Food Insecurity and Child Health

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abstract

OBJECTIVES: Food insecurity is an important public health problem facing children in the United States. Although a number of previous studies suggest that food insecurity has negative impacts on health, these studies have not dealt thoroughly with issues of selection bias. We use propensity scoring techniques to approximate the causal effects of food insecurity on children's health and health care use outcomes.

METHODS: We use nationally representative data from the 2013–2016 waves of the National Health Interview Study (N = 29 341). Using inverse probability of treatment weighting, a propensity scoring method, we examine a broad range of child health outcomes and account for a comprehensive set of controls, focusing on a sample of children 2 to 17 years old.

RESULTS: Household food insecurity was related to significantly worse general health, some acute and chronic health problems, and worse health care access, including forgone care and heightened emergency department use, for children. Compared to rates had they not been food insecure, children in food-insecure household had rates of lifetime asthma diagnosis and depressive symptoms that were 19.1% and 27.9% higher, rates of foregone medical care that were 179.8% higher, and rates of emergency department use that were 25.9% higher. No significant differences emerged for most communicable diseases, such as ear infections or chicken pox, or conditions that may develop more gradually, including anemia and diabetes.

CONCLUSIONS: Policies used to reduce household food insecurity among children may also reduce children's chronic and acute health problems and health care needs.

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Ms Thomas conducted the analysis, drafted the initial manuscript, and reviewed and revised the manuscript; Dr Miller contributed to the analysis, assisted in the interpretation of results, and drafted sections of the manuscript; Dr Morrissey assisted in the interpretation of results and drafted sections of the manuscript; and all authors contributed to the conceptual design of the study, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

DOI: https://doi.org/10.1542/peds.2019-0397

Accepted for publication Jul 15, 2019

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

WHAT'S KNOWN ON THIS SUBJECT: A large body of research suggests that food insecurity negatively affects health. Most studies have not adequately accounted for selection factors associated with the experiences of both food insecurity and poor health, which is necessary to estimate causal associations.

WHAT THIS STUDY ADDS: Using nationally representative data and quasi-experimental analysis techniques, we find that food insecurity affects children's health in a number of negative ways.

To cite: Thomas MMC, Miller DP, Morrissey TW. Food Insecurity and Child Health. *Pediatrics.* 2019;144(4): e20190397

Food insecurity is a persistent social problem. In 2017, 11.8% of US households (~15 million) were food insecure, meaning that members lacked "enough food for an active, healthy life."[1] Although food insecurity rates have dropped since 2011, current levels are still as high or higher than at any point in the 10 years before the Great Recession.[1] Food insecurity is especially prevalent among low-income families with children. Nearly 35% of households with children and incomes below 185% of the federal poverty level (FPL) were food insecure in 2017 compared to <6% among more affluent households.[1]

Eradicating food insecurity is important for many reasons. Researchers often point to deleterious consequences of food insecurity among children to justify attention to the problem. In particular, researchers frequently cite early work finding food insecurity to be associated with a slew of negative outcomes for children, including worse general health, increased use of emergency department (ED) services, worse academic performance, poorer social outcomes, and anxiety and depression.[2–5] Food insecurity may negatively affect children's acute and chronic health in both direct and indirect ways. In the case of very low food security, reductions in food amount or quality or disrupted eating patterns may lead to poorer weight outcomes and immune system functioning.[1,6] Even when children do not experience reduced food intake, however, they may have poorer nutrition or eat lower-quality food[7] because food-insecure households are more likely to have tight budget constraints and purchase cheaper, energy-dense foods.[8] The stress produced by food insecurity may be directly related to mental health outcomes such as depression[9,10] and may indirectly impact physical health through compromised immune functioning.[11,12] Finally, previous evidence suggests food insecurity may impact children's health care use because children who are food insecure have a greater risk of hospitalization since birth,[13] and food-insecure households have higher mean health care expenditures ($6072) than that of food-secure households ($4208), amounting to $77.5 billion a year.[14]

