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Food Insecurity and Obesity in US Adolescents: A Population-Based Analysis

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Abstract

Background: Food insecurity and obesity are significant problems affecting adolescents. There is a paucity of recent data examining this relationship. This study utilizes a recent nationally representative sample of US adolescents to examine the relationship between obesity and food security status, as well as other risk factors.

Methods: A cross-sectional analysis of 4777 US adolescents (13–18 years old) was performed using data from the National Health and Nutrition Examination Surveys 2007–2016. Prevalence of obesity based on food security status was calculated. Multivariable logistic regression was performed to examine characteristics of adolescents in relationship to obesity.

Results: The prevalence of obesity among adolescents from food insecure households was significantly higher compared to those who were not, with a prevalence ratio of 1.3 (95% CI: 1.2–1.5, $p < 0.0001$). Food insecurity was associated with a higher unadjusted rate of obesity, with an odds ratio of 1.4 (95% CI: 1.2–1.7, $p = 0.0002$). After adjustment for potential confounding factors, food insecurity was no longer significantly associated with obesity (OR 1.19, 95% CI: 1.0–1.4, $p = 0.08$). However, other factors such as black race, Hispanic ethnicity, male sex, and households with a monthly income ≤185% of the poverty line were associated with increased odds of obesity.

Conclusions: While the prevalence of obesity in adolescents from food insecure households was higher compared to those who were not, no association between the two was found when accounting for other risk factors. Data on independent food-seeking behaviors of adolescents may help clarify this complex relationship in future work.

Keywords: adolescents; body mass index; food insecurity; obesity; pediatric obesity; poverty

Introduction

Adolescence is considered one of three critical periods, along with early infancy and the 5–7-year age range, for the development of obesity and its subsequent complications.[1] One of the sequela of obesity in adolescence is metabolic syndrome in adulthood—a compilation of clinical traits that lead to increased cardiovascular disease and type II diabetes mellitus, which are associated with increased morbidity and mortality.[2,3] Over one-third of children aged 2–17 years are either overweight or obese.[4] According to the most recent data from the National Health and Nutrition Examination Survey (NHANES), 20.6% of US adolescents (12–19 years) are living with obesity. This prevalence is higher compared to that of younger children.[5] Research focused on identifying risk factors that contribute to obesity in adolescence is crucial to highlight potential areas of intervention such as lifestyle and socioeconomic modifications.[3]

Food insecurity, which is defined by the USDA as the lack of "access at all times to enough food for an active, healthy life," has been shown to impact the quality of food consumed by adolescents.[6,7] In fact, the majority of adolescents fail to meet most of the US dietary guidelines and go on to develop poor dietary behaviors during this phase of life.[8] It is believed that food insecurity puts adolescents at a greater risk of obesity due to unpredictable food availability and limited healthy food options when food is available.[9,10] In 2018, the prevalence of food insecurity was estimated to be 11.1% of all US households and 13.9% of US households with children and adolescents.[7] In households with adolescents, food insecurity is almost twice as prevalent compared

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to households with children up to age 4 years, and the dietary quality of food is lowest for adolescents experiencing food insecurity.[11,12]

Although the link between food insecurity and childhood obesity has been previously examined, studies examining the association between obesity and food insecurity among adolescents are sparse, out of date, and mostly include smaller sample sizes.[13–20] Furthermore, results have been conflicting and do not adequately address the effect of confounding environmental and behavioral factors. Factors such as race and ethnicity, health care access, and socioeconomic conditions (*e.g.,* poverty level) are some of the important ones to consider. Racial and ethnic minorities experience significant health disparities due to the effects of implicit bias and systemic racism, and thus should always be examined for points of intervention.[21] Health care access and poverty level are two examples of the social determinants captured by NHANES, and that contribute to ''the conditions in which people live, learn, work, play, and worship'' which in turn impact their health.[22] In light of this, and the fact that poor diet quality is a determinant of obesity,[23] further elucidating the relationship between food insecurity and obesity in adolescents is essential. Independent choices about health behaviors and dietary patterns are shaped during childhood, including adolescence and interventions targeted specifically at this age group have the potential for significant long-term impact.[24–27]

Due to the limitations of current literature regarding food insecurity as it relates to obesity in adolescence, the present study sought to examine the association of food insecurity, among other risk factors, with obesity in a population-based sample of adolescents interviewed during NHANES 2007–2016. It was hypothesized that food insecurity would be associated with obesity after adjusting for other relevant risk factors in the model. Importantly, if no association was found, such findings would suggest that other risk factors are more directly associated with obesity and would position food insecurity instead as a mediating factor.

