Title

Household Food Insecurity is Associated with Higher Adiposity among US Schoolchildren Ages 10—15 Years: The Healthy Communities Study

Journal

Journal of Nutrition, 149(9)

ISSN

0022-3166

Authors

Au, Lauren E
Zhu, Sonya M
Nhan, Lilly A
et al.

Publication Date

2019-09-01

DOI

10.1093/jn/nxz108

Peer reviewed

The Journal of Nutrition
Community and International Nutrition

Household Food Insecurity Is Associated with Higher Adiposity among US Schoolchildren Ages 10–15 Years: The Healthy Communities Study

Lauren E Au,[1] Sonya M Zhu,[2] Lilly A Nhan,[3] Kaela R Plank,[1] Edward A Frongillo,[4] Barbara A Laraia,[5] Klara Gurzo,[6] and Lorrene D Ritchie[1]

[1]Nutrition Policy Institute, Division of Agriculture and Natural Resources, University of California, Berkeley, CA, USA; [2]Maternal, Child, and Adolescent Health Program, School of Public Health, University of California, Berkeley, CA, USA; [3]Department of Community Health Sciences, University of California Los Angeles Fielding School of Public Health, Los Angeles, CA, USA; [4]Department of Health Promotion, Education, and Behavior, University of South Carolina, Columbia, SC, USA; [5]Public Health Nutrition Program, School of Public Health, University of California, Berkeley, CA, USA; and [6]Department of Public Health Sciences, Stockholm University, Stockholm, Sweden

ABSTRACT

Background: Limited research exists on the relationship between food insecurity and children's adiposity and diet and how it varies by demographic characteristics in the United States.

Objective: The aim of this study was to assess the relationship between household food insecurity and child adiposity-related outcomes, measured as BMI (kg/m^2) *z* score (BMI-*z*), weight status, and waist circumference, and diet outcomes, and examined if the associations differ by age, sex, and race/ethnicity.

Methods: Data collected in 2013–2015 from 5138 US schoolchildren ages 4–15 y from 130 communities in the cross-sectional Healthy Communities Study were analyzed. Household food insecurity was self-reported using a validated 2-item screener. Dietary intake was assessed using the 26-item National Cancer Institute's Dietary Screener Questionnaire, and dietary behaviors were assessed using a household survey. Data were analyzed using multilevel statistical models, including tests for interaction by age, sex, and race/ethnicity.

Results: Children from food-insecure households had higher BMI-*z* (β: 0.14; 95% CI: 0.06, 0.21), waist circumference (β: 0.91 cm; 95% CI: 0.18, 1.63), odds of being overweight or obese (OR: 1.17; 95% CI: 1.02, 1.34), consumed more sugar from sugar-sweetened beverages (β: 1.44 g/d; 95% CI: 0.35, 2.54), and less frequently ate breakfast (β: −0.28 d/wk; 95% CI: −0.39, −0.17) and dinner with family (β: −0.22 d/wk; 95% CI: −0.37, −0.06) compared to children from food-secure households. When examined by age groups (4–9 and 10–15 y), significant relationships were observed only for older children. There were no significant interactions by sex or race/ethnicity.

Conclusions: Household food insecurity was associated with higher child adiposity-related outcomes and several nutrition behaviors, particularly among older children, 10–15 y old. *J Nutr* 2019;149:1642–1650.

Keywords: children, food insecurity, adiposity, obesity, dietary intake, dietary behaviors

Introduction

In 2017, an estimated 11.8% of households in the United States were food insecure, with 6.5 million children living in households where at least 1 child was food insecure (1). Low food security is defined as lacking consistent access to adequate food resulting in reduced quality, variety, or desirability of the diet; very low food security is further defined as having disrupted eating patterns and lower food intake (2). Numerous studies have documented a link between childhood food insecurity and adverse outcomes across multiple domains. Children living in food-insecure households are more likely to have poor-quality diets, lower physical activity, poorer physical and mental health, behavioral problems, and lower academic achievement (3–13).

Research is inconclusive on whether or not household food insecurity is associated with obesity in children (14–16). A life-course perspective suggests that exposure to food insecurity can occur over time and create disparities in obesity (17). For example, in a longitudinal study of US children, Burke et al. (17) found that there was a significant relationship between food insecurity and greater BMI (kg/m^2) growth from kindergarten through eighth grade among females, and the relationship between food insecurity and BMI depends on the life-course stage, with different results when female children were kindergarten age versus in eighth grade. Few studies

Manuscript received January 24, 2019. Initial review completed March 1, 2019. Revision accepted April 29, 2019.
First published online June 7, 2019; doi: https://doi.org/10.1093/jn/nxz108.

note an association between household food insecurity and overweight status for young children of preschool age to 5 y old (18–20), whereas others see a positive relationship only for older children who are from food-insecure households (21, 22). In addition to age, differences by sex have also been observed, with girls in food-insecure homes being at greater risk for weight gain and overweight than boys (13, 18, 22). This may be attributed to the stress of food insecurity affecting females more than males (23). With regard to race/ethnicity, although the likelihood of being overweight or obese is greater for non-Hispanic African-American and Hispanic children than non-Hispanic white and non-Hispanic Asian children (24, 25), there is limited research on racial/ethnic disparities in overweight or obesity by food-insecurity status among children, and findings by race/ethnicity are mixed (22, 26, 27).

Assessing the food insecurity–obesity association also raises questions pertaining to dietary intake and diet related behaviors. The risk of food insecurity is higher among households with incomes at or below the Federal Poverty Level (1), and low-income households are more likely to consume unhealthy foods and beverages, which are often low cost, energy dense, and limited in nutrients (28). Nutrient-dense foods are typically less available and more expensive in low-income communities (29, 30). As such, food-insecure individuals are more likely to derive a higher portion of their energy needs from fat and carbohydrates, eat less protein, and consume fewer fruits and vegetables (14, 31, 32). They are also more likely to eat irregular meals or skip breakfast (33, 34).

