received adequate attention, and should be pursued more intentionally. Previous research suggested that children are shielded from much of the experience of food insecurity by adults in their households, either by adults rationing food in ways that spare children from the experience of hunger, or by adults engaging in coping strategies that buffer children from much of the anxiety or worry about the household food situation. Most of what is known about children's experience of food insecurity and hunger is derived from parental reports, either of the household food conditions, or of their perceptions and understanding of their children's experiences of those conditions.

However, recent research calls the accuracy and completeness of parents' understanding and reports of their children's experience of food insecurity into question, and indicates that children have their own experience of food insecurity and hunger that is separate from that of their parents. This research also suggests that children are less completely buffered from the affective component of food insecurity, and that they are far more aware of the household food conditions than was previously thought. It also suggests that some children participate much more actively in actions aimed at obtaining food or increasing household food resources.

In one study children (ages 11-16 Yrs) described food insecurity in terms of quantity (eating less than usual, or eating more or fast when food is available), quality (having only a few, low-cost foods), affective states (worry/anxiety/sadness about the family's food, shame/fear of being labeled "poor", feelings of having no choice, adults trying to shield children from food insecurity), and social dynamics (using social networks to get food, or being socially excluded).<sup>60</sup> Another study found that children (9-16 Yrs) experience food insecurity distinct from parents experience and reports of the condition, and have cognitive, emotional and physical awareness of food insecurity; adults are not always aware of children's experience of food insecurity.<sup>61</sup>

A third study found children (10-17 Yrs) in peri-urban areas of Miranda State, Venezuela were cognitively aware of food insecurity, their parents' worries about it, and causes both internal and external to their households, emotionally aware (expressing feelings of concern, anguish, sadness; episodes of crying), and physically aware (of hunger, reduced quantity and quality of intake, eating smaller meals, and thinness and fainting as consequences). Children's responses included reducing quantity and quality of intake, child labor, food from waste, sacrifice in food consumption, seeking food from extended family, strategies for obtaining, preparing and cooking food. Children were not always protected from hunger by adults.<sup>62</sup>

A fourth study explored children's (9-10 Yrs) understanding of family finances and how they related to "eating healthily" in two contrasting SES schools in the North of England. These authors found children incorporated a variety of media information into their understanding, and sought explanations from personal experience. Children had sophisticated ideas about interrelationships between diet, cost and health, and were keenly aware of how family finances influenced food purchases. Children proposed a variety of strategies for eating healthily on a budget, but prioritized state and corporate responsibility in ensuring that eating healthily is affordable.<sup>63</sup>

Taken together these studies indicate that children in families experiencing food insecurity have their own extensive experience of that food insecurity, and they are very much

aware of the conditions underlying the situation. This research also indicates that policies aimed at reducing household food insecurity need to take into account children's awareness of the condition and their actions to contribute to its alleviation. Even more important, however, this research suggests that children may be affected by food insecurity in more ways, and to a greater extent than was previously understood.

### **What We Still Need to Know About Child Food Insecurity and Health**

In spite of the tremendous volume of food security research completed since the Food Security Measurement Project released its reports in 1997, there is still much that we do not yet understand about child food insecurity and its implications for child health, growth and development. Several subsets of children whose food and nutrition requirements, or socio-demographic characteristics, may place them at special risk need further study. Among those are children with special health care needs (CSHCN), children of immigrant parents, and children who have been exposed to extraordinary hardships or stresses. This latter category includes children who have been exposed to: homelessness (either living in homeless conditions themselves, or having mothers who were homeless during their pregnancies), extreme toxic stress (such as child abuse or violence), and children living in chronic poverty.

#### *Children with Special Health Care Needs*

Data from the 2009-2010 National Survey of Children with Special Health Care Needs (CSHCN) indicate approximately 15% of U.S. children have some kind of special health care needs. Among different race/ethnicity groups the prevalence is highest for non-Hispanic Black children (17.5%) and lowest for Hispanic children (11.2%), with non-Hispanic White children intermediate (16.3%). The situations of many CSHCN are such that one or both parents are sometimes prevented from working, or are required to work part time, placing limitations on household resources. Food insecurity may be an exacerbating factor for families with CSHCN, or *vice versa*, having a child with SHCN may make a family more likely to be food insecure, but we do not yet know. We need to do the research that will enable us to clarify the basic relationships between food security and CSHCN, and to develop policies that effectively assist affected families.

