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Research Article

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ABSTRACT

Introduction

Research has demonstrated that food insecurity during childhood is associated with worse physical and mental health in childhood. However, little is known about how food insecurity during childhood impacts health outcomes in young adulthood.

Methods

This study analyzed data from the Future of Families and Child Wellbeing Study (2024), a longitudinal birth cohort study of children born in 1998-2000. Childhood food insecurity trajectory groups from age 3 to 15 years were identified using group-based trajectory modeling. Associations between childhood food insecurity trajectory groups and young adult weight (BMI, overweight status, and obese status) and high self-reported health (good/excellent) at age 22 were modeled with multivariate linear and logistic regression.

Results

Three trajectories were identified among 4,296 participants: 66.9% were food secure, 7.5% were food insecure, and 25.6% transitioned from being food insecure-to-secure throughout childhood. In adjusted analyses, young adults assigned to the food insecure-to-secure trajectory group as children had higher BMI (B 0.82, 95% CI [0.07-1.58]) and higher odds of overweight status (OR 1.24, 95% CI [1.01-1.52]) than young adults assigned to the food secure trajectory group as children. Young adults in the food insecure trajectory group as children had lower odds of high self-reported health than those in the food secure trajectory group as children (OR 0.65, 95% CI [0.48-0.89]).

Conclusions

Food insecurity in childhood is associated with high weight status and poor self-reported health in young adulthood. These findings highlight the importance of childhood food insecurity screening and interventions to promote health throughout the life course.

Keywords: Food Insecurity; Obesity; overall health

INTRODUCTION

Food insecurity, "the uncertain availability of nutritionally adequate foods,",[1] affected 13.5% percent of U.S. households (18 million households) in 2023.[2] Food insecurity is associated with increased risks for chronic diseases such as obesity, hypertension, and coronary artery disease in adults,[3] as well as poor overall health, mental health, and development in children.[4–6]

Furthermore, food insecurity can be a continuous, cumulative stressor impacting health across the life course.[7] Research has shown that experiencing food insecurity throughout childhood is linked to higher BMI, poor mental health, and poor academic performance in later childhood.[8–10] One study examining childhood food insecurity trajectories in Canada found that children who experienced longitudinal food insecurity had poorer diet and higher obesity risk in young adulthood compared to those who experienced food security.[11] Most studies on childhood food insecurity trajectories, however, have been conducted in a general population rather than in populations with socioeconomic disadvantage, who are at higher risk of food insecurity and adverse health outcomes.[9,11,12] Furthermore, data on how childhood food insecurity trajectories impact comprehensive health outcomes beyond weight in young adulthood are limited.[9,11,13] Understanding the effects of longitudinal childhood food insecurity on health outcomes in young adulthood, particularly among vulnerable populations, may better inform U.S. policies that promote food security and health throughout the life course.

To address these gaps, this study used data from the Future of Families and Child Wellbeing Study (FFCWS), a longitudinal U.S. birth cohort study that included a high proportion of households with low socioeconomic status.[14] Grounded in the life course perspective that

cumulative exposures to stressors over time influence health,[15] this study aimed to identify distinct patterns or trajectories of food insecurity throughout childhood among children with socioeconomic disadvantage. This study also aimed to examine associations between childhood food insecurity trajectory groups and young adulthood weight (BMI, overweight status, obese status) and self-reported health, the inclusion of which offers a more comprehensive view of health,[16] particularly when chronic diseases may not have emerged.[17,18] The study's hypotheses were that 1) distinct trajectories of childhood food insecurity would be identified, including one of consistent food security, 2) certain baseline sociodemographic characteristics would be associated with these trajectories and 3) trajectories of higher food insecurity would be associated with high weight status and low self-reported health in young adulthood.

METHODS

Study Sample

This study used data from the FFCWS,[19] an ongoing cohort of 4,898 children born in large U.S. cities from 1998-2000. The FFCWS oversampled unmarried birthing parents at a ratio of 3:1, resulting in the inclusion of a high proportion of Black, Hispanic, and low-income households. The FFCWS interviewed parents shortly after birth and when children were 1, 3, 5, 9, 15, and 22 years old, and it interviewed focal children when they were 15 and 22 years old. This study used parent surveys to assess household food insecurity when children were 3, 5, 9, and 15 years old. Focal child surveys were used to assess health outcomes at age 22. As the FFCWS is a publicly available and deidentified database, NYU Langone Health's Institutional Review Board did not require human subjects review.