Because the evidence regarding the relationship between food insecurity and adiposity among children and adolescents is mixed, it is important that research not only evaluate adiposity-related outcomes, but also investigate the potential mechanisms by which food insecurity may influence adiposity, such as dietary intake or diet related behaviors; however, few studies of food insecurity in children have incorporated both adiposity and diet related outcomes. This study examined the relationship between household food insecurity and adiposity-related outcomes [BMI *z*-score (BMI-*z*), overweight or obese status (assessed from BMI), and waist circumference] among a sample of diverse US schoolchildren. It was hypothesized that household food insecurity would be associated with higher BMI-*z*, higher waist circumference, and higher odds of being overweight or obese, with a greater association for older children (ages 10–15 y) than younger children, girls than boys, and minority racial/ethnic groups than non-Hispanic white children. This study also examined the relationship between household food insecurity and dietary intake and diet related behaviors with the hypothesis that household food insecurity would be associated with less healthy dietary intake and diet related behaviors.

This research was supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under award number K01HL131630. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The funding source had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. The authors acknowledge the Global Food Initiative at the University of California Office of the President for their support of this project.

Author disclosures: LEA, SMZ, LAN, KRP, EAF, BAL, KG, and LDR, no conflicts of interest.

Supplemental Table 1 is available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/jn/.

Address correspondence to LEA (e-mail: leau@ucanr.edu).

Abbreviations used: BMI-*z*, BMI *z* score; DSQ, Dietary Screener Questionnaire; HCS, Healthy Communities Study; lasso, least absolute shrinkage and selection operator; NCI, National Cancer Institute; SSB, sugar-sweetened beverage.

Methods

Participants

The Healthy Communities Study (HCS) was an observational study from 2013 to 2015 of US schoolchildren ages 4–15 y, which was designed to assess how community programs and policies targeting child obesity are related to diet, weight status, and physical activity (35). A logic model of HCS is illustrated in Ritchie et al. (36)

Data were collected on 5138 children from kindergarten through eighth grade. The HCS used a hybrid sampling method for selecting communities to maximize variation in community childhood obesity programs and policies (37). From the national probability-based sample of 195 communities and 69 additional communities termed certainty communities, which were selected based on their known programs and policies addressing childhood obesity, 130 diverse US communities were selected (102 randomly selected communities and 28 certainty communities). A community was defined as a high school catchment area. The probability-based sampling was proportional to the number of children ages 4–15 y in each census tract, such that communities were randomly selected with probability proportional to size. The HCS was designed to oversample communities with high proportions of low-income and African-American and Hispanic/Latino communities as these populations are at higher risk for obesity (37). To develop a stratification variable related to income, the HCS adopted the US Department of Housing and Urban Development designation of Qualified Census Tracts for purposes of the Low-Income Housing Tax Credit program (37). Minority tracts were defined as having at least 30% of the community population being African American or Hispanic (37).

Within HCS communities, up to 2 public elementary and 2 public middle schools were recruited. Child participants were selected from participating households if they met the study's recruitment goals related to sex, age, and race/ethnicity. At the household level, 67.9% of those who agreed to participate completed visits (38). The sampling is further discussed in Strauss et al. and the recruitment outcomes are outlined in Sagatov et al. (37, 38).

Measures

The HCS protocol included assessment of child dietary intake, anthropometry, physical activity, and demographics. More detailed descriptions on the entire set of measures used are provided in papers on the HCS methods (35–41). Trained field data collectors, who were residents of the study communities or lived nearby, conducted home visits to collect household- and child-level data. The visit included a household survey, which was completed by a primary respondent determined by the child's age: parent/adult caregiver proxy for children 4–8 y old with child assistance; children 9–11 y old with adult assistance; and children 12–15 y old with input from adult only if needed. Demographic questions were answered solely by the parent/adult caregiver, and included items on parent educational attainment, employment status, race, ethnicity, household income, and food insecurity (36).

Food insecurity

A validated 2-item screener was used to identify families at risk for food insecurity (42). The screener items were derived from the USDA 18-item Household Food Security Survey. HCS parents/adult caregivers responded on a 5-point Likert scale (very often, often, sometimes, rarely, or never) to the following questions: *1*) "Within the past 12 months we worried whether our food would run out before we got money to buy more" and *2*) "Within the past 12 months the food we bought just didn't last and we didn't have money to get more." Households were classified as food insecure if responses were affirmative (very often, often, or sometimes) to one or both of the items.

Adiposity-related outcomes

To assess adiposity, field data collectors took measurements of children's weight, height, and waist circumference according to standard NHANES procedures (43), which were adapted for the home setting (40). While neither BMI nor waist circumference accurately measure body fat mass, previous research on children suggests that high BMI is an adequate measure of weight status and waist circumference is an adequate measure of central adiposity (44–47). By using CDC growth charts (48), BMI was adjusted for age and sex to create a BMI-z for each child, and children were categorized as overweight or obese if their BMI was at the 85th percentile or greater for age and sex. Biologically implausible values and observations with measurement issues were excluded. For a full description of the anthropometric protocol, see Sroka et al. (40)

Dietary intake and diet related behaviors

The Dietary Screener Questionnaire (DSQ), a 26-item food frequency questionnaire developed by the National Cancer Institute (NCI) was administered during household visits (49). Prior studies have evaluated the DSQ, and found that it is an acceptable tool to measure dietary intake among a nationally representative sample of the US population (50) and among a diverse population of children in the HCS sample (51). The DSQ assesses intake on selected foods consumed as meals or snacks at home, school, or elsewhere over the past 30 d in number of times per day, week, or month. NCI-generated scoring algorithms were used to convert reported frequencies to estimated quantities of select food groups and nutrients, based on age- and sex-specific 24-h dietary recall portion size data from NHANES (52). Dietary intake outcomes included fruits/vegetables/legumes (without fried potatoes), dairy, whole grains, dietary fiber, total added sugar, sugar from sugar sweetened beverages (SSBs), and frequency of consumption of energy-dense foods of minimal nutritional value (e.g., fried potatoes, candy, cookies, desserts, chips, and crackers) (36). The household survey also included questions on children's diet related behaviors within the past week, such as frequency of eating dinner while watching television, eating at a fast food restaurant, eating dinner with family, eating breakfast, and regular consumption of lower-fat milk (skim, 1%, or soy milk).

The Battelle Memorial Institute Institutional Review Board approved the study, and the US Office of Management and Budget approved the study protocol and data collection forms. Participant burden, safety, and study progress were reviewed by an NIH-appointed Observational Study Monitoring Board. Written informed consent for children's participation was obtained from parents/caregivers. The data for this study were provided in de-identified form. For further details on human subject protections, see John et al. (39).