#### *Children of Immigrants*

Some food security research has addressed the situations of children of immigrant parents, but there remains much that we do not understand about both the risk and protective factors that may be attendant to having immigrant parents. Immigration is self-selective on many characteristics that are highly valued by our society, including a strong work ethic, economic and social resilience, and supportive family relationships. Many children of immigrants are themselves U.S.-born citizens, giving rise to families of mixed immigration status. And it seems clear that immigrants comprise a rapidly-growing component of the U.S. population, with growing economic, social and political influence. Consequently, it is very important to understand food security and food insecurity among children of immigrants in the U.S., including policy needs peculiar to this subset of children.

#### *Children Exposed to Extreme Stresses*

The National Center on Family Homelessness estimates that approximately 1.6 million U.S. children experience homelessness for some period each year. Data from the 2008 National

Survey of Children's Exposure to Violence indicate approximately 61% of U.S. children had some exposure to violence, crime, or abuse, direct or witnessed, during the year prior to the survey date. According to the Census Bureau's Current Population Survey, 7.2 million U.S. children (9.8%) lived in households with incomes below 50% of their federal poverty thresholds in 2011. These extreme hardships and stresses place the children experiencing them at very high risk for adverse health, growth and developmental outcomes. It is likely that living in food insecure households in addition to these stresses may amplify the harm they inflict on children. It is also possible that these hardships and the conditions within which they occur make it more difficult to avoid food insecurity. We need to know more about food insecurity among children exposed to these kinds of extreme stresses.

### ***Multiple Family Hardships***

There is extensive evidence that many families who experience food insecurity also experience other hardships. Households that are food insecure also have difficulties paying utility bills and become energy insecure, and they frequently have trouble paying rent and become housing insecure. Often households cope by trading hardships off against each other, paying rent one month, utility bills the next, and adjusting food purchases to accommodate those expenditures. While each of these hardships can in principle be addressed through existing policy solutions, it may be more efficient to consider and address them together.

Research is needed to improve our understanding of the extent of multiple family hardships, and how policy solutions can be used most effectively to address those hardships. It may be more effective and efficient to treat multiple family hardships as a "package" instead of individually. Or it may be that for some families one hardship is more debilitating than others, and that treating that one could make the others more manageable.

### ***Non-nutrition Pathways of Food Insecurity's Influence on Health***

Relatively more is known about nutrition pathways of food insecurity's influence on child health than about the non-nutrition pathways. The recent research on children's experience of food insecurity strongly suggests that non-nutrition pathways involving the affective component of food security are important avenues of influence, and they need to be understood more fully. It may be that such non-nutrition pathways of adverse influence on children's physical and mental health are as or more important than the nutrition pathways. The relatively new body of literature on "toxic stress" and its adverse effects on brain architecture raise the question whether food insecurity may itself become a form of toxic stress under some circumstances. If so, that has profound implications for brain growth and development, school readiness, academic achievement, educational attainment, and lifetime human capital accumulation. It also has profound implications for work-life earnings capacity, and for economic prosperity generally.

A large number of studies have associated maternal depression in one way or another with food insecurity. While establishing direction of causality can be impracticable in many study designs, it seems clear that parental depression is a very real correlate of food insecurity. Whether caused by, or a cause of food insecurity, parental depression is a serious risk factor for child developmental problems and has recently been associated with children's development of a propensity to become overweight or obese.

These are just two examples of potentially very important non-nutrition pathways through which food insecurity can adversely influence children's health and well-being



throughout their lives. We need to know more about these and other non-nutrition pathways of influence. Implementation of the Affordable Care Act may open windows of opportunity for new, creative policy approaches for addressing some of the non-nutrition pathways through which food insecurity influences child health, growth and development. Greater emphasis on preventive health measures may facilitate both research and policy solutions in these important areas.