Measures

The way researchers measure food insecurity has evolved over time.[20] The FFCWS assessed food insecurity at every wave in childhood but did not use the same assessment at every wave. The study's authors collaborated with the FFCWS data team to confirm the FFCWS' approach to measuring food insecurity at each time point. Aligned with current evidence, this study prioritized using the Hunger Vital Sign (HVS) and questions from the U.S. Department of Agriculture (USDA) Household Food Security Survey Module (HFSSM) to identify food insecurity.[20–23] Questions used to identify food insecurity status at each time point are reviewed below. Appendix Table 1 includes a full description of the selection process.

To assess food insecurity at ages 3 and 5 years, the FFCWS questions "(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more" and "The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more" were used. These questions closely matched HVS questions 1 and 2, respectively.[24] Households were categorized as food insecure if caregivers answered "Often true" or "Sometimes true" to either question or food secure if they answered "Never true" to both questions.

To assess food insecurity ages 9 and 15 years, the HVS was not available. The only item available from the USDA HFSSM was "(In the past twelve months), were you ever hungry, but didn't eat because you couldn't afford enough food?,[25,26] which was thus used for analysis. Households that answered "yes" were categorized as food insecure. This question represents more severe food insecurity than the questions at ages 3 and 5, as it assesses not having enough to eat rather than difficulty acquiring adequate food.[27]

Young adults' self-reported weight and height at age 22 were used to calculate BMI. Per World

Health Organization criteria for adults, overweight status was defined as having a BMI≥25, and

obese status was defined as having a BMI≥30.[28] Study-measured weight and height were

available at age 15 from in-home visits, so sensitivity analysis was conducted for weight

outcomes at age 15.

Adult self-reported health has been established as a valid indicator of overall health and

mortality.[16,29] The FFCWS asked 22-year-old young adults, "Would you say your health in

general is 1) excellent, 2) very good, 3) good, 4) fair, or 5) poor?" Answering "excellent" or

"good" was defined as having high self-reported health.

Statistical Analysis

Analyses were conducted in 2024. Of the overall sample (n=4,898), 3,255 children (66.5%) lived

food-insecure households at ages 3 and 5 years, and 3,512 (71.7%) lived in food-insecure

households at ages 9 and 15 years. The analytic sample included participants with at least one

food insecurity measure from ages 3-15 years (n=4,296, 87.7% of the overall sample).

Incomplete case analysis was used to avoid biasing the sample towards food secure households,

who are likely easier to retain in a cohort. Sensitivity analysis was conducted in participants with

complete food insecurity data across all timepoints.

GBTM is a statistical methodology that clusters individuals who follow similar trajectories of

development, behavior, or experiences over time.[30] Trajectory models do not model each

individual experiences precisely but rather estimate group patterns and categorize participants based on their likelihood of membership in each group. GBTM is useful for modeling incomplete data, as it utilizes all available information to provide maximum-likelihood estimates of model parameters. This study followed established GBTM procedures to select models that categorized distinct trajectories of food insecurity experiences from ages 3-15 years. Bayesian information criterion was used to determine the number of trajectory groups by systematically testing multiple polynomial variations and orders, testing both an *a priori* zero-term to represent a "consistently secure" trajectory of food insecurity and fitting statistics without a pre-specified theory. The final model was selected based on maximum Bayesian information criterion and entropy, with group posterior probabilities meeting the 0.70 threshold and consistency between observed and estimated group membership probabilities. Participants were assigned to the group with the highest estimated membership probability.

Descriptive statistics were used to describe sample characteristics. For groupwise comparisons, chi-square testing was used for categorical variables and ANOVA for continuous variables. Linear regression was used to model BMI, and logistic regression was used to model overweight, obesity, and high self-reported health. As the FFCWS primarily included participants with socioeconomic disadvantage, covariates were selected to capture additional within-group variability based on prior literature and conceptual models of food insecurity, obesity, and self-reported health.[10–12,31–33] Covariates included biological sex (male, female), first-born status (first-born, not first-born), race and ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, other or multiracial), maternal U.S. born status (yes, no), educational attainment at age 22 (less than high school, high school or higher), and number of people living in the household at

age 22. In supplemental analyses, covariates representing similar constructs (biological, social, and young adult characteristics) were added into the model in a stepwise manner. Supplemental analyses also included outcome comparisons between other trajectory groups excluding the reference group. Statistical analyses were completed using Stata Version 17 (College Station, Texas) and the 'traj' package for GBTM procedures.

