Food Security, Poverty, and Human Development in the United States

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Access to food is essential to optimal development and function in children and adults. Food security, food insecurity, and hunger have been defined and a U.S. Food Security Scale was developed and is administered annually by the Census Bureau in its Current Population Survey. The eight child-referenced items now make up a Children's Food Security Scale. This review summarizes the data on household and children's food insecurity and its relationship with children's health and development and with mothers' depressive symptoms. It is demonstrable that food insecurity is a prevalent risk to the growth, health, cognitive, and behavioral potential of America's poor and near-poor children. Infants and toddlers in particular are at risk from food insecurity even at the lowest levels of severity, and the data indicate an "invisible epidemic" of a serious condition. Food insecurity is readily measured and rapidly remediable through policy changes, which a country like the United States, unlike many others, is fully capable of implementing. The food and distribution resources exist; the only constraint is political will.

Key words: **children's health; human development; hunger; poverty**

Introduction

Optimal physiological, cognitive, and emotional development and function in children and adults requires access to food of adequate quantity and quality at all stages of the lifespan. Efficient epidemiological measurement of access to food by U.S. populations has challenged researchers since the 1980s. Lack of access to adequate food by U.S. households because of constrained household financial resources has been measured by questions assessing "hunger," "risk of hunger," "food insufficiency," and most recently "food insecurity."[1–5] In 1990 an expert working group of the American Institute of Nutrition developed the following conceptual definitions of food security, food insecurity, and hunger, which were published by the Life Sciences Research Office of the Federation of American Societies for Experimental Biology.[2]

- *Food security*. "Access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum: (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies)."
- *Food insecurity*. "Limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways."
- *Hunger*. "The uneasy or painful sensation caused by a lack of food. The recurrent and involuntary lack of access to food. Hunger may produce malnutrition over time. . .. Hunger . . . is a potential, although not necessary, consequence of food insecurity."

These conceptual definitions were made operational, and a scale was developed to measure the operational conditions at the household level in the U.S. population under the guidance and sponsorship of the National Center for Health Statistics and the U.S. Department of Agriculture in 1995–1997.[3–5] Consisting of 18 questions, the U.S. Food Security Scale (FSS) is administered annually by the Census Bureau in its Current Population Survey, with results reported by the U.S. Department of Agriculture's (USDA) Economic Research Service (ERS). These repeated cycles of the FSS now provide a 10-year time series of data on food security, food insecurity, and hunger in the U.S. population for 1995–2005.[6]

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TABLE 1. Questions in the U.S. Food Security Scale, with Child Food Security Scale questions in the lower section

1. "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? 2. "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?	Household Food Secure
3. "We couldn't afford to eat balanced meals." Was that often, sometimes, or never true for you in the last 12 months? 4. 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) 5. (If yes to Question 4) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months? 6. 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) 7. In the last 12 months, were you ever hungry, but didn't eat, because you couldn't afford enough food? (Yes/No)	Household Food Insecure Without Hunger
8. In the last 12 months, did you lose weight because you didn't have enough money for food? (Yes/No) 9. 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) 10. (If yes to Question 9) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?	Household Food Insecure With Hunger
(Questions 11–18 are asked only if the household included children aged 0–18 years) 11. "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?	Child Marginally Food Secure
12. "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? 13. "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? 14. 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? (Yes/No)	Child Food Insecure Without Hunger
15. In the last 12 months, were the children ever hungry but you just couldn't afford more food? (Yes/No) 16. In the last 12 months, did any of the children ever skip a meal because there wasn't enough money for food? (Yes/No) 17. (If yes to Question 16) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months? 18. 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)	Child Food Insecure With Hunger

Relatively recently, a Children's Food Security Scale (CFSS) consisting only of the eight child-referenced items in the larger 18-item FSS has been validated by USDA/ERS. The CFSS can be scored and scaled to more directly depict the food security status of children in a household. This child-referenced scale has also been shown to yield higher prevalence of child hunger when administered separately than that obtained from the FSS.[7] The 18 questions making up the FSS are shown in TABLE 1, with the eight items that make up the CFFS in the lower section. Thresholds for the various household and child food security categories are also indicated.

USDA/ERS recently implemented more changes in how results from the Census Bureau's annual administration of the FSS are reported.[8] These changes affect terminology used to label the most severe level of deprivation measured by both the household and children's scales by replacing the term "hunger" with the blander term "very low food security."[6] Because this change is relatively recent, and not uniformly accepted by either scientists or advocates, we have elected to use the original term "hunger" in this review where appropriate.

In this chapter, we summarize available research on the direct associations of household and children's food

insecurity with children's health and development and with mothers' depressive symptoms by using a developmental framework extending from the prenatal period to adolescence. Within selected developmental stages, we briefly review the effect of the Food Stamp Program (FSP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on outcomes influenced by food insecurity. We also delineate emerging information about food insecurity's complex roles as an outcome, mediator, and moderator of effects of multiple risks, as well as its associations with policies such as income maintenance ("welfare"), housing assistance, and home energy assistance—factors not historically considered nutritional issues.

Relationship of Food Insecurity to Poverty

Food insecurity and hunger, as measured by the FSS, are specifically related to limited household resources.[3,5] Thus, by definition they are referred to as "resource-constrained" or "poverty-related" conditions. Financial resources available to households can include income earned by household members and additional resources derived from cash and in-kind assistance provided by public and private safety-net programs, including public and private food assistance programs, housing subsidies, and energy assistance.[9–12] The Department of Health and Human Services manages most federal sources of cash assistance available to families and children. You can find descriptions of these financial assistance programs at http://www.dhhs.gov/children/#income (last accessed June 25, 2007).