Statistical analysis

To examine the unadjusted associations between household food insecurity and outcomes and covariates of interest, t tests and chi-square tests were performed. Due to the large number of sociodemographic variables available in the dataset and the highly correlated nature of these variables, the least absolute shrinkage and selection operator (lasso) technique was used to determine the model covariates (53). The lasso technique was carried out separately for adiposity and diet related outcomes, resulting in different covariates used in the respective models. The individual-level covariates included in the models were from this set: age, sex, child height, parental employment status, maximum biological mother employment, maximum biological father education, race/ethnicity, annual household income, seasonality of interview (based on sinusoidal curve over time), and/or maximum parental education depending on the outcome variable of interest (adiposity or diet). The community-level covariates included were from this set: US region, urbanicity, proportion of population below the federal poverty level and/or unemployed, and/or whether a minority population (30% or more African American or Hispanic).

Multilevel statistical models were generated to relate food insecurity with adiposity, dietary intake, and diet related behaviors, adjusting for child- and community-level covariates and clustering by school and community levels (37). For binary outcomes, multilevel logistic models were generated. Missing data due to nonresponse were addressed via multiple imputations, which created 20 imputed datasets that were then combined for inference (54).

Since the food insecurity–obesity relationship may differ across subgroups, interactions by child sex, age group (4–9 and 10–15 y old), and race/ethnicity were assessed. The age groups were chosen based on NIH research regarding the onset of puberty, between ages 8 and 13 y for girls and ages 9 and 14 y for boys (55). Reported predicted means (or predicted probabilities for binary outcomes) were determined for all interaction subgroups based on the overall sample and adjusted model for each outcome. For outcomes with an overall significant interaction at the $P < 0.05$ level, pairwise comparisons were conducted and adjusted using Bonferroni corrections for multiple comparisons, thereby decreasing the likelihood of committing a type I error. For pairwise comparisons, significance was set at $P < 0.008$ ($P = \alpha/n = 0.05/6$ groups $= 0.008$). Analyses were conducted in SAS 9.4 (SAS Institute).

Results

The average age of the study sample was about 9 y old (**Table 1**). About half of the sample was female (50.9%), and nearly half of the children were of Hispanic or Latino origin (44.7%). About 40% of the children were categorized as overweight or obese, and distribution of food-security status was fairly even (55.4% food secure). A little more than one-quarter of the children (26.9%) lived in a household with a total annual income <$20,000. About 40% of the children had parents with a maximum education level of high school or less, and nearly three-quarters (73.0%) had at least 1 parent employed full-time. At the community level, about one-third of children (34.8%) lived in a community classified as low income. About 60% of children lived in communities with a census tract minority classification of African American or Hispanic. Geographic region was more concentrated in the South (41.6%) compared to other regions. All adiposity and many dietary intake and dietary behavior variables were significantly different by food-insecurity status in unadjusted analyses.

Household food insecurity was significantly associated with child adiposity measures in both unadjusted and adjusted analyses. In the adjusted analysis, children in food-insecure households had a BMI z-score of 0.14 higher (95% CI: 0.06, 0.21) and a waist circumference of 0.91 cm higher (95% CI: 0.18, 1.63) than children in food-secure households (**Table 2**). Compared to children in food-secure households, children in food-insecure households had 1.17 times the odds of being overweight or obese (adjusted OR: 1.17; 95% CI: 1.02, 1.34). After adjustment for child- and community-level covariates, intake of sugar from SSBs ($P = 0.01$), eating breakfast ($P < 0.0001$), and eating together with family ($P = 0.006$) were significantly associated with food insecurity. Children in food-insecure households consumed on average 1.44 g more per day of sugar from SSBs (95% CI: 0.35, 2.54) than children in food-secure households. For dietary behaviors, on average children in food-insecure households ate breakfast (−0.28 d/wk; 95% CI: −0.39, −0.17) and ate dinner together with family (−0.22 d/wk; 95% CI: −0.37, −0.06) less frequently than children in food-secure households.

The overall interaction terms between food-insecurity status and age group differed significantly for adiposity outcomes

TABLE 1 Demographic, adiposity, and dietary characteristics of children in the Healthy Communities Study by food security status[1]

Characteristic	All children $n = 5138$	Food secure $n = 2845$ (55.4%)	Food insecure $n = 2293$ (44.6%)	P value[2]
Sociodemographic characteristics				
Age, y	9.3 ± 2.7	9.1 ± 2.6	9.4 ± 2.6	<0.0001
Child overweight or obese,[3] %	40.5	34.6	47.8	<0.0001
Female, %	50.9	48.9	53.4	0.001
Child race/ethnicity,[4] %				<0.0001
Non-Hispanic white	29.6	41.4	15	
Non-Hispanic African American	18	15.3	21.5	
Non-Hispanic other	7.7	9.5	5.5	
Hispanic or Latino	44.7	33.9	58.1	
Household annual income, %				<0.0001
<$20,000	26.9	15.5	41.1	
$20,000–35,000	24.5	16.5	34.4	
$35,000–50,000	12.6	11.7	13.6	
$50,000–75,000	10.9	14.1	6.9	
$75,000–100,000	7.8	12.1	2.4	
>$100,000	17.4	30.1	1.7	
Maximum parental education level of biological parents,[5] %				<0.0001
Less than high school	22.7	13.7	33.7	
High school diploma or equivalent	20.2	14.9	26.7	
Some college or Associate degree	25	22.9	27.5	
Bachelor degree	15.3	20.9	8.4	
Graduate degree	16.9	27.5	3.8	
Maximum employment status of biological parents,[6] %				<0.0001
Working full-time for pay now	73	82.3	61.3	
Working part-time for pay now	10.1	7.7	13.1	
Unemployed	6.1	3.5	9.4	
Other	10.9	6.6	16.2	
Community income classification,[7] %				0.001
High	65.2	67.1	62.8	
Low	34.8	32.9	37.2	
US region, %				0.03
Midwest	19.3	20.3	18.1	
Northeast	15.4	15.9	14.8	
South	41.6	39.9	43.7	
West	23.8	24	23.5	
Community minority classification, %				<0.0001
African American	20.6	18.5	23.2	
Hispanic	39.8	33.1	48.1	
Other	39.6	48.4	28.7	
Urbanicity, %				0.60
Rural	22.6	22.8	22.4	
Suburban	39.6	40	39	
Urban	37.8	37.2	38.6	
Outcome variables				
BMI,[8] kg/m^2	20.0 ± 5.4	19.3 ± 5.1	20.9 ± 5.7	<0.0001
BMI-z[8]	0.7 ± 1.2	0.5 ± 1.2	0.9 ± 1.2	<0.0001
Waist circumference,[8,9] cm	69.5 ± 14.9	67.5 ± 13.7	72.0 ± 16.0	<0.0001
Dietary intake outcomes				
Fruit/vegetable/legume, no fried potatoes, cup/d	2.5 ± 0.9	2.5 ± 0.9	2.4 ± 0.9	<0.0001
Whole grains, g/d	20.2 ± 12.3	20.2 ± 11.5	20.2 ± 13.3	0.93
Fiber, g/d	15.5 ± 3.9	15.6 ± 3.8	15.4 ± 4.1	0.03
Dairy, cup/d	2.5 ± 0.8	2.5 ± 0.7	2.5 ± 0.8	0.73
Calcium, mg/d	1110 ± 254	1110 ± 241	1110 ± 269	0.36
Total added sugar, g/d	76.1 ± 31.5	72.7 ± 27.7	80.4 ± 35.2	<0.0001
Sugar from SSBs, g/d	28.0 ± 19.1	25.6 ± 16.5	30.9 ± 21.6	<0.0001
Energy-dense foods of minimal nutritional value, times/d	2.0 ± 1.8	1.9 ± 1.7	2.0 ± 2.0	0.0009

