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Food Insecurity, Healthcare Utilization, and High Cost: A Longitudinal Cohort Study

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Abstract

Objectives: Reducing utilization of high-cost healthcare services is a common population health goal. Food insecurity--limited access to nutritious food owing to cost—is associated with chronic disease, but its relationship with healthcare utilization is understudied. We tested whether food insecurity is associated with increased emergency room visits, hospitalizations, and related costs.

Study Design: Retrospective analysis of a nationally-representative cohort

Methods: Adults (age > 18 years) completed food insecurity assessment (using 10-items derived from the USDA Household Food Security Module) in the 2011 National Health Interview Survey and were followed in the 2012–13 Medical Expenditures Panel Survey. Outcome measures were emergency department visits, hospitalizations, and days hospitalized, and whether participants were in the top 10%, 5%, and 2% of total healthcare expenditures.

Results: Of 11,781 participants, 2056 (weighted percentage: 13.2) were in food insecure households. Food insecurity was associated with significantly more emergency department visits (Incidence Rate Ratio [IRR] 1.47, 95% Confidence Interval [CI] 1.12 – 1.93), hospitalizations (IRR 1.47, 95% CI 1.14 – 1.88), and days hospitalized (IRR 1.54, 95% CI 1.06 – 2.24), after adjustment for demographics, education, income, health insurance, region, and rural residence.

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Food insecurity was also associated with increased odds of being in the top 10% (OR 1.73 95%CI 1.31 – 2.27), 5% (OR 2.53 95%CI 1.51 – 3.37), and 2% (OR 1.95 95% CI 1.09 – 3.49) of healthcare expenditures.

Conclusions: Food insecurity is associated with higher healthcare use and costs, even accounting for other socioeconomic factors. Whether food insecurity interventions improve healthcare utilization and cost should be tested.

Precis:

In a longitudinal study, the authors find that food insecurity is associated with greater emergency department visits, inpatient admissions, and length of stay.

Keywords

Food Insecurity; Health Expenditures; Delivery of Health Care; Socioeconomic Status; Diabetes; Cardiovascular Disease; Hypertension

A disproportionately large share of healthcare costs are generated in the course of care for small proportion of patients, which are often due to emergency department visits, inpatient hospitalizations, or long lengths of hospital stay.[12] The desire to improve use of these services has prompted investigations into risk factors for high use and costs. Programs targeting patients with particularly high total healthcare costs[3], for example, those in the top 10, 5%, or 1%, typically focus on clinical conditions or factors internal to the healthcare system, such as care coordination.[2] Because the impact of these programs can be modest[2], there has recently been increased interest in addressing modifiable social determinants of health with the intention of reducing health care utilization and cost (e.g., through the Accountable Health Communities model proposed by the Centers for Medicare and Medicaid Services).[4]

One particular area of focus is food insecurity, defined as lacking “access to enough food for an active, healthy life for all household members”.[5] Food insecurity affects 12.7% of American households as of 2015[5], and has been associated with increased prevalence of illness as well as worsened chronic disease management.[6–11] It is hypothesized that food insecurity increases healthcare utilization and cost by making it more difficult to follow a healthy diet (exacerbating diet-dependent conditions such as type 2 diabetes and congestive heart failure), forcing competing demands between food and other necessities such as medications or transportation, and reducing the cognitive bandwidth necessary to manage chronic illness.[912] Prior studies in both the Canadian[13] and American[14–16] context have found that food insecurity is associated with higher average healthcare costs. However, several of these studies had limitations, including cross-sectional[13] and ecological designs[1516], and none focused on the most relevant group for population health management —those with the highest healthcare use. For population health management, the extremes of the distribution, rather than the mean, may be most relevant.

To address these issues, we tested the hypothesis that food insecurity is associated with higher utilization of emergency department services, inpatient hospital admissions, and

length of stay, and an increased risk of being in top centiles (10%, 5%, and 2%) of total healthcare expenditure, accounting for socioeconomic covariates.