The official definition of poverty for the U.S. population uses income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps). The definition is based roughly on historical estimates of the portion of an average household's income required to purchase a "minimally nutritious diet" (about 30% in the early 1960s). Poverty thresholds, set at three times the amount necessary to buy such a diet, are amounts that the federal government estimates to approximate levels of necessity for families of different size and composition (i.e., number of people in the household and number of children or elderly). Although the cost of living varies widely from state to state and region to region, poverty thresholds do not vary geographically. They are, however, updated annually for inflation by using the Consumer Price Index, a broad national index of overall increases in aggregate consumer prices. Moreover, though an average U.S. family currently spends only about 12% of its total annual expenditures on food, implying a poverty threshold closer to eight (100%/12%) times the cost of a minimally nutritious diet instead of three times this "multiplier" has not been updated since its conception in the early 1960s. See "The Development of the Orshansky Thresholds and Their Subsequent History as the Official U.S. Poverty Measure," by Gordon M. Fisher (1992), at http://www.census.gov/hhes/www/povmeas/papers/orshansky.html (last accessed July 13, 2007). The official poverty threshold for families of four people—two adults and two children—was $20,444 in 2006.[13] All members of a household with income below this level will be categorized as being in poverty.

Both the definition of poverty and the poverty thresholds have been criticized on the grounds that they do not accurately reflect families' true financial resources or the amount of money that families actually need to be economically self-sufficient.[14] Estimates of minimum income levels required for families to achieve basic economic self-sufficiency range around twice the federal poverty thresholds.[15]

On the basis of the official poverty definitions, in 2005 (the latest year for which data are available) 37 million people (12.6%) lived in households with incomes below the poverty thresholds in the United States. Of these, 13 million were children younger than 18 years, and 5 million were children younger than 6 years. Subpopulations with highest prevalence of poverty are people in female-headed households with no spouse present (28.6%), blacks (24.9%), Latinos (21.8%), and children younger than 6 years (20.0%).[16] From 2000 to 2004, the poverty rates for all major ethnic groups increased steadily, though they declined in 2005 (Fig. 1).

Though the populations affected by poverty and food insecurity overlap, they are not identical. Not all poor people are food insecure, and the risk of food insecurity extends to people living above the federal poverty level.[3,6] In 2005, 35 million people (12.1%) lived in food-insecure households, 24.3 million in households without hunger, and 10.8 million with hunger. Of the 35 million food-insecure people in the United States in 2005, 12.4 million were children younger than 18 years. As with poverty, subpopulations with the highest prevalence of household food insecurity are blacks (22.4% of households), Latinos (17.9% of households), households with children younger than 6 years (16.7%), and single-mother households (30.8%).[6]

In 2005, 38.5% of all people in the United States with incomes below the poverty thresholds were food

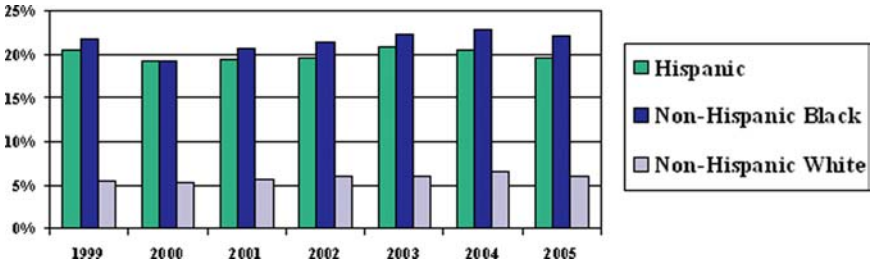

FIGURE 1. Proportion of U.S. Families with Incomes Below Poverty by Race/Ethnicity, 1999–2005*
*Includes households with and without children.

Source: U.S. Census Bureau, Current Population Survey, various years.

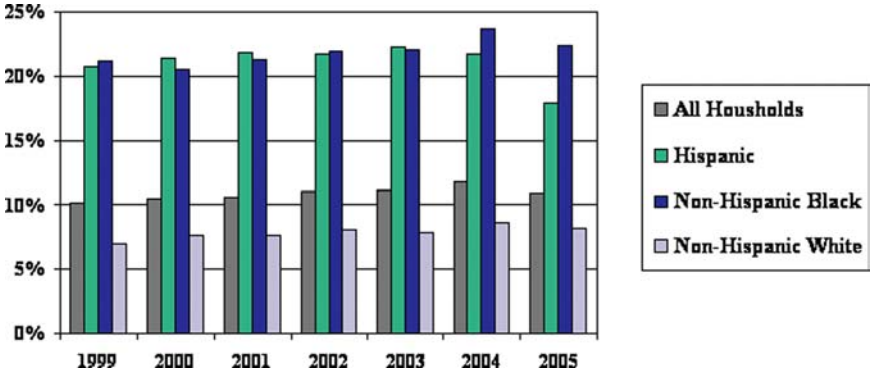

FIGURE 2. Proportion of U.S. Households that are Food Insecure by Race/Ethnicity: 1999–2005*
*Includes households with and without children.

