Appendix 2:
Estimating the Health-Related Costs of Food Insecurity and Hunger

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Introduction

Hunger is a health issue. This report is primarily about health-related costs attributable to food insecurity and hunger in the United States in 2014. The report also includes other kinds of costs associated with food insecurity, but its focus is health-related costs. Our charge is to update information on costs of food insecurity in the United States published in 2011,[1] employing the most recently available data on prevalence of food insecurity in 2014 with the most valid estimation procedures available, and to expand on the health-related costs attributable to food insecurity in the United States.

Executive Summary

Each September the Economic Research Service of the U.S. Department of Agriculture (USDA) reports estimates of the number and prevalence of people living in food insecure households by various demographic characteristics and levels of severity of food insecurity. Data for this report come from the December implementation by the Census Bureau of the Current Population Survey, a nationally representative survey of the U.S. population. In 2014, there were 48.135 million people (15.4 percent of the total population) living in households that were food insecure at some level of severity (Exhibit 1). The number of food-insecure people in the United States in 2014 was 11.906 million higher than in 2007, the year the Great Recession began, and only 0.697 million lower than in 2010. Between 2010 and 2014 the nation's food security situation did not improve appreciably.

Exhibit 1 **Number and percent of people living in food-insecure households in the US, 2007-2014**

Year	Total Number of Individuals Food Insecure (1000s)	Percent of Individuals Food Insecure
2007	36,229	12.2%
2008	49,108	16.4%
2009	50,162	16.6%
2010	48,832	16.1%
2011	50,120	16.4%
2012	48,966	15.9%
2013	49,078	15.8%
2014	48,135	15.4%

Source: Coleman-Jensen, et al., 2015[2].

The most recent prior estimates of the cost of food insecurity to the nation by researchers at Brandeis University[1] addressed costs within three domains: illness costs, education and related costs, and charity costs. The total illness costs estimated for calendar year 2010 within these three areas was $130.5 Billion.

We surveyed empirical food security research literature published in peer-reviewed academic journals between 2005 and 2015,

and based our estimates on relationships identifiable in that literature. Using information from the research literature reviewed, and from the 2011 Brandeis report, *we estimate the health-related costs attributable to food insecurity to be $160.07 Billion in 2014* (Exhibit 2).

Domains of Costs Addressed in this Report

The cost estimates described in this report address the following domains:

1. Direct costs of treatment of specific disease or health conditions that are plausibly attributable to household food insecurity.
2. Direct costs of special education in public primary and secondary schools plausibly attributable to food insecurity.
3. Indirect costs of lost work productivity resulting from:
   a. Workers' own illnesses or other health problems attributable to food insecurity,
   b. Workers providing care to a family member whose illness is attributable to food insecurity.

Exhibit 2 **Estimated Costs Attributable to Food Insecurity and Hunger in the US, 2014**

Source of Cost	Costs ($Billion 2014 Dollars)
Direct health-related costs in 2014 based on new research evidence	$29.68
Non-overlapping direct health-related costs reported by Brandeis researchers in 2011, continued in 2014 and expressed in 2014 dollars	$124.92
Indirect costs of lost work time due to workers' illnesses or workers providing care for sick family members based on new research evidence	$5.48
Total direct and indirect 2014 health-related costs	**$160.07**
Indirect costs of special education in public primary and secondary schools, based on new research evidence	$5.91
Total costs of dropouts reported by Brandeis researchers in 2011, continued in 2014 and expressed in 2014 dollars	$12.94
TOTAL ESTIMATED COSTS	**$178.93**

Sources described in document text.

Methods

To estimate the direct health-related costs attributable to food insecurity in 2014, we reviewed empirical research literature published in peer-reviewed journals from approximately 2005 to 2015, searching for quantitative findings of associations between food insecurity and health outcomes. We specifically searched for quantitative findings that involved either odds ratios (most often), likelihood ratios, or relative risk ratios expressing the differences in likelihood of a person living in a food-insecure household having a disease or disease condition compared to a person living in a food-secure household (food security status is the exposure variable).

Those probability ratios were then translated into population attributable fractions (PAFs) expressing the proportion of the total prevalence of the disease in the population attributable to food insecurity (i.e., the excess fraction attributable to food insecurity). As noted above, this process requires the assumption that food insecurity is causally related to the disease conditions.

In case-control studies, if adjusted odds ratios (ORs) are available, they can be transformed into relative risk ratios using formula 1 below[3]:

1. $RR = OR/[(1-Po)+(Po*OR)]$,

   where RR is the relative risk ratio,

   OR is the odds ratio, and

   Po is the proportion of the unexposed (food secure) who develop the outcome, or become cases.

This adjustment is desirable since, though the OR is an acceptable estimate of the Relative Risk ratio (RR) in case-control studies, and approaches RR in the situation of rare diseases in which very few of the unexposed develop the disease, the higher the prevalence of the disease in the unexposed popu-

lation (e.g., the food-secure population), the greater the deviation of the RR from the OR.

With the relative risk ratios thus calculated (or if they are available), they can be used to calculate estimates of the excess population attributable fractions (PAF) of the diseases arising due to exposure to the predictor, food insecurity, using formula 2 below[4]:

1. PAF = Pe (RR - 1) / [Pe (RR - 1) + 1] * 100%, where

   PAF is the excess population attributable fraction of disease in the population considered to result from the presence of the exposure variable or condition (i.e., food insecurity),

   RR is the relative risk ratio calculated as above, and

   Pe is the proportion of controls (those who do not have the outcome or disease) who were exposed (live in a food-insecure household).

A complete table of all the conditions for which we found new studies providing the information needed to calculate attributable fractions can be found in Appendix Exhibit A1. For most of the health conditions, the attributable fraction (AF) is relatively small, 10 percent or less. For a few conditions we found research results leading to more than one AF for a condition. In those cases, we either used the average of the AFs, or used the one which was more reliable for the specific age group and condition under consideration. And for a few conditions, we were either unable to find data on the prevalence and number of people in the relevant sub-population with the condition, or data on the cost of treating cases of the condition. In those few instances, we were unable to estimate the disease burden or the costs. This was particularly true when the condition was failure to receive recommended or prescribed treatment, or treatment foregone due to inability to pay as a result of food insecurity.

For a couple of conditions (e.g., PEDS concerns; parents report of developmental concerns about their child), we had to add an additional link to the chain of logic such as obtaining positive predictive value of the indicator (PEDS concerns) and the outcome (special education). With a few conditions for which we could not find needed prevalence data, we relied on data from the U.S. Census Bureau on relationships between reported health status and health services utilization.[5]

Using the information in Exhibit 1A, together with data from the Agency for Healthcare Research and Quality's Medical Expenditure Panel Survey (MEPS, or other national survey data) on the number of cases of each disease condition in the population in 2014 (when available), we estimated the fraction (proportion) of cases of each health condition attributable to food insecurity. Combining the results of these calculations with data on annual expenditures for treatment of individuals with the condition (from MEPS or other national health surveys), we estimated the total annual direct costs of treatment for all individuals with the condition.

Data on numbers of hospitalizations, and average costs of hospital stays were obtained from the Agency for Healthcare Research & Quality's Healthcare Cost & Utilization Project public access data obtained via the HCUPnet online query system (http://hcupnet.ahrq.gov/). Data were obtained from both the HCUP National Inpatient Database and the HCUP Kids' Inpatient Database. Several price index series were used to adjust the price of various healthcare services. These price indices were taken from the Bureau of Labor Statistics' online databases (http://www.bls.gov/cpi/). Resulting estimated costs for each condition are presented in Appendix Exhibit 2.