However, most previous research used to examine the links between food insecurity and child health is based on regression analyses with only limited control for potential confounders. For example, the authors of a majority of studies in this area use convenience samples of children or primary caregivers and control for a handful of child and caregiver characteristics including demographics, education and employment, and receipt of benefits from public assistance and nutrition assistance programs.[2,3,5,7,13] However, for regression analyses to generate causal estimates of the effects of food insecurity on health, one must assume that the regression controls for all potential confounding factors[15]; yet, food insecurity is a complex social phenomenon whose causes are not fully understood. As a result, food-insecure and food-secure households are likely to be different in both observable and unobservable ways. In turn, results from simple regressions are likely biased, and the nature and degree of this bias are not immediately clear.[15] Understanding the degree to which food insecurity affects the health of children or other household members is key both to making the case for its elimination and also to the design of effective social programs. Given the quality of available evidence, authors of a recent review called for researchers to more clearly identify the causal effects of food insecurity.[16]

Taking advantage of the recent inclusion of a measure of household food insecurity in the nationally representative National Health Interview Survey (NHIS), we use propensity scoring (PS) methods to investigate the effects of food insecurity on children's health. PS, a quasi-experimental family of methods, seeks to mimic the context of an experimental design by comparing outcomes among children who differ with respect to the household's food insecurity but who are alike in all other observable ways. Because of the highly detailed nature of the information available in the NHIS, we are able to use this method to create a sample that is balanced with respect to many of the known predictors of food insecurity, an important improvement over previous work.

METHODS

Data

In this study, we drew on a nationally representative sample of households with children from the NHIS using data harmonized by the Integrated Public Use Microdata Series.[17] The NHIS collects data on an extensive set of health, health behavior, and health care topics in addition to a robust set of sociodemographic and contextual factors. Core data are available about all household members, and more detailed information is gathered about 1 randomly selected sample adult and, if present, 1 randomly selected sample child.[18] Questions on household food insecurity were added to the NHIS in 2011.

Study Population

We examined a sample of children ages 2 to 17 drawn from the 2013–2016 NHIS surveys. Data were pooled to ensure a sufficient sample size, and 2013 was selected as the starting point of the study period because valuable data on respondents' neighborhoods were introduced to the survey in that year and because food insecurity was at historically high levels after the Great Recession.[1] During this period,

35 651 sample children ages 2 to 17 were surveyed in households with sample adults. Of this eligible sample, we omitted observations missing information on food insecurity (n = 8), health outcomes (n = 819), or covariates (n = 5483) (primarily household income). Our final analytic sample was composed of 29 341 sample children with complete data on an extensive set of health outcomes and covariates derived from the sample child, sample adult, and core household surveys.

Measures

Food Insecurity

Drawing on household-level responses to the 10-item version of the US Department of Agriculture (USDA) 30-day food security measure, which captures food insecurity among household adults, we constructed a binary variable indicating that children lived in food-insecure households.[1] The USDA recommends the 10-item scale to measure food insecurity in household with and without children.[19] In line with the USDA measure, we categorized households as food insecure if they affirmed ≥3 of the 10 food insecurity items.[1,19] Over the study period, 4080 children (13.9%) lived in a food-insecure household.

Child Health Outcomes

Capitalizing on the wealth of health and health care information available in the NHIS, we examined an array of children's health outcomes, which we organized into 4 domains: general health, chronic health, acute health, and health care access. For parent-reported general health, we tested 2 measures: an ordinal measure of health (1–5, with 1 being poor and 5 being excellent) and a 0 to 1 indicator for very good and/or excellent health. In the other domains, outcomes included (0–1) indicators for children's lifetime experience of chronic conditions such as asthma and diabetes; experience in the past 2 weeks of acute conditions such as respiratory or stomach problems; and experience in the past year of health care access issues, such as needing but being unable to afford medical care.

Covariates

The NHIS also includes a rich set of background information about families, including demographic characteristics, economic information, public program participation, and adult physical and mental health outcomes. Reflecting established practice,[20,21] for our PS analyses described below, we selected an extensive range of covariates (presented in Supplemental Table 3) that have been identified as predictors of food insecurity or child health in previous research.[22–26] An essential purpose of PS methods is to model the relationship between such covariates and putative causes like household food insecurity to estimate the independent effect of such causes on outcomes.[21] The availability in the NHIS data of such a wide range of measured covariates enabled us to account for individual (eg, race, US citizenship), household (eg, adult depression, public program participation), and neighborhood factors (eg, tenure, social cohesion).

