AN AVOIDABLE $2.4 BILLION COST

The Estimated Health-Related Costs of Food Insecurity and Hunger in Massachusetts

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The Greater Boston Food Bank

CHILDREN'S HealthWatch

The Greater Boston FOOD BANK®
Feeding Eastern Massachusetts

Hunger is a health issue.

This report communicates direct and indirect health-related expenditures attributable to food insecurity and hunger in the state of Massachusetts in 2016. It also includes special educational costs associated with food insecurity. In this report we use the most up-to-date information available on costs of treating health conditions in Massachusetts, and the most recently available research findings on food insecurity and its relationships to adverse health conditions from peer-reviewed journal articles and reports.

SUMMARY OF FINDINGS

Each September, the U.S. Department of Agriculture (USDA) Economic Research Service 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 U.S. Food Security Survey Module (USFSSM) in its Current Population Survey (CPS), an ongoing nationally representative survey of the U.S. population. In 2016, there were 41,204,000 people in the U.S. (12.9 percent of the total population) living in households that were food insecure at some level of severity. The number of food-insecure people in the U.S. in 2016 was 5.7 percent higher than in 2007, the year the Great Recession began, and even though it decreased 19.9 percent since 2010, the prevalence of food insecurity remained higher in 2016 than the pre-recession percentages (Exhibit 1).

EXHIBIT 1. Number and percent of people living in food-insecure households in the U.S., 2007-2016

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%
2015	42,238	13.4%
2016	**41,204**	**12.9%**

Source: Coleman-Jensen, et al., 2017.

According to USDA'S three-year average estimates from the CPS data, the average prevalence of household food insecurity, at any level of severity, in the state of Massachusetts between the years of 2014 and 2016 was 10.3 percent. This represents an increase of 2.3 percentage points above the prevalence in the pre-recession period of 2005/2007, and a decrease of -1.6 percentage points from its peak of 11.9 percent in the immediate post-recession period of 2009/2011 (Exhibit 2).

The cost estimates in this report are based on results from empirical food security research literature published in peer-reviewed academic journals and reports between 2003 and 2017, and relationships between food insecurity and adverse health conditions identifiable in that literature. Using quantitative information from the research literature reviewed, we estimated Population Attributable Fractions (AFs) representing the proportions of people in Massachusetts treated for several of the most common health conditions attributable to food insecurity.

Applying those estimated AFs to the numbers of people treated for each condition, we estimated the numbers of people for whom the presence of the condition or disease could be attributable to food insecurity. Using the best information available on expenditures per person with an expense for treatment of each health condition/disease, we then estimated the total health-related expenditures, or costs, for treatment of each condition, attributable to food insecurity. In aggregate, we estimated health-related costs attributable to food insecurity in the state of Massachusetts of more than **$2.4 billion in 2016** (Exhibit 3).

EXHIBIT 2. Trends in Prevalence of Food Insecurity in Massachusetts, 2005-2016

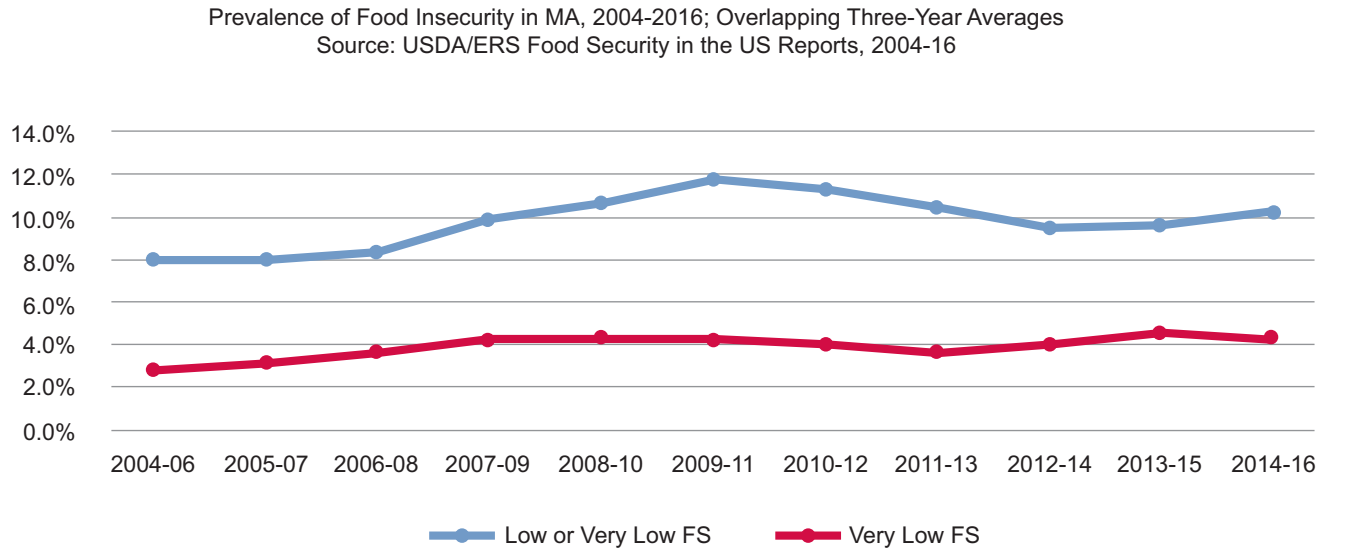
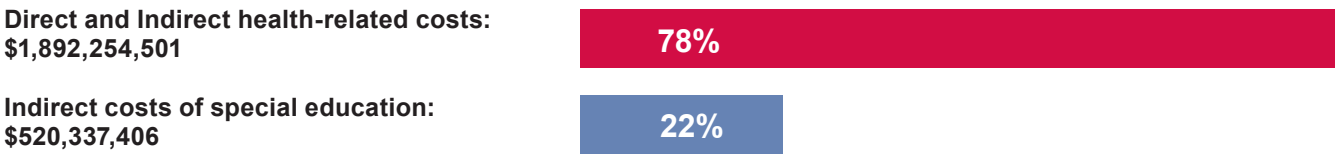


EXHIBIT 3. Health and Education-related Costs of Food Insecurity in Massachusetts, 2016



WHAT ARE THE HEALTHCARE COSTS?

