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Food Insecurity And Health Outcomes

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ABSTRACT Almost fifty million people are food insecure in the United States, which makes food insecurity one of the nation's leading health and nutrition issues. We examine recent research evidence of the health consequences of food insecurity for children, nonsenior adults, and seniors in the United States. For context, we first provide an overview of how food insecurity is measured in the country, followed by a presentation of recent trends in the prevalence of food insecurity. Then we present a survey of selected recent research that examined the association between food insecurity and health outcomes. We show that the literature has consistently found food insecurity to be negatively associated with health. For example, after confounding risk factors were controlled for, studies found that food-insecure children are at least twice as likely to report being in fair or poor health and at least 1.4 times more likely to have asthma, compared to food-secure children; and food-insecure seniors have limitations in activities of daily living comparable to those of food-secure seniors fourteen years older. The Supplemental Nutrition Assistance Program (SNAP) substantially reduces the prevalence of food insecurity and thus is critical to reducing negative health outcomes.

Food insecurity, a condition in which households lack access to adequate food because of limited money or other resources, is a leading health and nutrition issue in the United States. In 2013 almost fifty million Americans (14.3 percent) were food insecure.¹ About one-third of these were at a more serious level known as “very low food security.” The fact that so many people are food insecure is important in and of itself, but potentially more concerning are the possible negative health consequences of food insecurity. In this article we focus on recent research that examined the association of food insecurity and health.

We begin with an overview of how food insecurity is measured in the United States, followed by a presentation of recent trends in the preva-

lence of food insecurity. We then provide a selected review of the literature that has examined the impacts of food insecurity on health outcomes for children, nonsenior adults, and seniors.

Research on food insecurity and health emanates from a broad cross-section of disciplines in both the social and health sciences, and space limitations prohibit a meta-analysis. We therefore concentrate on papers that reflect the most recent work in this area, especially in the fields of economics, internal medicine, nutrition, public health, and social work. Within these areas, we emphasize research that reflects the central findings of the literature and that, in many cases, uses state-of-the-art methods.

Although the literature has grown considerably in the past few years, there are still some important gaps in our knowledge base. We there-

fore suggest future research directions. We conclude with policy recommendations for alleviating food insecurity, with a particular emphasis on the current and potential roles of the federally funded Supplemental Nutrition Assistance Program (SNAP, formerly known as the Food Stamp Program) in reducing food insecurity and with recommendations for health care professionals.

Defining Food Insecurity

The Department of Agriculture (USDA) measures food insecurity through responses to a series of eighteen survey questions and statements fielded to roughly 45,000 households in the Food Security Supplement of the Census Bureau's Current Population Survey (CPS-FSS).¹ The first item addresses worries about food running out, while the remaining items address possible reductions in food intakes because of financial constraints. Eight of the items are focused on children and thus are not used with households that contain no children under age eighteen. The items include: "I worried whether our food would run out before we got money to buy more" (the least severe), "Did you or the other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?," "Did you ever cut the size of any of the children's meals because there wasn't enough money for food?," and "Did any of the children ever not eat for a whole day because there wasn't enough money for food?" (the most severe for households with children).

Based on the responses to the survey, the USDA divides households into the following categories: high food secure (all household members had access at all times to enough food for an active, healthy life), with no affirmative responses to any of the eighteen items; marginal food secure (some members reported anxiety about food sufficiency or shortage of food in the house, but there was no indication of changes in diet or food intake), 1–2 affirmative responses; low food secure (at least some household members reported reduced quality, variety, or desirability of diet but not necessarily reduced food intake), 3–7 affirmative responses; and very low food secure (one or more household members reported multiple indications of disrupted eating patterns and reduced food intake), 8 or more affirmative responses. For households without children, low food security is 3–5 affirmative responses, and very low food security is 6 or more affirmative responses.

In most research and policy discussions, the categories of low and very low food secure are combined into a category called food insecure.¹ In some applications, however, a broader mea-

sure of marginal food insecurity is used, which combines marginal, low, and very low food secure.^{2–4} In nearly all cases, researchers report a rate or percentage of those who are food insecure by dividing the number of food-insecure people or households in a given population or subpopulation by the relevant population or subpopulation of interest. For example, the household food insecurity rate is found by totaling the number of households that are low or very low food secure and dividing by the total number of households in the population.

Food Insecurity In The United States

From 2001 to 2007 the food insecurity rate for US households was relatively steady, at about 11 percent for all households and almost 18 percent for those with children (Exhibit 1). The rates for both groups increased more than 30 percent after the onset of the Great Recession in December 2007, from 11.1 percent in 2007 to 14.6 percent in 2008 for all households and from 16.9 percent to 22.5 percent for households with children. Despite the official end of the Great Recession in June 2009, rates of food insecurity have remained at these elevated levels.