Analysis

We estimated the effects of food insecurity on children's health outcomes using PS methods. The goal of PS is to simulate randomized treatment assignment to estimate treatment effects in observational data. To do so, such methods model the probability of treatment (food insecurity) as a function of a set of salient covariates,[20,27] which are listed in Supplemental Table 3. The resulting variable, called the propensity score, is a single-number summary of the probability of treatment conditional on the values of the covariates. The successful application of PS balances treatment and control groups in observational data such that, conditional on the PS, treatment assignment is independent of all measured covariates.[20] Because PS approximates random assignment, the literature on PS methods uses causal language,[20,27] referring to model estimates as average treatment effects (ATEs), a convention we adopt in this study.

When appropriate, PS methods are preferable to traditional regression methods for several reasons. First, specifying the PS model requires no inclusion of or reference to the outcome of interest, allowing for unbiased accounting of confounding without consideration of the impact of covariates on the outcome. This separation of study design from study analysis preserves the independence of research design and enhances validity.[20] Second, PS methods allow the researcher to examine directly the balance of measured covariates between treatment and control groups and the overlap of the distributions of those covariates.[28] In contrast, there are no similar mechanisms to test whether traditional regression methods eliminate confounding.[20]

This study employed inverse probability of treatment weighting (IPTW), 1 of several PS methods. IPTW applies weights on the basis of PS in a manner similar to traditional survey weighting. The use of IPTW creates a synthetic sample, such that treatment assignment in the weighted sample is independent of measured covariates.[28] This simulation of random treatment assignment affords the opportunity to examine directly the effects of treatment on outcomes of interest. Reflecting best practice in the use of IPTW, we examined measures of balance including weighted standardized differences and overlap of the distributions of continuous covariates to ensure accurate specification of the PS model before conducting main analyses.[28] Examination of the IPTW-weighted standardized differences can be used

to assess the success of the PS process in creating comparable treatment and comparison groups. Although there is no definitive cutoff for determining successful balance, previous research suggests that standardized differences less than an absolute value of 0.10 indicate good balance.[28] After assessing balance, we examined IPTW estimates of the impact of food insecurity on children's health and health care access. We calculated effect sizes by dividing the ATE by the expected outcome level for children in the treatment group had they not experienced food insecurity, which is derived from the IPTW model.

RESULTS

Table 1 presents sample descriptive statistics for the full sample and unweighted food-secure and food-insecure subsamples, including prevalence of all child health outcomes. Of note, children in households with incomes <100% of the FPL make up 20% of the full sample, just 16% of the food-secure sample, and 46% of the food-insecure sample. Most children were of white non-Latinx ethnicity, just over 25% were of Latinx ethnicity, and children were ~10 years old, on average. Average households received Supplemental Nutrition Assistance Program (SNAP) benefits for 2 to 3 months per year. Supplemental Table 3 is used to present unweighted and IPTW weighted standardized differences in means, which quantify differences between the food-secure and food-insecure samples before and after propensity score weighting, respectively. Results from this analysis reveal that the application of IPTW created balance between the 2 samples. Whereas there were sizeable discrepancies in standardized differences in means between the unweighted food-secure and food-insecure subsamples, the weighted samples were balanced on all of these covariates, with no standardized difference measures >0.10.

In Table 2, we provide the ATE of food insecurity for each outcome from our IPTW models as well as effect sizes. These results reveal that food insecurity predicted poorer health outcomes across all domains. Children in food-insecure households had worse general health (a difference of 2.5%) and were less likely to be in very good or excellent health (3.1%) compared with peers in food-secure households. In terms of health care use, food insecurity predicted more ED visits among children (25.9%). In addition, children in food-insecure households were far more likely to delay medical care because of cost (146.5%) and to need but be unable to afford medical (179.8%), dental (105.5%), and mental health care (114.3%). Children in food-insecure households were more likely to experience some chronic health conditions, including a lifetime diagnosis of asthma (16.3%), current diagnosis of asthma (19.1%), experience of eczema or other skin allergies (49.3%), and experience of depressive symptoms (27.9%). Although no significant differences emerged in past-year acute health conditions, children in food-insecure families were more likely in the past 2 weeks to have had a cold (21.8%) and to have had stomach problems (41.2%).