There are several ways of defining and considering healthcare costs. Perhaps the one we hear about most is through the lens of payers. In the U.S., the main payers include:

- Medicare, Medicaid, and Child Health Insurance Program (CHIP), referred to as "public health insurance": overseen and managed by the Centers for Medicare & Medicaid Services (CMS)
- Veterans Administration (VA): serves many but not all veterans; may involve some other providers and third-party payers
- State health insurance programs: Section 1115 Waivers, accountable care organization (ACOs), and others; these usually involve some federal funding
- Private insurance companies: usually, though not always, obtained through an employer with employers and employees sharing policy costs; based on minimizing risks and maximizing revenue and profits
- Out-of-pocket payments by patients and their families: can include co-payments, deductibles, payment for uncovered conditions or services and expenditures exceeding annual maximum totals.

Another perspective from which to view healthcare costs is that of healthcare providers. The main providers include:

- Individual clinicians
- Practices, physician groups, doctors' and dentists' offices, and home health providers
- Health clinics and neighborhood health centers
- Residential care facilities: nursing homes, assisted-living facilities, hospice and others
- Individual hospitals: these can include community, not-for-profit, private-for-profit, teaching, state or VA hospitals; all employ a range of individual providers, and some own or are part of health networks or systems
- Healthcare networks or systems: may involve multiple hospitals, offices, clinics, labs, health centers, etc., and operate in parts or all of more than one state.

Costs, charges and expenditures also can be viewed from the perspective of the services provided/received, such as:

- Hospital inpatient services and specialty clinics
- Ambulatory services: doctor's office visits, hospital outpatient visits, emergency department visits, dentist office visits, prescription medication
- Home health services
- Residential treatment facilities and services

And finally, costs must ultimately also be considered from the perspective of the covered entity. This is usually an individual or family, and includes patients and their families/households; costs include insurance premiums and out-of-pocket expenditures.

As described herein, we obtained data on healthcare expenses or expenditures from several sources. Those include the Medical Expenditure Panel Survey (MEPS), the Healthcare Cost and Utilization Project (HCUP) and some secondary sources such as peer-reviewed journal articles and reports.

MEPS is a set of large-scale surveys of families and individuals, their medical providers and employers across the United States and is the most complete source of data on the cost and use of healthcare and health insurance coverage in the U.S. MEPS collects data on the specific health services that Americans use, how frequently they use them, the cost of these services, and how they are paid for, as well as data on the cost, scope and breadth of health insurance held by U.S. workers and families. MEPS data are well-suited for estimating health-related costs attributable to food insecurity in Massachusetts.[2] In MEPS, mean and median expenses per person with an expense are provided for treatment of a large number of health conditions and diseases by socio-demographic characteristics. MEPS expenses or expenditures refer to::

payments for medical events (office and hospital-based care, home healthcare, prescribed medicines, dental services, and other medical equipment and services reported during the calendar year). More specifically, expenditures in MEPS are defined as the sum of direct payments for care provided during the year, including out-of-pocket payments and payments by private insurance, Medicaid, Medicare, and other sources. Payments for over-the-counter drugs and phone contacts with medical providers are not included in MEPS total expenditure estimates. Indirect payments not related to specific medical events, such as Medicaid Disproportionate Share and Medicare Direct Medical Education subsidies, also are not included. Any charges associated with uncollected liability, bad debt, and charitable care (unless provided by a public clinic or hospital) are not counted as expenditures.[3]

Our main source for data on costs of inpatient hospital stays in Massachusetts was HCUP, a family of healthcare databases and related software tools and products developed through a federal-state-industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP databases bring together the data collection efforts of state data organizations, hospital associations, private data organizations, and the federal government to create a national information resource of encounter-level healthcare data. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. These databases enable research on a broad range of health policy issues, including cost and quality of health services, medical practice patterns, access to healthcare programs, and outcomes of treatments at the national, state, and local market levels.[4] Data on Massachusetts inpatient hospital stays are provided to HCUP annually by the Massachusetts Center for Health Information and Analysis (CHIA). The most recent data available for Massachusetts is for 2014. HCUP defines costs as follows:

Costs tend to reflect the actual costs of production, whereas charges represent what the hospital billed for the stay. Total charges were converted to costs using cost-to-charge ratios[a] *based on hospital accounting reports from the Centers for Medicare and Medicaid Services (CMS). In general, costs are less than charges. For each hospital, a hospital-wide cost-to-charge ratio is used because detailed charges are not available across all HCUP States.*[5]

For this study, we used weighted average costs per stay adjusted for age groups (<18 years and 18+ years) as defined by HCUP for all inpatient hospital costs. For costs of treating specific diseases or conditions, we used mean expenses per person with an expense for treatment of the diseases or conditions, as defined by MEPS. In a few cases we used costs from peer-reviewed journal articles based on MEPS data. All costs were inflated to 2016 dollars using appropriate price inflators.