Source: USDA/ERS Food Security in the United States, various years.

insecure. Of all people with incomes equal to or above the poverty threshold but below 130% of poverty (gross income cutoff for the FSP), 28.7% were food insecure, whereas 20.8% of all people with incomes equal to or above 130% but below 185% of poverty (gross income cutoff for WIC) were food insecure. Only 5.4% of all people with incomes at or above 185% of poverty were food insecure. These prevalence estimates indicate that for some families "safety net" programs—such as the national food assistance programs; housing and energy subsidies; and in-kind contributions not included in the federal poverty calculations, like those from relatives, friends, food pantries, or other charitable organizations, not included in the federal poverty calculations—may partly decrease the risk of food insecurity. Families who do not receive public benefits for which they are income eligible (either because of bureaucratic barriers or because the programs are not entitlements and are insufficiently funded to reach all who are eligible) may be more likely to be food insecure. Moreover, many families whose incomes exceed the eligibility cutoff for these programs may still be unable to avoid food insecurity without assistance if the costs of competing needs such as energy or housing are overwhelming. We will present empirical data below to support these contentions. From 1999 to 2004, the prevalence of food insecurity increased steadily for all major race/ethnic groups but declined in 2005 (FIG. 2).

Food Insecurity, Child Health, and Development

Food insecurity influences health and development through its effects on nutrition and as a component of overall family stress. The condition of food insecurity includes both inadequate quantities and inadequate quality of nutrients available. At less severe levels of food insecurity, household food managers (usually mothers) trade off food quality for quantity to prevent household members, especially children, from feeling persistently hungry.[3,5] Conceptually, social safety-net programs can influence the relationships between food insecurity and child health, growth, and development by helping to prevent food insecurity or by moderating its effects once it does occur.

Overall, less expensive filling foods are more energy dense and nutrient sparse, whereas nutrient-dense,

energy-sparse foods are more expensive.[17] This inverse relationship between food prices and food quality has implications for micronutrient deficiencies at all ages and has recently been suggested as a potential factor in the widespread emergence of overweight in adults and possibly in older children.[17–21] Inexpensive energy-dense foods can be cost-effective for low-income and food-insecure families, especially those whose members can ward off the feeling of hunger only by consuming cheap foods, which often contain large amounts of starches, sugar, salt, and fats. In contrast, for infants and younger children with smaller stomach capacity, satiety is rapidly reached with nutrient-poor, cheap foods, such as sweetened liquids and french fries. Although a young child subsisting on cheap "junk food" may not cry from hunger, total intake of both macronutrients (calories and protein) and micronutrients may be insufficient for normal growth, leading to stunted growth (nutritional short stature) and underweight for age or height.[22]

Moreover, poor nutrition, and by extension food insecurity, influences health and well-being throughout the life cycle, from the prenatal period on into elder years.[22–28] Also, effects of food insecurity on adults in households with children can adversely affect those children in a variety of ways, including diminution of parents' energy for providing care and developmental stimulation. Parental (especially maternal) depression has been associated with food insecurity,[29] and in many contexts, not limited to those involving food insecurity, such depression has been linked with adverse effects on parenting, parent–child interaction and attachment, child growth, development, health, and well-being.[30–33]

Prenatal and Neonatal Periods

Adequate prenatal nutrition is critical for normal development of the fetal body and brain. Although much research has confirmed the importance of nutrition during the prenatal and neonatal periods,[22–25,34–36] far fewer studies have specifically addressed the role of food security per se for this part of the life cycle. Food insecurity has been associated with low-birthweight deliveries[37] and with a variety of psychosocial risk factors in moderate-risk to high-risk pregnancies with observable dose–response relationships (increasingly higher psychosocial risks with increasing severity of food insecurity).[38] However, evidence on the influence of food insecurity on prenatal development remains mostly indirect, deriving from the large body of evidence for the critical role of healthful nutrition during this period.

Many recent studies have examined prenatal nutrition and care within a broader scope that includes birth spacing and nutrition and care between births.[39–44] Motivated in part by persistently high rates of low birthweight and preterm births in some U.S. subpopulations, a growing recognition of the limits of prenatal care alone in reducing these problems has emerged, with increasing attention being paid to preconception and internatal care.[39–43] Amid this emerging view of maternal health are expressions of concern about the effects of food insecurity on nutrition and health during the internatal period.[39,43,44] Of particular concern is the risk of food-insecure mothers entering pregnancy with insufficient iron stores and with low-folate diets. Poor iron and folic acid status are linked to preterm births and fetal growth retardation, respectively.[36,39] Prematurity and intrauterine growth retardation are critical indicators of medical and developmental risks that affect not only children's short-term well-being but also extend into adulthood, where these problems have been linked recently to obesity, adult-onset diabetes, and risk of cardiac disease.[35,43,44] A woman's folate-poor diet in the periconceptual period has also been clearly associated with neural tube defects and possibly other birth defects.[36] For low-income mothers, especially black, Latina, and single mothers, food insecurity is a prevalent risk factor generally, including during internatal periods.[6,16,19,44]

Breastfeeding and the Neonatal Period

Breastfeeding is the best possible choice for neonatal nutrition under a wide range of circumstances.[45] Although relatively few studies have directly examined associations between breastfeeding behavior and food insecurity, there is some evidence that mothers in food-insecure households have lower rates of initiating breastfeeding at all and that they initiate and continue breastfeeding for shorter periods on average than do mothers in food-secure households.[46] However, relationships between food insecurity and breastfeeding are poorly studied and appear to vary with mother's ethnicity, immigration status, and other factors.