RESULTS

Three childhood food insecurity trajectory groups were identified (Figure 1). One trajectory group was "food secure" at every time point (66.9%), one trajectory group was "food insecure" at every time point (7.5%), and another trajectory group transitioned from being "food insecure-to-secure" (25.6%). No trajectory group transitioning from food security-to-insecurity was detected. Children assigned to the food secure trajectory group were less likely to be first-born compared to children assigned to the food insecure and food insecure-to-secure trajectory groups (58.4%, 69.1%, 66.7%, respectively, p<0.001) and more likely to identify as non-Hispanic White (15.0%, 6.9%, 6.5%, respectively, p<0.001). At age 22, young adults assigned to the food secure trajectory group as children were more likely to have a college degree than those assigned to the food insecure and food insecure-to-secure trajectory groups as children (3.9%, 0.3%, 1.8%, respectively, p<0.001). Young adults assigned to the food secure trajectory group as children had lower mean BMI (27.3, 28.8, and 28.1, respectively, p=0.006), were less likely to have obesity (26.9%, 32.2%, and 31.7%, respectively, p=0.02), and were more likely to have high self-reported health (60.3%, 47.8%, and 59.1%, respectively, p=0.001) compared to young adults assigned to the food insecure and food insecure-to-secure trajectory groups as children (Table 1).

In the analytic sample (participants with at least one food insecurity measure), unadjusted analyses showed that young adults assigned to the food insecure-to-secure trajectory group in childhood had higher BMI (B 0.79, 95% CI [0.09-1.49]), increased odds of overweight status (OR 1.19, 95% CI [1.00-1.42]), and increased odds of obese status (OR 1.26, 95% CI [1.05-1.53]) compared to young adults assigned to the food secure trajectory group in childhood. In adjusted analyses, food insecure-to-secure trajectory group membership was associated with higher BMI (B 0.82, 95% CI [0.07-1.58]) and increased odds of overweight status (OR 1.24, 95% CI [1.01-1.52]) but not obese status. Before adjustment, young adults assigned to the food insecure trajectory group as children had higher BMI (B 1.55, 95% CI [0.41-2.69]) and lower odds of high self-reported health (OR 0.60, 95% CI [0.46-0.79]) compared to young adults assigned to the food secure trajectory group as children. After adjustment, young adults assigned to the food insecure trajectory group were still less likely to have high self-reported health (OR 0.65, 95% CI [0.48-0.89]), but the association between food insecure trajectory group membership and BMI was no longer significant (Table 2).

In supplemental analyses, stepwise adjustment procedures supported main findings (Appendix Table 2). When comparing trajectory groups excluding the food secure reference group, young adults assigned to the childhood food insecure-to-secure trajectory group had increased odds of high self-reported health compared to those assigned to the childhood food insecure trajectory group. Other outcomes were not statistically significant (data not shown). In sensitivity analysis of participants with complete food insecurity data, compared to young adults assigned to the food secure trajectory group as children, young adults assigned to the food insecure-to-secure trajectory group as children had higher BMI (B 0.96, 95% CI [0.02-1.90]), and young adults

assigned to the food insecure trajectory group as children had lower self-reported health (OR 0.56, 95% CI [0.38-0.84]) (Appendix Table 3). In sensitivity analysis of adolescent weight outcomes, in unadjusted analyses, adolescents assigned to the food insecure-to-secure trajectory group had higher BMI (B 1.01, 95% CI [0.14-1.88]) and higher odds of obesity (OR 1.53, 95% CI [1.07-2.18]) compared to adolescents assigned to the food secure trajectory group. Associations were not significant in adjusted analyses (Appendix Table 4).

DISCUSSION

Using longitudinal data of children from minoritized and low socioeconomic status backgrounds in large U.S. cities, this study identified three food insecurity trajectories: food secure, food insecure, and food insecure-to-secure. The food secure trajectory group was associated with being non-Hispanic White and having higher educational attainment in young adulthood. In adjusted analyses, when compared to food secure trajectory group membership, food insecure-to-secure trajectory group membership was predictive of high weight status, and food insecure trajectory group membership was predictive of low self-reported health. These results contribute to knowledge about food insecurity trajectories throughout childhood and their associations with health outcomes in young adulthood.