[a]According to recent data from CMS, the average operating cost-to-charge ratio for all hospitals in Massachusetts for FY2017 is 0.464. Cost-to-charge-ratios in each state vary by hospital type, and rural versus urban location.

Methods

To estimate the direct health-related costs attributable to food insecurity in 2016, we reviewed empirical research literature published in peer-reviewed journals and reports from 2003 to 2017, 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 risks 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 or predictor, 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 below, this process requires the assumption that food insecurity is causally related to the disease/conditions examined.

The majority of studies included in this report estimated their associations in Odds Ratios (OR), adjusted for potential confounding factors instead of Relative Risks (RR). Because the formula used in this report uses RR instead of OR (Formula 1)[6], we utilized Formula 2 to translate OR into RR.

This epidemiologic approach implicitly assumes that food insecurity is causally related to the health conditions whose costs are estimated herein. Food insecurity does not have to be the only cause, or even a major cause, but it does have to have some causal relationship to the disease or condition. Conclusive, unassailable evidence that food insecurity causes, even partially, the multitude of illnesses and adverse health conditions that a very large body of research literature 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 at least partially causal are so grave that we believe we are justified in acting on strong evidence even if it is not absolutely conclusive and unassailable.[8] Consequently, we are comfortable assuming that food insecurity is causally related to the health conditions whose costs are assessed in this study.

FORMULA 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 calculated according to Formula 2, and Pe is the proportion of controls (those who do not have the outcome – condition/disease) who were exposed (live in a food-insecure household).

Odds ratios (ORs) can be transformed into relative risks using Formula 2[7] below:

FORMULA 2:

Relative risk (RR) = OR/[(1-Po)+(Po*OR)], OR is the odds ratio, and Po is the proportion of the unexposed (food secure) who develop the outcome (disease/condition), or become cases.

A complete table of all 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.

For some 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 instances, we were unable to estimate the disease burden or the costs. It is worth noting that those costs we were unable to determine are real costs to the state and a real burden to the population. This was particularly true when the condition was failure to receive or adhere to recommended or prescribed treatment, or treatment foregone due to inability to pay as a result of food insecurity. In addition, there are associations of food insecurity and diseases or disease conditions that have not been studied yet, therefore we were unable to produce estimates of their costs.

For a couple of conditions (e.g., Parents' Evaluation of Developmental Status (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 Massachusetts prevalence data, we relied on data from the U.S. Census Bureau on relationships between reported health status and health services utilization.[9]

COSTS RELATED TO FAIR/POOR HEALTH STATUS ATTRIBUTABLE TO FOOD INSECURITY

Respondent-reported health status, based on responses to a standard, validated health status question used in a number of different national surveys, is closely related to medical care and health services utilization. Respondents indicate whether they consider their, or their child's, health to be "excellent, very good, good, fair, or poor." The U.S. Census Bureau publishes periodic reports based on data from the Survey of Income and Program Participation (SIPP), an ongoing nationally representative longitudinal survey of the noninstitutionalized U.S. population, which asks the health status question along with questions about medical expenses and utilization of healthcare services. We used data from the most recent Census Bureau tabulations of SIPP data on this topic to estimate excess costs of healthcare services used by adults (ages 18 years and above) and children (ages 0-17 years) in Massachusetts with reported "fair or poor" health status attributable to food insecurity.

Empirical research results from several peer-reviewed journal articles show that food insecurity is strongly tied to reports of "fair/poor" health status (compared to excellent, very good, or good health status). We estimated attributable fractions, or proportions, of the adults and children in Massachusetts with health status reported as "fair/poor" in the state's administration of the CDC's Behavior Risk Factor Surveillance System, attributable to food insecurity. We then applied those estimates to numbers from the Census Bureau's tabulations of SIPP data on health services utilization, and data on mean per person expenditures on various healthcare services, adjusted by age and health status, from MEPS, to estimate excess expenditures on three types of ambulatory health services in Massachusetts; office-based medical provider visits, hospital outpatient visits and emergency department visits.

We also used data from these sources to estimate excess expenditures for dental care visits and prescription medications in the state of Massachusetts, as well as excess expenditures for hospital inpatient stays among adults, attributable to food insecurity. Since the most recent Massachusetts data available from both HCUP and MEPS are for 2014, we used the Personal Healthcare Index (PHCI) recommended by AHRQ for expenditures on each service from MEPS data to inflate or project their value to 2016 dollars.[10]

COSTS RELATED TO INPATIENT HOSPITAL STAYS BY CHILDREN ATTRIBUTABLE TO FOOD INSECURITY

Food insecurity has been shown by research conducted by Children's HealthWatch and other researchers to be related to higher likelihood of experiencing illnesses severe enough to require inpatient hospital stays. Using results from that research, we estimated the attributable fraction, or proportion, of hospital stays by children in Massachusetts in 2014 attributable to food insecurity. We obtained data on the number of non-neonatal, non-pregnancy-related, inpatient hospital stays by children ages <18 years in Massachusetts from the AHRQ's HCUP state database. The most recent Massachusetts HCUP data are for 2014, but they include mean cost per stay by patient age and gender, as well as length of stay and other information.

We applied the estimated attributable fraction or proportion of hospital stays attributable to food insecurity in children to the HCUP data on number of hospital stays by children in Massachusetts, and their mean costs per stay by age group, to estimate the excess expenditures for inpatient hospital stays among children attributable to food insecurity in Massachusetts in 2014. We then used the PHCI for hospital care to project or inflate the estimated costs in 2014 dollars to 2016 dollars.