(*Continued*)

TABLE 1 (*Continued*)

Characteristic	All children $n = 5138$	Food secure $n = 2845$ (55.4%)	Food insecure $n = 2293$ (44.6%)	P value[2]
Diet related behaviors				
Eating breakfast,[10] d/wk	6.1 ± 1.8	6.4 ± 1.5	5.9 ± 2.0	<0.0001
Eating dinner with family,[10] d/wk	5.0 ± 2.4	5.3 ± 2.3	4.7 ± 2.6	<0.0001
Eating fast food,[10] d/wk	1.0 ± 1.2	1.0 ± 1.1	1.1 ± 1.2	0.006
Regular consumption of nonfat or 1% milk,[11,12] %	27.7	32	22.5	<0.0001
Eating dinner while watching TV,[13] %	39.2	36	43.1	<0.0001

[1] Households were classified as food insecure if responses were affirmative (very often, often, or sometimes) to one or both of the items on validated 2-item screener derived from the USDA 18-item Household Food Security Survey. Values are means ± SDs or percentages, overall sample size is $n = 5138$ unless otherwise noted, percentages may not add up to 100% due to rounding. BMI-*z*, BMI *z* score; SSB, sugar-sweetened beverage.
[2] Results from chi-square tests for categorical variables or *t* tests for continuous variables.
[3] Overweight/obese includes BMI at ≥85th percentile for age and gender using CDC growth charts (48). Biologically implausible values were excluded.
[4] Child race/ethnicity: other includes non-Hispanic American Indian/Alaska Native; Native Hawaiian/Pacific Islander; Asian; more than 1 race including African American; and more than 1 race not including African American.
[5] Graduate degree includes masters, professional, and doctorate degrees.
[6] Unemployed includes only temporarily laid off, on sick leave or maternity leave, looking for work, unemployed; other includes disabled, keeping house, retired, student, other.
[7] To develop a stratification variable related to income, the HCS adopted the US Department of Housing and Urban Development designation of Qualified Census Tracts for purposes of the Low-Income Housing Tax Credit program (37).
[8] Mean BMI and waist circumference exclude observations with measurement issues.
[9] Waist circumference sample size: $n = 5094$.
[10] Reported frequency in last week.
[11] Reported usually drinking skim, 1%, or soy milk.
[12] Regular consumption of nonfat or 1% milk sample size: $n = 4976$.
[13] Reported often/very often or never/rarely/sometimes.

and 1 dietary behavior (**Table 3**). Children 10–15 y old from food-insecure households had higher BMI-*z* (0.83 versus 0.62; $P < 0.0001$), waist circumference (69.4 cm versus 67.3 cm; $P < 0.0001$), overweight or obesity (44.4% versus 36.9%; $P = 0.0009$), and ate dinner together with their families less frequently (4.4 d/wk versus 4.8 d/wk; $P = 0.0006$) than their food-secure counterparts; no significant associations were seen among food-insecure and food-secure 4–9-y-old children. Interactions between sex or race/ethnicity and food-insecurity status were not found to be statistically significant for any outcomes (**Supplementary Table 1**).

Discussion

Children living in food-insecure households had higher BMI-*z*, waist circumference, and odds of being overweight or obese than children living in food secure households. When examined by age, these associations were true only for older children, consistent with a life-course perspective which emphasizes that obesity does not occur spontaneously but rather develops over time (17). For example, exposure to food insecurity may be associated with changes in BMI growth for younger children, but not enough to classify them as overweight or obese, whereas adolescents may have had more exposure to food insecurity over their life-course (17). Further, although parents can seek to protect their children from reduced food availability and disrupted meal patterns (8, 56–60), food insecurity is stressful for children. This may be particularly true for older children, who are more cognitively and socially aware of the strains of food insecurity (61).

Considering food insecurity as a chronic stressor, some individuals may cope with stress by restricting intake and losing weight, whereas others may consume more highly palatable foods that contain higher amounts of fats, sugar, or salt; are energy dense; and can reduce the impact of stress on the brain (62–66). In this study, children in food-insecure households, on average, consumed 31 g sugar from SSBs and about 80 g total added sugar per day, which far exceeds current American Heart Association recommendations for children to consume ≤25 g (6 teaspoons) of added sugar per day (67). Although there was a significant difference in added sugar intake between food-insecurity groups, children in food-secure households consumed almost 73 g total added sugar per day, which also exceeds this recommendation.

People living in poverty may concurrently experience high levels of food insecurity and high levels of obesity, which is also relevant in explaining the association between household food insecurity and child adiposity (13, 68). Episodic food shortages may lead an individual to overconsume previously restricted foods once the period of shortage ends, such that an individual's dietary choices or physiologic adaptations in response to food deprivation contribute to increased body fat, otherwise known as the feast–famine hypothesis (8, 68–71). In this study, children in food-insecure households exhibited lower frequencies of eating breakfast and eating dinner with their families. These differences were on average about one-quarter times per day, which may be interpreted as being almost equivalent to eating 1 less meal or snack per week for children in food-insecure households. More information is needed in future studies to examine this feast–famine hypothesis, however, as these 2 meal-related questions do not assess amounts consumed.

