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Food Insecurity Was Associated With Greater Family Health Care Expenditures In The US, 2016–17

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Abstract

Food insecurity has been associated with individual healthcare expenditures, but can affect the entire family. Evaluating the relationship between food insecurity and family expenditures provides a better understanding of the financial implications of food insecurity interventions. Our primary objective was to evaluate the association between food insecurity one year (2016) and family healthcare expenditures—for all members, children only, and adults only--the next year (2017). We also evaluated whether this association varies across types of insurance coverage within families: all private, all public, or mixed (including uninsured). Using nationally representative data, we found that food-insecure families had 20 percent greater total healthcare

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expenditures than food-secure families, an annual difference of $2,456. Food insecurity was associated with greater expenditures across all family insurance patterns, including the 19.1 percent of families with mixed coverage. Our findings suggest that, in families with mixed coverage, positive impacts of food insecurity interventions on healthcare utilization may accrue to family members other than the targeted beneficiaries and who have different insurance, benefitting the entire family but potentially discouraging single-payor investments.

Introduction

Food insecurity is the limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.[1] In 2020, 10.5% of U.S. households experienced food insecurity. Households with children are at highest risk of food insecurity, and in 2020, 14.8% of U.S. households with children were food insecure.[1] Food insecurity affects many areas of peoples' lives, such as their diet and ability to adhere to prescribed medications.[2–4] Food insecurity has also been associated with numerous negative health outcomes in children and adults.[2,3,5]

Food insecurity is a household-level construct and has detrimental effects on all family members in the home. Prior studies have shown that food insecurity is associated with increased healthcare expenditures in adults[6–8] and may be associated with increased expenditures in children.[9–11] What is needed, however, is to quantify the association across the entire family. Evaluating the relationship between food insecurity and the total family healthcare costs could provide a better understanding of the financial implications of food insecurity for families overall. This nuanced information is important for understanding the potential impact of food insecurity interventions, which can have spillover effects throughout the family even when targeted to an individual. Therefore, given the growing interest and investment among health systems and health insurers, both public and private, to assist patients with food insecurity[12–14], not understanding the relationship between food insecurity and family healthcare expenditures represents an important knowledge gap.

To fill this gap in the literature, the primary objective of this longitudinal study was to determine the association between food insecurity across the family one year and healthcare expenditures of the entire family the following year. For this study, our measure of interest was the family unit, which we refer to as 'family' in the manuscript and is defined in the Medical Expenditure Panel Survey (MEPS) as two or more persons living in the same household who were related by blood, marriage, or adoption. Further, we sought to contextualize these findings by evaluating different insurance coverages within families (e.g. all privately insured) and whether the relationship between food insecurity and healthcare expenditures may vary across coverage patterns. As a secondary analysis, we evaluated whether continuation of or change in families' food security status during the year healthcare expenditures were measured affected the association between prior food security and subsequent healthcare expenditures.

Methods

Study design and population

We conducted a retrospective longitudinal cohort study using data from Panel 21 of the MEPS.[15] MEPS is a longitudinal study conducted annually by the Agency for Healthcare Research and Quality (AHRQ) and the results are representative of the non-institutionalized U.S. population. MEPS follows the same cohort of households for two years, and households are interviewed multiple times during the study period. All data is reported by a single household respondent. MEPS contains data on a variety of characteristics including sociodemographics, health insurance, and healthcare expenditures. Panel 21 completed their interviews in 2016 and 2017 and is the only MEPS panel to have completed food insecurity screening at two time periods.[15]

We included all adult and child participants in Panel 21 (N=16,074). We excluded participants who were missing food insecurity data in 2016 (N=1,297) or healthcare expenditures in either year (N=111) for a total unweighted sample of 14,666 (91.2% of the panel). The Wake Forest University School of Medicine Institutional Review Board deemed this study of publicly available, de-identified data exempt from human subjects research.