These findings, which incorporate experiences of food insecurity over a decade, expand current literature on food security status trajectories in childhood. Using USDA HFSSM measures of food insecurity in a nationally representative sample of children in the U.S., Jyoti et al. identified food insecurity experiences from kindergarten to third grade by creating a categorical variable to capture transitions in food insecurity status,[9] and Miller et al. identified food insecurity

trajectories from kindergarten to the eighth grade through growth curve modeling.[13] In contrast to Jyoti et al. and Miller et al., this study did not identify a food secure-to-insecure trajectory group, potentially reflecting this study's different population, use of group-based trajectory modeling, and longer follow-up period. This study's identification of a food insecure-to-secure trajectory group could reflect the change in food insecurity measures from ages 3 and 5 to ages 9 and 15, resulting in decreased affirmative responses. However, it is worth noting that Jyoti et al. and Miller et al. also observed a food insecure-to-secure group.[9,13] These results support the importance of using consistent, validated measures of food insecurity across childhood in future cohorts. Additionally, future studies can employ qualitative open-ended interviews to explore facilitators of and barriers to household food security,[34] further understanding nuances of families' food insecurity experiences.

In adjusted analyses, compared to food secure trajectory group membership, food insecure-to-secure trajectory group membership was associated with higher BMI and increased risk of overweight status in young adulthood, while food insecure trajectory group membership was not. Early childhood may be a key period for shaping food attitudes and behaviors,[35–38] and food insecurity has been associated with consuming an energy-dense, nutrient-poor diet and overeating when food is available.[36,39,40] For children who transition from food insecurity-to-security, their new increased access to food, combined with possible attitudes and behaviors established from their earlier food insecure experiences, may put them at risk of developing high weight status.[41,42] On the other hand, for children with persistent food insecurity, their continued inconsistent access to food may attenuate the risk of overweight and obese status.[43] Federal food and nutrition assistance programs such as the Supplemental Nutrition Assistance Program and

the Supplemental Nutrition Assistance Program for Women, Infants, and Children target food insecurity.[44,45] However, literature indicates that many households participating in these programs still experience food insecurity.[46,47] The persistence of food insecurity despite potential access to these programs underscores the need for further research to investigate broader factors influencing food access, such as neighborhood-level determinants. Future studies can also explore how experiences of food insecurity in childhood shape dietary and nutritional patterns across the lifespan. While research has linked persistent childhood food insecurity to increased sugar sweetened beverage and processed meat intake in young adulthood,[11] less is known about how transitioning from food insecurity-to-security influences dietary and nutritional practices.

Compared to food secure trajectory group membership in childhood, food insecure trajectory group membership was associated with low self-reported health in young adulthood, while food insecure-to-secure trajectory group membership was not. The finding that the food insecure trajectory group had lower self-reported health in young adulthood, while the food insecure-to-secure trajectory group had higher weight, suggests that young adults' health assessments encompass more than the physical aspects of weight. This aligns with literature demonstrating that multidimensional factors, including mental, social, and environmental factors, shape self-reported health.[48–50] For children experiencing persistent household food insecurity, food insecurity may be a chronic, cumulative stressor that adversely impacts self-reported health in later life, as supported by literature linking cumulative adverse childhood experiences to worse physical and mental health in adulthood.[51,52] Additionally, children in food insecure-to-secure households may experience other upward socioeconomic mobility in later childhood, which could have a protective effect for their self-reported health in young adulthood.[53] Future research

may further investigate the mechanisms through which longitudinal childhood food insecurity

trajectories impact self-reported health in young adulthood, as well as possible socioeconomic

mediators of these relationships.

Limitations

Social desirability bias and mistrust of research entities due to historical mistreatment of

minoritized communities may contribute to underreporting of food insecurity. The food

insecurity assessments are limited by the use of different food insecurity tools at ages 3 and 5

compared to 9 and 15, along with the reliance on a single USDA HFSSM item at ages 9 and 15

that has not been validated as a food insecurity screener. Use of self-reported rather than study-

measured weight and height at age 22 increases the risk of reporting and recall bias. Data

indicate that young adult self-reported weight reasonably approximates measured weight, though

higher BMI is associated with underestimation of weight.[54] Unmeasured socioeconomic factors

may bias this study's models. Lastly, the food insecure trajectory group's sample size may limit

detection of associations between this group and high weight status.