The Brandeis researchers estimated the cost of the private food assistance system at $17.8 Billion in 2010 ($19.52 Billion in 2014 dollars), and we calculated the total cost of the public food assistance system to be $103.55 Billion in 2014. However discussions with healthcare colleagues and others led us to the position that the costs of these two complementary food assistance systems are more accurately viewed as the costs of prevention of food insecurity, not as a cost of food insecurity itself. The costs of these two food assistance systems are the costs of the vaccine that prevents food insecurity and hunger from occurring in the nation's households, families and children. Thus the costs of these two systems are not included as costs attributable to food insecurity.

Background and Context

A Note on Hunger

Hunger is probably a more complex phenomenon than most people imagine. The term is used to mean several different things, and its scope varies depending on its intended meaning. First, hunger is part of humans' "creatureliness," arising from of our nature as living systems that require regular intake of food to live, act, grow, develop, and be healthy. We all experience hunger every day; we know when we are hungry, and we can tell someone how hungry we are; i.e., we can "self-report" our hunger and its severity.[6]

At its most basic level, hunger is a neurochemical feedback loop: a reinforcing feedback loop that leads to more food intake the hungrier we are. The hunger feedback loop involves transmission of information to the brain as the stomach empties and its biochemical state changes. The time required for this emptying process is approximately 2-4 hours, depending on the contents of the stomach, activity levels, and other factors. It coincides generally with humans' customary schedule of eating three meals per day. When a person's normal pattern of food intake is interrupted by a lack of food, she becomes hungry. If she doesn't eat, she becomes even hungrier.[6]

Hunger can be described and measured in several ways. It is a drive to find and consume food, and the intensity of this drive depends partly on the amount of food eaten during, and length of time since, the last episode of food intake. Hunger also is a state, with physical and mental components; it is the opposite of satiety. When we are hungry, and food is readily available, and accessible, we eat until we are sated, or no longer hungry, and normally then we stop eating. Satiety is also a neurochemical feedback loop; a balancing feedback loop that leads to less food intake as the stomach fills and sends neurochemical signals to the brain causing the feeling of satiety to increase, and the feeling of hunger to decrease. Healthy people, with no eating issues, stop eating when they become sated.

But the "processes" of hunger and satiety are neither mechanistic nor completely regular. And they are not isolated within an individual. They occur within and are strongly influenced by social contexts, because humans are social beings. Each of us is a set of body systems living and acting within concentrically larger and more complex social systems. And we experience hunger as both a personal and a social condition. Our very earliest social interactions involve being fed, and nurtured. And as we grow, food, hunger, eating together, sharing food, being fed, nourished and nurtured, and nourishing and nurturing others, are fundamental social processes through which we learn to trust, respect, and care for each other.

We learn through social interactions around hunger, food, and eating that we depend on others, and that others depend on us. We learn etiquette: basic social rules that form a foundation on which we build ethics, and moral values. We celebrate important life-cycle events, such as birthdays, graduations, marriages, religious and civil holidays, and deaths, by enjoying and sharing food. Food and satisfying hunger are at the base of Maslow's hierarchy of needs,[7] and until their food and hunger needs are met, humans cannot fulfill other higher-order needs. But food and hunger are also social, and they permeate our social lives. We employ food and hunger, and satisfying hunger, in pursuit of higher-order needs.

So hunger is an individual set of feelings and sensations, grounded in individuals' neurochemical feedback loops, but it is even more a set of social feelings and sensations, grounded in humans' social nature. We live in relationships, some intimate, some casual, some formal, some informal, but all fundamental to our nature as social beings. Hunger is both an individual and a social process, experienced and responded to in social contexts through social interactions and processes. And when hunger cannot be satisfied, for whatever reasons, it affects our social beings, our social lives, social relationships, and social interactions.

Hunger becomes problematic when it cannot be reduced, or when we cannot respond to it appropriately, because we lack the wherewithal or resources necessary to obtain and consume food in socially acceptable ways. The reinforcing feedback loop of hunger can become out of control, and cause the system to collapse, literally, if the balancing feedback loop of satiety is not able to operate. But neither of these feedback loops operates

in isolation; both also are social processes operating within social contexts. And they involve and depend on social interactions to reestablish balance.

Hunger becomes a social policy issue when the social context, and all the social relationships it involves, fail to provide socially acceptable ways for individual or family systems to obtain the food needed to address hunger in socially acceptable ways. When this occurs, those systems are placed at risk for toxic stresses. And toxic stress, intense acute stress or less intense chronic stress, can be very corrosive and destructive. It damages both child and adult health, and is especially pernicious in young children. Toxic stress can damage the architecture of children's developing brains[8, 9] and place significant constraints on their human capital development, impairing the trajectories of their entire lives.[10]

The toxic stress of socially ignored or tolerated hunger damages physical and mental health, but it also erodes basic trust in and respect for social relationships, institutions, and the people within them. Our health, well-being, and prosperity depend on a strong functional base of trust, respect, and compassion in all our relationships. These are the glue that binds the public together and makes it healthy and strong. And without a healthy, strong public, none of us can really be healthy and strong or prosperous, either as individuals or in relationships. Humans are social, inter-dependent beings, and our health, strength, well-being and prosperity depend on the public welfare and strong public infrastructure. As trivial as it can sometimes sound, we very literally are all in this together. There is no "us" and "them," there is only us. And when some of us experience food insecurity or hunger, it harms and diminishes us all.

Food Insecurity and Hunger

"Food security—access by all people at all times to enough food for an active, healthy life—is one of several conditions necessary for a population to be healthy and well nourished."[11] Food insecurity and hunger are measured in the US with a household survey administered each December by the U.S. Census Bureau. The U.S. Food Security Survey Module and the Food Security Scales it contains were developed in the 1990s under the Food Security Measurement Study, a multi-agency collaborative effort involving scientists and academics, government analysts and policy experts, and individuals from for-profit and not-for-profit private entities.[6] The primary food security scale development activities were implemented through a competitive contracting process sponsored and overseen by the USDA and the National Center for Health Statistics (NCHS), with Abt Associates, Inc. as the prime contractor.

The food security and hunger scales developed by the Abt team were incorporated into the ongoing national Current Population Survey (CPS) implemented by the Census Bureau annually. Data from administration of the scales in the CPS are delivered by the Census Bureau to the USDA Economic Research Service (ERS) for summary analysis, estimation of prevalence in different socio-demographic subgroups, tabulation and reporting in its annual reports on food security in the US.

A Note on Causality

Establishing causation is correctly the ideal of all scientific endeavor, but it is seldom achieved, especially in the health and social sciences. The experimental design considered by most scientists, and many non-scientists, to be the "gold standard" for determining causality is the randomized controlled trial or "RCT," in which randomization can "control for" unobserved potentially confounding factors that might lead researchers to erroneously infer causation in relationships, by rendering those confounders random in the studied samples. Yet as good as they are, RCTs are not perfect, nor are they immune from various kinds of error.[12]

Moreover, many of the phenomena and conditions of interest in both health sciences and social sciences are not amenable to randomization. It would be unethical, for example, to randomly assign subjects to conditions of food insecurity or hunger, or to randomly assign food-insecure households to receive or not receive food assistance or other interventions. Consequently, food security research almost always relies on creative quasi-experimental designs, and efforts to control for unobserved confounders statistically.