Food insecurity

Our primary predictor was food insecurity in 2016. Food insecurity is measured in MEPS using the validated 10-item U.S. Department of Agriculture (USDA) Adult Food Security Survey Module with a 30-day reference period.[16] We utilized the established scoring system to categorize families as food secure (0–2 affirmative responses) or food insecure (≥3 affirmative responses).[16]

Healthcare expenditures

Our primary outcome was healthcare expenditures in 2017 expressed as a continuous variable in 2017 U.S. dollars. We evaluated total healthcare expenditures and expenditures broken down by type: inpatient, emergency department, outpatient, prescription drug, and out-of-pocket expenditures. Primary respondents identify all family members and report on their prior healthcare use, and information on healthcare use for each family member is supplemented with information collected from healthcare providers. Expenditures are then determined by the direct payments for care provided during the year and include out-of-pocket payments and payments by private insurance, Medicaid, Medicare, and other sources.[15] MEPS uses weighted hot deck statistical imputation methods, incorporating sample weights and sociodemographic characteristics, to impute missing or unavailable expenditure data.[17]

Covariates

Because sociodemographic and socioeconomic characteristics may confound the relationship between food insecurity and expenditures, we extracted data from MEPS on several covariates. All covariates were based on 2016 data and included age, sex, self-reported race and ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, and multiple race or other), region of residence (Northeast, Midwest, South, and

West), and household income (expressed as a percent of the federal poverty level and accounting for household size). We also included participants' health insurance (private, Medicaid/Children's Health Insurance Program (CHIP)/other public insurance, Medicare, or uninsured) as of December 31, 2016. For participants 18 years of age or older, our adult specific models also included highest education level achieved (<high school, high school graduate, or > high school) and if an adult reported having any one of the following chronic medical conditions (yes or no): hypertension, diabetes, chronic obstructive pulmonary disease (COPD; including chronic bronchitis or emphysema), or cardiovascular disease (CVD; including coronary heart disease, angina, myocardial infarction, or stroke). For our child specific models, we included if a child had special healthcare needs (CSHCN; yes or no), defined as being at increased risk for chronic health conditions or requiring greater than usual use of healthcare services based on the validated CSHCN screening instrument included in MEPS.[18] All children 2–17 years of age were screened for CSHCN.

Statistical analysis

We performed univariate analysis and bivariate analysis, using chi-square test or t-test. To determine the association between food insecurity and total family healthcare expenditures for our main analysis, first we evaluated the association between food insecurity in 2016 and individual adult and child healthcare expenditures in 2017 using a two-part model.[19] We used a two-part model because of known challenges with modeling healthcare expenditures (e.g. extreme observations, point mass at zero). Sensitivity analyses using a one-part generalized linear models (GLM), with log link function and gamma distribution, and zero-inflated negative binomial regression found similar results (data not shown). The first part of the model utilized multivariable logistic regression to evaluate the association between food insecurity in 2016 and having any healthcare expenditures in 2017. Among those with any healthcare expenditures, the second part of the model used a GLM with log link and gamma distribution to evaluate the association between food insecurity in 2016 and total healthcare expenditures in 2017. We constructed one two-part model for adults (≥18 years of age) and one two-part model for children (<18 years of age). Both models adjusted for age, sex, race/ethnicity, region, income, insurance, and 2016 healthcare expenditures. For the adult model, we also adjusted for education level and chronic medical conditions. For the child model, we adjusted for CSHCN. We used predictive margins to determine the adjusted mean total healthcare expenditures using the 'margins' command in Stata. Second, we then summed the adult and child estimates per family and evaluated the difference in total family expenditures by food security. We utilized the family identifier provided in MEPS, which is based on the Current Population Survey definition of a family.[20] Single people are also given a family identifier in MEPS, which was included in our analysis.

As is commonly recommended[6], we used a winsorizing cutoff at the 97.5th percentile of total expenditures ($38,263 in this sample) because healthcare expenditures can be highly skewed and outliers can distort the estimated means. We conducted sensitivity analyses at different winsorizing thresholds (95th, 99th, and no winsorizing) and found similar results (data not shown). We used the same approach to evaluate the association between food insecurity in 2016 and healthcare expenditures broken down by type (inpatient, emergency department, outpatient, prescription drugs, and out-of-pocket) per family in 2017. For

analyses evaluating the association between food insecurity and expenditure type, we adjusted for the specific expenditure type in 2016 (e.g., 2016 inpatient expenditures for analyses where 2017 inpatient expenditures was the outcome).