Methods

Data Source and Study Sample

Data for this study were obtained from the 2011 National Health Interview Survey (NHIS)[17] and the 2012–2013 Medical Expenditure Panel Survey (MEPS). The 2012–2013 panel of MEPS is drawn from respondents to 2011 NHIS to be nationally-representative, and the responses were linked by anonymized identification number.[18] We included all adults (age > 18 years at time of NHIS completion) with information on food security status (non-response rate for food insecurity items: <1%)[19] in our analysis. Interviews were conducted by trained interviewers in English or Spanish.[17,18]

The Human Research Committee at Partners Healthcare exempted this study from human subjects review as it made use of de-identified data.

Food Insecurity

Food insecurity was assessed at the household level with a 30-day look back period in the NHIS using a 10-item food insecurity instrument derived from the USDA Household Food Security Module.[20] An example item asked whether the respondent and their household often, sometimes or never worried about whether "food would run out before [they] had money to get more". The full instrument is available from: https://ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Survey_Questionnaires/NHIS/2011/English/qfamily.pdf. An affirmative response to three or more items indicated food insecurity, in accord with standard scoring practices for this instrument.[21] Owing to sample size limitations, we did not further subdivide the food insecure category into low versus very low food security. These data came from the 2011 NHIS.

Healthcare Utilization and Expenditures

Information on healthcare expenditures and use that occurred in 2012 and 2013 was taken from MEPS. Because they are often the focus of programs to reduce healthcare utilization[2], we evaluated the number of emergency department visits not resulting in a hospital admission, the number of inpatient hospital admissions, and the number of days spent as a hospital inpatient. To provide context, we also examined the medical conditions associated with use of these services, and outpatient service use. Because a disproportionate share of total healthcare costs are attributable to a small number of people with the highest costs, it is important to understand other parts of the distribution of healthcare expenditures besides the mean. Therefore, we examined those in 3 commonly used thresholds: those in the top 10% of expenditures, those in the top 5%, and those in the top 2%.[1] Using the top 2% rather than the top 1% gives more stable estimates owing to the larger samples sizes. For consistency, we used the Consumer Price Index to convert all expenditures to 2015 dollars, (http://data.bls.gov/cgi-bin/cpicalc.pl).

Other Measures

We considered several factors that may confound the relationship between food insecurity and healthcare utilization and expenditure. We used data from the 2011 NHIS to determine the participant's age (at time of NHIS interview), gender, race/ethnicity (categorized as non-Hispanic white, non-Hispanic black, Hispanic, and other), education (less than high school diploma, high school diploma, greater than high school diploma), income expressed as a percentage of federal poverty level (which accounts for household size), health insurance (private, Medicare, other public insurance [which includes Medicaid, Medicare and Medicaid dual-eligibles, and coverage through the Department of Veterans' Affairs], and no health insurance). Because area of residence is associated with variation in healthcare expenditure and use, we used data from MEPS to assess census region of residence (Northeast, Midwest, South, or West) and urban vs. rural residence. We also assessed the presence of 4 common conditions (heart disease [coronary heart disease, angina pectoris, myocardial infarction, or other heart disease], diabetes mellitus, respiratory illness [asthma, emphysema, or chronic bronchitis], and hypertension), using data from MEPS.[22]

Statistical Analysis

When developing our analysis plan, we relied on a published conceptual model of food insecurity and poor health that recognizes food insecurity may be associated with poor health both by increasing the prevalence of chronic conditions, and by making these conditions more difficult to manage once present.[12] Therefore, our main analytic strategy was to adjust for sociodemographic covariates that may confound the association between food insecurity and poor health, but not adjust for clinical characteristics that may mediate the association between food insecurity and poor health. However, because healthcare systems often implement disease-specific management programs (e.g., a diabetes management program), we conducted sensitivity analyses that adjust for four conditions commonly targeted by disease management programs: heart disease, diabetes mellitus, respiratory illness, and hypertension. This helps ensure that any differences observed were not solely due to different burden of common chronic disease, and helps provide evidence regarding the association between food insecurity and healthcare use within levels of a specific condition (e.g., whether those with food insecurity and diabetes have greater healthcare use than those with diabetes but without food insecurity). We used zero-inflated negative binomial regression for our utilization analyses because many participants have zero healthcare utilization for a given type (for example, no emergency department visits).[23] We conducted both unadjusted analyses, and analyses adjusted for the covariates described above. To help understand differences in use and cost, we also analyzed whether participants had a routine source of care (using logistic regression), and their outpatient utilization (using zero-inflated negative binomial regression).