COSTS RELATED TO TREATMENT OF DEPRESSION IN ADULTS ATTRIBUTABLE TO FOOD INSECURITY

Depression is among the most prominent and costly mental health problems related to food insecurity in adults. It seems likely that there is dual causality involved in their relationship, with food insecurity increasing the likelihood of depression, and depression increasing the likelihood of food insecurity. In all the studies we reviewed that reported strong quantitative results on their relationship, depression was treated as an outcome and food insecurity as a predictor or exposure variable. We followed that pattern in our estimation of an attributable fraction, calculating the proportion of adults treated for depression in Massachusetts attributable to food insecurity.

In 2014, nearly 50 million Americans had expenditures for some kind of healthcare services for treatment of mental health problems, a number exceeded only by the number with expenditures for treatment of hypertension (62 million).[11] In 2009, 17.6 million adults had expenditures for treatment of depression in the U.S., spending nearly $23 billion ($26.4 billion in 2016 dollars), primarily on ambulatory care and prescription medication.[12]

In 2015, according to data from the CDC's Behavior Risk Factor Surveillance System (BRFSS), an estimated 1,110,821 adults were diagnosed with depression at various levels of severity in Massachusetts. We obtained data on the number of inpatient hospital stays by adults with depression as the primary diagnosis for the stay from HCUP data for Massachusetts in 2014. We also obtained data from MEPS on the distribution of expenditures for treatment of depression in adults by type of service (hospital inpatient, emergency room visits, other ambulatory visits, prescription medication, and home healthcare). Using these data, we estimated the total cost of each type of treatment for depression in Massachusetts adults, inflating the amounts to 2016 dollars using the appropriate PHCI recommended by AHRQ.

COST OF LOST WORK TIME AND PRODUCTIVITY AMONG EMPLOYED ADULTS DUE TO DEPRESSION ATTRIBUTABLE TO FOOD INSECURITY

Several studies have estimated the per capita and aggregate costs of lost work time and lost productivity due to various types of illness. We used data from a study published in JAMA[13] estimating the cost of work and productivity loss due to depression, together with 2015 BRFSS data on the number of adults diagnosed with depression in Massachusetts, and our estimated attributable fraction for proportion of people diagnosed with depression in Massachusetts attributable to food insecurity. We obtained data from the National Bureau of Labor Statistics (BLS) on labor force participation and employment rates in Massachusetts in 2016 to estimate the total costs of lost work time and productivity in Massachusetts in 2016, adjusted to 2016 dollars using the Employment Cost Index.

COST OF TREATMENT OF ARTHRITIS, RHEUMATOID ARTHRITIS, GOUT, LUPUS OR FIBROMYALGIA IN ADULTS ATTRIBUTABLE TO FOOD INSECURITY

We used data from a study on the relationship of food insecurity to arthritis, rheumatoid arthritis, gout, lupus or fibromyalgia to estimate an attributable fraction of the proportion of cases of these conditions in Massachusetts attributable to food insecurity. We obtained data on the number of adults diagnosed with these conditions from the CDC's BRFSS for Massachusetts in 2015, and data on mean expenditures for treatment of the conditions from MEPS. Using data from these sources, we estimated the total costs of treating the conditions in Massachusetts in 2015, and inflated the costs to 2016 dollars using the overall PHCI recommended by AHRQ.

COST OF TREATMENT OF IRON-DEFICIENCY ANEMIA IN CHILDREN ATTRIBUTABLE TO FOOD INSECURITY

Anemia is the most common disease in children. The combination of two laboratory results to combine iron deficiency and anemia make iron-deficiency anemia (IDA) a less prevalent disease in children than iron deficiency alone, but also more severe. Previously, Massachusetts reported anemia prevalence through the Pediatric Nutrition Surveillance System (PedNSS), however that survey was ended. The National Health and Nutrition Examination Survey (NHANES) reports prevalence of IDA, therefore we used national estimates from NHANES to compose this cost since our attributable fraction refers to an association between food insecurity and IDA. Also, we used data on mean expenditures for treatment of anemia and other deficiencies from MEPS, and inflated the costs to 2016 dollars using the overall PHCI recommended by AHRQ for prescription drugs.

COST OF TREATMENT OF DIABETES IN ADULTS ATTRIBUTABLE TO FOOD INSECURITY

BRFSS reports prevalence of diabetic adults for Massachusetts. Diabetes type 2 accounts for 90-95 percent of all diagnosed diabetes cases in the U.S. and our cost estimate reflects only this specific type of the disease. A well-conducted study by the American Diabetes Association[14] on per capita cost of diabetes in the U.S. and some states, including Massachusetts, reported direct and indirect costs of the disease. Direct costs were comprised by hospital inpatient, nursing home, physician office visits, emergency department visits, ambulance services, hospital outpatient visits, home health, hospice, podiatry, insulin, diabetic supplies, other anti-diabetic agents, prescription medication and other equipment and supplies. Indirect cost included absenteeism, presenteeism, reduced productivity for those not in labor force, unemployment for disability and premature mortality. Total cost was inflated to 2016 dollars using the BLS' Consumer Price Index for all Urban Consumers (CPI-U) not seasonally-adjusted for medical care services.

COST OF TREATMENT OF OBESITY IN ADULT WOMEN ATTRIBUTABLE TO FOOD INSECURITY

Obesity, defined as Body Mass Index (BMI) equal to or above 30 kg/m^2 by the World Health Organization, is a multifactorial disease. Although multiple studies refer to a link between obesity and food insecurity, it has been significantly associated only among adult women. BRFSS reports prevalence of BMI categories by gender for Massachusetts, and two different national reports[15,16] determined the economic cost per capita of obesity, including direct total expenditures, and indirect total absenteeism and lost of productivity due to early death. Total cost was inflated to 2016 dollars using CPI-U not seasonally-adjusted for medical care services.