Because many insurers are implementing initiatives to address food insecurity[21], we then evaluated how family insurance coverage modifies the relationship between food insecurity and healthcare expenditures. We created three mutually exclusive insurance categories based on the collective insurance status of all family members. These were: (1) all family members reported having private insurance; (2) all family members reported being publicly insured (including Medicaid, CHIP, other public insurance, and Medicare); and (3) mixed (any combination of privately insured, publicly insured, and uninsured). We evaluated the interaction between food insecurity and family insurance category in 2016 to determine if differences in total family healthcare expenditures in 2017 varied by insurance coverage pattern. We also evaluated for differences in family healthcare expenditures by family demographics (race/ethnicity of primary respondent, income, and region) by evaluating the interaction between food insecurity and sociodemographic characteristics. Additionally, we evaluated the association between food security status in both 2016 and 2017 on total family healthcare expenditures in 2017. We categorized families as: (1) food secure in both 2016 and 2017; (2) food secure in 2016 and food insecure in 2017; (3) food insecure in 2016 and food secure in 2017; or (4) food insecure in both 2016 and 2017 (see Appendix Technical brief for further details).[22]

All analyses accounted for the complex survey design of MEPS by applying sample weights, clustering, and the primary sampling unit. For all multivariable analyses, we used bias corrected bootstrapping, with 500 iterations. Because missingness was low (<5%), we did not conduct any imputations for missing data. We used a two-sided hypothesis test and considered a p-value <0.05 statistically significant. All analyses were conducted using Stata 15.1 (StataCorp, College Station, TX).

Limitations

There are several limitations to this study that should be acknowledged. First, in this observational study, unmeasured confounding is an important concern. We attempted to account for this by adjusting for 2016 healthcare expenditures, which can help control for unmeasured time-invariant confounders, but we recognize there may be residual confounding, including confounding due to unmeasured time-varying factors.

Second, because of small sample sizes, and being unable to identify the specific carrier, we had to broadly categorize families as either all having private insurance, all public insurance, or mixed, and could not assess uniform coverage with the same carrier. Further, sample size limitations also precluded us from separately considering families who were all uninsured (which we grouped with mixed coverage) and non-group/exchange (which we counted as private coverage).

Third, we were limited to identifying a family based on the definition included in MEPS. Persons living in the same home, but who were not related by blood, marriage, or adoption were defined as separate families.

Fourth, we adjusted for individual covariates (e.g. diabetes), as opposed to family covariates as we thought these likely to be more influential for an individual's healthcare expenditures. We were concerned that utilizing family covariates implicitly assumes that everyone in the family is affected by the variable to the same extent, which could lead to misclassification that may bias results to the null. Characteristics of other family members (e.g. if anyone in the family had a chronic condition), however, could influence other individuals' receipt of healthcare, and should be considered for future studies.

Results

Study sample

The study population included 14,666 children and adults (weighted N=308,082,576) from 6,621 distinct families. Most of the study sample was female, non-Hispanic white, and had private health insurance (Exhibit 1). Within the study sample, 90.0% (N=12,616) of individual participants were food secure and 10.1% (N=2,050) of individual participants were food insecure in 2016. In bivariate analysis, participants who reported food insecurity were more likely to be younger age, non-Hispanic Black, Hispanic, have a lower income, and either have public insurance or be uninsured. We found similar differences when stratifying by adult and child participants (Appendix Exhibits A and B).[22]

Among families, the mean age of the primary respondent was 49.2 years and 26% had at least one child (Appendix Exhibit C).[22] Within the study sample, 89.7% (N=5,719) of families were food secure and 10.3% (N=902) of families were food insecure in 2016. Of the families included, 50.6% reported that all family members had private insurance, 30.3% reported that all family members had public insurance, and 19.1% reported having a mix of insurance types.