Latina mothers have higher breastfeeding initiation rates than those of black or white mothers and are more likely to follow American Academy of Pediatrics infant feeding recommendations.[47] Also, U.S. citizen infants born to Latina immigrant mothers have higher initiation rates than those of similar infants born to black or white immigrant mothers.[48] Although the families of breastfed infants of immigrant mothers generally had greater odds of being food insecure in this latter study than those of nonbreastfed infants of immigrant mothers, the breastfed infants had lower odds of having their health status reported as fair/poor (versus excellent/good), lower odds of having a chronic health

condition, and lower odds of having previously been hospitalized than those of nonbreastfed infants of immigrant mothers,[48] indicating that breastfeeding in the early months of life may buffer young infants from the adverse health effects of household food insecurity.

Early Childhood: Ages 0–3 Years

A relatively large number of studies have examined associations between food insecurity and child health and development in this age group, many conducted by the Children's Sentinel Nutrition Assessment Program (C-SNAP). (We [Cook and Frank] are among the principal investigators in the C-SNAP study group.) An ongoing multisite pediatric clinical research program, C-SNAP has conducted household-level surveys and medical record audits at seven central-city medical centers, including acute care and primary care clinics (Baltimore, MD; Minneapolis, MN; Philadelphia, PA; and Washington, DC) and hospital emergency departments (Boston, MA; Little Rock, AR; and Los Angeles, CA) since 1998 (sites in Los Angeles, CA, and Washington, DC are currently inactive). Primary adult caregivers accompanying children aged 0–36 months seeking care are interviewed by trained interviewers in private settings during waiting periods. We chose this age group for sampling because its special vulnerability makes it a sentinel population for adverse health outcomes in pediatric populations related to constrained household resources and changes in social policies and economic conditions. Because of their locations in inner cities, the C-SNAP sites serve populations with high prevalence of low-income families, those most affected by social policy changes. Children's weight and, if possible, length are recorded at the interview. The C-SNAP survey instrument consists of questions on household characteristics, children's health and hospitalization history, maternal health, maternal depressive symptoms, participation in federal assistance programs, energy insecurity, and changes in benefit levels. The C-SNAP interview also includes the U.S. Food Security Scale,[3,4,48,49] and recent cycles of data collection since July 2004 have added the PEDS (Parents' Evaluation of Developmental Status, a well-validated and reliable standardized instrument that meets the American Academy of Pediatrics standards for developmental screening).[50] These studies suggest complex relationships between food insecurity and participation of families with young children in public income maintenance and nutrition programs. They also indicate similarly complex relationships between participating in these programs and food insecurity, health, growth, and development of young children.

Welfare Reform and the Health of Young Children

Welfare reform legislation passed in 1996 (the Personal Responsibility and Work Opportunity Reconciliation Act) made sweeping changes to the main cash assistance program in the United States (Temporary Assistance to Needy Families [TANF], previously known as Aid to Families with Dependent Children). These changes included several previously nonexistent requirements enforced by a range of punitive sanctions, which often led to partial or total termination of a family's TANF benefits. C-SNAP found that families with children younger than 3 years whose welfare benefits had been reduced or terminated by sanctions had 50% greater odds of being food insecure than those with stable benefits. Children in families that suffered welfare sanctions also had 30% greater odds of having been hospitalized since birth, and 90% greater odds of being admitted from an emergency department (ED) visit (only for children whose caregivers were interviewed in one of the three ED sites), than those of similar children in families whose benefits had not decreased, after adjusting for relevant confounding factors.[51] Unexpectedly, we also found that infants and toddlers in families whose TANF benefits had been reduced administratively because of changes in income or expenses also had 50% greater odds of being food insecure, and 182% greater odds of being admitted the day of an ED visit, than those of children in families whose benefits had not been reduced. We also found that receiving food stamps did not mitigate the associations of losing TANF benefits with these health outcomes.

Food Insecurity and Adverse Health Outcomes in Young Children

By 2003, much research literature had confirmed a range of adverse health and development outcomes associated with malnutrition in young children, and a few had found food insufficiency (a precursor construct to the food security measures), hunger, and risk of hunger related to poor health in children (aged <18 years).[51–55] However, there were no studies directly examining whether food insecurity as measured by the new FSS is independently associated with bad health outcomes among children in this critical age group (0–3 years). C-SNAP tested this hypothesis and found that, after adjustment for confounders, food-insecure children had 90% greater odds of having their health reported as "fair/poor" (versus "excellent/good"), and 31% greater odds of having been hospitalized since birth, than those of similar children in food-secure households.[56] We also found a

dose–response relation between fair/poor health status and severity of food insecurity, with higher odds of "fair/poor" health at increasingly higher levels of severity of food insecurity. In the overall C-SNAP sample, receipt of food stamps attenuated the effects of food insecurity on this outcome but did not eliminate it.[56] These results were the first to show that food insecurity is independently associated with adverse health outcomes in children aged 0–3 years.