Since HCS uses an observational, cross-sectional study design, it is not possible to draw any causal conclusions between food insecurity and the outcomes of interest or to look at food insecurity over time in relation to child weight or diet outcomes. The dietary assessments were self-reported and are subject to recall error and reporting bias. The USDA screener for food insecurity is a household-level measure reported by parents, so it does not entirely capture the child's experience of food insecurity and thus has limited validity as a construct, because parents and children differ in perceptions and experience of food insecurity (57, 61, 72). For example, Fram

TABLE 2 Relationship of food insecurity with adiposity, dietary intake, and diet related behaviors of children in the Healthy Communities Study (n = 5138)[1]

Variable		P value[2,3]
Adiposity-related outcomes		
	β (95% CI)	
BMI-z	0.14 (0.06, 0.21)	0.0005
Waist circumference,[4] cm	0.91 (0.18, 1.63)	0.01
	OR (95% CI)	
Normal weight	Ref	
Overweight or obese	1.17 (1.02, 1.34)	0.02
Dietary intake		
	β (95% CI)	
Fruit/vegetable/legume, no fried potatoes, cup/d	− 0.04 (−0.10, 0.02)	0.21
Fiber, g/d	− 0.14 (−0.39, 0.10)	0.26
Total added sugar, g/d	1.62 (−0.23, 3.47)	0.09
Energy-dense foods of minimal nutritional value, times/d	0.00003 (−0.12, 0.12)	0.90
Whole grains, g/d	0.39 (−0.41, 1.2)	0.34
Dairy, cup/d	0.02 (−0.03, 0.07)	0.37
Sugar from SSBs, g/d	1.44 (0.35, 2.54)	0.01
Calcium, mg/d	5.77 (−9.34, 20.87)	0.45
Diet related behaviors		
	β (95% CI)	
Eating breakfast, d/wk[5]	− 0.28 (−0.39, −0.17)	<0.0001
Eating dinner with family, d/wk[5]	− 0.22 (−0.37, −0.06)	0.006
Eating fast food, d/wk[5]	0.06 (−0.01, 0.14)	0.10
	OR (95% CI)	
Not regular consumption of nonfat/1% milk	Ref	
Regular consumption of nonfat or 1% milk [6,7]	0.89 (0.76, 1.05)	0.16
Not eating dinner while watching TV	Ref	
Eating dinner while watching TV[8]	1.10 (0.96, 1.30)	0.16

[1]Binary predictor of interest in all models was food insecure compared to food secure (0 = food secure, 1 = food insecure). BMI-z, BMI z score; Ref, reference; SSB, sugar-sweetened beverage.
[2]Analyses used multilevel modeling for BMI-z, waist circumference, dietary intake, and eating breakfast, dinner with family, and fast food; and multilevel logistic regression for overweight or obese status, regular consumption of nonfat or 1% milk, and eating dinner while watching TV.
[3]Covariates included age (as polynomial with degrees as follows: 0 for regularly consumed lower-fat milk; 1 for fruit and vegetables; 2 for waist circumference, dairy, whole grains, fiber, ate breakfast; 3 for sugar from SSBs; 4 for total added sugar, energy-dense foods of minimal nutritional value), sex (diet, diet related behaviors, and waist circumference only), child height (waist circumference only), maximum father education (adiposity only), maximum maternal employment (adiposity only), maximum parental education (diet and diet related behaviors only), maximum parental employment (diet and diet related behaviors only), race/ethnicity, annual household income, and seasonality (diet and diet related behaviors only). The community-level covariates included US region, minority, urbanicity (diet and diet related behaviors only), proportion of population below the federal poverty level and/or unemployed (diet and diet related behaviors only), and whether a minority population tract (30% or more African American or Hispanic) (diet and diet related behaviors only). The SEs are clustered at the community and school levels.
[4]Waist circumference analytical sample size: n = 5094.
[5]Reported frequency in last week.
[6]Reported usually drinking skim, 1%, or soy milk.
[7]Regular consumption of nonfat or 1% milk analytical sample size: n = 4976.
[8]Reported often/very often or never/rarely/sometimes.

et al. reported that children 11–16 y old were aware of food insecurity and undertook strategies to manage food resources; they concluded that children are in the best position to relate their own experiences of food insecurity (61). In addition, the severity of household food insecurity was not assessed with the 2 food insecurity questions used in this study. Further, while households were considered food insecure if they reported experiencing indicators of food insecurity at any time over the past year, dietary intakes were reported over the past 30 d. It is possible that dietary impacts of food insecurity may have been missed because they did not concur with periods of household food insecurity. Although socioeconomic status was controlled by income categories, educational level, and employment as covariates, some residual confounding may have remained because these variables may not have fully captured socioeconomic status and/or the association of these variables with food insecurity may not have been the same over the range of socioeconomic status.

In conclusion, household food insecurity in children was associated with a higher BMI-z and waist circumference, greater likelihood of being overweight or obese, consuming more sugar from SSBs, and less frequently eating breakfast and eating dinner with family. Observed relationships were particularly strong among older children. Further research is needed to disentangle the complex picture of how food insecurity is a possible contributor to childhood obesity and to poorer dietary outcomes in diverse populations. More research is needed to investigate whether reducing household food insecurity

TABLE 3 Relationship of food insecurity with child adiposity, dietary intake, and dietary related behavior outcomes of children in the Healthy Communities Study, by age group ($n = 5138$)