Thus, conclusive, unassailable evidence that food insecurity causes the multitude of illnesses and adverse health conditions that a very large body of research liter-

ature indicates it is strongly related to most likely cannot be produced. Yet, as with the relationships between smoking tobacco and lung, throat, and mouth cancers, the evidence of relationships between food insecurity and these health outcomes is so strong, and the expected consequences of not treating the relationships as causal are so grave that we are justified in acting on strong evidence even if it is not absolutely conclusive and unassailable.

A Groundbreaking Study Helps Provide A Path Forward

An extremely important recent study of the relationships between food insecurity and health care costs in Ontario, Canada, where health insurance is universally available, achieves a major breakthrough toward providing conclusive evidence of causal relationships between food insecurity and adverse health outcomes. Since health insurance is universally available in Ontario, the intractable obstacle of adverse selection bias is virtually eliminated in this study. Successfully merging administrative data on health services utilization and costs in Ontario with data on food security status of Ontario households from the Canadian Community Health Survey, the researchers come closer than any yet to demonstrating that food insecurity causes bad health outcomes.

Results from this path-breaking research show a monotonic dose-response relationship between severity of food insecurity and total health care costs per person, after adjusting for a number of potential confounders known to be social determinants of health, even after excluding prescription drug costs which are only covered for a subset of the population.[13] Moreover, food insecurity was strongly and significantly related to healthcare costs, whereas income quintile of patients' neighborhood was not.[13]

While this study does not connect food insecurity causally with specific diseases, results are described as consistent with findings from other research of strong associations between food insecurity and poorer self-reported health status, increased likelihood of chronic disease diagnoses, poorer management of disease, and increased healthcare costs. The study's authors also note that "the extreme levels of material deprivation associated with household food insecurity, and severe food insecurity in particular, have been associated with extensive dietary compromise, higher levels of stress, and compromises across a broad spectrum of basic needs, all of which diminish individuals' abilities to manage health problems and potentially increase the need for health care.[13]

So while the presence of causal relationships between food insecurity and specific diseases and adverse health outcomes remains to be conclusively established, this study comes closer than any previous research to establishing conclusive causal relationships between food insecurity and higher health services utilization and health related costs. It is, therefore, a breakthrough, and provides strong support for the cost estimates produced in this current study.

Updating the October 2011 Hunger in America Cost Estimates

In October 2011, researchers at Brandeis University published a set of estimates of national-level costs

Exhibit 3 **Estimated costs of food insecurity and hunger in the US, 2007 and 2010.**

	2007 ($Billions)	2010 ($Billions)	Amount of Change, 2007-2010 ($Billions)	Percent Change, 2007-2010
Illness Costs	$98.4	$130.5	$32.1	33%
Education and Related Costs	$13.9	$19.2	$5.3	38%
Charity Costs	$13.2	$17.8	$4.6	35%
Total Hunger Bill	**$125.5**	**$167.5**	**$42.0**	**33%**

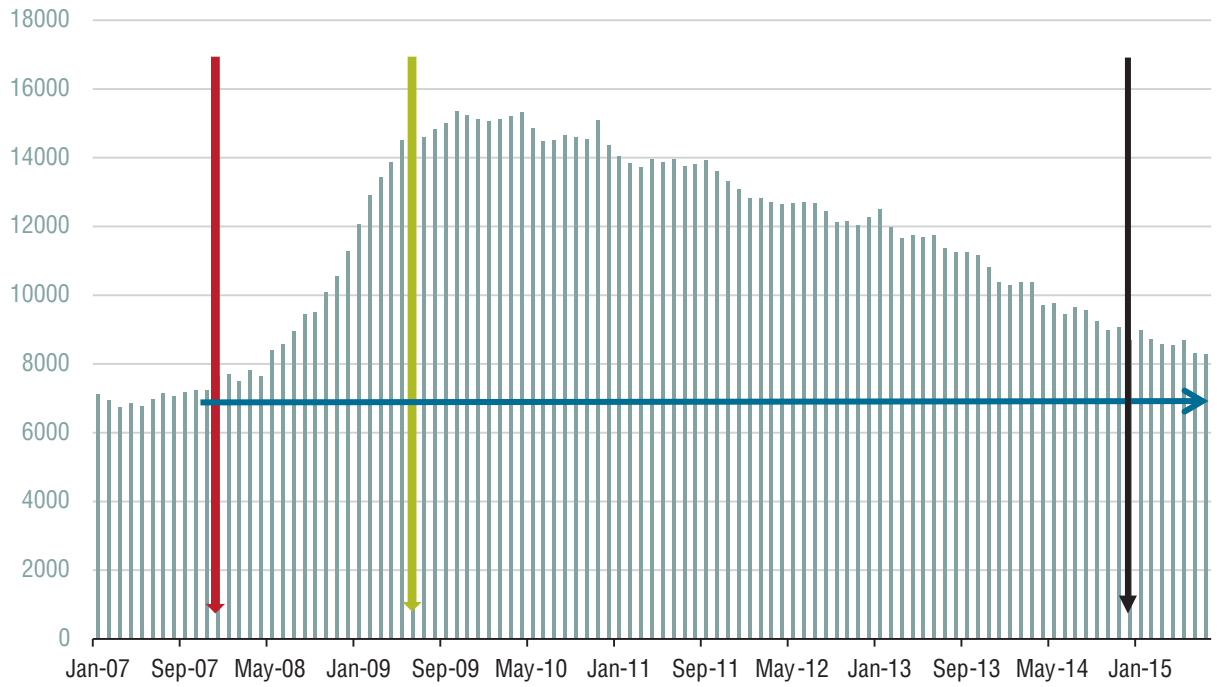
Source: Recreated from Shepard, et al., 2011[1].

attributable to food insecurity and hunger in 2010.[1] Those estimates (Exhibit 3) comprised an update of an earlier set published in 2007.[14] The authors concluded that costs attributable to food insecurity and hunger in 2010 conservatively amounted to a total of $167.5 Billion spread over illness-related costs, education-related costs, and charity costs (Exhibit 3). The costs estimates produced for 2010 ranged from 33 percent to 38 percent higher than the 2007 estimates across these categories. As described in the remainder of this section, there is little evidence that economic conditions in 2014 were sufficiently better than those in 2010 to suggest significant reductions in the costs attributable to food security over that period.

Over the period 2007-2010, food insecurity increased dramatically, mainly due to the Great Recession and the massive increases in unemployment during the recession and after it officially ended (Exhibit 4). In Exhibit 4, the red vertical arrow indicates the month the Great Recession began (December 2007), and the green vertical arrow the month it was determined by the National Bureau of Economic Research (NBER) Business Cycle Dating Committee to have ended (June 2009). The horizontal blue arrow marks the level of unemployment in the month before the recession began (November 2007). As the chart shows, the number unemployed in January 2013 was above 12.3 million, but declined steadily throughout the year, ending at just over 10.3 million. However, more than six years after the end of the recession (July 2015), the number of unemployed people in the U.S. labor force had not returned to its pre-recession level.