DISCUSSION

The results of this study reveal the deleterious effects of household food insecurity on children's health. Our findings point to a unique and negative effect of household food insecurity on child health that is not due to the composition of their homes, the safety of the neighborhoods, their receipt of public assistance, or their household income (see Supplemental Table 3). In doing so, our study joins the small number of previous studies in which authors have used rigorous methods such as bounding or instrumental variables[29] to demonstrate that food insecurity causes poor health. Using a rich, nationally representative data set of US children and PS techniques, we were better able to assess the causal impact of food insecurity on key domains of child health and health care use. Notably, in our analyses, we compared the outcomes of children in food-secure homes to those in food-insecure homes who were alike with respect to race and ethnicity, household income, adult physical and mental health, participation in food and nutrition assistance programs, neighborhood quality, and adult health behaviors, among others.

Our findings point to pervasive negative impacts of household food insecurity on children's health. We found that children in food-insecure homes face probabilities of delayed or forgone health care that are between 2 to 3 times higher (effect sizes between 105% and 180%) than they would have been had they been food secure. Also consistent with other work,[7] we found that food insecurity leads to an increase in ED visits of 25.9%. Our results are also consistent with other research that finds higher rates of health care use among children in food-insecure families.[13] Authors of recent research suggest SNAP participation may reduce health care costs by as much as 25% among low-income adults, which, coupled with our findings, suggests that a cost-benefit analysis of SNAP's effects on reducing food insecurity and related reductions in ED use could be warranted.[30]

Our results also lend support to previous correlational findings that identify the negative impact of food insecurity in childhood on short- and long-term health outcomes.[3,5,9,29,31–35] For instance, our results are consistent with previous findings that children in food-insecure households are less likely to be in good or excellent health and are at higher risk for asthma and for internalizing behavior issues, such as depressive symptoms, compared

TABLE 1 Unweighted Sample Descriptive Statistics and Health Outcomes of Children Living in Food-Secure and Food-Insecure Households, NHIS 2013–2016 (N = 29 341)