CONCLUSION

This study identified three distinct childhood food insecurity trajectories: food secure, food

insecure, and transitioning from food insecure-to-secure. Children assigned to the food secure

trajectory group were more likely to be Non-Hispanic White and have higher educational

attainment in young adulthood than those assigned to the food insecure-to-secure and food

insecure trajectory groups. Compared to persistent food security in childhood, transitioning from

food insecurity-to-security was predictive of high weight status in young adulthood, while

persistent food insecurity was predictive of low self-reported health in young adulthood. These findings support the life course perspective that childhood food insecurity experiences impact health outcomes in young adulthood. Even with current national and local food programs, food insecurity remains prevalent among households with children, indicating that additional interventions are necessary. Potential strategies include expanding access to and benefit adequacy of food assistance and nutrition programs,[55,56] integrating repeated food insecurity screening into healthcare visits to follow trajectories,[57] and advancing reforms that address related health-related social needs,[58,59] ultimately promoting health and wellbeing for individuals across the life course.

Author Statement

Olivia Liu: Conceptualization, Methodology, Software, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization. **Robin Ortiz:** Conceptualization, Writing – Review & Editing. **Jennifer Woo Baidal:** Conceptualization, Writing – Review & Editing. **Kristyn Pierce:** Validation, Writing – Review & Editing. **Eliana Perrin:** Conceptualization, Writing – Review & Editing**. Carol Duh-Leong:** Conceptualization, Methodology, Software, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization, Supervision.

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Conflict of interest

The authors have no competing interests relevant to this article to disclose.

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Figure 1. Food insecurity trajectory groups identified from the Future of Families and Child Wellbeing Study using group-based trajectory modeling.
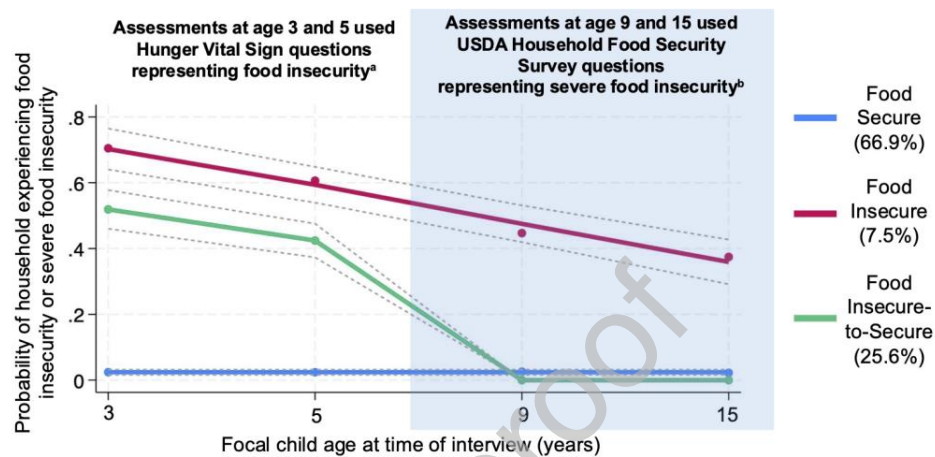
[a]Items used to assess household food insecurity were "(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more" and "The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more."
[b]Item used to assess severe household food insecurity was "(In the past twelve months), were you ever hungry, but didn't eat because you couldn't afford enough food?"

Table 1. Baseline sociodemographic characteristics of focal child, overall and by food insecurity trajectory group.