Within families who reported all receiving private insurance, 54.5% of adults reported receiving employer-sponsored insurance and 13% reported having more than one policy holder (Appendix Exhibit D).[22] Among those reporting all public insurance, 53.2% had Medicare and 46.8% had Medicaid/CHIP/other public insurance. Of families reporting mixed insurance coverage, 31.5% had private insurance, 28.6% Medicaid/CHIP/other public insurance, 10.2% Medicare, and 29.7% were uninsured.

Food insecurity and individual healthcare expenditures

In multivariable models adjusting for sociodemographics, clinical covariates, and 2016 healthcare expenditures, we found that food insecurity in 2016, compared to food security, was associated with greater total healthcare expenditures in 2017 ($6,693, 95% CI: $5,694, $7,693 vs $5,387, 95% CI: $5,148, $5,625) with an estimated difference of $1,307 (95% CI: $279, $2,335) among adults (Exhibit 2). We did not find a significant association between food insecurity and child healthcare expenditures in adjusted multivariable models (see Appendix Exhibits E and F for full two-part model results).[22]

Food insecurity and family healthcare expenditures

Families that were food insecure had 20% greater subsequent adjusted total healthcare expenditures than their food secure counterparts ($14,625, 95% CI: $13,909, $15,341 vs $12,169, 95% CI: $11,983, $12,355) for an estimated difference of $2,456 (95% CI: $1,736, $3,176). Food insecurity was not associated with greater subsequent out-of-pocket expenditures (Exhibit 3), but was associated with greater subsequent expenditures across all other types of health care spending (inpatient, emergency department, outpatient, and prescription drugs).

Food insecurity and healthcare expenditures by family insurance coverage

We found that food insecurity in 2016 was associated with greater adjusted total healthcare expenditures in 2017 among families across all insurance coverage types (Exhibit 4). Food insecurity was associated with $2,017 (95% CI: $271, $3,764) greater total expenditures among families whose members all received private insurance; $1,855 (95% CI: $979, $2,731) greater expenditures among families whose members all received public insurance; and $3,531 (95% CI: $2,189, $4,873) greater expenditures among families with mixed insurance coverage. The between-group differences (all private vs all public vs mixed) in healthcare expenditures were not statistically significant.

We also found that food insecurity was associated with greater healthcare expenditures when stratifying by the race/ethnicity of the primary respondent, family income, and region of residence (Appendix Exhibit G-I).[22]

In multivariable models, we found families who were food insecure in both 2016 and 2017 had greater total healthcare expenditures in 2017 than families who were food secure in both years ($14,096, 95% CI: $13,061, $15,131 vs $12,247, 95% CI: $12,046, $12,448) for a difference of $1,849 (95% CI: $778, $2,920) (Appendix Exhibit J).[22] Families who were food insecure in 2016 and food secure in 2017 had greater total expenditures in 2017 than families who were food secure in both years ($13,622, 95% CI: 12,775, 14,468 vs $12,247, 95% CI: $12,046, 12,448) for a difference of $1,375 (95% CI: $538, $2,211). We did not find a significant difference in healthcare expenditures between families who were food secure in 2016 and food insecure in 2017 compared to families who were food secure in both years.

Discussion

In this nationally representative cohort of U.S. families, we found that food insecurity in 2016 was associated with greater total family healthcare expenditures in 2017. Also, families who were food insecure in 2016—whether food insecure or food secure in 2017--had greater total healthcare expenditures than families who were food secure in both years. Food insecurity was associated with greater total healthcare expenditures for families that were privately insured, publicly insured, or had mixed insurance coverage. One in 5 families, however, had multiple forms of insurance coverage, which would complicate any efforts to see returns on social investments in ameliorating food insecurity by any one payor.