### ***Levels of Severity of Food Insecurity***

Several recent studies have emphasized the comparability of health outcomes associated with a wide range of severity of food insecurity, some finding that even marginal food security is associated with the same serious adverse health outcomes as low food security. We need to know more about why marginal food security is more like food insecurity than food security. And we need a better understanding of the implications of categorizing households with marginal food security as food secure. Several recent studies suggest that we may be underestimating the associations of food insecurity with adverse health outcomes by including marginally food secure households in the food-secure category.

On the other end of the severity scale, there currently seems to be a consensus to consider children in households with very low food security in children as measured by the child food security scale, as indicative of “children with hunger”, at least for the purposes of the Healthy, Hunger-Free Kids Act of 2010. As is well known, the prevalence of this category of food insecurity is quite small; 1.1% (845,000 children) in 2011. And while raising these children out of this most severe category of food insecurity is a laudable goal, and must be done, focusing on this category alone would be a grave mistake.

In 2011, there were 6.8 million households with very low food security (VLFS) on the household scale, with 16.9 million people living in those households; 12.1 million adults & 4.8 million children. That same year there were 3.9 million households with 8.6 million children with low food security on the child scale, and 845,000 children with VLFS on the child scale. Assuming that all 845,000 children with VLFS on the child scale lived in households with VLFS at the household level, this implies that almost 4 million children lived in households where adults had VLFS, but the children did not. And since approximately 7.7 million children lived in households with low food security in children on the child scale, some presumably large portion (if not all) of the 4 million children in households with VLFS among adults also experienced low food security as measured by the child scale.

Given that the evidence indicates even marginal food security is associated with adverse health outcomes in adults and children, it is inadvisable to focus only on the 845,000 children in households with VLFS in children, and to pay less attention to those approximately 4 million children in households with VLFS in adults but not in children, or the 7.7 million children in households with low food security on the child scale. On the basis of health care costs alone that would be ill-advised.

Moreover, in light of recent evidence regarding children’s experience of food insecurity (described above), it seems appropriate to ask how the approximately 4 million children in households with VLFS among the adults but only low food security among children experience that situation. How do they experience the adults’ hunger? How does it affect them? And how is their experience different from the approximately 12 million children who only experience low food security at the household level? These are questions worth researching.

### ***The “Dynamics” of Child Food Insecurity and Hunger***

USDA/ERS has performed some analyses of the dynamics of food insecurity, or the proportions of households experiencing food insecurity for different numbers of months out of the year. Other researchers have examined changes in food insecurity over different time periods using longitudinal data (e.g., the ECLS). But we still do not have a very clear picture of how much movement there is across the different food insecurity severity categories.

It seems logical that, as with poverty, there would be “spells” of food insecurity. But how does experiencing food insecurity at one severity level influence the likelihood of experiencing a more severe level of food insecurity? How often do households move from one category to another? How is that movement influenced by changes in the economy (e.g., recessions and recoveries)? Is the “cliff effect” observed among SNAP recipients part of that picture? And how do the dynamics of child food insecurity and hunger influence the effectiveness of SNAP and other assistance programs?

### ***Child Food Insecurity, Community Food Security, and Food System Reform***

In spite of more than a decade of parallel creative research and other activity in the areas of household food security and community food security, we still know far too little about how these two areas influence each other, or whether they might be missing opportunities for cost-effective synergies. Recent work on food deserts and other aspects of geographic accessibility of healthful foods at the community level has shed light on some aspects of community food security, but there still is not a clear, evidence-based picture of how these two realms of food security are related.

The WIC Farmers Market coupon program and efforts to obtain and use SNAP EBT machines at farmers markets have had some success, but there has been relatively little empirical research to evaluate the potential or effectiveness of these programs in reducing child food insecurity or improving the quality of recipients’ diets. There continues to be a need for better evidence and understanding of how household and community food security “fit together”, if at all, and whether there are policy approaches that can bring together the best aspects of each to form synergistic solutions to child food insecurity.