	Full Sample (N = 29 341)		Food Secure (n = 25 261)		Food Insecure (n = 4080)	
	Mean or %	SD	Mean or %	SD	Mean or %	SD
Sample characteristics						
Survey year, %						
2013	25.6	—	25.0	—	30.0	—
2014	27.3	—	27.0	—	28.0	—
2015	24.8	—	25.0	—	23.0	—
2016	22.3	—	23.0	—	19.0	—
Region of residence, %						
Northeast	14.7	—	15.0	—	14.0	—
North-central and/or Midwest	20.3	—	21.0	—	17.0	—
South	35.6	—	35.0	—	40.0	—
West	29.5	—	30.0	—	29.0	—
Child race and ethnicity, %						
White, non-Latinx	50.5	—	53.0	—	34.0	—
African American, non-Latinx	14.0	—	13.0	—	23.0	—
Asian American, non-Latinx	5.8	—	6.0	—	2.0	—
Other, non-Latinx	2.5	—	2.0	—	4.0	—
Latinx, any race	27.3	—	26.0	—	37.0	—
Family income–to-poverty ratio, %						
Less than 100% FPL	19.8	—	16.0	—	46.0	—
100%–200% FPL	23.3	—	21.0	—	35.0	—
200%–400% FPL	28.8	—	31.0	—	17.0	—
400% or greater FPL	28.0	—	32.0	—	2.0	—
Female child (versus male), %	48.5	—	48.5	—	48.3	—
No. children under 18 in family	1.95	1.01	1.93	0.99	2.04	1.15
Child lives with mother and father, %	64.9	—	68.4	—	43.4	—
Sample adult in very good and/or excellent health, %	63.7	—	67.7	—	39.5	—
Child age, y	9.65	4.69	9.623	4.69	9.84	4.65
Child is a US citizen, %	95.4	—	95.5	—	94.7	—
Child ever attended Head Start, %	23.0	—	20.7	—	37.3	—
Average work of adults in family, h/wk	29.33	15.15	30.57	14.61	21.66	16.16
No. family members receiving SSI	0.06	0.30	0.05	0.26	0.16	0.46
No. family members receiving SSDI	0.04	0.21	0.03	0.18	0.10	0.32
No. family members receiving nondisability Social Security benefits	0.08	0.36	0.08	0.36	0.10	0.39
No. family members receiving income from assets	0.36	0.82	0.41	0.86	0.07	0.36
No. mo family received SNAP	2.51	4.69	2.00	4.31	5.68	5.63
Family rents home (versus owns), %	39.7	—	35.3	—	67.4	—
No. times adult(s) in family needed but could not afford health care (0–7)[a]	0.47	1.14	0.34	0.94	1.31	1.77
No. family members receiving WIC benefits	0.16	0.52	0.14	0.49	0.27	0.65
Index of neighborhood quality[b]	3.04	0.84	3.10	0.81	2.65	0.91
Child does not have health insurance, %	5.9	—	5.3	—	9.7	—
No. family members with any functional limitation	0.35	0.70	0.29	0.63	0.70	0.95
No. children needing special education and/or early intervention services	0.16	0.44	0.14	0.42	0.26	0.56
Index of sample adult anxiety and/or depression symptoms[c]	0.44	0.66	0.36	0.57	0.9	0.92
Any family member is a veteran, %	10.4	—	10.9	—	7.2	—
No. family members born outside of the United States	0.65	1.15	0.64	1.14	0.75	1.25
Sample adult No. drinks when drinking	1.61	2.12	1.61	2.09	1.60	2.30
Sample adult No. cigarettes per d	1.87	5.33	1.60	4.94	3.53	7.08
Child has learning disability, developmental delay, and/or intellectual disability, %	9.1	—	8.0	—	16.1	—
Average mo member(s) of family received cash welfare (TANF, GA, and/or cash assistance)	0.36	1.92	0.27	1.66	0.91	3.01
Average age of adults in family, y	39.24	8.56	39.44	8.52	38.01	8.71
Child health outcomes						
General health[d]						
Child health status (1–5; poor to excellent)	4.41	0.79	4.46	0.76	4.10	0.93
Child is in very good and/or excellent health (0–1), %	84.6	—	86.6	—	72.0	—
Health care use[d]						
Child No. ED visits (0–4+)	0.23	0.57	0.21	0.54	0.37	0.72
Child saw a mental health provider (0–1), %	8.3	—	7.5	—	13.2	—
Child No. medical office visits (0–6+)	1.95	1.12	1.94	1.11	2.03	1.22

TABLE 1 Continued

	Full Sample (N = 29 341)		Food Secure (n = 25 261)		Food Insecure (n = 4080)	
	Mean or %	SD	Mean or %	SD	Mean or %	SD
Child medical care delayed because of cost (0–1), %	2.6	—	1.9	—	7.0	—
Child needed but could not afford medical care (0–1), %	1.6	—	1.0	—	4.9	—
Child needed but could not afford dental care (0–1), %	4.7	—	3.6	—	11.7	—
Child needed but could not afford mental health care (0–1), %	0.8	—	0.5	—	2.7	—
Child time since last doctor's visit (<6 mo to never), mo	0.41	0.88	0.41	0.87	0.45	0.95
Child received flu vaccine (0–1), %	47.7	—	47.9	—	46.4	—
Chronic health conditions,[d] %						
Child depressive symptoms (past 6 mo) (0–1)[e]	11.1	—	9.7	—	19.5	—
Child ever diagnosed with ADHD or ADD (0–1)	8.6	—	7.8	—	13.7	—
Child ever diagnosed with asthma (0–1)	15.0	—	14.0	—	21.1	—
Child currently has asthma (0–1)	9.7	—	8.9	—	15.0	—
Child ever diagnosed with diabetes (0–1)	0.2	—	0.2	—	0.3	—
Child had respiratory allergy (0–1)	11.6	—	11.0	—	15.4	—
Child had skin allergy (0–1)[f]	12.5	—	12.0	—	16.0	—
Child had food allergy (0–1)	6.1	—	5.8	—	7.5	—
Acute health conditions,[d] %						
Child had cold (past 2 wk) (0–1)	15.4	—	14.5	—	20.5	—
Child ever had chicken pox (0–1)	10.7	—	10.5	—	12.2	—
Child had chicken pox (0–1)	0.2	—	0.2	—	0.4	—
Child had diarrhea (0–1)	1.4	—	1.2	—	2.7	—
Child had anemia (0–1)	1.2	—	1.0	—	2.2	—
Child had 3+ ear infections (0–1)	4.7	—	4.3	—	7.0	—
Child had stomach problem with vomit and/or diarrhea (past 2 wk) (0–1)	5.2	—	4.7	—	7.8	—