Child Food Insecurity Intensifies Adverse Effects of Household Food Insecurity

The FSS categorizes many households with children as food insecure at the household level, but because none of the child-referenced items are affirmed, the households cannot be said to show specific evidence of child food insecurity per se. Typically, adult caregivers in food-insecure U.S. households ration food to spare children from suffering hunger, though doing so often dramatically reduces the overall quality and variety of foods available in the household.[3–5,17–21]

In the C-SNAP sample of 17,158 caregiver–child dyads interviewed between 1998 and 2004, 10% reported household food insecurity only, and 12% household and child food insecurity, with child food insecurity measured by the CFSS (TABLE 1).[7] Versus food-secure children, after adjustment for confounders, those with only household food insecurity (HFI) had statistically significantly higher odds of fair/poor health (51% higher) and being hospitalized since birth (19% higher), whereas those with both HFI and child food insecurity (CFI) experienced even greater adverse effects (100% greater odds of fair/poor health and 23% higher odds of hospitalization, respectively). The presence of CFI in addition to HFI resulted in a statistically significant increase in the odds of fair/poor health above the odds when only HFI was present (from 1.51 to 2.00). Although the presence of CFI in addition to HFI resulted in an increase in odds of hospitalization from 1.19 to 1.24, this increment was not statistically significant.[57]

Participation in the FSP modified the effects of food insecurity on child health status (odds of fair/poor health), reducing but not eliminating them. Children in FSP-participating households that were HFI only had adjusted odds of fair/poor health 24% lower than those in similar non-FSP households, whereas children in FSP-participating households that had both HFI and CFI had adjusted odds of fair/poor health 42% lower than those in non-FSP households.[57]

These results, like previous ones, indicate that the relationship between food insecurity and the health status of very young children is such that the adverse effects of food insecurity worsen as its severity increases. They also indicate that food stamps, like a therapeutic drug prescribed in inadequate doses, appear to attenuate but not fully reverse this association.

CFI and Iron Deficiency

Iron deficiency and iron deficiency anemia (IDA) are the most prevalent nutritional deficiencies in the United States and worldwide.[58,59] Iron deficiency in early life is linked to concurrent and persistent deficits in cognition, attention, and behavior even after treatment. Several recent studies have reported a prevalence of IDA in children up to 18% in some high-risk subpopulations in the United States.[60–63] Joint or separate participation in WIC and the FSP reduced the risk of iron deficiency.[59] The link between these child nutrition programs and iron deficiency confirms findings of a recent C-SNAP study that examined associations between CFI and IDA in children aged 6–36 months.[64] This study excluded infants younger than 6 months and children with established diagnoses known to increase risk of anemia (e.g., low birth weight, HIV/AIDS, sickle-cell disease, or lead level > 10 μg/dL). In logistic regressions adjusted for a range of possible confounders, food-insecure children had adjusted 140% greater odds of having IDA than those of food-secure children. This study examined only CFI not HFI.[64]

Food Insecurity, Maternal Depression, and Child Health

Maternal depression is strongly related to child development in a variety of ways, including reduced ability to provide needed care, impaired mother–child interaction and attachment, and child neglect and abuse.[30–33,65–69] Several recent studies have found associations between food insecurity and maternal depression.[23,29,38,65–70]

A recent C-SNAP study examined associations among mothers' positive depressive symptoms (PDS), food insecurity, and changes in benefits from federal assistance programs.[29] Using a subsample of 5,306 mother–child dyads seen at three C-SNAP sites, we found that mothers with PDS had 169% greater odds of reporting household food insecurity, 58% greater odds of fair/poor child health, and 20% greater odds of child hospitalizations than those of mothers without PDS, after adjusting for possible confounders. Also, controlling for the same covariates, mothers with PDS had 52% greater odds of reporting decreased welfare support and 56% greater odds of reporting loss of FSP benefits than those of mothers without PDS.[29]

These results indicate that maternal depression may be an indirect pathway by which HFI negatively influences child health and development. Determining the direction of causality from these results or ruling out the possibility of some amount of dual causality is not possible. We need more research to determine whether and under what circumstances maternal depression temporally precedes food insecurity or vice versa.

Effects of Program Participation on Food Insecurity

In a C-SNAP study examining associations between participation in the WIC program and indicators of underweight, overweight, length, child's health status, and food security in children aged 12 months or less, infants that did not receive WIC benefits because of access problems were more likely to be underweight, be short, and perceived as having fair/poor health than were WIC recipients, after adjusting for possible confounders.[71] Although these two groups did not differ statistically significantly on food security status after adjustment for covariates, children in both groups were more likely to be food insecure than children whose caregivers did not perceive a need for WIC. These results supported findings from other research indicating that low-income infants aged 12 months or less benefit from participation in the WIC program.[59,72,73]

Another C-SNAP study examining the relationships between receiving housing subsidies and nutritional and health status among low-income, food-insecure children younger than 3 years living in rented housing found that children in food-insecure renting families not receiving housing subsidies had statistically significantly lower weight for age than those in families receiving subsidies. Also, compared with food-insecure children in subsidized housing, those in nonsubsidized housing had 111% greater odds of having weight-for-age *z*-scores that were more than 2 standard deviation units below the mean.[74] These findings help inform another dimension in the understanding of how household food security interacts with other survival needs to influence children's health, in concert with recent studies showing strong associations between housing conditions and health among low-income children.[75–77]

Similar findings have emerged in evaluating the association between a family's participation in the Low-Income Home Energy Assistance Program (LIHEAP) and the anthropometric status and health of their young children. LIHEAP is the nation's primary assistance program for helping low-income families having difficulties affording energy payments. Using a sample of 7,074 caregiver–child dyads in households eligible to receive LIHEAP, this study, after controlling for identified confounders, found that children in nonrecipient households had greater adjusted odds of being at aggregate nutritional risk for growth problems (defined as weight for age below the 5th percentile or weight for height below the 10th percentile) and had statistically significantly lower age-gender–specific weight-for-age *z*-scores than those of similar children in recipient households. Also, for the 4,445 of 7,074 children evaluated at ED sites, those from eligible households not receiving LIHEAP had greater adjusted odds of acute hospital admission on the day of the interview.[78] These findings highlight the difficult tradeoffs that low-income parents must make during times of extreme temperature variations.[79,80] Recent trends in energy and food price increases indicate that this "heat or eat" threat to child health, growth, and development is likely to increase in the future.