In July 2015 there were still more than a million more unemployed workers than in the month prior to the start of the recession (November 2007). Unemployment more than doubled during the recession, going from 7.24 million in November 2007 to 14.71 million in June 2009, the month the recession ended. And it continued to increase, surpassing 15 million in September 2009 and

Exhibit 4 **Number of unemployed workers in the US labor force by month, from January 2007 through July 2015.**



Source: US Bureau of Labor Statistics (http://data.bls.gov/pdq/SurveyOutputServlet;jsessionid=AE49BA7CEF85EEB690DE95D4FC5D758F.tc_instance5).

staying above 15 million until May 2010. The recovery of jobs since the recession ended has been extraordinarily slow, with ups and downs as Exhibit 4 shows.

Among the most harmful aspects of the very high unemployment levels during and after the Great Recession was the unparalleled expansion of the number of long-term unemployed, workers who had been unemployed for 27 weeks or longer. The number of long-term unemployed reached a record high of 6.7 million, 45.1 percent of all the unemployed in the second quarter of 2010. In addition, the proportion of unemployed workers who had been unemployed for 52 weeks or longer reached a record high of 31.9 percent in the second quarter of 2011, and the proportion who had been unemployed for 99 weeks or longer reached a record high of 15.1 percent in the fourth quarter of 2011.[15] And while all three of these measures of long-term employment have declined over the past several years, they remain high by historical standards.

Another extraordinary characteristic of the very slow job recovery from the Great Recession has been the large numbers of people withdrawing from the labor force; some for non-economic reasons, but others because they could not find suitable work, or any work at all. Between the end of the recession in June 2009, and December 2010, nearly 6 million people (5.999 million) withdrew from the labor force. By the end of 2013, an additional 6.6 million had withdrawn. Workers have continued to withdraw from the labor force since the end of 2013, but the rates of withdrawal have slowed and been nearly offset by new entrants. Even so, in July 2015, there were 12.6 million more workers not in the labor force than when the recession ended in June 2009.[16]

Among the 12.6 million people who withdrew from the labor force since the recession ended, nearly half chose to attend or return to school, or to engage in other non-labor force activities voluntarily. However, just over half reported they were available to work and wanted a job, but were not finding any. In addition to these labor-force leavers, the number of so-called "discouraged workers," who had looked for work sometime within the past year, but recently stopped looking because they believed there were no jobs available for them, went from 363,000 to 793,000 during the recession, and reached 1.318 million by December 2010. The number of "discouraged workers" remained close to 1.0 million over 2012-2014, but had declined to 668,000 by July 2015, still nearly double the number when the recession began.

In addition to the very large increases in numbers of unemployed, long-term unemployed, and those who withdrew from the labor force for economic reasons, the Great Recession also led to major increases in the number of "involuntary part time workers," people who wanted to be working full time but were only able to find part-time work. From November 2007, the month before the recession began, to when it ended in June 2009, the number of involuntary part-time workers doubled,[16] increasing from 4.494 million to 9.024 million. And as with unemployment, this number remained little changed through December 2010 when it was 8.935 million. By the end of 2013 the number of involuntary part time workers had fallen to 7.776 million, and in July 2015, at 6.325 million it was still 41 percent higher than in the month before the recession began.[16]

Thus in terms of labor market conditions, the unprecedented high levels of unemployment during and following the Great Recession have slowly declined over the past six years, but labor markets and the employment situation has by no means returned to normal, unless this is the "new normal." While the number of unemployed per month over the period January 2008 to December 2010 averaged 12.683 million workers, during the period January 2011 to December 2013, most of the period over which we are updating the estimates of costs attributable to food insecurity and hunger (indicated by the black vertical arrow in Exhibit 4), the average number of unemployed each month was 12.563 million, less than 1.0 percent lower (0.95 percent) than the average over 2008-2010. Thus on the basis of unemployment, under-employment, long-term unemployment, labor force withdrawals, and other labor force conditions, there is no reason to expect food insecurity, or its costs, to be significantly lower in 2014 than in 2010, and several reasons to expect them to be higher.

While the recovery has been very robust in terms of growth in GDP and corporate profits, with GDP growing at an average annual rate of 3.28 percent, and

corporate profits increasing by an average of nearly 10 percent per year over the period 2010-2014 in the non-financial sector of the economy (which includes manufacturing, transportation, utilities, wholesale and retail trade, and information), average weekly earnings for workers in private non-agricultural industries only increased in real (inflation-adjusted) terms over that period, by an average of 0.08 percent per year. The unavoidable implication of these numbers is that many people who have been able to find jobs during the recovery are earning less and less in real, inflation-adjusted terms, while corporate profits have increased at unprecedented rates.[17] These stagnant weekly earnings resulted in median annual income levels in real 2014 dollars for households declining from 2007-2010 by -6.7 percent. And while median income levels did not decline further from 2010-2014, they only increased by 0.28 percent, i.e., by less than three tenths of a percentage point in real 2014 dollars over the five years. It is worth noting that these trends in real average weekly earnings and real median income are unprecedented in the history of the U.S. economy since the Great Depression ended.

The unprecedented increase in food insecurity during the first year of the Great Recession is apparent in the data on food insecurity levels and prevalence in Exhibit 5, as is the persistence of high prevalence of all levels of severity of household food insecurity throughout the period 2008-2010, as well as 2011-2014. The economic context underlying the dramatic increases in food insecurity prevalence at all levels of severity was characterized primarily by massive increases in job losses and unemployment.* The economic context underlying the persistence of resulting

Exhibit 5 **Numbers and percents of people in the United States living in Food-Insecure households by food security status of the household, 2007-2014.**

Year	Total Number of Individuals Food Insecure (1000s)	Percent of Individuals Food Insecure	Number of Individuals In Households With Low Food Security (1000s)	Percent of Individuals In Households With Low Food Security	Number of Individuals in Households with Very Low Food Security (1000s)	Percent of Individuals in Households with Very Low Food Security
2007	36,229	12.2%	24,287	8.2%	11,942	4.0%
2008	49,108	16.4%	31,824	10.6%	17,284	5.8%
2009	50,162	16.6%	32,499	10.8%	17,663	5.9%
2010	48,832	16.1%	32,777	10.8%	16,055	5.3%
2011	50,120	16.4%	33,232	10.9%	16,888	5.5%
2012	48,966	15.9%	31,787	10.3%	17,179	5.6%
2013	49,078	15.8%	31,974	10.3%	17,104	5.5%
2014	48,135	15.4%	30,922	9.9%	17,213	5.5%

Source: Coleman-Jensen, et al., 2015[2].