These results help provide a clearer understanding of the relationship between food insecurity and healthcare costs for families, and how potential investments to address food insecurity could lead to cost savings for insurers and capitated healthcare systems. Our results, when considering individual family members, are consistent with prior studies that examined this association among individual adults and children. Among adults, our results are consistent with the growing evidence showing that food insecurity is associated with greater healthcare expenditures.[6–8] In children, several studies, including this one, have not found associations between food insecurity and healthcare costs.[9–11] The difference between adults and children may be because, on average, children use fewer health services. It may also be that the negative impacts of food insecurity on health can take many years to manifest.[23,24] A major component of healthcare expenditures in our study, as in others, were prescription drug costs.[6,8] The greater healthcare expenditures we found in adults could be due to the worsening of underlying chronic conditions requiring medications, which would be less likely to occur in children. Further studies that evaluate the impact of food insecurity on health and healthcare expenditures over many years are needed.

Our results have important implications for policy and clinical practice. From a policy standpoint, there have been growing investments by Medicare, Medicaid, and Commercial health insurers in addressing food insecurity as a way to improve health, mitigate avoidable utilization, and reduce healthcare expenditures. Examples include more robust screening of food insecurity, referrals to community-based organizations, and the provision of medically tailored meals.[12,21] Our findings are consistent with the promise of that approach, as we found greater healthcare spending in families that experienced food insecurity. As families generally share food and other resources, an intervention that addresses food insecurity in one or more specific family members may provide benefits to other family members, even if only a single individual qualifies for the benefit. Thus, for families covered by the same carrier, initiatives at the insurer level could increase every member’s access to food, improve the health of children and adults, and reduce family healthcare expenditures in a way that unlocks both financial and health benefits.

However, we found 1 in 5 families had more than one insurance plan. Observing the full financial benefit of food insecurity interventions may be more challenging for families with mixed coverage, potentially creating conditions which discourage investment. The number of low and middle-income parents/guardians who enroll their children on Medicaid or CHIP, rather than their employer-sponsored health insurance, is increasing due to the rising out-of-pocket expenses of private insurance, and these families are often at high risk of having unmet social needs.[25] It is also likely the true percentage of families with mixed coverage is higher than 20% given our inability to identify the exact carrier/plan of each individual.[26] Among families categorized as all having public insurance, 50% reported being insured by Medicare and 50% by Medicaid/CHIP/other public insurance. Even for families all receiving Medicaid, many families may not have been on the same health plan as nearly two-thirds of Medicaid recipients are enrolled in a health maintenance organization and auto-assignment algorithms may enroll members of the same family on different managed care plans.[27] Similarly, for family members who reported private insurance, 13% of families had more than one policy holder, suggesting even within these households, different employers or benefit structures may exist. Also of note, food insecurity may be associated with greater

differences in health expenditures among families with mixed coverage than among families with all private or all public insurance. While we found those differences not statistically significant on average, they were large—and may warrant further examination.

This complexity of households with mixed insurance coverage means that a single carrier financing an intervention may not see the full benefits of that intervention reflected in the improved health or reduced healthcare costs of the targeted family members. Such a situation could be understood as an externality in the sense that there are third party benefits (that is, benefits to parties other than the insurer and its members) that may result from a food insecurity intervention. Economic theory would suggest that such externalities could lead to less investment in initiatives than might be socially desirable.[28] One way to address such externalities would be public subsidies for food insecurity interventions undertaken by insurers or utilizing social impact bonds.[29] Alternatively, addressing food insecurity at the public health or social policy level, where stakeholders have responsibility for the entire population may be needed. Such approaches include expansion of nutrition subsidies (e.g. Supplemental Nutrition Assistance Program (SNAP)) or income support (e.g. the Child Tax Credit). For example, multiple studies have shown that SNAP leads to reductions in food insecurity.[30] The recent recalibration of the Thrifty Food Plan has led to significant increases in the benefit amounts families receive and will potentially have a profound impact on improving food security in the U.S.[31] Expansion of SNAP eligibility could also reduce, or potentially eliminate, food insecurity.[32] Other policy options could include encouraging insurer participation across numerous lines of business (i.e., Medicaid managed care and private coverage) in a state to promote more uniformity in coverage or developing quality metrics at the family level.[26]

