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Food Insecurity and Increased BMI in Young Adult Women

Holly C. Gooding[1], Courtney E. Walls[2] and Tracy K. Richmond[1]

Food insecurity has been associated with weight status in children and adults although results have been mixed. We aimed to identify whether food insecurity was associated with BMI in young adults and whether this association differed by gender and was modified by food stamp use and the presence of children in the home. Cross-sectional data from wave 4 (2007–2008) of the National Longitudinal Study of Adolescent Health were analyzed. Multiple linear regression was used to investigate the association between food insecurity and BMI in gender stratified models of young adult women (n = 7,116) and men (n = 6,604) controlling for age, race/ethnicity, income, education, physical activity, smoking, alcohol use, the presence of children in the home, and food stamp use in young adulthood and/or adolescence. Food insecurity was more common in young adult women (14%) than young adult men (9%). After controlling for a variety of individual variables, food insecure women had a BMI that was on average 0.9 kg/m^2 units higher than women who were food secure. This difference in BMI persisted after controlling for recent or past food stamp use and was not different among women with or without children in the household. No relationship was found between food insecurity and BMI in young adult men. Providers should inquire about food insecurity, especially when treating obesity, and policy initiatives should address the role of access to healthy food in those facing food insecurity.

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INTRODUCTION

Obesity is a major public health problem with numerous consequences, including reductions in life expectancy (1) and quality-of-life (2). Food insecurity has emerged as an important factor that may contribute to the disproportional development of obesity in those from lower socioeconomic backgrounds (3). Food security is defined by the United States Department of Agriculture (USDA) as "access by all people at all times to enough nutritious food for an active, healthy life" (4). In the latest USDA data from 2009, 14.7% of American households were food insecure, with higher proportions reported by households with children headed by a single woman (37%) and by blacks (25%) and Hispanics (27%) (5).

Food insecurity has been linked to increased weight in several studies (6), a phenomenon known as the "food insecurity-obesity paradox" (7). Individuals who experience food insecurity may alternate between periods of hunger and consumption of high-calorie or high-fat foods to avoid hunger, as nutrient-poor energy-dense foods cost less than lean meats, vegetables, and fruits (8). These compensatory strategies employed during food adequacy and shortage, in combination with constrained dietary options of lesser nutritional value, may in turn lead to cyclic weight gain (9). Several studies have found that women reporting food insecurity are more likely to be overweight or obese compared to women who are food secure (10–16). Food insecurity has been investigated less frequently in men; some studies have found an association with BMI (14) while others have not (10,13). The data in children and adolescents are also mixed (17–22).

Although the reasons for a stronger effect of food insecurity on women are unclear, two potential explanations include women's greater participation in the Supplemental Nutrition Assistance Program (SNAP) and role in childrearing. The USDA administers the SNAP, formerly known as the Food Stamp Program, to help address issues of hunger and food insecurity (23). Notably, several studies have found higher rates of overweight and obesity in food insecure (24,25) and low-income (26,27) adults receiving food stamps compared to those not participating in the program. As hypothesized by Dinour and colleagues (7), some women may sacrifice their own nutritional resources in order to protect their children from hunger. Although several studies have focused on the relationship between food insecurity and obesity in small populations of women with children (11,12), we are unaware of studies assessing the affects of receipt of supplemental nutrition or having children in the home on the relationship between food insecurity and BMI in a large cohort of women of childbearing age.

[1]Division of Adolescent and Young Adult Medicine, Department of Medicine, Children's Hospital Boston, Boston, Massachusetts, USA; [2]Clinical Research Program, Children's Hospital Boston, Boston, Massachusetts, USA. Correspondence: Holly C. Gooding (holly.gooding@childrens.harvard.edu)

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The National Longitudinal Study of Adolescent Health (Add Health), a nationally representative sample of over 15,000 participants surveyed prospectively from adolescence into young adulthood, offers a unique opportunity to further clarify these relationships between food insecurity and obesity. As young adulthood is a time of transition to self-sufficiency as well as a critical time point in the establishment of adult obesity (28), this age group may be particularly vulnerable to food insecurity and its effects on weight. Add Health also includes participants from a wider variety of racial and ethnic groups than previously studied and includes important data on parenting as well as receipt of supplemental assistance in young adulthood and adolescence. This study uses data from Add Health to clarify the relationship between food insecurity and BMI by investigating whether food insecurity is differentially associated with BMI in young adult men and young adult women and whether a history of receiving food stamps or the presence of young children in the household modifies any association between food insecurity and BMI.

METHODS AND PROCEDURES

Participants

This study uses data from the fourth Wave of the National Longitudinal Study of Adolescent Health (n = 15,701), a nationally representative school-based study of adolescents enrolled in grades 7–12 at initial recruitment. Wave I data were collected in 1994–1995 and wave IV data in 2007–2008, when the participants were aged 24–32. Informed consent was obtained at wave I and the study was approved by the institutional review board at the University of North Carolina Chapel Hill (29). Participants with missing data for sample weights were excluded (n = 901) because it was not possible to take into account the complex survey design for these individuals. Those currently pregnant (n = 487) were excluded due to concern that their weight status might be influenced by factors different than in the nonpregnant population. Those with height <58 inches or >84 inches, as well as those with weight <80 lbs or >440 lbs (the maximum capacity of the scale used to weigh participants), were also excluded due to concerns about biologic plausibility or measurement error (n = 264). In addition to these exclusions, those who had missing data for either the dependent variable or for any of the key independent variables were excluded (n = 329). Because there was a high nonresponse rate for income (~7%), income was imputed by Gaussian normal regression in order to avoid selection bias. After this imputation and all exclusions, the final sample contained 13,720 young adults (87.4% of wave IV participants).