ADD, attention deficit disorder; ADHD, attention-deficit/hyperactivity disorder; GA, General Assistance; SSDI, Social Security Disability Insurance; SSI, Supplemental Security Income; TANF, Temporary Aid for Needy Families; WIC, Women, Infants, and children; —, not applicable.

[a] This variable sums household adults' forgone care in 7 domains: medical, dental, vision, mental health, medication, follow-up, and specialist care.

[b] This variable indexes 4 indicators of neighborhood quality, with 1 being low and 4 being high: neighborhood is close-knit, people in the neighborhood can be counted on, people in the neighborhood can be trusted, and people in the neighborhood help each other out.

[c] This variable indexes symptoms of nonspecific psychological distress among household adults, including feelings of unresolvable sadness, nervousness, restlessness, hopelessness, worthlessness, feeling everything was an effort, and feelings interfering with life.[41]

[d] The reference period for all outcomes is the past year unless otherwise specified.

[e] The indicator for child depressive symptoms is 1 if the child is reported to be often depressed, unhappy, or tearful and 0 if the child is reported not to be often depressed, unhappy, or tearful.[42]

[f] The indicator for skin allergy is 1 if the child is reported to have eczema or another skin allergy and 0 if not.

with children in food-secure households.[5,7,29,31] Our IPTW results point to rates of ever having been diagnosed with asthma, current asthma diagnosis, and of depressive symptoms that are, respectively, 19.1%, 16.3%, and 27.9% higher than if children had not experienced food insecurity.

Finally, our findings regarding chronic health outcomes (eg, higher rates of asthma, depressive symptoms, and eczema and other skin allergies) among children in food-insecure households suggest the role of stress related to material hardship and food insecurity as a factor directly affecting children's mental health[36] and reinforce previous research that suggests parental stress and depression related to food insecurity affect children's health and development.[9,37,38] Stress may also depress immune functioning[11,12] and thus lead to more communicable diseases, such as the higher rates of recent (past 2 weeks) cold and stomach problems we found among children in food-insecure families. We did not, however, find differences in rates of past-year diarrhea, which is likely also caused by communicable disease. Although we also found no differences in rates of anemia and diabetes, these health outcomes are both relatively rare in children and may develop gradually over time, which likely explains the limited effects of a cross-sectional measure of food insecurity on these outcomes. In addition, food insecurity is often experienced transiently rather than chronically,[39] which may explain why we do not find impacts on some chronic or severe health outcomes.

Despite its strengths, this study also has limitations. First, although PS methods offer important advantages over typical regression analyses, they only help to address confounding from observed sources and do not address the potential threats to causal inferences that originate from unobserved differences between food-insecure and food-secure children or their families. Nonetheless, in drawing on a sample that was balanced to address confounding from an extensive set of factors, the current study is a major improvement over a great deal of previous research. Another limitation of this study stems from the cross-sectional nature of the data.