The energy and human capital that is going into food system reform nationally and globally is vibrant and active, and may hold potential for creative solutions to child food insecurity over the longer term. A variety of creative activities involving school learning environments, and combining those with school food environments, are emerging. It would be very useful to have a fuller understanding of the potential that these non-traditional food system activities might hold for helping to address the seemingly intractable problem of child food insecurity.

### ***Effectiveness and Importance of SNAP in Addressing Child Food Insecurity***

There is a strong consensus that SNAP is the most important nutrition assistance program in existence, and recent innovative approaches to measuring its effectiveness in reducing food insecurity have strengthened that consensus even further. Yet pressure continues to mount for changes to SNAP that would provide disincentives for its use in purchases of “bad foods”, e.g. sugar-sweetened beverages (SSBs) or other obesogenic foods. At times there seems to be a fundamental lack of understanding about how SNAP works, including whether it is even logistically possible to accomplish what is proposed. In addition, whether right or wrong, and for whatever reasons, there is relentless pressure from opponents of SNAP and other social safety-

net programs to reduce support for SNAP in the Federal budget. Consequently, it would be very helpful to have empirical evidence on the costs and benefits of using SNAP to discourage purchase of obesogenic foods.

This is a complicated set of questions that includes issues of policy across a wide spectrum that encompasses agriculture, the food industry, nutrition assistance, and health. As a result it is not likely to be an easy set of questions to achieve consensus on. But there is clearly a need for additional evidence, and a fuller understanding of the pros and cons of attempting to use SNAP to discourage purchases of obesogenic foods.

## **Conclusion**

Child food insecurity is a pernicious threat to the physical and mental health of U.S. children in all stages of childhood. It is especially damaging to children during the perinatal period and the first 3-4 years of life when their brains are growing and developing at very rapid rates. Adverse impacts of food insecurity can occur during these early life periods through both nutrition and non-nutrition pathways. We have learned much in the time since the food security measures were created, but there is still much that we do not know about the ways food insecurity adversely impacts child health, growth and development, and how to prevent those adverse impacts.

The future prosperity of the American economy and population depend on successful human capital accumulation by each generation of children. Food insecurity presents a drain on human capital formation throughout childhood and on into adulthood, and can make it virtually impossible for children to fulfill their potential.

Establishing causation is correctly the ideal for research on child food insecurity. But many of the relationships of interest do not lend themselves to randomization, making creative quasi-experimental and other kinds of approaches necessary. The numerous contingent relationships involved in families' efforts to juggle food insecurity, housing insecurity, energy insecurity, health care and other needs often make determining causality impracticable. There is great heterogeneity in people's abilities to make those tradeoffs rationally and effectively; humans are fallible, and often unpredictable. Thus inferences are almost always probabilistic, and effects are frequently the result of multiple causes. Moreover, some causes are also effects; causation can be bidirectional. Yet, we have a responsibility to strive to identify manipulable "causes" that precede manipulable effects, and for that, identifying causation must always be the ideal.

Data requirements for determining causation in multivariate statistical modeling are non-trivial, and costly. Longitudinal data sometimes enable researchers to demonstrate causality, or come close to it. Randomized controlled trials (RCTs) are the "gold standard" for research designs that can demonstrate causality, however there are prohibitive ethical considerations that make randomization infeasible for most questions of interest to food security researchers. This does not rule out creative design of RCTs that could be productive, but it undoubtedly limits what can be done with that design form.

There is currently considerable variety in the kinds of food security research being done, and that is likely to continue. I believe this is a sign of a healthy, strong and vibrant body of inquiry, and I hope it will continue. Much can be learned through qualitative research methods that can complement and inform quantitative research, and *vice versa*. There are many compelling reasons for USDA to continue supporting research employing a variety of methods

and data. Among those reasons are a need to nurture the next generation of food security researchers.

There is still a great deal that we need to learn and understand about food insecurity in the U.S. Its effects on human capital accumulation are clearly a large barrier to achieving national economic prosperity. Among the most disturbingly puzzling questions begging for clarification is why the supposed wealthiest nation cannot eliminate food insecurity and hunger from its population? What would it take to create the will among our nation's decision makers, and the populace, to achieve that end? That question is at least worth thinking about, and talking about, even if we are unlikely to discover simple or definitive answers through our research.

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