Variable	Analytic Sample	Food Secure	Food Insecure	Food Insecure-to-Secure	p-value
	n = 4,296	n = 2,876 (66.9%)	n = 320 (7.5%)	n = 1,100 (25.6%)	
Biological sex					0.055
Male	2,230 (51.9%)	1,469 (51.1%)	186 (58.1%)	575 (52.3%)	
Female	2,066 (48.1%)	1,407 (48.9%)	134 (41.9%)	525 (47.7%)	
First-born					**< 0.001**
Yes	2,634 (61.3%)	1,679 (58.4%)	221 (69.1%)	734 (66.7%)	
No	1,647 (38.3%)	1,185 (41.2%)	99 (30.9%)	363 (33.0%)	
Race and ethnicity					**< 0.001**
White, non-Hispanic	523 (12.2%)	430 (15.0%)	22 (6.9%)	71 (6.5%)	
Black, non-Hispanic	1,339 (31.2%)	814 (28.3%)	123 (38.4%)	402 (36.6%)	
Hispanic	773 (18.0%)	505 (17.6%)	64 (20.0%)	204 (18.6%)	
Other or multiracial	214 (5.0%)	159 (5.5%)	15 (5.3%)	38 (3.5%)	
Missing	1,447 (33.7%)	968 (33.7%)	94 (29.4%)	385 (35.0%)	
U.S. born mother					**0.043**
Yes	3.630 (84.5%)	2,413 (83.9%)	286 (89.4%)	931 (84.6%)	
No	656 (15.3%)	457 (15.9%)	34 (10.6%)	165 (15.0%)	
Educational attainment at age 22					**< 0.001**
Less than high school	1,330 (31.0%)	872 (30.3%)	120 (37.5%)	338 (30.7%)	
High school or equivalent	953 (22.2%)	616 (21.4%)	72 (22.5%)	265 (24.1%)	
Some college or technical education	173 (4.0%)	123 (4.5%)	12 (3.8%)	33 (3.0%)	
College degree or higher	132 (3.1%)	111 (3.9%)	1 (0.3%)	20 (1.8%)	
Other	3 (0.1%)	3 (0.1%)	0 (0.0%)	0 (0.0%)	
Missing	1,705 (39.7%)	1,146 (39.9%)	115 (35.9%)	444 (40.4%)	
Household size at age 22					0.621
3 or less	1,480 (34.5%)	994 (34.6%)	113 (35.3%)	373 (33.9%)	
4 to 5	1,054 (24.5%)	717 (24.9%)	82 (25.6%)	255 (23.2%)	

6 or more	410 (9.5%)	268 (9.3%)	35 (10.9%)	107 (9.7%)	
Missing	1,352 (31.5%)	897 (31.2%)	90 (28.1%)	365 (33.2%)	
BMI[a] at age 22; mean (SD)	27.6 (8.0)	27.3 (7.2)	28.8 (11.6)	28.1 (8.7)	**0.006**
Overweight[b] at age 22	1,511/2,778 (54.4%)	994/1,864 (53.3%)	113/214 (52.8%)	404/700 (57.7%)	0.123
Obesity[c] at age 22	802/2,778 (28.5%)	511/1,864 (26.9%)	69/214 (32.2%)	222/700 (31.7%)	**0.024**
High self-reported health[d] at age 22	1,712/2,871 (59.0%)	1,159/1,922 (60.3%)	108/226 (47.8%)	427/723 (59.1%)	**0.001**

[a]Body mass index in units of pounds/inches^2.

[b]Overweight defined as body mass index of 25 or higher

[c]Obesity defined as body mass index of 30 or higher.

[d]High self-reported health defined as "good" or "excellent" self-reported health.

Table 2. Unadjusted and adjusted analyses of young adult outcomes based on food insecurity trajectory groups.

Outcome	n	Food Secure	Food Insecure	Food Insecure-to-Secure
Body mass index[a]				
Unadjusted, B [95% CI]	2,778	Reference	**1.55 [0.41 – 2.69]****	**0.79 [0.09 – 1.49]***
Adjusted, B [95% CI]	2,214	Reference	0.44 [-0.78 - 1.67]	**0.82 [0.07 – 1.58]***
Overweight[b]				
Unadjusted, OR [95% CI]	2,778	Reference	0.98 [0.74 – 1.30]	**1.19 [1.00 – 1.42]***
Adjusted, OR [95% CI]	2,214	Reference	0.89 [0.64 – 1.23]	**1.24 [1.01 - 1.52]***
Obesity[c]				
Unadjusted, OR [95% CI]	2,778	Reference	1.29 [0.95 – 1.76]	**1.26 [1.05 – 1.53]***
Adjusted, OR [95% CI]	2,214	Reference	1.10 [0.77 – 1.57]	1.21 [0.97 – 1.51]
High self-reported health[d]				
Unadjusted, OR [95% CI]	2,871	Reference	**0.60 [0.46 – 0.79]*****	0.95 [0.80 – 1.13]
Adjusted, OR [95% CI]	2,283	Reference	**0.65 [0.48 – 0.89]****	1.04 [0.85 – 1.27]

[a]Body mass index in units of pounds/inches^2.

[b]Overweight defined as body mass index of 25 or higher

[c]Obesity defined as body mass index of 30 or higher.

[d]High self-reported health defined as "good" or "excellent" self-reported health.

Adjusted analysis controlled for all covariates (sex, first-born status, race and ethnicity, maternal U.S. born status, educational attainment at age 22, and household size at age 22).

*p<0.05; **p<0.01; ***p<0.005.

B: unstandardized regression coefficient.