COST OF TREATMENT OF ASTHMA IN ADULTS AND CHILDREN ATTRIBUTABLE TO FOOD INSECURITY

BRFSS reports two categories of asthma for adults and children; they are "ever had asthma" and "currently have asthma". Although the prevalence of "currently have asthma" is smaller than the "ever had asthma" category, we decided to use the former to cost asthma in Massachusetts reflecting the current circumstances the person is under at the time of interview. Adult cost[17] took into consideration prescription medication, office-based visits, emergency department visits, outpatient visits and inpatient visits. Also, indirect costs included days of work lost per year. Children's[17] direct costs included the same categories as adults, and indirect costs of lost days of school per year due to asthma. Total cost was inflated to 2016 dollars using CPI-U not seasonally-adjusted for medical care services.

COST OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN ADULTS ATTRIBUTABLE TO FOOD INSECURITY

Chronic obstructive pulmonary disease (COPD) is a combination of two diseases, both of which are associated with food insecurity; emphysema and chronic bronchitis. Although we could not find an attributable fraction for COPD and food insecurity, we had an AF from two studies separately and were able to calculate a mean AF for this category. Using a report[18] on direct cost of COPD that included physician office visits, hospitalizations, home care and prescription medications, and indirect costs stemming from disabling effects of COPD, which are most commonly exhibited as days off from work per year, we calculated 2016 costs of COPD in Massachusetts. Total cost was inflated to 2016 dollars using CPI-U not seasonally-adjusted for medical care services.

COST OF SPECIAL EDUCATION IN CHILDREN ATTRIBUTABLE TO FOOD INSECURITY

The National Survey of Children's Health reports Massachusetts prevalence of children's physical, behavioral or social development concerns using the Parents' Evaluation of Developmental Status screening test (PEDS). To report cost on special education given the report of one or more PEDS concerns we had to include an additional pathway to the chain of logic that included the positive predictive value of the indicator (PEDS) in reference to the outcome (special education). Combining these measures enabled us to estimate the number of diagnosed children that seek and receive special education in Massachusetts, attributable to food insecurity. The number of children in special education in 2015 accounted for 21.1 percent of the total cost of education in the state, according to the Massachusetts Department of Elementary and Secondary Education.

OVERLAPPING COSTS OF DISEASES AND CONDITIONS

Depression, arthritis, rheumatoid arthritis, gout, lupus or fibromyalgia, asthma, diabetes, obesity, and COPD are diseases/conditions that could lead to reports of "fair/poor" health status. Consequently, part of the costs estimated for these conditions could overlap with those attributed to excess health services utilization on the basis of prevalence of "fair/poor" health status, compared to "excellent, very good or good", by age. In order to avoid duplication or double-counting costs of services used for treatment of these diseases/conditions, such as hospitalizations, ambulatory visits and prescription medication, we adjusted their prevalence by the proportions of people both having the diseases/conditions and reporting their health status as "fair/poor" using Massachusetts BRFSS data.

A CONSERVATIVE PARTIAL ESTIMATE

It is important to note that these costs do not represent all health-related costs attributable to food insecurity in Massachusetts in 2016, but are a conservative partial estimate. Total health-related costs attributable to food insecurity are far greater than $2.4 billion. Our cost estimates reflect expenditures by payers for treatment of some, but not nearly all, health conditions found to be connected to food insecurity in the research literature. However, for many health conditions, insufficient data were available at the state level to estimate the number of people treated or the amount of expenditures for treatment. Moreover, for several health conditions known to be influenced by food insecurity, all data needed to estimate attributable fractions were not available in the literature. And finally, these estimates only include personal healthcare expenditures. They do not include costs of administration of the state healthcare system, the costs of maintaining the many medical teaching facilities in the state, or the total costs healthcare providers themselves consider they incur for providing the treatment received, especially the state's private nonprofit and teaching hospitals. Moreover, the cost estimates presented here do not include the costs of quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs) lost by patients whose health-related quality of life was adversely impacted by food insecurity or hunger. Estimating those costs, which are undoubtedly large, was beyond the scope of this study. Future research on health-related costs attributable to food insecurity in Massachusetts will hopefully also include examination of those costs.

Policy Recommendations

Given the data demonstrating the impact of food insecurity on health and the associated healthcare costs, we must take concrete steps to reduce food insecurity in Massachusetts. The Greater Boston Food Bank and Children's HealthWatch have determined the following recommendations critical to reducing food insecurity, improving the health of food-insecure Massachusetts residents, and reducing healthcare costs for individuals, families and the Commonwealth. Circumstances and timing within the federal and state legislative calendars may alter the order of these recommendations.

HEALTHCARE SECTOR

Screen and intervene to address food insecurity in clinical settings. Healthcare providers should screen patients for food insecurity as part of the routine clinical visit. Patients who screen positive should be referred to resources that increase their access to healthy food, including government nutrition assistance programs, area food pantries and meal programs, and related services. In order to accurately measure prevalence rates of patients screening positive for food insecurity, identify areas of high need, and track utilization patterns and outcomes across the Commonwealth, providers should adopt a universal screening tool. The Greater Boston Food Bank and Children's HealthWatch recommend universal adoption of The Hunger Vital Sign™, a validated, simple and efficient, two-question screening tool.