Methods

Sample

The NHANES program conducts a series of cross-sectional surveys designed to assess the health and nutritional status of noninstitutionalized, civilian adults and children in the United States based on a weighted representative sample. This program is overseen by the National Center for Health Statistics (NCHS), which is a part of the CDC.[28] The use of these data for research purposes has been approved by the NCHS Research Ethics Review Board under Protocols #2005–06 and #2011–17.[29] Data from the five most recent complete survey cycles, 2007–2016, were used. Respondents aged 13–18 years with complete data were included in the study.

Food Insecurity

NHANES has been using the Food Security Survey Module, similar to the module included in the Current Population Survey, to assess food security since 1999. This module is included in the family questionnaire portion of the NHANES household interview. An adult family member, typically the head of household, answers the family questionnaire on behalf of the entire family and questions refer to *all* household members. Households with children younger than 18 years of age receive an additional 8 questions for a total of 18 items, compared to households without children.[30] Data collected from these responses are then released on each household participant's record. Four categories classify the level of household food security based on the number of affirmative responses to the 18 items: full food security, marginal food security, low food security, and very low food security.[30] To fall into the low or very low food security categories, households required 3–7 and 8–18 affirmative responses, respectively. For analysis, a binary variable was created where the low and very low food security categories were labeled as food insecure, and the full and marginal food security categories were grouped as food secure.[7,30] Although NHANES also screens for food insecurity at the child- and individual-level, the questions and who answers them varies based on age. A proxy provides the answers to specific questions for participants younger than 16 years of age at the child-level, and younger than 12 years of age at the individual-level. Individual-level questions referred to the past month, whereas the child- and household-level questions refer to the past year. Furthermore, child food security data are only generated for children younger than the age of 18, and individual-level food security data collection was discontinued in 2011. Thus, the use of the household aggregate measure allows for the inclusion of 18 year olds in this analysis and ensures consistency in the data among this study's specific age group.

Obesity

In addition to interviews, NHANES is unique in that it also performs physical examinations according to the Anthropometric Standardization Reference Manual.[31] The body measurement data is collected by trained health technicians within mobile examination centers where staff performance is monitored by a chief health technician. Supervisory staff also ensure scheduled equipment calibration. Unusual and erroneous values are flagged and reviewed within the context of the entire body measurements. Weight in kilograms was recorded for respondents of all ages and heights in centimeters were recorded for those who were 2 years and older. BMI, measured as a function of body weight and height in kilograms per meters squared by NHANES staff, within this dataset was used as a marker of obesity (BMI ≥95th percentile) in adolescents according to age- and sex-specific percentiles on the standard growth charts outlined by the CDC.[31,32] If an adolescent did not meet the BMI ≥95th percentile threshold for obesity (*i.e.*, <95th percentile), they were considered not to have obesity (*i.e.*, ''No Obesity'') and the BMI percentile range for girls and boys of that group was >5th percentile to <95th percentile.[33]

Covariates

Covariates, including age, race, sex, household poverty level, and routine access to health care were also captured from the NHANES datasets and included in our final model. Covariates were identified by literature review and clinical judgement.[9,13,17,34] Similar to food security, data on household income and access to health care were collected through the family questionnaire. The family monthly poverty level index is a ratio of a family's monthly income to poverty as determined by the Department of Health and Human Services' poverty guidelines for that year. It is used by many federal programs, including supplemental food programs to determine eligibility of participants. Participants were grouped into households with a monthly income ≤185% of the poverty line and a monthly income >185% of the poverty line because households with incomes ≤185% are at increased risk of being food-insecure.[7] In addition, this categorization is consistent with the categories used by NHANES and the USDA Economic Research Service.[35,36] Routine access to health care was captured as a binary variable. If respondents answered "Yes" or stated "There is more than one place" to the NHANES question HUQ030: "Is there a place that [you/SP] usually [go/goes] when [you are/he/she is] sick or [you/s/he] need[s] advice about [your/his/her] health?" they were categorized as having "routine access to healthcare." If the respondents answered "there is no place," they were categorized as "no routine access to healthcare."[37] Data quality control was checked by NHANES staff.