Although this study identified variation in health insurers within families, there may be an analogous challenge for clinical care providers, where a growing number of food insecurity interventions are being conducted.[33,34] These interventions primarily focus on individual-level outcomes, and thus may not assess how addressing social needs could have positive benefits for other family members—members who may be seen in different clinics or even different healthcare systems. This may be particularly relevant for pediatric providers. There has been a strong endorsement among national pediatric societies for pediatricians to screen for and address food insecurity as a routine part of clinical care.[35] Although addressing food insecurity at pediatric visits could have important long-term benefits for children, we find, as have other researchers, that short-term ‘return on investment’ in the form of reduced healthcare expenditures may not occur. Improving families’ access to food at a pediatric visit, however, could have important health benefits for other children and adults in the home and short-term reductions in healthcare expenditures may occur for adult family members. Similar to health insurance level initiatives, there could be an important externality with clinic or health system food insecurity interventions, and less investment in these initiatives may occur than socially desirable. Future studies are needed to evaluate the effect of addressing food insecurity at an individual patient visit on the health outcomes and healthcare utilization of other family members.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Exhibit 1:

Characteristics of individuals in the study sample, 2016

Characteristic	Total Individuals (N=14,666,weighted N=308,082,576)	Food Secure Individuals (N=12,616,weighted %=90.0%)	Food Insecure Individuals (N=2,050,weighted %=10.1%)
Age (mean), years ****	38.6	39.1	33.5
Female, % *	51.0	50.8	53.4
Race/ethnicity, % ****			
Non-Hispanic, White	60.0	61.7	45.5
Non-Hispanic, Black	12.3	11.5	19.3
Hispanic	18.1	17.2	26.2
Other	9.6	9.7	9.0
Region of residence, %			
Northeast	17.5	17.9	14.6
Midwest	21.0	20.7	23.5
South	37.7	37.4	40.9
West	23.8	24.1	21.0
Family income, % ****			
<100% FPL	12.9	10.7	33.0
100-<125% FPL	4.0	3.2	11.4
125-<200% FPL	14.1	13.0	24.4
200-<400% FPL	29.9	30.5	24.2
≥400% FPL	39.1	42.6	7.1
Insurance type, % ****			
Private	58.6	61.2	34.7
Medicaid/CHIP/other public insurance	19.0	16.1	45.3
Medicare	15.1	15.9	7.7
Uninsured	7.4	6.8	12.2
Age group, % ***			
Adult (≥18 years of age)	71.6	72.1	67.0
Children (<18 years of age)	28.4	27.9	33.0
Education level, % (adults only) ****			
< High school	13.3	12.0	25.8
High school graduate	45.6	44.6	54.9
> High school	41.2	43.5	19.3
Medical conditions, %			
Hypertension (adults only)	32.7	32.6	33.9
Diabetes (adults only) ****	10.4	10.0	14.3
COPD (adults only) ****	3.5	3.0	8.4

Characteristic	Total Individuals (N=14,666,weighted N=308,082,576)	Food Secure Individuals (N=12,616,weighted %=90.0%)	Food Insecure Individuals (N=2,050,weighted %=10.1%)
CVD (adults only) **	15.7	15.4	18.1
CSHCN (children only) ***	14.5	13.7	20.3

Source: Author's analysis of study data

Notes: "Family" was defined as two or more persons living in the same household who were related by blood, marriage, or adoption based on the Current Population Survey definition of a family. The study population included 14,666 children and adults from 6,621 distinct families. CHIP-Children's Health Insurance Program, CVD-cardiovascular disease, COPD-chronic obstructive pulmonary disease, CSHCN-children with special healthcare needs, FPL-Federal Poverty Level.