Reimburse providers for screening and intervention. Insurers should reimburse healthcare providers for Hunger Vital Sign™ screening and for intervention programs that improve access to healthy foods. In addition, accountable care organizations should include such programs in their package of reimbursable flexible services.

PUBLIC SECTOR

Federal

Maintain current funding and structure of the Supplemental Nutrition Assistance Program. The Supplemental Nutrition Assistance Program (SNAP) is our nation's first line of defense in reducing food insecurity and is associated with reduced healthcare spending among low-income adults, according to a 2017 study.[19] Any benefit cuts, eligibility changes, work requirements or time limits would reduce the number of people who depend on this vital program, including seniors, people with disabilities, children and low-income families, and put them at higher risk for food-insecurity-related diseases and conditions. Further, SNAP's current structure enables this vital federal nutrition program to respond rapidly to economic downturns and natural and man-made disasters. Changing the structure of SNAP, as has been proposed, would eliminate its flexibility during times of need, increase costs to the states, and result in greater food insecurity.

PUBLIC SECTOR

State

Increase Massachusetts Emergency Food Assistance Program (MEFAP) funding to $20 million annually to ensure the Commonwealth's four food banks can purchase a consistent supply of healthy foods.

Create a common application for MassHealth and SNAP to ensure low-income individuals and families applying for health insurance also have access to food assistance. Research has shown increased access to SNAP reduces MassHealth costs.[20]

Mandate high-poverty schools serve breakfast after the bell to increase participation in the federal School Breakfast program. A recent case study indicates increased access to breakfast reduces school nurse visits.[21]

Improve access to federal child nutrition assistance programs administered by the state, including the Child and Adult Care Food Program and the Summer Food Service Program to address nutritional needs of children in child care and in after-school and summer programs.

Increase funding for the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) in the state budget to ensure high-quality services for eligible children and mothers and increase retention of participants in the program.

Conclusion

FURTHER RESEARCH

Several gaps in food insecurity research were identified in the report as high priorities for future investigation. Among these gaps are:

High and rising-risk populations: Below are key groups of people for whom the existing research is insufficient and who are at great and increasing health risk.

> Families with children with special healthcare needs

> Veteran and active duty military families

> People with substance use disorders and their families

Intervention studies: We need to know who is at risk for food insecurity, what kinds of risks they face, and which infrastructures will make a difference in addressing food insecurity, such as:

> Test interventions, such as referrals and follow-up procedures involving both private and public food assistance systems, after screening for food insecurity.

Health outcomes and hardships: The following health outcomes and hardships are critically important to reducing health costs and population burden of poor health.

> Stress/depression among children younger than 18 years

> Obesity among children younger than 18 years

> Healthcare cost sacrifices (paying for needed healthcare and thus struggling to pay for other basic needs)

The findings in this research indicate that food insecurity costs Massachusetts at least $2.4 billion dollars per year. Fortifying current nutrition assistance programs and identifying new policy solutions to minimize food insecurity will lead to healthcare and special education cost savings. These cost savings will be reflected in the health of the population and the economy. If we make a commitment to improving food security across our Commonwealth, and follow through with sustained actions, children and their families will become healthier and perform better at school and in their workplace, seniors will be able to remain at home and maintain their well-being, the economy will experience an increase in productivity, and healthcare costs will decrease substantially. However, with one out of 10 households in Massachusetts still facing food insecurity nine years after the Great Recession, achieving this requires immediate action.

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APPENDIX

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[22]
2	HFI & Caregivers' report of child health status fair/poor	1.90	1.73	12.47%	Cook, et al., J Nut, 2004[22]
3	HFI & Caregivers' report of PEDS 1+ concerns	1.59	1.53	12.43%	Cook, et al., Adv Nut, 2013[23]
4	HFI & Caregivers' self-reported health status fair/poor	2.28	1.91	6.81%	Cook, et al., Adv Nut, 2013[23]
5	HFI & Caregivers' self-report of Positive Depressive Symptoms	3.06	2.28	10.96%	Cook, et al., Adv Nut, 2013[23]
6	CFI & Iron deficiency Anemia:	2.40	2.01	8.25%	Skalicky, et al., J MCH, 2006[24]
7	HFI + PDS & Caregivers' report of child health status fair/poor	2.45	2.12	8.45%	Black, et al., Arch Ped Adoles Med, 2012[25]
8	HFI + PDS & Child non-perinatal hospitalization (yes-no)	1.35	1.25	2.10%	Black, et al., Arch Ped Adoles Med, 2012[25]
9	HFI + PDS & Caregivers' report of PEDS 1	2.49	2.26	9.83%	Black, et al., Arch Ped Adoles Med, 2012[25]
10	HVLFS % Adults' Depression	3.42	2.97	31.69%	Leung, et al., J Nutr, 2015[26]
11	FI (based on subset of 4 of the 18 USFSSM questions) & failure of children, 3-5 years & 11-17 years, to receive recommended well-child visits (postponed recommended care)	1.40	1.09	7.44%	Ma, et al., Ambul Pediatr, 2008[27]
12	FI (based on subset of 4 of the 18 USFSSM questions) & failure of children, 3-5 years & 11-17 years, to receive needed health care (foregone needed care)	1.61	1.58	17.66%	Ma, et al., Ambul Pediatr, 2008[27]
13	FI (based on subset of 4 of the 18 USFSSM questions) & failure of children, 3-5 years & 11-17 years, to receive prescribed medication (foregone needed care)	2.48	2.42	34.07%	Ma, et al., Ambul Pediatr, 2008[27]
14	FI and iron deficiency in pregnant women ages 13-54 years, based on Ferritin <12 ug/L reported in a 24-hour 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[28]