Statistical Analysis

Demographic data were summarized using mean and standard deviation for normal data and median and interquartile range for nonnormal data. Descriptive analyses were performed for the overall sample and presented based on food security status. The chi-squared test was used to compare categorical variables, and Student's *t*-test or its nonparametric analog was used to compare continuous variables. A two-sided p-value <0.05 was considered significant for all hypothesis tests. Appropriate sample weights, masked variance strata, and units corresponding to the 10-year cycle were used to account for the complex survey design. The difference in prevalence of obesity between adolescents from food secure and food insecure households was examined. Multivariable logistic regression was used to explore the relationship between food insecurity, as well as the other model covariates, and the primary outcome of obesity. All analyses were generated using SAS® Version 9.4, SAS Institute, Inc. (Cary, NC).

Results

A total of 4843 adolescents aged 13–18 years were initially identified. Sixty-five (1.3%) participants had missing food security data, and one participant had missing food security and health access data; they were therefore excluded from the analysis. Ultimately 4777 adolescents were included in the analysis, and the majority were male (51.4%), Hispanic (33.8%), and were from a household with a

Table 1. Differences in Demographics of 4777 US Adolescents Aged 13–18 Years from the National Health and Nutrition Examination Survey Based on Food Security Status

Demographic variable	Food insecure, *N* (%)	Food secure, *N* (%)	*p*
Total	1331 (27.9)	3446 (72.1)	
Age, years, median (IQR)	15 (14–17)	15 (14–17)	0.08
Sex			
Male	703 (52.8)	1757 (51.0)	0.23
Race			<0.0001
Black	378 (28.4)	829 (24.1)	
Hispanic	568 (42.7)	1041 (30.2)	
Mixed	99 (7.4)	511 (14.8)	
White	286 (21.5)	1065 (30.9)	
Obese[a]	341 (25.6)	714 (20.7)	0.0003
Family monthly poverty level index category, %			<0.0001
≤185	1111 (83.5)	1682 (48.8)	0.0001
>185	220 (16.5)	1764 (51.2)	
Health care access	1124 (84.5)	3053 (88.6)	

[a]Unadjusted prevalence of obesity, for adjusted prevalence see Table 2.

IQR, interquartile range.

Table 2. Prevalence of Obesity in Adolescents from Households with and without Food Security

Food insecure		Food secure			
Obesity	No obesity	Obesity	No obesity	Prevalence ratio	*p*
25.9% (22.9–28.9)	74.1% (71.1–77.1)	19.5% (17.6–21.5)	80.5% (78.6–82.4)	1.3 (1.2–1.5)	<0.0001

Percentage of adolescents and 95% confidence intervals are reported for each category. The 95% confidence interval is presented in parentheses for the prevalence ratio.

monthly poverty level income ≤185% of the poverty line (57.7%). Approximately 26% were living with obesity and 27.9% were from a food insecure household. Differences in demographics based on food insecurity status are outlined in Table 1.

The prevalence of obesity among adolescents from food insecure households was significantly higher when compared to those from food secure households (Table 2), with a prevalence ratio of 1.33 (95% CI: 1.15–1.53, $p < 0.0001$). Food insecurity was associated with a higher unadjusted rate of obesity, with an odds ratio of 1.44 (95% CI: 1.20–1.74, $p = 0.0002$). However, on multivariable logistic regression adjusting for age, sex, race, poverty level, and routine access to health care (Table 3), food insecurity was no longer associated with adolescent obesity (OR: 1.19, 95% CI: 0.98–1.44, $p = 0.08$). Black and Hispanic participants, males, and those with a household monthly income ≤185% of the poverty line were some of the covariates associated with increased odds of obesity within the model. No significant interactions between our independent variable, food insecurity, and the other covariates in the model were identified. As a measure of model discrimination for binary outcomes in a logistic regression model, the c-statistic (also known as the area under the receiver operating curve) for the multivariable model was 0.57.[38]

Table 3. Risk Factors of Obesity after Multivariable Logistic Regression

Variable	Odds ratio (95% confidence interval)	*p*
Food insecurity	1.19 (0.98–1.44)	0.08
Age	0.95 (0.85–1.06)	0.86
Sex (male)	1.27 (1.07–1.50)	0.007
African American/black (vs. white)	1.31 (1.01–1.70)	0.04
Hispanic (vs. white)	1.29 (1.04–1.60)	0.02
Mixed Race (vs. white)	0.88 (0.61–1.28)	0.50
Household monthly income <185% of poverty threshold	1.36 (1.13–1.64)	0.002
No routine health care access	1.00 (0.74–1.35)	1.00

Discussion

This is the most recent study of NHANES data examining the relationship between food insecurity and obesity in US adolescents. The present study demonstrated that the prevalence of obesity is higher among US adolescents from food insecure homes compared to those from food secure homes. However, after adjusting for age, sex, race, poverty, and health care access, no association was found between food insecurity and obesity.