Association between Food Insecurity and Early Childhood Developmental Risk

A recent C-SNAP study evaluated the relationship between household food security status and developmental risk among 2,010 children aged 4–36 months on the basis of responses to the PEDS.[81] After controlling for established correlates of child development, including mothers' depressive symptoms and education, the study found that food-insecure children in this age group were statistically significantly more likely to be identified by their caretakers as being at developmental risk than were similar children in food-secure households.[81]

School Age and Adolescence

Over the past decade, a modest but steadily accumulating body of research has examined the influence of food insecurity on physical and mental health and academic, behavioral, and psychosocial functioning of preschool-aged and school-aged children. These studies have used several different measures of food insecurity, including one screening question developed by the USDA and referred to as "the USDA food sufficiency question," a scale developed by the Community Childhood Hunger Identification Project prior to release of the U.S. FSS, and the FSS itself. These measures differ in the questions they include, in the wording of some questions, and in psychometric properties.[3,5] Although each research report addresses a somewhat different set of correlates of food insecurity and related constructs, there is consistency in the basic findings that emerge from applications of these measures regarding adverse

effects on physical and mental health, academic performance, and behavioral and psychosocial problems in preschool-aged and school-aged children.

Several studies using data on responses to the USDA food sufficiency question in the Third National Health and Nutrition Examination Survey (NHANES III) examined associations between household food sufficiency and children's health, school performance, and psychosocial functioning. One study, consistent with the C-SNAP food insecurity work summarized above, found food insufficiency 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.[53] Another found that children aged 6–11 years in food-insufficient families had lower arithmetic scores, and were more likely to have repeated a grade, to have seen a psychologist, and to have had more difficulty getting along with other children, than similar children whose families were food sufficient. This study also found teenagers from food-insufficient families 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.[82] A third study showed children aged 15–16 years from food-insufficient households 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.[83]

Another set of studies used a food security measurement tool developed by the Community Childhood Hunger Identification Project (CCHIP[1]; a validated scale to assess hunger in children developed prior to, and partly incorporated into, the FSS) to examine associations between hunger and physical and mental health in school-aged children. One of these studies, using data from implementation of the CCHIP scale in nine states, found that children younger than 12 years categorized as hungry or at risk of hunger were twice as likely as nonhungry 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.[54]

A second CCHIP study used a sample of 328 parents and children from families with at least one child younger than 12 years. Parents with a child aged between 6 and 12 years completed a Pediatric Symptom Checklist (PSC). This study found that children categorized as hungry by the CCHIP scale were more likely to have clinical levels of psychosocial dysfunction on the PSC than either at-risk or nonhungry children. Analysis of individual items from the PSC found that most all behavioral, emotional, and academic problems were more prevalent in hungry children, but aggression and anxiety had the strongest degree of association with hunger.[55]

A third CCHIP study used data on externalizing and internalizing behaviors and anxiety/depression from the Child Behavior Checklist, along with chronic health indicators adapted from the National Health Interview Survey, Child Health Supplement, in a sample of 180 preschool-aged and 228 school-aged children in Worcester, Massachusetts. This research found that, after adjustment for confounders, severe hunger 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, after adjusting for confounders.[84]

Finally, a small set of fairly recent studies used data from administration of the FSS in national and local surveys to examine associations of food insecurity with health, growth, and development after the first 3 years of life. A recent study used data from the new Early Childhood Longitudinal Survey Kindergarten cohort (ECLS-K) to test the hypothesis that food insecurity is associated with overweight among kindergarten-aged children. The authors found no statistically significant association of food insecurity with overweight in this cross-sectional study, in any of several configurations of regression models. The authors conclude that though there are many sound reasons to be concerned about food insecurity in kindergarten-aged children, the results indicate that concern about overweight should not be one.[85]

A second study from the ECLS-K included data from the kindergarten and third grade administrations in a longitudinal assessment of how food insecurity over time is related to changes in reading and mathematics test performance, weight and body mass index (BMI; kilograms per square meter of body surface area), and social skills in children.[86] This much more elaborate and extensive longitudinal study found food insecurity in kindergarten associated with lower mathematics 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 in a lagged model. Using difference score and dynamic models based on changes in predictors and outcomes from kindergarten to third

grade, the authors found that children from persistently food-insecure households (food insecure at both kindergarten and third grade years) had greater gains in BMI and weight than those of children in persistently food-secure households, after controlling for covariates, though these effects were statistically significant only for girls in stratified analysis. Also among girls, but not boys, persistent food insecurity was associated with smaller increases in reading scores over the period than for persistently food-secure girls.

In dynamic models, for households that transitioned from food security to food insecurity over kindergarten to third grade (i.e., became food insecure), the transition was associated with statistically significantly smaller increases in reading scores for both boys and girls than those for children from households remaining food secure. For children transitioning from food insecurity 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. Similarly, in difference models when children from households that became food insecure were compared with children who became food secure, food insecurity was associated with smaller increases in reading scores for both boys and girls, though differences were statistically significant only for girls.

In gender-stratified difference models examining BMI, weight, and social skills, becoming food insecure was associated with statistically significantly greater weight and BMI gains for boys but not for girls. Becoming food insecure was associated with greater declines in social skills scores for girls but not boys.