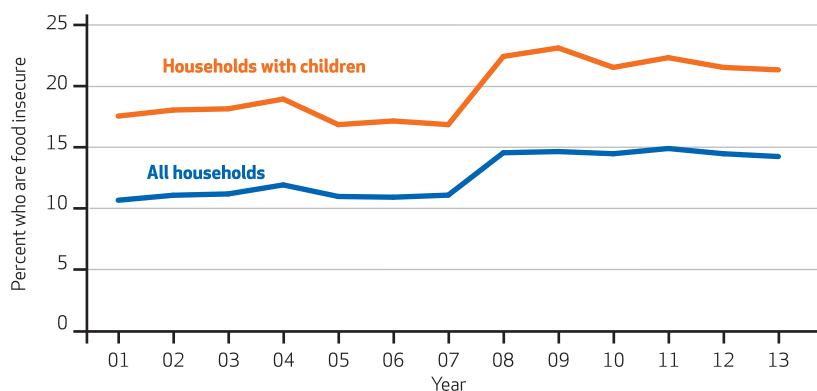
Within the US population there is a great deal of heterogeneity in the probability of food insecurity.¹ For example, before other factors are controlled for, households with lower incomes and households headed by an African American or Hispanic person, a never-married person, a divorced or separated person, a renter, a younger person, or a less-educated person are all more likely to be food insecure than their respective counterparts. In addition, households with children are more likely to be food insecure than those without. Research using multivariate methods has generally found that the characteristics listed above are positively associated with food insecurity, even after other factors are controlled for. This general set of findings holds whether the sample is households with or without children, including households headed by a senior.^{2–4}

Food Insecurity And Negative Health Outcomes

The USDA, in consultation with other federal agencies, academics, and members of the policy community, developed the food insecurity measure used in the United States in part because of the myriad negative health outcomes that were thought to be associated with food insecurity. Understanding the existence of certain negative health outcomes that stem from food insecurity is of direct importance to health care profession-

EXHIBIT 1

Trends In Food Insecurity In The United States, 2001-13



SOURCE Authors' analysis of data from Coleman-Jensen A, et al. Household food security in the United States in 2013 (Note 1 in text).

als and to the policy makers and program administrators charged with improving health and well-being. After the introduction of the CPS-FSS, dozens of papers have examined whether food insecurity is associated with poor health outcomes. Controlling for other confounding factors, such as income, is especially important because many of the determinants of food insecurity are also determinants of health.

Study Data And Methods

In what follows, we review some of the major findings from the literature examining food insecurity and health that takes into account both self-reports of health and clinical outcomes. We break the major findings down into three broad age categories: children, nonsenior adults, and seniors. Within each of these categories, we highlight work that illustrates salient points regarding the relationship between food insecurity and health.

Our review is confined to research on food insecurity and health in the United States and, to a limited extent, in Canada, since these two countries measure food insecurity in a similar fashion. A parallel literature has examined this topic in non-high-income countries, but that is beyond the scope of this article.

Along with this geographical concentration, our review concentrates on research that with few exceptions has appeared in peer-reviewed journals since 2001. While most of the papers use the USDA's measure of food insecurity (defined above) as the key variable of interest, in some cases we include papers that used variants on this measure of food insecurity. To reflect the interdisciplinary nature of food insecurity re-

search, we include papers in journals in disciplines that reflect the most recent work in this area, especially in the fields of economics, agricultural economics, internal medicine, pediatrics, nutrition, public health, and social work. Because different disciplines focus on different aspects of food insecurity and health, our key search terms included *food insecurity and health* and *food insufficiency and health*. We also conducted more refined searches in which we replaced the word *health* with *well-being*, *depression*, *child* (or *senior*) *health*, and so on.

Because of space limitations, we were unable to include all papers that examined the relationship between food insecurity and health outcomes. Thus, ours was not a meta-analysis. Instead, we cite at least one paper for each health outcome that has been found to be associated with food insecurity. When multiple papers found similar results, we restricted our coverage to more recent papers that used state-of-the-art methods and the standard food insecurity measure. As a result, most of the work we cite has been published in the past seven years.

Study Results

CHILDREN The majority of research examining food insecurity in general and its effects on health outcomes has concentrated on children. This research has found that food insecurity is associated with increased risks of some birth defects,⁵ anemia,^{6,7} lower nutrient intakes,⁸ cognitive problems,⁹ and aggression and anxiety.¹⁰ It is also associated with higher risks of being hospitalized⁸ and poorer general health^{8,11,12} and with having asthma,¹³ behavioral problems,^{10,14} depression,¹⁵ suicide ideation,¹⁶ and worse oral health.^{17,18} Exhibit 2 gives details about the data sets and methods used in a subset of these papers and, in some cases, the magnitude of the effects reported. For example, compared to children in food-secure households, children in food-insecure households had 2.0–3.0 times higher odds of having anemia,^{6,7} 2.0 times higher odds of being in fair or poor health,⁸ and 1.4–2.6 times higher odds of having asthma, depending on the age of the child.¹³

Most of these papers used binary comparisons of children in food-insecure households (those with three or more affirmative responses to items in the CPS-FSS) with children in food-secure households (those with zero, one, or two affirmative responses). However, households with one or two affirmative responses (those in the category of marginal food secure) may be more similar to the food-insecure households than to the food-secure households and may also be at risk of suffering from negative

23%

Food insecure

Even after the Great Recession ended in 2009, 22.5 percent of US households with children remain food insecure.