	Ages 4–9 y		Ages 10–15 y		
Variable	Food secure	Food insecure	Food secure	Food insecure	P interaction[1,2,3,4]
Adiposity-related outcomes, mean (95% CI) or %					
BMI-z[5]	0.64 (0.51, 0.77)[b]	0.70 (0.56, 0.84)[b]	0.62 (0.49, 0.76)[b]	0.83 (0.70, 0.97)[a]	0.03
Waist circumference,[5,6] cm	70.1 (68.8, 71.4)[a]	70.0 (68.6, 71.3)[a]	67.3 (66.0, 68.6)[b]	69.4 (68.1, 70.8)[a]	0.0004
Overweight or obese[7], %	35.5[b]	35.4[b]	36.9[b]	44.4[a]	0.009
Dietary intake outcomes, mean (95% CI)					
Fruit and vegetables,[5] cup/d	2.5 (2.3, 2.6)	2.4 (2.3, 2.5)	2.6 (2.5, 2.7)	2.5 (2.4, 2.6)	0.83
Fiber,[5] g/d	15.0 (14.5, 15.4)	14.9 (14.4, 15.3)	15.8 (15.4, 16.2)	15.6 (15.2, 16.1)	0.65
Total added sugar,[5] g/d	71.1 (67.9, 74.4)	72.3 (68.9, 75.8)	82.2 (78.9, 85.5)	84.3 (80.9, 87.7)	0.56
Energy-dense foods,[5] (times/day)	2.0 (1.8, 2.2)	2.0 (1.8, 2.2)	2.0 (1.8, 2.2)	2.0 (1.7, 2.2)	0.91
Whole grains,[5] g/d	20.0 (19.3, 21.4)	20.7 (19.3, 22.1)	18.9 (17.5, 20.3)	19.0 (17.6, 20.4)	0.37
Dairy,[5] cup/d	2.5 (2.4, 2.6)	2.5 (2.4, 2.6)	2.4 (2.3, 2.5)	2.4 (2.4, 2.5)	0.53
Sugar from SSBs,[5] g/d	25.0 (23.0, 27.0)	25.5 (23.4, 27.6)	32.9 (30.9, 34.9)	35.3 (33.2, 37.3)	0.07
Calcium,[5] mg/d	1099 (1073, 1125)	1103 (1076, 1130)	1110 (1083, 1136)	1117 (1090, 1144)	0.78
Diet related behaviors, mean (95% CI) or %					
Breakfast,[5] d/wk	6.5 (6.3, 6.7)	6.3 (6.1, 6.5)	5.8 (5.6, 6.0)	5.5 (5.3, 5.7)	0.31
Eating fast food,[5] d/wk	0.89 (0.76, 1.02)	0.92 (0.8, 1.1)	0.92 (0.8, 1.1)	1.1 (0.9, 1.2)	0.19
Eating dinner with family,[5] d/wk	5.2 (4.9, 5.4)[c]	5.1 (4.8, 5.4)[c]	4.8 (4.5, 5.1)[b]	4.4 (4.2, 4.7)[a]	0.04
Regular consumption of 1% milk[7], %	26.5	26.4	27.9	23.3	0.09
Eating dinner while watching TV[7,8], %	34.4	38.2	41.2	41.8	0.25

[1]Analyses used multilevel modeling for BMI-z, waist circumference, dietary intake, and eating breakfast, dinner with family, and fast food; and multilevel logistic regression for overweight or obese status, regular consumption of nonfat or 1% milk, and eating dinner while watching TV. All models included an interaction term for binary predictor of food security (food secure versus food insecure) by age group (ages 4–9 versus ages 10–15).

[2]Covariates included sex (diet, diet related behaviors, and waist circumference only), child height (waist circumference only), maximum father education (adiposity only), maximum maternal employment (adiposity only), maximum parental education (diet and diet related behaviors only), maximum parental employment (diet and diet related behaviors only), race/ethnicity, annual household income and seasonality (diet and diet related behaviors only). The community-level covariates included: US region, minority, urbanicity (diet and diet related behaviors only), proportion of population below the federal poverty level and/or unemployed (diet and diet related behaviors only), and whether a minority population tract (30% or more African American or Hispanic) (diet and diet related behaviors only). The SEs are clustered at community and school levels.

[3]Results from overall test for interaction by age group for outcome variable at $P < 0.05$.

[4]The different letters ([a, b, c]) indicate significant differences between values, adjusted for multiple comparison using the Bonferroni method, with significance set at $P < 0.008$. For example, for the outcome BMI-z, children ages 10–15 y from food-insecure households had higher BMI-z scores than children ages 10–15 y from food-secure households, as well as children ages 4–9 y from both food-insecure and food-secure households.

[5]Values reported are predicted means (95% CIs) from adjusted analysis using multilevel linear regression.

[6]Waist circumference analytical sample size: ($n = 5094$).

[7]Values reported are predicted probabilities (as percentages) from adjusted analysis using multilevel logistic regression.

[8]Eating dinner while watching TV analytical sample size: ($n = 4976$).

results in improved adiposity and diet related outcomes in children.

Acknowledgments

This research was supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under award number K01HL131630. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The funding source had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. The authors acknowledge the Global Food Initiative at the University of California Office of the President for their support of this project. The authors also acknowledge Sophia Navarro and Laurel Moffat for their assistance with references and table formatting. The authors' responsibilities were as follows—LDR, LEA, and SMZ: designed the research question; SMZ and KRP: analyzed data with support from KG, LEA, and EAF; SMZ, LEA, and LAN:. wrote the paper; and all authors had responsibility for final content and read and approved the final manuscript.

References

1. Coleman-Jensen A, Rabbitt M, Gregory C, Singh A. Household food security in the United States in 2017. Washington (DC): US Department of Agriculture, Economic Research Service; 2018.
2. Coleman-Jensen A, Gregory C, Rabbitt M. Definitions of food security. [Internet]. 2017[cited 2019 Feb 1]; Available from: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security.aspx.
3. Fram MS, Ritchie LD, Rosen N, Frongillo EA. Child experience of food insecurity is associated with child diet and physical activity. J Nutr 2015;145:499–504.
4. To QG, Frongillo EA, Gallegos D, Moore JB. Household food insecurity is associated with less physical activity among children and adults in the U.S. population. J Nutr 2014;144:1797–802.
5. Cook JT, Black M, Chilton M, Cutts D, Ettinger de Cuba S, Heeren TC, Rose-Jacobs R, Sandel M, Casey PH, Coleman S, et al. Are food insecurity's health impacts underestimated in the U.S. population? Marginal food security also predicts adverse health outcomes in young U.S. children and mothers. Adv Nutr 2013;4:51–61.
6. Council on Community Pediatrics, Committee on Nutrition. Promoting food security for all children. Pediatrics 2015;136:e1431.
7. Kimbro R, Denney J. Transitions into food insecurity associated with behavioral problems and worse overall health among children. Health Aff 2015;34:1949–55.
8. Burke M, Martini L, Çayir E, Hartline-Grafton H, Meade R. Severity of household food insecurity is positively associated with mental disorders among children and adolescents in the United States. J Nutr 2016;146:2019–26.