To examine whether food insecurity was associated with being in the top 10%, 5%, and/or 2% of expenditures, we conducted additional analyses. We tested unadjusted associations using chi-squared tests. Next, we constructed adjusted logistic regression models that included age (both linear and quadratic), gender, race/ethnicity, education, income, health insurance, region of residence, and rural vs. urban residence.

To determine the difference in the mean expenditures between those with and without food insecurity by insurance coverage, we fit a generalized linear regression using a gamma distribution and log link, and calculated the marginal differences, adjusting for other covariates.[2425] The gamma regression approach was selected on the basis of a modified Park test, as the distribution best fit to the healthcare expenditures data.[25]

Finally, while sample size limitations prevented detailed exploration of the diagnoses associated with emergency department and inpatient use, we conducted exploratory analyses focused on the top 20 conditions responsible for emergency department visits and the top 20 responsible for inpatient conditions, which, when combined, yielded 30 total condition categories.[26]

Analyses were conducted SAS version 9.4 (SAS Institute, Cary, NC) and Stata SE 14.1 (StataCorp, College Station, Tx). All analyses accounted for survey design information (sampling strata and weights).

Results

There were 11,781 adults included in the study. Of these, 13.2% (n=2056, percentage is weighted) belonged to households that reported food insecurity in 2011. Those in food insecure households were more likely to be younger, racial/ethnic minorities, and be poorer, compared with those in food secure households (Table 1).

Among study participants, unadjusted utilization was highly right-skewed, with most participants having no utilization (eTable 1, eFigure 1a-1c). In zero-inflated negative binomial models, adjusted for age, age squared, gender, race/ethnicity, education, income, health insurance, region, and living in a rural area, food insecurity was associated with significantly greater emergency department visits (Incidence Rate Ratio [IRR] 1.47, 95% Confidence Interval [CI] 1.12 – 1.93) (Table 2). Similarly, food insecurity was associated with greater inpatient hospitalizations (IRR 1.47, 95% CI 1.14 – 1.88), and greater number of days hospitalized (IRR 1.54, 95% CI 1.06 – 2.24). The adjusted differences for those with Medicare were: difference in emergency department visits: 0.42 visits, p=0.01; difference in inpatient admissions: 0.25 admissions, p = 0.01; difference in days hospitalized: 1.93 days, p=0.04; p-values represent comparison between predicted values for those with and without food insecurity when insurance type is Medicare). The adjusted differences for other public insurance, which includes Medicaid and ‘dual-eligibles’ were: difference in emergency department visits: 0.39 p<.0001; difference in inpatient admissions: 0.10 admissions, p = 0.005; difference in days hospitalized: 0.62, p=0.03 (full models in eTables 2–4).

In zero-inflated negative binomial models that additionally included high-priority clinical conditions, results were generally similar to analyses without clinical conditions, with no qualitative or significant changes in the results. Food insecurity was associated with greater ED visits (IRR 1.41, 95% CI 1.12 – 1.78), inpatient admissions (IRR 1.28 95% CI 1.01 – 1.61) and days hospitalized (IRR 1.61, 95% CI 1.12 – 2.31; Full models eTables 5–7).

We next examined use of outpatient services and having a usual source of care. In models adjusted for age, age squared, gender, race/ethnicity, education, income, health insurance,

region, and living in a rural area, we found that participants with food insecurity had higher rates of outpatient visits (IRR 1.30 95% CI 1.11 – 1.52) but were less likely to report having a usual source of care (OR 0.69, 95%CI 0.51 – 0.93) (full models in eTables 8–9).