EXHIBIT 2
Summary Of Research On Food Insecurity And Health Among Children In The United States And Canada Published During 2006–14

Authors	Title	Data source	Central findings
Eicher-Miller et al. (Note 6)	Food insecurity is associated with iron deficiency anemia in US adolescents.	1999–2004 NHANES	Odds of having iron deficiency anemia among 12–15-year old children in households with food insecurity were 2.95 times higher ($p = 0.02$) than among children in households without food insecurity.
Cook et al. (Note 8)	Child food insecurity increases risks posed by household food insecurity to young children's health.	1998–2004 Children's HealthWatch, various cities	Odds of fair or poor health among children ≤ 36 months old with household and child food insecurity were 2.14 (95% CI: 1.81, 2.54) times higher than among children in food-secure households. The odds among nonrecipients of food stamps were 1.72 (95% CI: 1.34, 2.21) times higher than among food stamp recipients.
Howard (Note 9)	Does food insecurity at home affect non-cognitive performance at school? A longitudinal analysis of elementary student classroom behavior.	1999–2003 ECLS-K	Noncognitive performance among children in grades 1, 3, and 5 was about 0.068 (SE: 0.039) to 0.079 (SE: 0.039) units lower for children with any food insecurity, compared to food-secure children.
Whitaker et al. (Note 10)	Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children.	1998–2000 Fragile Families and Child Wellbeing Study	Food-insecure mothers had 2.2 (95% CI: 1.6, 2.9) times higher rates of mental health issues than fully food-secure mothers. The odds of behavioral problems among children with food-insecure mothers were 2.1 (95% CI: 1.6, 2.7) times higher than among children with food-secure mothers.
Kirkpatrick et al. (Note 13)	Child hunger and long-term adverse consequences for health.	1994–2005 Canadian NLSCY	Odds of asthma among children ages 10–15 in households ever experiencing hunger were 1.41 (95% CI: 0.79, 2.51) times higher than among children in households never experiencing hunger. Odds of asthma among youth ages 16–21 were 2.66 (95% CI: 0.93, 7.63) times higher for those ever experiencing hunger.
Melchior et al. (Note 15)	Food insecurity and children's mental health: a prospective birth cohort study.	1997–2005 Québec Longitudinal Study of Child Development	Odds of having high depression or anxiety among children ages 4–8 in food-insecure households were 1.79 (95% CI: 1.15, 2.79) times higher than among children in food-secure households.
McIntyre et al. (Note 16)	Depression and suicide ideation in late adolescence and early adulthood are an outcome of child hunger.	1994–2009 Canadian NLSCY	Odds of depression or suicide ideation among youth ages 14–25 in households experiencing hunger were 2.3 times higher ($p = 0.01$) than among youth in households without hunger.
Chi et al. (Note 17)	Socioeconomic status, food security, and dental carries in US children: Mediation analyses of data from the National Health and Nutrition Examination Survey, 2007–2008.	2007–2008 NHANES	Odds of tooth decay among children with low food security were 2.00 times higher ($p = 0.03$) than among children with full food security when socioeconomic status was held constant.

SOURCE Authors' summary of information from articles cited in the text. **NOTES** If no mention is made of p values, standard errors, or confidence intervals, they were not reported or the results in the article were not statistically different from zero. CI is confidence interval. SE is standard error. NHANES is the National Health and Nutrition Examination Survey. ECLS-K is Early Child Longitudinal Study–Kindergarten Class. NLSC is National Longitudinal Survey of Children. NLSCY is National Longitudinal Survey of Children and Youth.

health outcomes.

For example, data from Children's HealthWatch—a sentinel study of over 40,000 children younger than age four in five large urban hospitals, which began in 1998—indicate that compared to children in fully food-secure households, those in marginal-food-secure households are more likely to be in fair or poor health and more likely to have a mother who reported one or two substantial concerns about the child's development on the Parent's Evalua-

tion of Developmental Status.¹⁹ One implication is that some research examining the impact of food insecurity on health outcomes might have underestimated the consequences by ignoring households that are marginally food secure.

NONSENIOR ADULTS There has been less research on the impacts of food insecurity on health outcomes among nonsenior adults. However, some of the studies in this limited set have shown that food insecurity is associated with decreased nutrient intakes;^{20–25} increased rates

EXHIBIT 3

Summary Of Research On Food Insecurity And Health Among Nonsenior Adults In The United States And Canada Published During 2004-14

Authors	Title	Data source	Central findings
Whitaker et al. (Note 10)	Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children.	1998–2000 Fragile Families and Child Wellbeing Study	Food-insecure mothers had 2.2 (95% CI: 1.6, 2.9) times higher rates of mental health issues than fully food-secure mothers. The odds of behavioral problems among children with food-insecure mothers were 2.1 (95% CI: 1.6, 2.7) times higher than among children with food-secure mothers.
Muirhead et al. (Note 18)	Oral health disparities and food insecurity in working poor Canadians.	2007 nationally representative stratified random sample of working poor Canadians ages 18–64	Odds of oral health problems among the working poor with food insecurity were 3.31 times higher ($p < 0.001$) than among those with food-secure households.
Park et al. (Note 25)	Iron deficiency is associated with food insecurity in pregnant females in the United States: National Health and Nutrition Examination Survey 1999–2010.	1999–2010 NHANES	Odds of iron deficiency (classified by ferritin status) among pregnant women ages 13–54 with food insecurity were 2.90 times higher ($p < 0.05$) than among pregnant women who were food secure.
Heflin et al. (Note 26)	Food insufficiency and women's mental health: findings from a 3-year panel of welfare recipients.	Women's Employment Study, 1997–99	Women's changing food insufficiency status was positively associated with a change in major depression status ($p < 0.01$). No apparent results were found for the association of food-insufficiency status and a woman's sense of mastery, or being a causal agent in her environment.
Casey et al. (Note 29)	Maternal depression, changing public assistance, food security, and child health status.	Children's Sentinel Nutritional Assessment Program household-level survey, 1998–2001 (at emergency departments and primary care clinics)	Self-report of maternal depression was associated with loss or reduction of welfare support (50% [95% CI: 3, 125]) as well as being two times more likely to experience household food insecurity.
Seligman et al. (Note 31)	Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutritional Examination Survey (NHANES) 1999–2002.	1999–2002 NHANES	Food-insecure individuals have approximately twice the odds of experiencing diabetes (95% CI: 1.1, 4.0), compared to food-secure individuals. Diabetes was reported in 10% of individuals with mild, and 16% of individuals with severe, food insecurity.
Seligman et al. (Note 32)	Food insecurity is associated with chronic disease among low-income NHANES participants.	1999–2004 NHANES	Food insecurity is associated with a 20% (95% CI: 4, 38) increase in the risk of self-reported measures of hypertension and a 30% (95% CI: 9, 55) increase in risk of self-reported hyperlipidemia but not self-reported diabetes. Food-insecure individuals have 2.4 (95% CI: 1.44, 4.08) times higher risk of diabetes and hypertension.