* p<0.10

** p<0.05

*** p<0.01

**** p<0.001.

Exhibit 2:

Association between food security status in 2016 and total healthcare expenditures in 2017, at the individual and family levels

Level of total healthcare expenditures/ Age Group	Food security status in 2016	Estimated mean annual total healthcare expenditures in 2017, $	Estimated difference in mean annual total healthcare expenditures in 2017, food insecure versus food secure, $
Individual Level			
Adults	Food insecure	$6,693	$1,307***
	Food secure	$5,387	---
Children	Food insecure	$1,893	$28
	Food secure	$1,921	---
Family Level			
All families (includes one-person families)	Food insecure	$14,625	$2,456****
	Food secure	$12,169	---
Families with 2 or more individuals	Food insecure	$16,884	$3,104****
	Food secure	$13,780	---
Families with at least one child	Food insecure	$17,618	$2,811****
	Food secure	$14,807	---

Source: Author's analysis of study data

Notes: Results represent adjusted mean total healthcare expenditures. Individual adult and child results were determined using a multivariable two-part model evaluating the association between food insecurity in 2016 and individual healthcare expenditures. The first part of the model utilized multivariable logistic regression to evaluate the association between food insecurity in 2016 and having any healthcare expenditures in 2017. Among those with any healthcare expenditures, the second part of the model used multivariable generalized linear model (GLM) with log link and gamma distribution to evaluate the association between food insecurity in 2016 and total healthcare expenditures in 2017. To determine family level results, we summed the adult and child estimates per family and evaluated the difference in total family expenditures by food security. "Family" was defined as two or more persons living in the same household who were related by blood, marriage, or adoption based on the Current Population Survey definition of a family.

* p<0.10

** p<0.05

*** p<0.01

**** p<0.001.

Exhibit 3:

Association between food security status in 2016 and family healthcare expenditures in 2017, by expenditure category

Healthcare expenditure category	Food security status in 2016	Estimated mean annual healthcare expenditures in 2017, $	Estimated difference in mean annual healthcare expenditures in 2017, food insecure versus food secure, $
Inpatient	Food insecure	$1,751	$281****
	Food secure	$1,471	---
Emergency department	Food insecure	$428	$108****
	Food secure	$320	---
Outpatient	Food insecure	$2,997	$213***
	Food secure	$2,783	---
Prescription drugs	Food insecure	$2,710	$500****
	Food secure	$2,210	---
Out-of-pocket costs	Food insecure	$1,407	$16
	Food secure	$1,391	---

Source: Author's analysis of study data

Notes: Results represent adjusted mean healthcare expenditures per family. Individual adult and child results were determined using a multivariable two-part model evaluating the association between food insecurity in 2016 and healthcare expenditures in 2017 by expenditure category, controlling for sociodemographics, clinical covariates, and healthcare expenditures in 2016. To determine family level results, we summed the adult and child estimates per family and evaluated the difference in family expenditures by food security. "Family" was defined as two or more persons living in the same household who were related by blood, marriage, or adoption based on the Current Population Survey definition of a family.

* p<0.10

** p<0.05

*** p<0.01

**** p<0.001.

Exhibit 4:

Association between food security status in 2016 and total healthcare expenditures in 2017, by family health insurance type

Family members' health insurance	Food security status in 2016	Estimated mean annual total healthcare expenditures in 2017, $	Estimated difference in mean annual total healthcare expenditures in 2017, food insecure versus food secure, $
All members privately insured	Food insecure	$14,024	$2,017**
	Food secure	$12,006	---
All members publicly insured (Medicaid, CHIP, other public, Medicare)	Food insecure	$11,471	$1,855****
	Food secure	$9,616	---
Members with mixed insurance (any combination of private, public, uninsured)	Food insecure	$18,455	$3,531****
	Food secure	$14,924	---

Source: Author's analysis of study data

Notes: Results represent adjusted mean total family healthcare expenditures by family insurance type. Individual adult and child results were determined using a multivariable two-part model evaluating the association between food insecurity in 2016 and total healthcare expenditures in 2017, controlling for sociodemographics, clinical covariates, and healthcare expenditures in 2016. To determine family level results, we summed the adult and child estimates per family and evaluated the difference in family expenditures by food security. "Family" was defined as two or more persons living in the same household who were related by blood, marriage, or adoption based on the Current Population Survey definition of a family.

* p<0.10

** p<0.05

*** p<0.01

**** p<0.001.