TABLE 2 ATE of Food Insecurity on Children's Health Outcomes (N = 29 341)

Outcome[a]	ATE	95% CI	Effect Size,[b] %
General health			
Child health status (1–5; poor to excellent)	−0.110*	−0.158 to −0.059	−2.45
Child in very good and/or excellent health (0–1)	−0.030*	−0.044 to −0.008	−3.11
Health care use			
Child No. ED visits (0–4+)	0.060*	0.016 to 0.105	25.88
Child saw mental health provider (0–1)	−0.001	−0.014 to 0.012	—
Child No. medical office visits (0–6+)	0.040	−0.057 to 0.137	—
Child medical care delayed due to cost (0–1)	0.030*	0.023 to 0.043	146.53
Child needed but could not afford medical care (0–1)	0.020*	0.016 to 0.031	179.83
Child needed but could not afford dental care (0–1)	0.040*	0.030 to 0.058	105.5
Child needed but could not afford mental health care (0–1)	0.010*	0.004 to 0.011	114.31
Child time since last doctor's visit (<6 mo to never)	−0.150	−0.057 to 0.027	—
Child received flu vaccine (0–1)	−0.020	−0.058 to 0.020	—
Chronic health conditions			
Child depressive symptoms (past 6 mo) (0–1)	0.030*	0.010 to 0.050	27.91
Child ever diagnosed with ADHD or ADD (0–1)	−0.005	−0.015 to 0.006	—
Child ever diagnosed with asthma (0–1)	0.025*	0.001 to 0.048	16.28
Child currently has asthma (0–1)	0.020*	0.001 to 0.037	19.1
Child ever diagnosed with diabetes (0–1)	0.000	−0.002 to 0.001	—
Child had respiratory allergy (0–1)	0.030	−0.005 to 0.059	—
Child had skin allergy (0–1)	0.060*	0.022 to 0.101	49.34
Child had food allergy (0–1)	0.030	−0.006 to 0.057	—
Acute health conditions			
Child had cold (past 2 wk) (0–1)	0.030*	0.008 to 0.058	21.81
Child ever had chicken pox (0–1)	0.010	−0.019 to 0.031	—
Child had chicken pox (0–1)	0.010	−0.007 to 0.037	—
Child had diarrhea (0–1)	0.010	−0.003 to 0.016	—
Child had anemia (0–1)	0.003	−0.002 to 0.008	—
Child had 3+ ear infections (0–1)	0.010	−0.002 to 0.022	—
Child had stomach problem with vomit and/or diarrhea (past 2 wk) (0–1)	0.020*	0.001 to 0.040	41.22

ADD, attention deficit disorder; ADHD, attention-deficit/hyperactivity disorder; CI, confidence interval; —, not applicable.

[a] The reference period for all outcomes is the past year unless otherwise specified.

[b] Effect sizes describe the predicted ATE of living in a food-insecure household divided by the predicted outcome level had children not experienced food insecurity.

* $P < .05$.

Specifically, it is possible that reverse causality is occurring, wherein poor child health leads to food insecurity, such as when a parent reduces work hours or exits the labor force to take care of an ill child. Additionally, the food insecurity measure captures household food insecurity in the past 30 days, whereas the child health outcomes are primarily measured over the past year. The household food insecurity measure is correlated with child food insecurity and the USDA recommends its use for households with children[19,40]; however, future research using longitudinal data and including child-specific food insecurity could address these limitations.

CONCLUSIONS

Establishing the independent impact of food insecurity on child health serves to guide efforts to prevent food insecurity and ameliorate its consequences. We find there are clear and consistent harmful impacts of food insecurity on children's general health, chronic health, acute health, and access to health care, suggesting the urgent need for action. Policy and program responses to the immediate consequences of food insecurity might include increasing SNAP benefits broadly for families with very low food security and introducing supplementary benefits for SNAP recipients to make nutrient-dense but more expensive food available to all food-insecure families. With our current study, we offer evidence that without intervention, household food insecurity will likely continue to detrimentally impact children's health.

ABBREVIATIONS

ATE: average treatment effect
ED: emergency department
FPL: federal poverty level
IPTW: inverse probability of treatment weighting
NHIS: National Health Interview Survey
PS: propensity scoring
SNAP: Supplemental Nutrition Assistance Program
USDA: US Department of Agriculture

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Pediatrics 2019;144;
DOI: 10.1542/peds.2019-0397 originally published online September 9, 2019;

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DOI: 10.1542/peds.2019-0397 originally published online September 9, 2019;