SOURCE Authors' summary of information from articles cited in the text. **NOTES** If no mention is made of values, standard errors, or confidence intervals, they were not reported or the results in the article were not statistically different from zero. CI is confidence interval. NHANES is National Health and Nutrition Examination Survey.

of mental health problems and depression,^{10,26–30} diabetes,^{31,32} hypertension,³³ and hyperlipidemia;³² worse outcomes on health exams;³³ being in poor or fair health;^{23,34} and poor sleep outcomes³⁵ (Exhibit 3). In terms of effect sizes, mothers who are food insecure are over twice as likely to report mental health problems¹⁰ and over three times as likely to report oral health problems, compared to their food-secure peers.¹⁸

SENIORS In general, there has been a great deal of research on the health status of seniors but surprisingly little work on food insecurity and

health. The work that has been done has found, for example, that compared food-insecure seniors report lower nutrient intakes,^{2,36,37} are more likely to be in poor or fair health^{2,36,37} and to be depressed,^{2,38} and are more likely to have limitations in activities of daily living,² compared to their food-secure peers (Exhibit 4).

In terms of effect sizes, food-insecure seniors were 2.33 times more likely to report being in fair or poor health, compared to food-secure seniors.³⁷ Moreover, a senior who is marginally food insecure compared to one who is fully food secure has reduced nutrient intakes roughly

Summary Of Research On Food Insecurity And Health Among Seniors In The United States Published During 2001–08

Authors	Title	Data source	Central findings
Ziliak et al. (Note 2)	The causes, consequences, and future of senior hunger in America.	CPS 2001–5, NHANES 1999–2002, PSID 1999–2003	Seniors experiencing food insecurity are more likely to have limitations in activities of daily living ($p < 0.05$) akin to a food-secure senior 14 years older. Food-insecure seniors have lower nutrient intakes than food-secure seniors ($p < 0.05$), similar to a food-secure senior earning \$15,000 less per year.
Lee and Frongillo (Note 36)	Factors associated with food insecurity among U.S. elderly persons: importance of functional impairments.	NHANES 1988–1994, National Survey of the Elderly in New York State 1994	Seniors with limitations in activities of daily living have higher odds of 1.94 (95% CI: 1.34, 2.80) to 2.8 (95% CI: 1.04, 7.54) of facing food insecurity, and those with limitations in instrumental activities of daily living face higher odds of 1.4 (95% CI: 0.82, 2.36) to 2.2 (95% CI: 1.04, 4.56).
Lee and Frongillo (Note 37)	Nutritional and health consequences are associated with food insecurity among U.S. elderly persons.	NHANES 1988–1994, National Survey of the Elderly in New York State 1994	Seniors are more likely than others to have lower intakes of eight nutrients. Food-insecure elderly individuals were 2.33 (95% CI: 1.73, 3.14) times more likely than their food-secure peers to report fair or poor health status and had higher nutritional risk.

SOURCE Authors' summary of information from articles cited in the text. **NOTES** If no mention is made of p values, standard errors, or confidence intervals, they were not reported in the article or the results were not statistically different from zero. CI is confidence interval. CPS is Current Population Survey. NHANES is National Health and Nutrition Examination Survey. PSID is Panel Study of Income Dynamics.

equivalent to having \$15,000 less income.² Similarly, the effect of being marginally food insecure on having a limitation in an activity of daily living (ADL) is roughly equivalent to being fourteen years older.² Unfortunately, most of the other papers covered in our review did not report the full set of coefficients in the multivariate models, so we cannot make similar comparisons in those cases.

Possible Mechanisms

Researchers do not always carefully articulate the mechanisms by which food insecurity causes negative health outcomes. A good counterexample is the work of Hilary Seligman and co-authors,³² who considered why food insecurity is more likely to increase a person's odds of developing diabetes than hypertension. They argued that diabetes is more affected than hypertension by limitations in diet, while hypertension is more affected than diabetes by medication adherence. Peripheral insulin resistance, a precursor to diabetes, may emerge as a result of food scarcity,³⁹ and the stress associated with food insecurity may lead to increases in cortisol and, hence, central adiposity, which is often associated with diabetes.