Examining high cost participants, those in the top 10% had expenditures ≥ $26,201 over the two-year period, those in the top 5% had expenditures ≥ $42,116, and those in the top 2% had expenditures ≥ $68,314. In unadjusted, likely confounded, analyses, participants from food insecure households were not more likely to be in the top 10% (11.6% of food insecure participants in top 10% vs. 9.8% of food secure, p=0.09), but were more likely to be in the 5% (6.9% vs. 4.7%, p=0.01) and top 2% (3.0% vs. 1.9%, p=0.03) of expenditures. In the fully adjusted models, food insecurity was associated with increased odds of being in the top 10% (OR 1.73 95%CI 1.31 – 2.27), top 5% (OR 2.53 95%CI 1.51 – 3.37), and top 2% (OR 1.95 95% CI 1.09 – 3.49) of expenditures (full models in appendix eTables 10–12).

In gamma regression modeling, with total cost as the outcome and adjusting for the same factors, the mean annual cost difference between a food insecure and food secure Medicare beneficiary was $5527.06 (95% CI $2552.39 to $8501.73, p <.0001), and between a food insecure and food secure participant with public health insurance other than Medicare was $1826.40 (95% CI $797.69 to $2855.11, p=.001) (full model in eTable 13).

Exploratory logistic regression models examining the clinical conditions associated with emergency department and inpatient use are presented in the online (appendix eFigure 2). Point estimates suggest visits related to diabetes and respiratory illnesses were more common in those with food insecurity, but, owing to small sample sizes, confidence intervals were wide and often crossed 1.

Discussion

In this study of nationally-representative healthcare utilization and expenditure data in adults, we found that food insecurity was associated with significantly greater healthcare utilization, including emergency department visits and inpatient admissions, which are common targets of programs to reduce healthcare use. We further found that food insecurity was associated with increased odds of subsequently being a high-cost healthcare user. We found that the higher use of emergency and inpatient services in food insecure participants occurred despite higher use of outpatient services.

The findings in this study are consistent with and extend those in previous work.[2728] Higher emergency department and inpatient service use despite higher outpatient service use suggests that, rather than food insecurity being associated with less healthcare access, the healthcare system, as currently structured, may be unable to address the factors that worsen health for these patients. Fragmentation of care, as indicated by food insecure participants being less likely to report having a usual source of care, may help explain this finding. A single-center study of food insecure diabetes patients had a similar finding.[29] Two prior studies have estimated the total burden of food insecurity on healthcare costs in the U.S., but relied on ecological methods where the healthcare costs of individuals experiencing food insecurity were not assessed.[1516] A prior cross-sectional study of food insecurity and

healthcare costs, based in Canada[13], found that mean costs are higher in those who experience food insecurity, and a longitudinal study based in the U.S. reached a similar conclusion.[14] The study presented here used individual-level, nationally representative longitudinal data to delve further into these findings by examining the distribution of healthcare costs. We found that very high use by a few participants greatly affects total healthcare expenditures, and thus may be an important focus of interventions.

This study has several important implications. The longitudinal nature of these data may be particularly useful for care management programs. The ability to target resources to those likely to generate high healthcare costs in the subsequent two years is highly relevant for population health management efforts. Newly validated tools like brief 2-item screeners for food insecurity may help accomplish this in clinical settings.[3031] Programs that assess for unmet needs in clinical care, and then link patients to community resources that help meet these needs may be one strategy to aid patients.[32–34] We also think it is important to note that emergency department visits or inpatients admissions are not necessarily to be avoided in all situations. Often they represent appropriate care.[35–37] But, given the clear association between food insecurity and these types of healthcare use, which are often disruptive to patients and represent worsening of clinical conditions, interventions to determine whether addressing food insecurity can help alter healthcare use in a way beneficial for both patients and the healthcare system are warranted.

This study should be interpreted in light of several important limitations. We cannot exclude the possibility of unmeasured confounding, and the association between food insecurity and healthcare use and cost cannot be viewed as causal. Since food insecurity is often episodic, the single assessment, with only a 30-day look back period, used in NHIS may have resulted in misclassifying some participants who did experience food insecurity during the study period as food secure. This would tend to reduce the magnitude of observed associations. Finally, given the low number of emergency department visits or inpatient admissions for any given clinical condition, and lack of clinic detail about the health service use, we were not able to investigate the causes of the observed differences in great depth in this study, and we were not able to adjust for the specific diagnoses associated with the ED visit or admission.