	RELATIONSHIP	AOR*	RR*	AF*	SOURCE
15	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 use and bilateral swelling, or steroid use and bilateral swelling, in the absence of another autoimmune disease), in women 35-74 years old	1.50	1.49	4.33%	Parks, et al., Ann Rheum Dis, 2013[29]
16	MFS & LDL cholesterol in adults 18-50 years; NHANES 1999-2002	1.85	1.30	3.68%	Tayie; Zizza Prev Med, 2009[30]
17	MFS & TRG/HDL ratio in adults 35-50 years; NHANES 1999-2002	1.98	1.33	4.05%	Tayie; Zizza Prev Med, 2009[30]
18	HLFS & TRG in adults 35-50 years; NHANES 1999-2002	1.91	1.31	3.64%	Tayie; Zizza Prev Med, 2009[30]
19	HSFI (6-10 Adult Scale items affirmed) & Diabetes in Adults ages >20 years, NHANES 1999-2002	2.20	1.89	7.89%	Seligman, et al., J Gen Inter Med, 2007[31]
20	FI & Poor Glycemic Control in Adult Diabetics in the Immigration, Culture & Healthcare Study, San Francisco, CA, 2008-09	1.46	1.27	10.17%	Seligman, et al., J Gen Inter Med, 2007[31]
21	HFI & Poor Diabetes Control in adults ages >21 years with DM, from clinics in Boston	1.97	1.40	5.00%	Berkowitz, et al, Diabetes Care, 2014[32]
22	FI without Hunger (HLFS) & Major Depressive Disorder in Women 20-39 years old in a subsample of NHANES 1999-2004 receiving MDD measurement	2.76	2.43	10.32%	Beydoun; Wang J Affect Disord, 2010[33]
23	HFI & Birth Defects (NTD, Orofacial Clefts, Conotruncal Heart Defects) in newborns	1.41	1.12	1.11%	Carmichael, et al., J Nutr, 2007[34]
24	HFI, SES, & Dental Caries in Children 5-17 years in the NHANES, 2007-2008	2.51	2.01	15.34%	Chi, et al., Am J Public Health, 2014[35]
25	VLFS & T2D in Latina Women, 35-60 years old	3.33	1.61	7.79%	Fitzgerald, et al., Ethn Dis, 2011[36]
26	MFS & MDE in Mothers age >18 years in the Fragile Families data, 1998-2000	1.40	1.32	5.53%	Whitaker, et al., Pediatrics, 2006[37]
27	FI & MDE in Mothers age >18 years in the Fragile Families data, 1998-2000	2.20	1.88	9.10%	Whitaker, et al., Pediatrics, 2006[37]
28	MFS & GAD in Mothers age >18 years in the Fragile Families data, 1998-2000	1.70	1.66	11.13%	Whitaker, et al., Pediatrics, 2006[37]
29	FI & GAD in Mothers age >18 years in the Fragile Families data, 1998-2000	2.30	2.20	13.93%	Whitaker, et al., Pediatrics, 2006[37]

	RELATIONSHIP	AOR*	RR*	AF*	SOURCE
30	MFS & Either MDE or GAD in Mothers age >18 years in the Fragile Families data, 1998-2000	1.40	1.32	5.46%	Whitaker, et al., Pediatrics, 2006[37]
31	FI & Either MDE or GAD in Mothers age >18 years in the Fragile Families data, 1998-2000	2.20	1.86	8.70%	Whitaker, et al., Pediatrics, 2006[37]
32	MFS & Aggression in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	1.50	1.45	7.53%	Whitaker, et al., Pediatrics, 2006[37]
33	FI & Aggression in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	1.90	1.68	8.11%	Whitaker, et al., Pediatrics, 2006[37]
34	MFS & Anxiety/Depression in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	1.80	1.68	10.75%	Whitaker, et al., Pediatrics, 2006[37]
35	FI & Anxiety/Depression in 3-year-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[37]
36	MFS & Inattention/Hyperactivity in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	1.60	1.53	8.89%	Whitaker, et al., Pediatrics, 2006[37]
37	FI & Inattention/Hyperactivity in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	1.90	1.77	9.29%	Whitaker, et al., Pediatrics, 2006[37]
38	MFS & Any of the Three Behavior Problems in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	1.60	1.45	7.12%	Whitaker, et al., Pediatrics, 2006[37]
39	FI & Any of the Three Behavior Problems in 3-year-old Children of Mothers age >18 years in the Fragile Families data, 1998-2000	2.10	1.77	8.01%	Whitaker, et al., Pediatrics, 2006[37]
40	FI & severe obesity in pregnant women ≤400% poverty level in the Pregnancy, Infection, and Nutrition (PIN) cohort in NC, 2001-05	2.97	2.07	7.17%	Laraia, et al, J Am Diet Assoc, 2010[38]
41	HFI and poor glycemic control among diabetics ≥20 years old in the NHANES 1999-2008	1.53	1.42	4.16%	Berkowitz, et al., Diabetes Care, 2013[39]
42	HFI and poor LDL control among diabetics ≥20 years old in the NHANES 1999-08	1.86	1.32	2.37%	Berkowitz, et al., Diabetes Care, 2013[39]
43	FI and impulse control problems/violence (any violence) among non-institutionalized adults >18 years in the NESARC 2001-02, 2004-05	2.08	1.80	0.74%	Vaughn, et al., Environ. Res. Public Health, 2016[40]