9. McLaughlin K, Green J, Alegria M, Jane Costello E, Gruber M, Sampson N, Kessler R. Food insecurity and mental disorders in a national sample of U.S. adolescents. J Am Acad Child Adolesc Psychiatry 2012;51:1293–303.
10. Weinreb L, Wehler C, Perloff J, Scott R, Hosmer D, Sagor L, Gundersen C. Hunger: its impact on children's health and mental health. Pediatrics 2002;110:e41.
11. Kleinman RE, Murphy JM, Little M, Pagano M, Wehler CA, Regal K, Jellinek MS. Hunger in children in the United States: potential behavioral and emotional correlates. Pediatrics 1998;101:E3.
12. Slopen N. Poverty, food insecurity, and the behavior for childhood internalizing and externalizing disorders. J Am Acad Child Adolesc Psychiatry 2010;49:444–52.
13. Jyoti DF, Frongillo EA, Jones SJ. Food insecurity affects school children's academic performance, weight gain, and social skills. J Nutr 2005;135:2831–9.
14. Dinour LM, Bergen D, Yeh M-C. The food insecurity–obesity paradox: a review of the literature and the role food stamps may play. J Am Diet Assoc 2007;107:1952–61.
15. Larson N, Story M. Food insecurity and weight status among U.S. children and families: a review of the literature. Am J Prev Med 2011;40:166–73.
16. Laraia B. Food insecurity and chronic disease. Adv Nutr 2013;4:203–12.
17. Burke MP, Frongillo EA, Jones SJ, Bell BB, Hartline-Grafton H. Household food insecurity is associated with greater growth in body mass index among female children from kindergarten through eighth grade. J Hunger Environ Nutr 2016;11:227–41.
18. Metallinos-Katsaras E, Must A, Gorman K. A longitudinal study of food insecurity on obesity in preschool children. J Acad Nutr Diet 2012;112:1949–58.
19. Metallinos-Katsaras E, Sherry B, Kallio J. Food insecurity is associated with overweight in children younger than 5 years of age. J Am Diet Assoc 2009;109:1790–4.
20. Bhattacharya J, Currie J, Haider S. Poverty, food insecurity, and nutritional outcomes in children and adults. J Health Econ 2004;23:839–62.
21. Casey PH, Simpson PM, Gossett JM, Bogle ML, Champagne CM, Connell C, Harsha D, McCabe-Sellers B, Robbins JM, Stuff JE, et al. The association of child and household food insecurity with childhood overweight status. Pediatrics 2006;118:e1406.
22. Alaimo K, Olson CM, Frongillo EA Low family income and food insufficiency in relation to overweight in US children: is there a paradox? Arch Pediatr Adolesc Med 2001;155:1161–7.
23. Power M, Schulkin J. Sex differences in fat storage, fat metabolism, and the health risks from obesity: possible evolutionary origins. Br J Nutr 2007;99:931–40.
24. Flegal KM, Ogden CL, Yanovski JA, Freedman DS, Shepherd JA, Graubard BI, Borrud LG. High adiposity and high body mass index–for-age in US children and adolescents overall and by race-ethnic group. Am J Clin Nutr 2010;91:1020–6.
25. Ogden CL, Carroll MD, Lawman HG, Fryar CD, Kruszon-Moran D, Kit BK, Flegal KM. Trends in obesity prevalence among children and adolescents in the United States, 1988–1994 through 2013–2014. JAMA 2016;315:2292–9.
26. Whitaker RC, Orzol SM. Obesity among US urban preschool children: relationships to race, ethnicity, and socioeconomic status. Arch Pediatr Adolesc Med 2006;160:578–84.
27. Buscemi J, Beech BM, Relyea G. Predictors of obesity in Latino children: acculturation as a moderator of the relationship between food insecurity and body mass index percentile. J Immigr Minor Health 2011;13:149–54.
28. Woodward-Lopez G, Ritchie LD, Gerstein D, Crawford PB. Obesity: dietary and developmental influences. Boca Raton(FL): CRC Press; 2006.
29. Connell C, Zoellner J, Yadrick M, Chekuri S, Crook L, Bogle M. Energy density, nutrient adequacy, and cost per serving can provide insight into food choices in the lower Mississippi Delta. J Nutri Educ Behav 2012;44:148–53.
30. Drewnowski A, Darmon N. Food choices and diet costs: an economic analysis. J Nutr 2005;135:900–4.
31. Widome R, Neumark-Sztainer D, Hannan PJ, Haines J, Story M. Eating when there is not enough to eat: eating behaviors and perceptions of food among food-insecure youths. Am J Public Health 2009;99: 822–8.
32. Kirkpatrick SI, Tarasuk V. Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. J Nutr 2008;138:604–12.
33. Kempson KM, Keenan DP, Sadani PS, Ridlen S, Rosato NS. Food management practices used by people with limited resources to maintain food sufficiency as reported by nutrition educators. J Am Diet Assoc 2002;102:1795–9.
34. Ma Y, Bertone ER, Stanek EJ, III, Reed GW, Hebert JR, Cohen NL, Merriam PA, Ockene IS. Association between eating patterns and obesity in a free-living US adult population. Am J Epidemiol 2003;158:85–92.
35. Arteaga SS, Loria CM, Crawford PB, Fawcett SB, Fishbein HA, Gregoriou M, John LV, Kelley M, Pate RR, Ritchie LD, et al. The Healthy Communities Study: its rationale, aims, and approach. Am J Prev Med 2015;49:615–23.
36. Ritchie LD, Wakimoto P, Woodward-Lopez G, Thompson FE, Loria CM, Wilson DK, Kao J, Crawford PB, Webb KL. The Healthy Communities Study nutrition assessments: child diet and the school nutrition environment. Am J Prev Med 2015;49:647–52.
37. Strauss W, Sroka C, Frongillo E, Arteaga S, Loria C, ES L, Wu C, Patrick H, Fishbein H, John L. Statistical design features of the Healthy Communities Study. Am J Prev Med 2015;49:624–30.
38. Sagatov RDF, John LV, Gregoriou M, Arteaga SS, Weber S, Payn B, Strauss W, Weinstein N, Collie-Akers V. Recruitment outcomes, challenges and lessons learned: the Healthy Communities Study. 2018;13:27–35.
39. John LV, Gregoriou M, Pate RR, Fawcett SB, Crawford PB, Strauss WJ, Frongillo EA, Ritchie LD, Loria CM, Kelley M, et al. Operational implementation of the Healthy Communities Study: how communities shape children's health. Am J Prev Med 2015;49:631–5.
40. Sroka CJ, McIver KL, Sagatov RDF, Arteaga SS, Frongillo EA. Weight status measures collected in the Healthy Communities Study: protocols and analyses. Am J Prev Med 2015;49:642–6.
41. Fawcett SB, Collie-Akers VL, Schultz JA, Kelley M. Measuring community programs and policies in the Healthy Communities Study. Am J Prev Med 2015;49:636–41.
42. Hager ER, Quigg AM, Black MM, Coleman SM, Heeren T, Rose-Jacobs R, Cook JT, de Cuba SAE, Casey PH, Chilton M, et al. Development and validity of a 2-item screen to identify families at risk for food insecurity. Pediatrics 2010;126:e26.
43. Centers for Disease Control. National Health and Nutrition Examination Survey (NHANES): anthropometry procedures manual. Washington (DC): US Department of Health and Human Services; 2013.
44. Ali O, Cerjak D, Kent JW, James R, Blangero J, Zhang Y. Obesity, central adiposity and cardiometabolic risk factors in children and adolescents: a family-based study. Pediatr Obes 2014;9:e58–62.
45. Javed A, Jumean M, Murad MH, Okorodudu D, Kumar S, Somers VK, Sochor O, Lopez-Jimenez F. Diagnostic performance of body mass index to identify obesity as defined by body adiposity in children and adolescents: a systematic review and meta-analysis. Pediatr Obes 2014;10:234–44.
46. Garnett SP, Baur LA, Srinivasan S, Lee JW, Cowell CT. Body mass index and waist circumference in midchildhood and adverse cardiovascular disease risk clustering in adolescence. Am J Clin Nutr 2007;86:549–55.
47. Weber DR, Leonard MB, Shults J, Zemel BS. A comparison of fat and lean body mass index to BMI for the identification of metabolic syndrome in children and adolescents. J Clin Endocrinol Metab 2014;99:3208–16.
48. Centers for Disease Control. 2000 CDC growth charts for the United States: methods and development. Washington (DC): DHHS; 2002.
49. National Cancer Institute. Dietary Screener Questionnaire in NHANES 2009–2010. [Internet]. 2014[cited 2017 Aug 1]; Available from: http://appliedresearch.cancer.gov/nhanes/dietscreen/.
50. Thompson FE, Midthune D, Kahle L, Dodd KW. Development and evaluation of the National Cancer Institute's Dietary Screener Questionnaire scoring algorithms. J Nutr 2017;147:1226–33.
51. Hewawitharana SC, Thompson FE, Loria CM, Strauss W, Nagaraja J, Ritchie L, Webb KL. Comparison of the NHANES dietary screener questionnaire to the Automated Self-Administered 24-Hour Recall for Children in the Healthy Communities Study. Nutr J 2018;17:111.