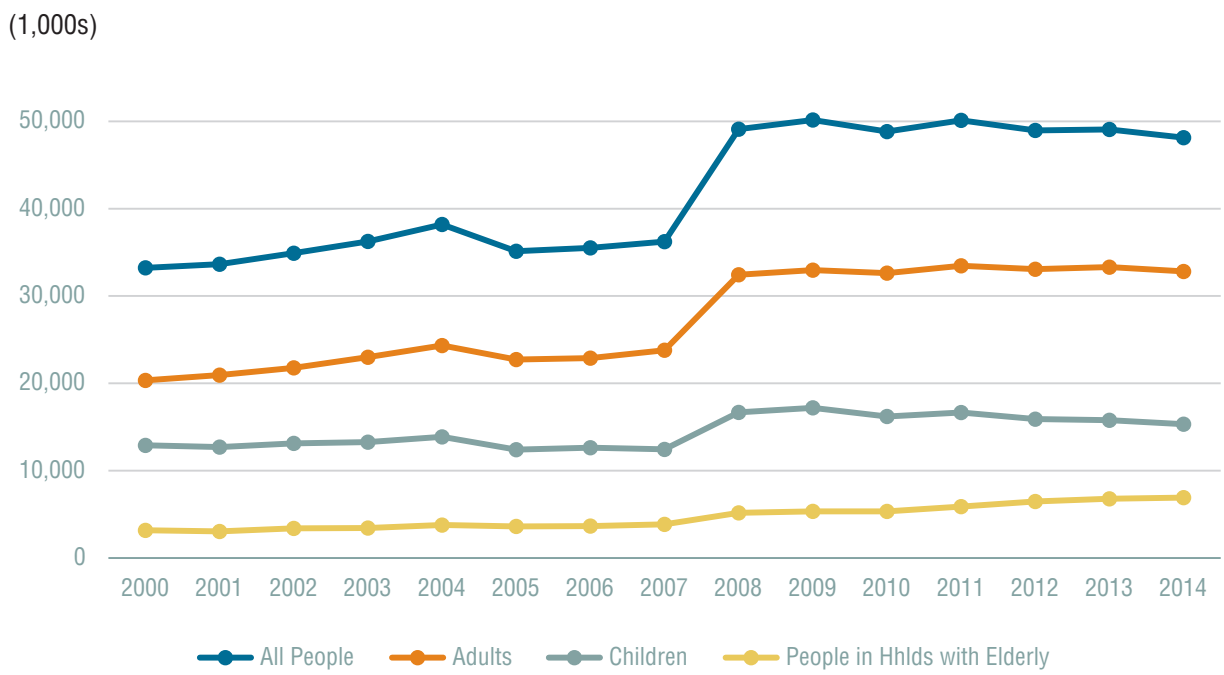
*The bursting of the housing bubble and collapse of the financial institutions whose unfettered speculative gambling with contrived "bundled instruments" of questionable legality was responsible for the subprime mortgage debacle, and ultimately for both the housing bubble and its bursting, led to unprecedented losses of wealth held in the form of owner-occupied residential real estate. That huge loss of wealth together with the large debt loads many homeowners had accumulated through "equity lines of credit" supported by the homes whose mortgages they were no longer able to afford, and the massive devaluation of residential real estate that followed bursting of the bubble, all contributed to the complex, multi-faceted market failures accompanying the financial market collapse. And all these market failures worked to shut down activities that had been employing millions of workers, thus playing a major role in initiation of the Great Recession. While the "too big to fail" banks and other financial institutions who were propped up and bailed out with public revenues quickly recovered and are among the corporations now earning unprecedented profits, the millions of homeowners, and other people who lost their homes, their wealth and their jobs are still struggling to recover. And they are among the millions of Americans still suffering from food insecurity. However, as relevant, interesting and important as this larger story is, its telling is beyond the scope of this project.

high prevalence of food insecurity in the years since the recession ended was one of declining weekly earnings, declining then stagnant real median income levels, major increases in the numbers of people engaging in involuntary part-time work, extraordinary numbers of workers withdrawing from the labor force for economic reasons, mainly because they could not find jobs, and the large increase and persistence of high numbers of long-term unemployed and "discouraged workers" over these two periods. Unfortunately there are few reasons to expect these conditions to change for the better in the near term.

The effects of these labor market dynamics on food insecurity are depicted graphically in Exhibits 6 and 7. While the increase in household food insecurity was rapid and extensive for adults and children, it was less pronounced among people living in households with elderly (Exhibit 6). However, while the number of food insecure adults stabilized at its higher level over the period 2010-2014, and the number of food-insecure children declined slightly from its peak in 2009, the number of food-insecure people in households with elderly continued to increase throughout the period 2010-2013, offsetting the decline in the number of food-insecure children. The net result of these subgroup changes was a fairly stable plateau of the total number of people living in food-insecure households at a level 12-14 million higher than its pre-recession level. Most notably, in spite of the supposed recovery from the recession, and significant declines in the total number of people unemployed over the period 2010-2013, economic conditions persisted that prevented food insecurity from declining.

Though the absolute numbers are comparatively smaller, the number of people living in households with very low food security, or severe food insecurity (previously food insecurity with hunger), increased in a pattern very similar to low food security (Exhibit 6). A notable difference between the trends in low food

Exhibit 6 **Numbers of people in the United States living in food-insecure households by age group, 2000-2014.**



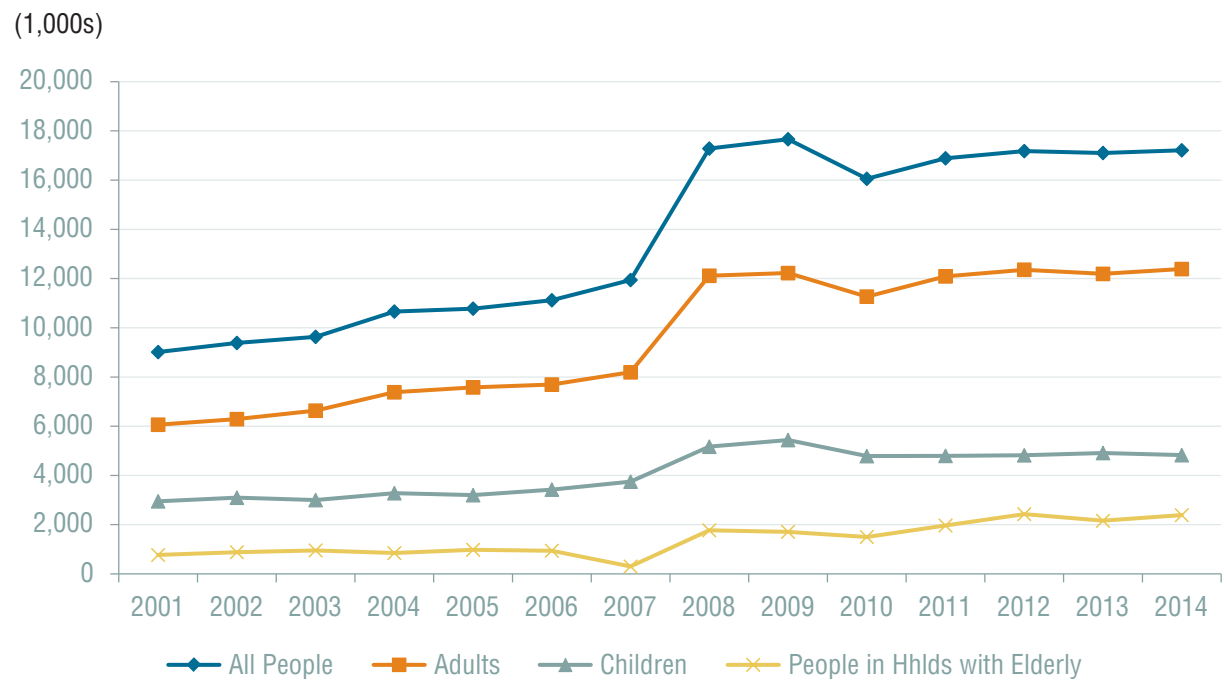
Source: Coleman-Jensen, et al., 2015[2]. (People in households with elderly can be of any age.)

security (Exhibit 6) and those for very low food security (Exhibit 7) is that the prevalence of very low food security had been on an upward trajectory since 2000, especially among adults, but also to a lesser degree among children.