Another mechanism whereby food insecurity can influence health outcomes is through its effect on adherence to medical recommendations. Again considering diabetes, Seligman and co-authors showed that food-insecure adults re-

ported more difficulties affording a diabetic diet and lower abilities to address issues pertaining to diabetes, compared to those who are food secure.⁴⁰

Some of the mechanisms by which food insecurity adversely affects health outcomes are indirect. For example, there has been an interest in whether or not food insecurity is associated with obesity, which in turn is associated with other negative health outcomes, including diabetes.

A recent review by Nicole Larson and Mary Story⁴¹ examined the literature looking at food insecurity and obesity across various categories. For men and children, the consensus in the literature is that there is no association between food insecurity and obesity status, after relevant confounding factors are controlled for. For women, however, there is some limited evidence that food insecurity is associated with obesity, at least in the short run. One study found that women who are very low food secure are 10.8 percentage points more likely than women who are fully food secure to be obese.⁴² However, after one year those who were persistently food insecure were found to be no more or less likely than food-secure women to be obese.^{43–45}

Discussion

Although our review of the literature was necessarily limited to more recent studies, a compelling picture of food insecurity's association with negative health outcomes has emerged based on

a wide array of data sets and empirical methods. However, this literature has not always effectively addressed the issues of causality and endogeneity.

CAUSALITY In many of the cases discussed above, the causal relationship between food insecurity and health is clear. For example, it would be difficult to construct a scenario in which limited nutrient intake was a cause of food insecurity instead of the other way around. However, in other cases, the causality is not as clear.

Consider depression. In several studies, food insecurity is seen as leading to depression—that is, in the multivariate regression model, depression is the dependent variable and food insecurity is one of the independent variables.² From our perspective, this is plausible—the inability, say, of parents to feed their children could lead to depression. In contrast, others have used depression as a predictor of food insecurity, treating food insecurity as the dependent variable and depression as one of the independent variables.^{46,47}

Future research using longitudinal data with the appropriate econometric techniques should address these causality issues. A recent example of researchers who considered this issue in a convincing manner is Kelly Noonan and co-authors.⁴⁶ They used data from the Early Childhood Longitudinal Study Birth Cohort, which conducted four interviews of the parents and caregivers (including early childhood teachers) of 14,000 children born in 2001 between birth and the start of kindergarten. The researchers found that when mothers are moderately to severely depressed, the risk of child and household food insecurity rises by 50–80 percent, depending on the measure of food insecurity.

ENDOGENEITY In virtually all of the work mentioned above, the authors implicitly assumed that the effect of food insecurity was properly identified after other observed characteristics from the data set were controlled for. In other words, they assumed that there were no unobserved characteristics that led a household both to be more (or less) likely to be food insecure and to be more (or less) likely to suffer from a negative health outcome. This assumption is unlikely to hold, since we expect that multiple factors are not included as covariates in any given model. As a consequence, the results found in these papers are subject to some level of bias. The extent of this bias and its direction are unclear.

To address this issue, we make a suggestion. A number of econometric techniques could be used to reduce or eliminate endogeneity bias. For example, Craig Gundersen (one of the authors of this article) and Brent Kreider¹¹ used an econometric method that establishes bounds re-

The most direct way to ameliorate the health consequences associated with food insecurity is to reduce food insecurity.

garding the potential impact of food insecurity on health in the presence of unobserved characteristics that would lead one to be food insecure and in poor health. This approach does not allow, in general, for point estimates of the impact. However, the bounds are more reasonable insofar as they do not explicitly ignore unobserved characteristics. In some cases, there may be variables that influence food insecurity but not health outcomes, and in those cases, standard instrumental variable techniques could be used to derive point estimates of the impact of food insecurity on health outcomes.

Recommendations

Food insecurity and its health consequences present a serious challenge to policy makers, program administrators, and health care providers in the United States. In this section we emphasize one central policy mechanism that is used to alleviate food insecurity in the United States, and we make two suggestions for health care providers.

Obviously, the most direct way to ameliorate the health consequences associated with food insecurity is to reduce food insecurity. In the United States, SNAP has been used successfully for over fifty years to reduce food insecurity.⁴⁸ The scope of SNAP is reflected in both its reach and the size of its benefits. In 2014 over forty-six million people participated in the program, which had total expenditures of over \$74 billion.⁴⁹ The maximum monthly SNAP benefit is \$649 for a family of four; the average benefit per recipient is about 60 percent of this level.⁵⁰

Households are eligible for SNAP if they meet three criteria. First, their gross monthly income must be less than 130 percent of the federal poverty level. In recent years some states have opted to use a cutoff that is above 130 percent of poverty. Second, a household's net monthly income must be below poverty. Net income is defined as

Recent proposals to change the fundamental structure of SNAP could diminish its role in alleviating food insecurity.

gross income minus certain deductions, such as a 20 percent earned income deduction, a medical costs deduction for elderly and disabled people, and an excess shelter cost deduction. The net income test is the same in all states. Third, SNAP applicants need to have assets of less than \$2,000, except that households with at least one senior and households that include at least one person with a disability can have more assets. In recent years, however, most states have requested and received waivers to eliminate the asset test in their states.