	RELATIONSHIP	AOR*	RR*	AF*	SOURCE
44	FI and diabetes medication scrimping among adults with diabetes in NHIS 2011	5.89	3.74	29.51%	Knight, et al., Preventive Medicine, 2016[41]
45	FI and asthma among adults >=20 years in NHANES 2005-06	1.57	1.46	9.13%	Shiue Environ Sci Pollut Res, 2016[42]
46	FI and eczema among adults >=20 years in NHANES 2005-06	1.69	1.62	12.05%	Shiue Environ Sci Pollut Res, 2016[42]
47	FI and chronic bronchitis among adults >=20 years in NHANES 2005-06	2.01	1.90	16.44%	Shiue Environ Sci Pollut Res, 2016[42]
48	FI and depression among adults >=20 years in NHANES 2005-06	2.57	2.37	15.08%	Shiue Environ Sci Pollut Res, 2016[42]
49	FI and diabetes among adults >=20 years in NHANES 2005-06	1.32	1.28	5.67%	Shiue Environ Sci Pollut Res, 2016[42]
50	FI and emphysema among adults >=20 years in NHANES 2005-06	2.38	2.32	22.52%	Shiue Environ Sci Pollut Res, 2016[42]
51	FI and liver problem among adults >=20 years in NHANES 2005-06	2.06	1.99	17.91%	Shiue Environ Sci Pollut Res, 2016[42]
52	FI and obesity among women > 20 years with household income <=300% of the federal poverty level in Survey of the Health of Wisconsin 2008-11	2.09	1.52	7.81%	Shin, et al., Preventive Medicine, 2015[43]
53	FI and low HDL among adults > 20 years with household income <=300% of the federal poverty level in Survey of the Health of Wisconsin 2008-11	2.04	1.37	4.96%	Shin, et al., Preventive Medicine, 2015[43]
54	LFI and depression among adults age 20-65 with household incomes 130% of the federal poverty Level in NHANES 2005-10	2.1	1.96	25.90%	Leung, et al., J Nutr, 2015[44]
55	VLFI and depression among adults age 20-65 with household incomes 130% of the federal poverty Level in NHANES 2005-10	3.42	2.97	31.68%	Leung, et al., J Nutr, 2015[44]

*Abbreviations: AOR=Adjusted Odds Ratio; RR=Relative Risk Ratio; AF=Attributable Fraction; HFI=Household Food Insecurity; PEDS=Parents' Evaluation of Developmental Status; CFI=Child Food Insecurity; PDS=Positive Depression Screen; HVLFS=Household Very Low Food Security; FI=Food Insecurity; USFSSM=US Food Security Survey Module; NHANES=National Health and Nutrition Examination Survey; DMARD=Disease Modifying Antirheumatic Drugs; MFS=Marginal Food Security; LDL=Low-density lipoprotein; TRG=Triglycerides; HDL=High-density Lipoprotein; HLFS=Household Low Food Security; HSFI=Household Severe Food Insecurity; DM=Diabetes Mellitus; NTD=Neural Tube Defects; SES=Socio-economic Status; VLFS=Very Low Food Security; T2D=Type2 Diabetes; GAD=Generalized Anxiety Disorder; MDE=Major Depressive Episode; NESARC=National Epidemiologic Survey on Alcohol and Related Conditions; NHIS=National Health Interview Survey.

EXHIBIT A2. Detailed Description of Costs Attributable to Food Insecurity by Condition in Massachusetts, 2016.

Sources of Costs, 2016 Report	Costs Based on Evidence for Massachusetts ($2016 Dollars)
Cost of excess ambulatory visits in adults ages 18+ years with fair/poor health status	$128,667,638
Cost of excess dental care visits in adults ages 18+ years with fair/poor health status	$596,606
Cost of excess prescription medicine used by adults ages 18+ years with fair/poor health status	$137,817,028
Cost of excess hospital stays by adults ages 18+ years with fair/poor health status	$334,657,643
Cost of excess ambulatory visits in children ages <18 years with fair/poor health status	$3,450,763
Cost of excess dental care visits in children ages <18 years with fair/poor health status	$144,813
Cost of excess prescription medicine used by children ages <18 years with fair/poor health status	$4,011,736
Cost of excess non-neonatal hospital stays by children ages <18 years	$21,650,809
Cost of excess ambulatory visits for treatment of depression in adults ages 18+ years	$9,416,423
Cost of excess prescription medicine used in treatment of depression in adults ages 18+ years	$66,655,306
Cost of excess hospital stays for treatment of depression in adults ages 18+ years	$44,088,179
Cost of excess emergency department visits for treatment of depression in adults ages 18+ years	$492,606
Cost of excess home healthcare treatment of depression in adults ages 18+ years	$4,245,706
Cost of lost work time or productivity among employed adults ages 18+ years due to depression	$98,428,142
Cost of excess treatment of arthritis, rheumatoid arthritis, gout, lupus or fibromyalgia in adults ages 18+ years	$76,996,846
Cost of excess treatment of iron-deficiency anemia in children ages <18 years	$4,426,214
Cost of excess treatment of diabetes Type 2 in adults ages 18+ years	$251,150,134
Cost of excess treatment of obesity in adult women ages 18+ years	$132,749,745
Cost of excess healthcare expenses for treatment of asthma among people all ages	$417,478,367
Cost of excess treatment of chronic obstructive pulmonary disease in adults ages 18+ years	$155,129,797
Expenditures for special education in children ages 4 months to 21 years	$520,337,406
TOTAL health and education costs	**$2,412,591,907**

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