The fall in prevalence of very low food security over 2009-2010 (Exhibit 7) partially reflects the across the board 13 percent increase in SNAP (Supplemental Nutrition Assistance Program) benefits and enhanced eligibility for single adults who had lost jobs, instituted under the American Recovery and Reinvestment Act (ARRA).[18] SNAP is the largest federal food assistance program, and also an entitlement program, making it the most important "counter-cyclical" support program the United States has. Since it is an entitlement, SNAP must be provided to all eligible applicants. Therefore in economic downturns that occur periodically as part of the usual business cycle, when jobs are lost and unemployment increases, more families and individuals become eligible for SNAP, and SNAP enrollment increases. When a recovery gets underway and jobs are created, unemployment falls, and the number of families eligible for SNAP, and SNAP enrollment decline. That makes this food assistance program the only real counter-cyclical program in the United States. Relative to low food security, very low food security appears to have responded more noticeably to the higher SNAP benefit levels.

The persistence of high levels of food insecurity into 2014 is thus largely due to underlying weakness in the recovery from the Great Recession of 2007-2009, especially the extraordinarily slow recovery of jobs in the economy. It is also the result of changes in the structure of labor markets, work, and job stability. Emergence of "contingent labor," companies ability and willingness to rely on contract labor and temporary jobs that do not provide benefits, and to adjust their demand for labor practically in real time by notifying workers on

Exhibit 7 **Numbers of people in the United States living in households with very low food insecurity on the adult or household scale, 2000-2013.**



Source: Coleman-Jensen, et al., 2014[11]. (People in households with elderly can be of any age.)

a daily basis as to whether they are needed, all have made work, earnings, and income less stable. Volatility in earnings for wage workers may be the "new normal," and its effects can be seen in persistent poverty and food insecurity (Exhibit 8).

Effects of efforts to reduce or eliminate SNAP benefits, and other social infrastructure that provide support for U.S. working families are likely reflected in the reductions in both the number of people receiving SNAP and the average SNAP benefits per person from 2013 to 2014 (Exhibit 9). These declines in SNAP benefits and participation are, in turn, likely a factor in the persistence of high food insecurity levels from 2013 to 2014.

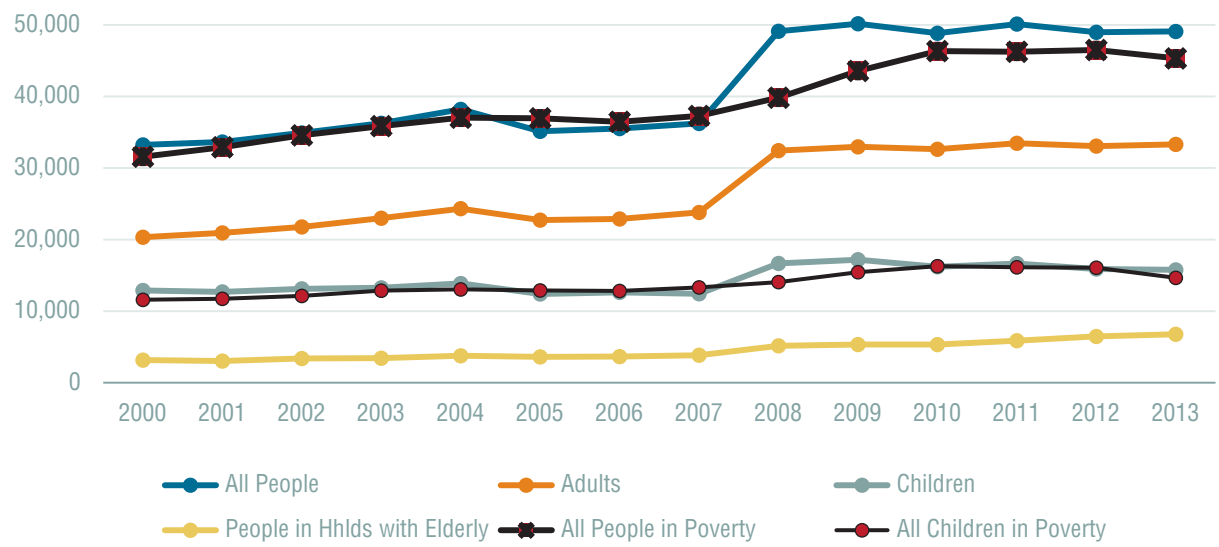
Conclusion

Food insecurity in the US was at an unacceptably high level in 2010, and remained so through 2014. The costs attributable to food insecurity are also unacceptably high. The extraordinarily slow recovery of employment from the Great Recession is a key factor in persistent food insecurity in the United States, however changes in labor market structures and practices also play a role.

The health-related costs associated with food insecurity are clearly high. Though we estimated costs related to several disease conditions that are plausibly attributable to food insecurity, there are others that we did not find sufficient evidence to estimate. What is clear is that the health-related costs of food insecurity and hunger are high, and are likely to increase unless addressed. The Affordable Care Act has provided several windows of opportunity for the healthcare system to engage with and contribute to viable solutions to food insecurity and hunger, and these need to be implemented and supported.

The public and private social infrastructures that have emerged in response to food insecurity and hunger in the United States have very large associated costs, but it is important to acknowledge that both the public and private food assistance systems meet multiple objectives, some of which are not directly related to reducing food insecurity. SNAP is our largest and

Exhibit 8 **Numbers of people in the United States living in food-insecure households by age group, with the numbers of all people and children in households with incomes below poverty, 2000-2013**