Food insecurity is closely associated with higher use of emergency department visits, inpatient admissions, and having high healthcare costs. While we do not yet know whether addressing food insecurity helps improve these outcomes, food insecurity indicates a group at high risk. Further work to integrate interventions on social determinants of health, such as food insecurity, into routine care may be an important step towards improving health and healthcare for vulnerable populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Take away points:

- Food insecurity is an important risk factor for use of emergency department and inpatient healthcare services
- Those with the highest healthcare costs are often food insecure
- Improving healthcare use for those with the highest cost may require addressing needs such as food insecurity, along with medical needs

Table 1:

Demographic and Clinical Characteristics of Included Participants

	Food Secure % (N) or mean (SE) N=9725	Food Insecure % (N) or mean (SE) N=2056	P
Age, years	47.06 (0.32)	41.52 (0.54)	<.0001
Female	51.80 (5190)	53.43 (1169)	0.1803
Race/Ethnicity			<.0001
Non-Hispanic white	68.89 (4033)	54.91 (537)	
Non-Hispanic black	10.43 (1851)	18.36 (585)	
Hispanic	13.33 (2712)	23.49 (842)	
Asian/Multi-/Other	7.35 (1129)	3.24 (92)	
Education			<.0001
<HS Diploma	12.35 (1818)	25.52 (708)	
HS Diploma	25.66 (2564)	33.28 (621)	
> HS Diploma	61.99 (5201)	41.20 (687)	
Income			<.0001
<100% FPL[a]	9.99 (1324)	35.04 (839)	
100–199% FPL	15.14 (1700)	33.76 (597)	
≥200% FPL	74.88 (5672)	31.20 (438)	
Census Region			0.1261
Northeast	18.27 (1711)	18.00 (335)	
Midwest	22.12 (1731)	19.18 (328)	
South	35.99 (3472)	42.08 (852)	
West	23.62 (2802)	20.75 (539	
Rural Residence	13.94 (1139)	16.80 (274)	0.1665
Insurance			<.0001
Private	68.31 (5559)	34.95 (507)	
Medicare	9.86 (863)	11.16 (228)	
Other Public	6.67 (1046)	19.15 (490)	
Uninsured	15.16 (2096)	34.74 (778)	
Health Conditions			
Heart Disease	15.62 (1291)	19.49 (325)	0.0077
Diabetes	8.30 (891)	12.46 (266)	<.0001
Respiratory illness	10.91 (978)	19.25 (331)	<.0001
Hypertension	36.23 (3401)	39.59 (805)	0.0749

% presented are weighted, not directly calculable from N

[a]FPL = Federal Poverty Level

Data Source: 2011 National Health Interview Survey and 2012–2013 Medical Expenditure Panel Survey

Sample: Adults (age > 18 years at time of NHIS completion)

Table 2:

Adjusted Differences in Healthcare Utilization, by Food Security Status

	Emergency Department Visits			Inpatient Admissions			Hospital Days		
	IRR (95% CI)	**Difference in events/year**	**p**	**IRR (95% CI)**	**Difference in events/year**	**p**	**IRR (95% CI)**	**Difference in events/year**	**p**
Main analyses, without clinical characteristics									
Food Insecure	1.47 (1.12 – 1.93)	0.14	0.006	1.47 (1.14 – 1.88)	0.04	0.003	1.54 (1.06 – 2.24)	0.29	0.02
Food Secure	ref	--	ref	ref	--	ref	ref	--	ref
Sensitivity analyses, with clinical characteristics									
Food Insecure	1.41 (1.12 -- 1.78)	0.19	0.004	1.28 (1.01 --1.61	0.04	0.04	1.61 (1.12 --2.31	0.45	0.01
Food Secure	ref	--	ref	ref	--	ref	ref	--	ref

*all results from zero-inflated negative binomial regression model adjusted for age, age squared, gender, race/ethnicity, education, income, health insurance, region, and rurality, and accounting for survey design characteristics. Sensitivity analyses further adjust for the presence of heart disease, diabetes mellitus, respiratory illness, and hypertension

Differences in events per year reflected model predictions (predictive margins)

Data Source: 2011 National Health Interview Survey and 2012–2013 Medical Expenditure Panel Survey

Sample: Adults (age > 18 years at time of NHIS completion)