The authors of this rather complicated study conclude that it provides the strongest empirical evidence to date that food insecurity is linked to developmental consequences for girls and boys, though these consequences are not identical across gender. Particularly strong associations are found between food insecurity and impaired social skill development, reading performance, and increased BMI and weight gain for girls, though the effects on BMI and weight gain appear to differ depending on whether the girls are persistently food insecure or their status changes over time. The longitudinal and dynamic nature of the models used and the extensive controls for confounders at the household and individual levels lead the authors to conclude that the most plausible interpretation of their findings is that food insecurity in the early elementary years has both nutritional and nonnutritional developmental consequences.[86]

A third study used data from a cross-sectional telephone survey of households including 399 children aged 3–17 years from 36 counties of the delta region of Arkansas, Louisiana, and Mississippi to examine associations between household food insecurity and proxy-reported or self-reported child health–related quality of life (CHRQOL). Researchers used the 23-item Pediatric Quality of Life Initiative (PEDS QL) survey, which yields a total score and two subscale scores: physical and psychosocial functioning. This study found food insecurity statistically significantly associated with total child CHRQOL and physical function after adjusting for confounders.

Parents reported children aged 3–8 years in food-insecure households to have lower physical function, whereas children aged 12–17 years reported lower psychosocial function. Black males in food-insecure households reported lower physical function and lower total CHRQOL than those in food-secure housholds.[87]

A fourth study used data from the 1997 Panel Study of Income Dynamics Child Development Supplement to compare the risk of a child aged 5–12 years being at or above the 85th percentile on age-gender–specific BMI in food-secure and food-insecure households when controlling for participation in the FSP, the National School Lunch Program, and the School Breakfast Program. The authors found that food-insecure girls who participated in all three of these food assistance programs had 68% lower odds of being at risk of overweight (85th percentile $\leq$ BMI $<$ 95th percentile) than those of food-insecure girls in nonparticipating households, after controlling for confounders. No statistically significant differences were found for girls in food-secure households or for boys in either food-secure or food-insecure households.[88]

Conclusion

Taken together, the reviewed studies offer solid evidence that food insecurity (or analogous earlier measures) is associated with a range of adverse health, growth, and development outcomes in children aged 0–18 years, although the relationships are complex, with some variability from study to study. Age, ethnicity, and gender, as well as multiple other factors, including program participation, contribute to this variability.

Food insecurity, even at the least severe household levels, has emerged as a highly prevalent risk to the growth, health, cognitive, and behavioral potential of America's poor and near-poor children. The threshold levels of severity for adverse effects of food insecurity on health and development in young children occur before the appearance of readily identifiable clinical markers such as underweight. The research reviewed

here (and summarized in Appendix Table 1) provides evidence that the effects of food insecurity worsen as its severity worsens and that CFI and hunger are associated with worse consequences than those of HFI alone. However, even at the lowest levels of severity, C-SNAP data suggest that, at least for babies, HFI is an established risk factor for impaired health and development. This indication leads to the troubling conclusion that for infants and toddlers food insecurity is an "invisible epidemic" of a widely prevalent and serious condition that is known to exist and to pose serious risks to child health and development and whose remedy is well understood and cost-effective but is being withheld from those at greatest risk.

Food insecurity can occur and inflict harm at any or all parts of the life cycle. However, the particular vulnerability of infants and toddlers aged 0–36 months undergoing especially rapid physical growth and neurocognitive development provides a special opportunity for protecting and positively influencing the rest of the life cycle. Moreover, the apparent heightened susceptibility of older girls to the negative effects of food insecurity in multiple domains suggests that decreasing this risk among those who will become mothers of the next generation of children is particularly urgent.

Of the many interlocking forms of deprivation experienced by poor and near-poor children in the United States, food insecurity is one of the most readily measured, as well as one of the most rapidly remediable by policy changes. Our country, unlike many others in the world, clearly can produce and distribute enough healthful food to all its inhabitants, constrained only by political will.

APPENDIX TABLE 1. Studies on Associations between Food Insecurity (FI), Child Health, and Development

Subject area	Reference	Major findings
Prenatal and neonatal periods	1) Borders *et al.* (2007): Chronic stress and low birth weight neonates in a low-income population of women	1) FI is positively associated with low-birthweight births.
	2) Laraia *et al.* (2006): Psychosocial factors and socioeconomic indicators are associated with HFI among pregnant women	2) FI positively associated with psychosocial indicators of perceived stress, trait anxiety, and depressive symptoms in pregnant women; indication of dose–response relationship with greater effects at more severe levels of FI.
Breastfeeding and the neonatal period	1) Zubieta *et al.* (2006): Breastfeeding practices in U.S. households by food security status	1) FI is negatively associated with initiation of breastfeeding and with duration if initiated.
	2) Neault *et al.* (2007, forthcoming): Breastfeeding and health outcomes among citizen children of immigrant mothers	2) Although families of US-born breastfed infants of immigrant mothers had greater odds of being food insecure than those of nonbreastfed infants of immigrant mothers, breastfed infants had lower odds of having fair/poor health (versus excellent/good), of having a chronic health condition, and of having previously been hospitalized than nonbreastfed infants of immigrant mothers.
Early childhood: ages 0–3 years	1) Cook *et al.* (2002): Welfare reform and the health of young children: a sentinel survey in 6 US cities	1) Reduction or termination of welfare benefits, by sanctions or otherwise, is positively associated with FI. Children in families suffering welfare sanctions or administrative benefit reductions are more likely to have been hospitalized since birth and to have been admitted from an ED visit (for caregivers interviewed at ED sites) than similar children in families whose benefits had not decreased. Receiving food stamps did not mitigate effects of losing TANF benefits on health outcomes.