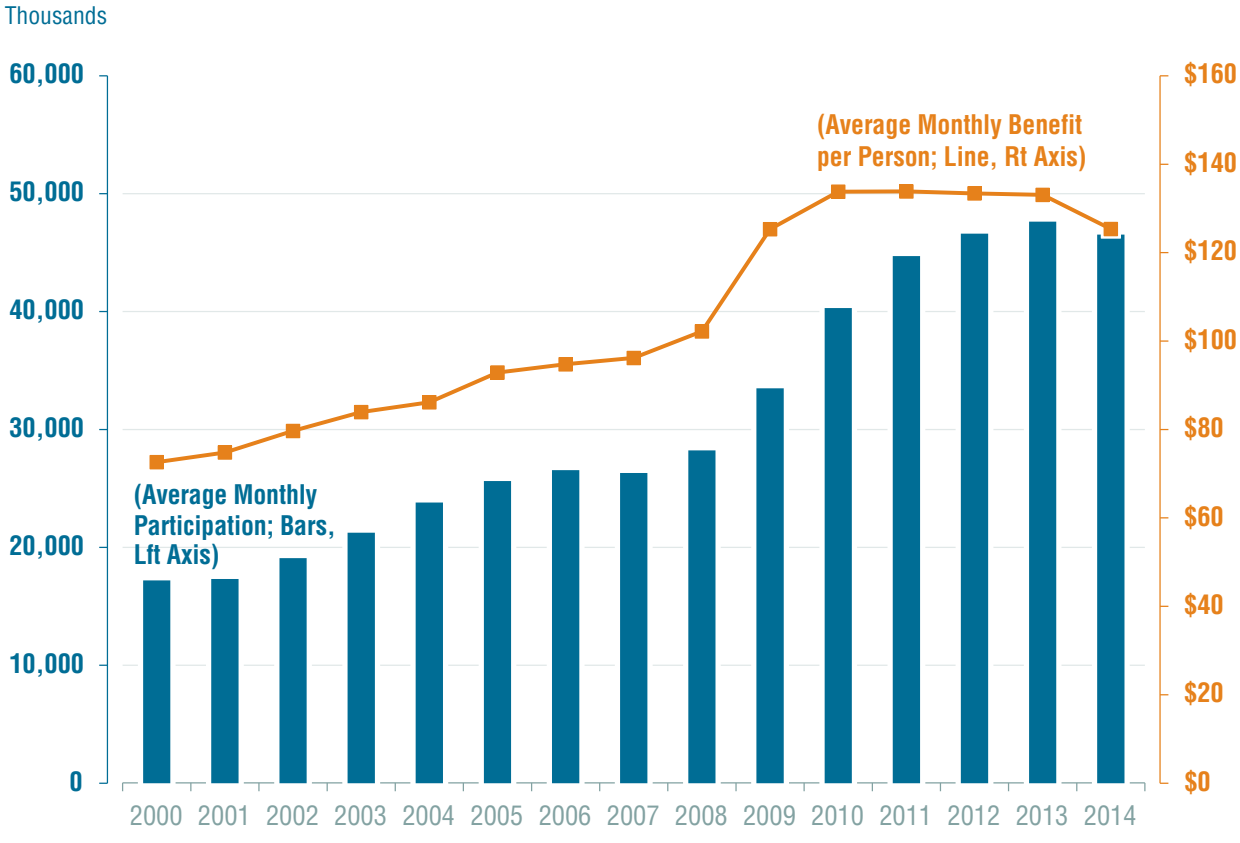
*Though data on poverty in the US in 2014 will be released by the Census Bureau later this month, they are currently only available through 2013.

most effective counter-cyclical program to offset the inevitable downturns in economic activity and availability of jobs that is systemically built into the U.S. economy. WIC provides nutrition education and medical services in addition to food targeted specifically to pregnant and lactating mothers, and infants and children.

In addition to providing much needed food and other services for low-income and food-insecure families and individuals, the private food assistance system also provides opportunities for corporations to remove unprofitable product from their inventories, reduce their tax burdens, and improve public perceptions of their degree of social responsibility. In addition, both the public and private food assistance systems provide much-needed jobs, many of which pay very well.

It is also extremely important to note that the public and private food assistance systems comprise complementary systems for dealing with food insecurity and hunger, with overlap and interaction between the two systems. And it is necessary to state the obvious fact that the two systems combined are still far from adequate solutions to the problems of food insecurity and hunger. Food insecurity and hunger, like poverty, their main proximal cause, are systemic problems that result from numerous market, policy, and leadership failures. And they will not be eliminated until those systemic failures are acknowledged, addressed, and resolved.

Exhibit 9 **Average monthly number of SNAP participants, and average monthly per person benefit level, 2000-2014.**



Source: USDA Food and Nutrition Service; SNAP program data (http://www.fns.usda.gov/pd/supplemental-nutrition-assistance-program-snap)

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Exhibit A1 **Health conditions for which information was available to calculate population attributable fractions indicating the proportion of cases in the population attributable to food insecurity.**

	Relationship	AOR*	RR*	AF*	Source
1)	HFI & Child non-perinatal hospitalization (yes-no):	1.31	1.23	4.55%	Cook, et al., J Nut, 2004[19]
2)	HHLD FI & Caregivers' report of child health status fair/poor:	1.90	1.73	12.47%	Cook, et al., J Nut, 2004[19]
3)	HFI & Caregivers' report of PEDS 1 concerns:	1.76	1.60	10.87%	Rose-Jacobs, et al., Peds, 2008[20]
4)	HHLD FI & Caregivers' report of PEDS 2 concerns:	1.46	1.43	9.09%	Cook, et al., Adv Nut, 2013[21]
5)	CFI & Iron deficiency Anemia:	2.40	2.01	8.25%	Skalicky, et al., J MCH, 2006[22]
6)	HFI & Caregivers' self-reported health status fair/poor:	2.28	1.91	6.81%	Cook, et al., Adv Nut, 2013[21]
7)	HFI & Caregivers' self report of Positive Depressive Symptoms:	3.06	2.28	10.96%	Cook, et al., Adv Nut, 2013[21]
8)	HFI + PDS & Caregivers' report of child health status fair/poor:	2.45	2.12	8.45%	Black, et al., Arch Ped Adoles Med, 2012[23]
9)	HFI + PDS & Child non-perinatal hospitalization (yes-no):	1.35	1.25	2.10%	Black, et al., Arch Ped Adoles Med, 2012[23]
10)	HFI + PDS & Caregivers' report of PEDS 1.	2.49	2.26	9.83%	Black, et al., Arch Ped Adoles Med, 2012[23]
11)	HVLFS % Adults' Depression	3.42	2.97	31.69%	Leung, et al., J Nutr, 2015[24]
12)	FI (based on subset of 4 of the 18 USFSSM questions) & failure of children, 3-5 yrs & 11-17 yrs, to receive recommended well-child visits (postponed recommended care)	1.40	1.09	7.44%	Ma, et al., Ambul Pediatr, 2008[25]
13)	FI (based on subset of 4 of the 18 USFSSM questions) & failure of children, 3-5 yrs & 11-17 yrs, to receive needed health care (foregone needed care)	1.61	1.58	17.66%	Ma, et al., Ambul Pediatr, 2008[25]
14)	FI (based on subset of 4 of the 18 USFSSM questions) & failure of children, 3-5 yrs & 11-17 yrs, to receive prescribed medication (foregone needed care)	2.48	2.42	34.07%	Ma, et al., Ambul Pediatr, 2008[25]
15)	FI and iron deficiency in pregnant women ages 13-54 yrs, based on Ferritin <12 ug/L reported in a 24 hr dietary recall and a 30-day supplement question; NHANES 1999-2010.	2.9	2.05	12.90%	Park; Eicher-Miller J Acad Nutr Diet, 2014[26]
16)	FI, based on 1 ad lib question; "When you were growing up, were there times your family didn't have enough to eat?", and Rheumatoid arthritis (self-reported with any current or past DMARD (disease modifying antirheumatic drugs) use and bilateral swelling, or steroid use and bilateral swelling, in the absence of another autoimmune disease), in women 35-74 yrs old.	1.50	1.49	4.33%	Parks, et al., Ann Rheum Dis, 2013[27]
17)	MFS & LDL cholesterol in males & females 18-50 yrs; NHANES 1999-2002	1.85	1.30	3.68%	Tayie; Zizza Prev Med, 2009[28]
18)	MFS & TRG/HDL ratio in males & females 35-50 yrs; NHANES 1999-2002	1.98	1.33	4.05%	Tayie; Zizza Prev Med, 2009[28]
19)	H LFS & Triglycerides in males & females 35-50 yrs; NHANES 1999-2002	1.91	1.31	3.64%	Tayie; Zizza Prev Med, 2009[28]
20)	H Severe FI (6-10 Adult Scale items affirmed) & Diabetes in Adults ages >20 yrs, NHANES 1999-2002.	2.20	1.89	7.89%	Seligman, et al., J Gen Inter Med, 2007[29]
21)	HFI & poor Diabetes Control in adults ages >21 yrs w DM, from clinics in Boston.	1.97	1.40	5.00%	Berkowitz, et al, Diabetes Care, 2014[30]
22)	FI w/o Hunger (HLFS) & Major Depressive Disorder in Women 20-39 yrs old in a subsample of NHANES 1999-2004 receiving MDD measurement.	2.76	2.43	10.32%	Beydoun; Wang J Affect Disord, 2010[31]