In a review from 2018, Eicher-Miller and Zhao highlighted the importance of addressing food insecurity among adolescents due to the relevance of this life stage to adult health. The authors stress the finding that adolescents have larger nutrient gaps and are more vulnerable to food insecurity within their households than younger children.[15] Despite this, obesity is still a prevalent issue for adolescents from food insecure households. It has been shown that adolescents enjoy some degree of autonomy, while still living with their families.[26] An explanation for the higher rate of obesity among food insecure adolescents may be reflective of their ability to find food for themselves. This food independence may be even truer in families with low-income, in an effect by the adolescent to reduce their financial burden in the household.[39] The foods adolescents choose are likely inexpensive and may not be healthy.[17] The null findings of this study on multivariable analysis raise the question of what down-stream effects, like altered behaviors or attitudes toward food, does food insecurity have on the weight status of adolescents who take responsibility to provide their own nutrition. In other words, food insecurity may instead be a mediating factor that influences alternative behaviors, which in turn lead to obesity. While NHANES captures the behavior of children and adolescents who avoid eating specific meals or eating at certain times due to their food insecurity, it does not capture their alternative food-seeking behaviors.

In 2006, Casey et al. published a study that examined the relationship between household food insecurity, child food insecurity, and overweight status among ~2798 children and adolescents, aged 13–17 years, using NHANES data from 1999 to 2002.[9] Similar to this present study, household food insecurity status was not associated with participants

who had a BMI ≥95th percentile.[9] In addition, a significant association between black race and a BMI ≥85th percentile was demonstrated, but no association was found between sex or poverty level, and overweight status. Furthermore, they did not demonstrate a relationship between race or sex, and obesity status (BMI ≥95th percentile). These findings are distinct from our study, which identified significant associations between obesity (BMI ≥95th percentile) and black race, Hispanic ethnicity, male sex, and participants from households with monthly incomes ≤185% of the poverty line.

Another more recent study examining the relationship between food insecurity and obesity among NHANES (2001–2010) children aged 2–11 years only found a significant association in the 6- to 11-year-old group as it relates to their individual-level food insecurity.[13] With regard to their child-level food insecurity, no association was found among all ages examined. Similar to this study, when aggregate measures of food security in children (child-level food insecurity or household food insecurity) are used, no association was found regardless of age.

The present study utilized the largest and most recent nationally representative sample of US adolescents and contributes to the understanding of the relationship, or lack thereof, between obesity and food insecurity among adolescents. It is possible that other sociodemographic factors that were not accounted for in the model or captured by NHANES may skew this relationship toward the null. However, no significant interactions between the effect of the covariates and food insecurity were found. Our results suggest that race, sex, and household income may have a greater effect on obesity than the measure of food insecurity itself. For example, there could be more variability (disparities) in poverty-level that could explain why it had the largest and most significant effect in the model. Therefore, it would not matter if one has access to healthy food if one cannot afford it and has to rely on cheaper, less healthy options.

There are some limitations to the study, including its cross-sectional nature and the use of a household measure of food insecurity as opposed to an individual one. Given the relatively small sample size of available NHANES data, the potential for type II error also exists. The present study also relies on the accuracy of survey responses, which inherently contain a level of measurement bias, as the respondent could under- or overestimate their responses to the food security questions. Furthermore, the study is limited by its retrospective nature, which precludes a determination of causality.

Conclusions

While the prevalence of obesity in adolescents from food insecure households was higher compared to those from food secure households, no association between obesity and food insecurity was found in this national representative sample, when accounting for possible confounding variables. However, factors such as black race, Hispanic ethnicity, male sex, and participants from households with monthly incomes ≤185% of the poverty line were independently associated with obesity. This null primary finding could be due to the fact that other factors within food insecure households may be driving obesity, including behavioral ones that are not captured in the NHANES survey. Nonetheless, in light of our findings, the focus of further work could be shifted to elucidate other risk factors as well as the mechanisms behind the complex relationship between food insecurity and obesity among adolescents.

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Author Disclosure Statement

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