52. National Cancer Institute. Dietary Screener Questionnaire in the NHANES 2009–10: data processing and scoring procedures. [Internet]. [cited 2019 Feb 1]; Available from: http://appliedresearch.cancer.gov/nhanes/dietscreen/scoring.
53. Tibshirani R. Regression shrinkage and selection via the lasso. J R Stat Soc Series B Stat Methodol 1996;58:267–88.
54. van Buuren S, Groothuis-Oudshoorn C, , MICE: Multivariate Imputation by Chained Equations in, *R. J Stat Softw* 2011;45:3.
55. US Department of Health and Human Services. Puberty and precocious puberty. [Internet]. December 1, 2016 [cited 2019 Feb 1]; Available from: https://www.nichd.nih.gov/health/topics/puberty.
56. Crawford PB, Webb KL. Unraveling the paradox of concurrent food insecurity and obesity. Am J Prev Med 2011;40:274–5.
57. Connell CL, Lofton KL, Yadrick K, Rehner TA. Children's experiences of food insecurity can assist in understanding its effect on their well-being. J Nutr 2005;135:1683–90.
58. Martin MA, Lippert AM. Feeding her children, but risking her health: the intersection of gender, household food insecurity and obesity. Soc Sci Med 2012;74:1754–64.
59. Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. J Nutr 2001;131:2670–6.
60. Althoff RR, Ametti M, Bertmann F. The role of food insecurity in developmental psychopathology. Prev Med 2016;92: 106–9.
61. Fram MS, Frongillo EA, Jones SJ, Williams RC, Burke MP, DeLoach KP, Blake CE. Children are aware of food insecurity and take responsibility for managing food resources. J Nutr 2011;141:1114–9.
62. Adam T, Epel E. Stress, eating and the reward system. Physiol Behav 2007;91:449–58.
63. Dallman MF, Pecoraro N, Akana SF, La Fleur SE, Gomez F, Houshyar H, Bell ME, Bhatnagar S, Laugero KD, Manalo S. Chronic stress and obesity: a new view of "comfort food." PNAS 2003;100: 11696–701.
64. Gearhardt AN, Davis C, Kuschner R, Brownell KD. The addiction potential of hyperpalatable foods. Curr Drug Abuse Rev 2011;4: 140–5.
65. Tomiyama AJ, Dallman MF, Epel ES. Comfort food is comforting to those most stressed: evidence of the chronic stress response network in high stress women. Psychoneuroendocrinology 2011;36:1513–9.
66. Dallman MF, Pecoraro NC, la Fleur SE. Chronic stress and comfort foods: self-medication and abdominal obesity. Brain Behav Immun 2005;19:275–80.
67. Vos MB, Kaar JL, Welsh JA, Van Horn LV, Feig DI, Anderson CAM, Patel MJ, Cruz Munos J, Krebs NF, Xanthakos SA, et al. Added sugars and cardiovascular disease risk in children: a scientific statement from the American Heart Association. Circulation 2017;135: e1017–e34.
68. Dietz WH. Does hunger cause obesity? Pediatrics 1995;95:766.
69. Fisher JO, Birch LL. Restricting access to palatable foods affects children's behavioral response, food selection, and intake. Am J Clin Nutr 1999;69:1264–72.
70. Polivy J, Zeitlin SB, Herman CP, Beal AL. Food restriction and binge eating: a study of former prisoners of war. J Abnorm Psychol 1994;103:409–11.
71. Polivy J. Psychological consequences of food restriction. J Am Diet Assoc 1996;96:589–92.
72. Harvey K. "When I go to bed hungry and sleep, I'm not hungry": children and parents' experiences of food insecurity. Appetite 2016;99:235–44.