	Relationship	AOR*	RR*	AF*	Source
23)	HFI & Birth Defects (NTD, Orofacial Clefts, Conotruncal Heart Defects) in newborns.	1.41	1.12	1.11%	Carmichael, et al., J Nutr, 2007[32]
24)	HFI, SES, & Dental Caries in Children 5-17 yrs in the NHANES, 2007-2008.	2.51	2.01	15.34%	Chi, et al., Am J Public Health, 2014[33]
25)	VLFS & T2D in Latina Women, 35-60 yrs old	3.33	1.61	7.79%	Fitzgerald, et al., Ethn Dis, 2011[34]
26)	MFS & MDE in Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.40	1.32	5.53%	Whitaker, et al., Pediatrics, 2006[35]
27)	FI & MDE in Mothers age >18 yrs in the Fragile Families data, 1998-2000.	2.20	1.88	9.10%	Whitaker, et al., Pediatrics, 2006[35]
28)	MFS & GAD in Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.70	1.66	11.13%	Whitaker, et al., Pediatrics, 2006[35]
29)	FI & GAD in Mothers age >18 yrs in the Fragile Families data, 1998-2000.	2.30	2.20	13.93%	Whitaker, et al., Pediatrics, 2006[35]
30)	MFS & Either MDE or GAD in Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.40	1.32	5.46%	Whitaker, et al., Pediatrics, 2006[35]
31)	FI & Either DME or GAD in Mothers age >18 yrs in the Fragile Families data, 1998-2000.	2.20	1.86	8.70%	Whitaker, et al., Pediatrics, 2006[35]
32)	MFS & Aggression in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.50	1.45	7.53%	Whitaker, et al., Pediatrics, 2006[35]
33)	FI & Aggression in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.90	1.68	8.11%	Whitaker, et al., Pediatrics, 2006[35]
34)	MFS & Anxiety/Depression in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.80	1.68	10.75%	Whitaker, et al., Pediatrics, 2006[35]
35)	FI & Anxiety/Depression in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	2.20	1.99	10.97%	Whitaker, et al., Pediatrics, 2006[35]
36)	MFS & Inattention/Hyperactivity in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.60	1.53	8.89%	Whitaker, et al., Pediatrics, 2006[35]
37)	FI & Inattention/Hyperactivity in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.90	1.77	9.29%	Whitaker, et al., Pediatrics, 2006[35]
38)	MFS & Any of the Three Behavior Problems in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	1.60	1.45	7.12%	Whitaker, et al., Pediatrics, 2006[35]
39)	FI & Any of the Three Behavior Problems in 3-yr-old Children of Mothers age >18 yrs in the Fragile Families data, 1998-2000.	2.10	1.77	8.01%	Whitaker, et al., Pediatrics, 2006[35]
40)	FI & Poor Glycemic Control in Adult Diabetics in the Immigration, Culture & Healthcare Study, San Francisco, CA, 2008-2009.	1.46	1.27	10.17%	Seligman, et al., J Gen Inter Med, 2007[29]
41)	FI & severe obesity in pregnant women ≤400% poverty level in the Pregnancy, Infection, and Nutrition (PIN) cohort in NC, 2001-2005.	2.97	2.07	7.17%	Laraia, et al, J Am Diet Assoc, 2010[36]
42)	HFI and poor glycemic control among diabetics ≥20 yrs old in the NHANES 1999-2008.	1.53	1.42	4.16%	Berkowitz, et al., Diabetes Care, 2013[37]
43)	HFI and poor LDL control among diabetics ≥20 yrs old in the NHANES 1999-2008.	1.86	1.32	2.37%	Berkowitz, et al., Diabetes Care, 2013[37]

*Abbreviations: AOR=Adjusted Odds Ratio; CFI=Child food insecurity; DMARD=Disease modifying antirheumatic drugs; DM=Diabetes mellitus; FI=Food insecurity; HDL=High-density lipoprotein; GAD=Generalized anxiety disorder; HFI=Household food insecurity; HVLFS=Household very low food security; LDL=Low-density lipoprotein; LFS=Low food security; MDD=Major depressive disorder; MDE=Major depressive episode; MFS=Marginal food security; NHANES=National Health and Nutrition Examination Survey; NTD=Neural tube defects; PAF=Population attributable fraction; PEDS=Parents' evaluation of developmental status; PDS=Positive depression screen; RR=Relative risk; SES=Socio-economic status; T2D=Type two diabetes; TRG=Triglycerides; USFSSM=US Food Security Survey Module; VLFS=Very low food security.

Exhibit A2 **Detailed description of costs attributable to food insecurity by condition**

Sources of Costs, 2014 Report	Costs Based on New Evidence ($Billions 2014 Dollars)	Types of Costs, 2010 Report	Costs From 2010 Report ($Billion 2010 Dollars)	Costs From 2010 Report Inflated to 2014 Dollars (% Change in CPI-U for medical care, 1010-2014=9.674%)	TOTAL
Cost of additional non-neonatal hospital stays among children ages <18 years	$1.82	Hospitalizations	$16.10	$17.66	(Estimate based on new evidence was used)
Cost of additional hospital stays among adults ages 18+ years	$8.19				
Cost of additional ambulatory visits among people all ages	$1.51				
		Migraine	$2.20	$2.41	
Cost of additional dental care visits among people all ages	$0.79				
		Colds	$0.80	$0.88	
Cost or treatment of mental health problems in children ages <18 years	$1.22				
		Depression	$29.20	$32.03	
Cost of treatment of mental health problems in adults ages 18-64 years	$4.75				
		Anxiety	$17.40	$19.08	
Cost of treatment of anemias and other deficiencies in people all ages	$0.85	Iron Deficiency	$0.50	$0.55	(Estimate based on new evidence was used)
		Suicide	$19.70	$21.61	
Treatment of osteoarthritis and other inflammation in joints among adults	$3.37				
		Upper GI Disorders	$5.70	$6.25	
Treatment of diabetes mellitus in people all ages	$4.90				
		Health Status	$38.90	$42.66	
Treatment of hyperlipidemia	$1.41				
Treatment of endocrine system problems related to poor control of diabetes mellitus	$0.81				
Treatment of congenital defects and complications of pregnancy and birth	$0.06				
Indirect costs of lost work time due to workers' illnesses or workers providing care for sick family members	$5.48				
TOTAL health costs	$35.16			$124.92	$160.07
Expenditures for special education in public primary and secondary education	$5.91	Special Education	$6.40	$7.02	(Estimate based on new evidence was used)
		Dropout due to Retention	$6.00	$6.58	
		Dropout due to Absenteeism	$5.80	$6.36	
TOTAL education & food assistance	$5.91			$12.94	$18.85
TOTAL health, education & food assistance					**$178.92**