A number of studies have demonstrated SNAP's success in achieving its central goal of alleviating food insecurity.^{51,52} In addition, the program has been found to reduce poverty.⁴⁸

However, recent proposals to change the fundamental structure of SNAP, such as the call by House Budget Committee Chairman Rep. Paul Ryan (R-WI) to make SNAP a block-grant program,⁵³ could diminish its role in alleviating food insecurity. SNAP is now an entitlement program, which means that federal spending on benefits increases and decreases along with a household's need. If it became a block-grant program, a fixed annual appropriation would be allotted to states, thereby reducing the program's potential responsiveness to changes in need, such as those resulting from a midyear economic recession. In addition, the experience of the Temporary Assistance for Needy Families program (TANF)—a federal block-grant program to states targeted to low-income families with dependent children under age eighteen that replaced an entitlement program, Aid to Families with Dependent Children, as part of the 1996 welfare reform—suggests that changing the financial structure of SNAP by making it a block-grant program would likely lead to the cutting of significant numbers of currently eligible families from the program.⁵⁴

Other members of Congress and the public

health community have argued for imposing further restrictions on the types of items that SNAP benefits can be used to purchase. SNAP benefits must be redeemed on food to be prepared in the home, and hot prepared food is the only ineligible food item.

Imposing additional restrictions would likely lead to reductions in participation in SNAP because of increases in stigma (for example, by being refused purchases when paying for food items) and transaction costs (such as the higher costs associated with having to ascertain which foods are eligible for SNAP), both of which can be seen in the recent experience of TANF.^{54,55} Since SNAP participants are less likely to be food insecure than nonparticipants who are eligible for SNAP,^{51,52} a fall in SNAP participation could lead to an increase in food insecurity and its resulting health consequences. Simply put, SNAP should be viewed as an important health care intervention for low-income Americans.

That said, many SNAP recipients remain food insecure even after receiving benefits. Furthermore, many people who are eligible for SNAP do not receive benefits. This is especially true among seniors, a population in which over 60 percent of those eligible do not receive assistance. These facts suggest that there is room for modifications to the current SNAP program.

First, for some SNAP recipients, benefit levels are not high enough to remove them from food insecurity. Consistent with the recommendations of an expert panel of the Institute of Medicine, it may be worthwhile to increase benefit levels for at least a subset of participants, especially those in high-cost urban areas.⁵⁶

Second, reducing the barriers to applying for SNAP and recertifying eligibility for the program—including the barriers related to stigma and transactions costs—would further reduce food insecurity.

Third, a substantial portion of food-insecure households have incomes above the gross income limit of 130 percent of poverty, which makes them ineligible for SNAP in many states. This suggests that setting a higher gross-income test for eligibility could reduce food insecurity of the so-called near-poor and, in turn, improve their health outcomes.

Conclusion

We conclude with two suggestions for how health care professionals might use the central findings of this review in their work. First, they should recognize the possibility that food insecurity may be one determinant, among others, of a patient's health challenges. Other nutrition-related health determinants, such as obesity,

have received quite a bit of attention within the context of the doctor-patient relationship, but food insecurity has not received nearly as much.

Second, to more fully ascertain who is at risk of food insecurity during visits to health care settings, health care professionals could ask for information about food insecurity along with other intake information. This is likely more important now than before, with the implementation of the Affordable Care Act and the concomitant expansion of Medicaid, which are bringing millions of low-income people into the health care system.

A two-item food-security questionnaire taken from the eighteen items in the CPS-FSS has been shown to be successful at identifying people in a clinical setting who are at risk of food insecurity, and the two-item questionnaire could be more widely tested nationally.⁵⁷ This would then give health care professionals one more tool to use in identifying food-insecure patients and offering care options. One option, not ordinarily considered in the context of an office visit, would be to refer patients to food assistance programs such as SNAP to alleviate food insecurity and, in turn, its associated poor health consequences. ■