Continued

APPENDIX TABLE 1. *Continued.*

Subject area	Reference	Major findings
	2) Cook *et al.* (2004): FI is associated with adverse health outcomes among human infants and toddlers	2) FI is positively associated with "fair/poor" health and having been hospitalized since birth. A dose–response relationship was found between severity of FI and likelihood of fair/poor health. Food stamps attenuated effect of FI on health status but did not eliminate it.
	3) Cook *et al.* (2006): CFI increases risks posed by HFI to young children's health	3) The presence of CFI in addition to HFI resulted in a statistically significant increase in the odds of fair/poor health above the odds when only HFI was present. Participation in the FSP modified the effects of FI on child health status (adjusted odds of fair/poor health), reducing but not eliminating them.
	4) Skalicky *et al.* (2006): CFI and IDA in low-income infants and toddlers in the United States	4) HFI positively associated with IDA in children aged 6–36 months.
	5) Casey *et al.* (2004): Maternal depression, changing public assistance, food security, and child health status	5) Maternal PDS are positively associated with HFI, fair/poor child health status, and child hospitalization. PDS also positively associated with reductions or loss of welfare and FSP benefits.
	6) Black *et al.* (2004): WIC participation and infants' growth and health: a multisite surveillance study	6) Infants (aged $\leq$ 12 months) that did not receive WIC benefits because of access problems were more likely to be underweight, short, and perceived as having fair/poor health than were WIC recipients. Both infants receiving WIC and those eligible but not receiving benefits because of access problems were more likely to be FI than infants whose caregiver perceived no need for WIC.
	7) Meyers *et al.* (2005): Subsidized housing and children's nutritional status	7) Children in FI families renting their homes and not receiving housing subsidies had statistically significantly lower weight for age than those in similar families receiving subsidies. Compared to FI children in subsidized housing, those in nonsubsidized housing had greater odds of having weight-for-age *z*-scores more than 2 standard deviation units below the mean.
	8) Frank *et al.* (2006): Heat or eat: the LIHEAP and nutritional and health risks among children less than 3 years of age	8) Children aged $\leq$ 3 years in households eligible for LIHEAP but not receiving it had greater odds of being at aggregate nutritional risk for growth problems (defined as weight for age below the 5th percentile or weight for height below the 10th percentile) and had statistically significantly lower age-gender–specific weight-for-age *z*-scores than those of similar children in recipient households. Children from eligible households not receiving LIHEAP had greater adjusted odds of acute hospital admission on the day of the interview (for those interviewed at ED sites).
	9) Rose-Jacobs *et al.* (2007, in press): HFI: associations with at-risk infant and toddler development	9) FI positively associated with parental reports of developmental issues on the PEDS after controlling for confounders.
School age and adolescence	1) Alaimo *et al.* (2001a): Food insufficiency, family income, and health in U.S. preschool and school-aged children	1) Food insufficiency 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.
	2) Alaimo *et al.* (2001b): Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development	2) Found that children aged 6–11 years in food-insufficient families had lower arithmetic scores and were more likely to have repeated a grade, to have seen a psychologist, and to have had more difficulty getting along with other children, than similar children whose families were food sufficient. Also found teenagers from food insufficient families 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.

Continued

APPENDIX TABLE 1. *Continued.*

Subject area	Reference	Major findings
	3) Alaimo *et al.* (2002): Family food insufficiency, but not low family income, is positively associated with dysthymia and suicide symptoms in adolescents	3) Found children aged 15–16 years from food-insufficient households 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.
	4) Murphy *et al.* (1998): Relationship between hunger and psychosocial functioning in low-income American children	4) Found children aged < 12 years categorized as hungry or at risk of hunger twice as likely as nonhungry 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.
	5) Kleinman *et al.* (1998): Hunger in children in the United States: potential behavioral and emotional correlates	5) Found children categorized as hungry by the CCHIP scale more likely to have clinical levels of psychosocial dysfunction on the PSC than either at-risk or nonhungry children. Analysis of individual items from the PSC 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.
	6) Weinreb *et al.* (2002): Hunger: its impact on children's health and mental health	6) Found that severe hunger 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.
	7) Rose & Bodor (2006): HFI and overweight status in young school children: results from the Early Childhood Longitudinal Study	7) Found no statistically significant association of FI with overweight in this cross-sectional study of kindergarten-aged children.
	8) Jyoti *et al.* (2005): FI affects school children's academic performance, weight gain, and social skills	8) In lagged models, found FI in kindergarten associated with lower math scores, increased BMI and weight gain, and lower social skills in girls at third grade, but not for 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, 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. 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.

Continued

APPENDIX TABLE 1. *Continued.*

Subject area	Reference	Major findings
	9) Casey *et al.* (2005): CHRQOL and household food security	9) Found FI negatively associated with total CHRQOL and physical function. Parents reported children aged 3–8 years in FI households to have lower physical function, whereas children aged 12–17 years reported lower psychosocial function.
	10) Jones *et al.* (2003): Lower risk of overweight in school-aged food insecure girls who participate in food assistance	10) Found that FI girls who participated in the FSP, the National School Lunch Program, and the School Breakfast Program had 68% lower odds of being at risk of overweight (85th percentile ≤ BMI < 95th percentile) than FI girls in nonparticipating households.

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