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NOTES

- Coleman-Jensen A, Gregory C, Singh A. Household food security in the United States in 2013 [Internet]. Washington (DC): Department of Agriculture, Economic Research Service; 2014 Sep [cited 2015 Sep 11]. (Economic Research Report No. 173). Available from: <http://www.ers.usda.gov/media/1565415/err173.pdf>
- Ziliak JP, Gundersen C, Haist M. The causes, consequences, and future of senior hunger in America [Internet]. Lexington (KY): University of Kentucky, Center for Poverty Research; [cited 2015 Sep 11]. Available from: <http://www.mowaa.org/document.doc?id=13>
- Gundersen C, Ziliak JP. Childhood food insecurity in the U.S.: trends, causes, and policy options [Internet]. Princeton (NJ): Future of Children; 2014 fall [cited 2015 Sep 11]. (Research Report). Available from: <http://www.princeton.edu/futureofchildren/publications/docs/ResearchReport-Fall2014.pdf>
- Gundersen C, Kreider B, Pepper J. The economics of food insecurity in the United States. *Appl Econ Perspect Policy*. 2011;33(3):281-303.
- Carmichael SL, Yang W, Herring A, Abrams B, Shaw GM. Maternal food insecurity is associated with increased risk of certain birth defects. *J Nutr*. 2007;137(9):2087-92.
- Eicher-Miller HA, Mason AC, Weaver CM, McCabe GP, Boushey CJ. Food insecurity is associated with iron deficiency anemia in US adolescents. *Am J Clin Nutr*. 2009;90(5):1358-71.
- Skalicky A, Meyers AF, Adams WG, Yang Z, Cook JT, Frank DA. Child food insecurity and iron deficiency anemia in low-income infants and toddlers in the United States. *Matern Child Health J*. 2006;10(2):177-85.
- Cook JT, Frank DA, Levenson SM, Neault NB, Heeren TC, Black MM, et al. Child food insecurity increases risks posed by household food insecurity to young children's health. *J Nutr*. 2006;136(4):1073-6.
- Howard LL. Does food insecurity at home affect non-cognitive performance at school? A longitudinal analysis of elementary student classroom behavior. *Econ Educ Rev*. 2011;30(1):157-76.
- Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. *Pediatrics*. 2006;118(3):e859-68.
- Gundersen C, Kreider B. Bounding the effects of food insecurity on children's health outcomes. *J Health Econ*. 2009;28(5):971-83.
- Hernandez DC, Jacknowitz A. Transient, but not persistent, adult food insecurity influences toddler development. *J Nutr*. 2009;139(8):1517-24.
- Kirkpatrick SI, McIntyre L, Potestio ML. Child hunger and long-term adverse consequences for health. *Arch Pediatr Adolesc Med*. 2010;164(8):754-62.
- Huang J, Oshima KM, Kim Y. Does food insecurity affect parental characteristics and child behavior? Testing mediation effects. *Soc Serv Rev*. 2010;84(3):381-401.
- Melchior M, Chastang J-F, Falissard B, Galéra C, Tremblay RE, Côté SM, et al. Food insecurity and children's mental health: a prospective birth cohort study. *PLoS One*. 2012;7(12):e52616.
- McIntyre L, Williams JV, Lavorato DH, Patten S. Depression and suicide ideation in late adolescence and early adulthood are an outcome of child hunger. *J Affect Disord*. 2013;150(1):123-9.
- Chi DL, Masterson EE, Carle AC, Mancini LA, Coldwell SE. Socioeconomic status, food security, and dental caries in US children: mediation analyses of data from the National Health and Nutrition Examination Survey, 2007-2008. *Am J Public Health*. 2014;104(5):860-64.
- Muirhead V, Quiñonez C, Figueiredo R, Locker D. Oral health disparities and food insecurity in working poor Canadians. *Community Dent Oral Epidemiol*. 2009;37(4):294-304.
- Cook JT, Black M, Chilton M, Cutts D, Ettinger de Cuba S, Heeren TC, et al. Are food insecurity's health impacts underestimated in the U.S. population? Marginal food security also predicts adverse health outcomes in young U.S. children and mothers. *Adv Nutr*. 2013;4(1):51-61.
- Dixon LB, Winkleby MA, Radimer KL. Dietary intakes and serum nutrients differ between adults from food-insufficient and food-sufficient families: Third National Health and Nutrition Examination Survey, 1988-1994. *J Nutr*. 2001;131(4):1232-46.
- Tarasuk VS, Beaton GH. Women's dietary intakes in the context of household food insecurity. *J Nutr*. 1999;129(3):672-9.
- Kirkpatrick SI, Tarasuk V. Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. *J Nutr*. 2008;138(3):604-12.
- McIntyre L, Glanville NT, Raine KD, Dayle JB, Anderson B, Battaglia N. Do low-income lone mothers compromise their nutrition to feed their children? *CMAJ*. 2003;168(6):686-91.
- Ziliak JP, Gundersen C. Food insecurity among older adults: full report [Internet]. Washington (DC): AARP Foundation; 2011 Aug [cited 2015

- Sep 14]. Available from: http://www.aarp.org/content/dam/aarp/aarp_foundation/pdf_2011/AARP_Foundation_HungerReport_2011.pdf
- 25 Park CY, Eicher-Miller HA. Iron deficiency is associated with food insecurity in pregnant females in the United States: National Health and Nutrition Examination Survey 1999–2010. *J Acad Nutr Diet*. 2014; 114(12):1967–73.
 - 26 Heflin CM, Siefert K, Williams DR. Food insufficiency and women's mental health: findings from a 3-year panel of welfare recipients. *Soc Sci Med*. 2005;61(9):1971–82.
 - 27 Heflin CM, Ziliak JP. Food insufficiency, food stamp participation, and mental health. *Soc Sci Q*. 2008;89(3):706–27.
 - 28 Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health, and household circumstances. *J Nutr*. 2001;131(10):2670–6.
 - 29 Casey P, Goolsby S, Berkowitz C, Frank D, Cook J, Cutts D, et al. Maternal depression, changing public assistance, food security, and child health status. *Pediatrics*. 2004;113(2):298–304.
 - 30 Hromi-Fiedler A, Bermúdez-Millán A, Segura-Pérez S, Pérez-Escamilla R. Household food insecurity is associated with depressive symptoms among low-income pregnant Latinas. *Matern Child Nutr*. 2011;7(4):421–30.
 - 31 Seligman HK, Bindman AB, Vittinghoff E, Kanaya AM, Kushel MB. Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutritional Examination Survey (NHANES) 1999–2002. *J Gen Intern Med*. 2007;22(7):1018–23.
 - 32 Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. *J Nutr*. 2010; 140(2):304–10.
 - 33 Stuff JE, Casey PH, Szeto KL, Gossett JM, Robbins JM, Simpson PM, et al. Household food insecurity is associated with adult health status. *J Nutr*. 2004;134(9):2330–5.
 - 34 Vozoris NT, Tarasuk VS. Household food insufficiency is associated with poorer health. *J Nutr*. 2003;133(1):120–6.
 - 35 Ding M, Keiley MK, Garza KB, Duffy PA, Zizza CA. Food insecurity is associated with poor sleep outcomes among US adults. *J Nutr*. 2015; 145(3):615–21.
 - 36 Lee JS, Frongillo EA Jr. Factors associated with food insecurity among U.S. elderly persons: importance of functional impairments. *J Gerontol B Psychol Sci Soc Sci*. 2001;56(2):S94–9.
 - 37 Lee JS, Frongillo EA Jr. Nutritional and health consequences are associated with food insecurity among U.S. elderly persons. *J Nutr*. 2001;131(5):1503–9.
 - 38 Laraia BA, Borja JB, Bentley ME. Grandmothers, fathers, and depressive symptoms are associated with food insecurity among low-income first-time African-American mothers in North Carolina. *J Am Diet Assoc*. 2009;109(6):1042–7.
 - 39 Reaven GM. Hypothesis: muscle insulin resistance is the (“not-so”) thrifty genotype. *Diabetologia*. 1998; 41(4):482–4.
 - 40 Seligman HK, Jacobs EA, López A, Tschann J, Fernandez A. Food insecurity and glycemic control among low-income patients with type 2 diabetes. *Diabetes Care*. 2012;35(2):233–8.
 - 41 Larson NI, Story MT. Food insecurity and weight status among U.S. children and families: a review of the literature. *Am J Prev Med*. 2011; 40(2):166–73.
 - 42 Hanson KL, Sobal J, Frongillo EA. Gender and marital status clarify associations between food insecurity and body weight. *J Nutr*. 2007; 137(6):1460–5.
 - 43 Jones SJ, Frongillo EA. Food insecurity and subsequent weight gain in women. *Public Health Nutr*. 2007; 10(2):145–51.
 - 44 Whitaker RC, Sarin A. Change in food security status and change in weight are not associated in urban women with preschool children. *J Nutr*. 2007;137(9):2134–9.
 - 45 Jones SJ, Frongillo EA. The modifying effects of Food Stamp Program participation on the relation between food insecurity and weight change in women. *J Nutr*. 2006; 136(4):1091–4.
 - 46 Noonan K, Corman H, Reichman NE. Effects of maternal depression on family food insecurity. Cambridge (MA): National Bureau of Economic Research; 2014 May. (NBER Working Paper No. 20113).
 - 47 Garg A, Toy S, Tripodis Y, Cook J, Cordella N. Influence of maternal depression on household food insecurity for low-income families. *Acad Pediatr*. 2015;15(3):305–10.
 - 48 Bartfeld J, Gundersen C, Smeeding TM, Ziliak JP, eds. SNAP matters: how food stamps affect health and well-being. Redwood City (CA): Stanford University Press; forthcoming.
 - 49 Department of Agriculture, Food and Nutrition Service. Supplemental Nutrition Assistance Program participation and costs [Internet]. Washington (DC): USDA; 2015 [cited 2015 Sep 23]. Available from: <http://www.fns.usda.gov/sites/default/files/pd/SNAPsummary.pdf>
 - 50 Department of Agriculture, Food and Nutrition Service. Supplemental Nutrition Assistance Program (SNAP) eligibility [Internet]. Washington (DC): USDA; [last published 2014 Oct 3; cited 2015 Sep 23]. Available from: <http://www.fns.usda.gov/snap/eligibility>
 - 51 Gregory C, Rabbitt M, Ribar D. The Supplemental Nutrition Assistance Program and food insecurity. In: Bartfeld J, Gundersen C, Smeeding TM, Ziliak JP, editors. SNAP matters: how food stamps affect health and well-being. Redwood City (CA): Stanford University Press; forthcoming. p. 74–106.
 - 52 Kreider B, Pepper JV, Gundersen C, Jolliffe D. Identifying the effects of SNAP (food stamps) on child health outcomes when participation is endogenous and misreported. *J Am Stat Assoc*. 2012; 107(499):958–75.
 - 53 House Budget Committee. The path to prosperity: fiscal year 2015 budget resolution [Internet]. Washington (DC): The Committee; 2014 Apr [cited 2015 Sep 14]. Available from: https://budget.house.gov/uploadedfiles/fy15_blueprint.pdf
 - 54 Ziliak JP. Temporary Assistance for Needy Families. Cambridge (MA): National Bureau of Economic Research; 2015 Mar. (NBER Working Paper No. 21038).
 - 55 Gundersen C. SNAP and obesity. In: Bartfeld J, Gundersen C, Smeeding TM, Ziliak JP, editors. SNAP matters: how food stamps affect health and well-being. Redwood City (CA): Stanford University Press; forthcoming. p. 161–85.
 - 56 Caswell JA, Yaktine AL, editors. Supplemental Nutrition Assistance Program: examining the evidence to define benefit adequacy. Washington (DC): National Academies Press; 2013.
 - 57 Hager ER, Quigg AM, Black MM, Coleman SM, Heeren T, Rose-Jacobs R, et al. Development and validity of a 2-item screen to identify families at risk for food insecurity. *Pediatrics*. 2010;126(1):e26–32.