Outcome measurements

Outcome variable. BMI (weight (kg)/height (m^2)) was the outcome variable. BMI was calculated from measured weight and height when available (98%) and from self-report in the small number of participants missing measured height and weight.

Primary predictor variable. The primary predictor variable of interest was self-report of food insecurity. Participants were asked "In the past 12 months, was there a time when (you/your household were/was) worried whether food would run out before you would get money to buy more?" to which they responded yes or no. There was a 99.9% response rate for this question. This question is the first item in the 18-item US Household Food Security Scale (30) and a positive response indicates individuals are either marginally food secure or food insecure (Mark Nord, Economic Research Service, USDA, personal communication). For the purposes of this analysis we will continue to use the term "food insecure" to refer to those with a positive response.

Additional independent variables. Race/ethnicity was constructed from two questions from the third wave of the study regarding racial identity and whether participants were of Hispanic/Latino origin, as these questions were not asked at wave IV. Six racial/ethnic categories were constructed based on participant responses: white, black/African American, Hispanic, American Indian/Native American, Asian/Pacific Islander, and multiracial. Participant report of household income was constructed as the midpoint of the income category chosen by the participant. Income was imputed using the Gaussian normal regression imputation method for those 835 participants who either refused to answer the income question or stated they did not know. The household income variable was then transformed into a continuous measure that was a ratio of household income relative to the poverty level in 2008 (31) based on the number of household members reported by the participant.

The highest level of education achieved by the participant was collapsed into four categories: less than high school (8th grade or less or some high school), high school graduate, some college (some college or vocational/technical training beyond high school), and college graduate (completed college, some graduate school, or a masters or doctoral degree). Physical activity was calculated as the sum of the number of physical activity episodes reported in a typical week, with a range of 0–49 activities. Activity duration and intensity data were not available. Smokers were designated as those currently smoking tobacco on >10 days in the proceeding 30 days. Alcohol users were identified as those consuming alcohol on 1 or more days a week in the past 30 days. Participants were coded as having dependent children at home if they reported any sons/daughters (biological, adopted, foster, or step-children) currently living in their household. Food stamp use/public assistance was considered present at wave 4 if the participant reported receiving any public assistance, welfare payments, or food stamps in the intervening years because the prior wave in which they were surveyed. Food stamp use was considered present at wave 1 if the mother or legal guardian reported that the household had received food stamps in the prior month. Data regarding the duration of time participants received food stamps was not available.

Statistical analysis

All analysis was performed using STATA SE 10.0 (Stata, College Station, TX). Survey sampling weights were applied to account for the unequal likelihood of certain subpopulations being sampled. Bivariate analyses of the covariates of interest with the primary predictor variable were done to test for significant relationships with χ^2-tests for categorical variables and simple linear regression for continuous variables. A multiple linear regression model was created to assess the association between food insecurity and BMI controlling for potential confounders in the overall sample. Confounders were identified as those variables associated with both food insecurity and BMI in bivariate analysis or based on empiric evidence. Interaction terms were then created and added based on either evidence from the literature or *a priori* hypotheses regarding the differential effect of food insecurity for certain populations (i.e., females, those raising children, those with an income <200% of the federal poverty level). Results were then stratified by gender based on evidence from the literature for a differential association between food insecurity and weight in women and men (10) and based on the significance of the interaction term for gender and food insecurity in the full model. Regression diagnostic procedures showed no evidence of multicollinearity, heteroscedasticity, or substantial influence from outliers.

RESULTS

The average age in this sample was 28.9 years. Females comprised 48% of the total population and males 52%. The racial and ethnic makeup of the sample was similar to that of the US population, with 66% of participants reporting they were white, 16% African American, 12% Hispanic, 4% Asian, and 2% American Indian. Thirty percent were college graduates

Table 1 Food security status of participants by demographic characteristics

Females	Food secure	Food insecure	*P* value
Age	28.7 ± 0.1	28.9 ± 0.2	0.218
Race/ethnicity[a]			**<0.001**
White	88%	12%	
African American	78%	22%	
Hispanic	87%	13%	
American Indian	69%	31%	
Asian	91%	9%	
Multiracial	87%	13%	
Highest education[b]			**<0.001**
Less than high school	69%	31%	
High school graduate	77%	23%	
Some college	84%	16%	
College graduate	95%	5%	
Income (thousands)	62.9 ± 1.1	33.8 ± 1.4	**<0.001**
Recent public assistance	71%	29%	**<0.001**
Food stamps in adolescence	72%	28%	**<0.001**
Children in household	82%	18%	**<0.001**
Smoker	78%	22%	**<0.001**
Alcohol use	89%	11%	**0.004**
Physical activity (#bouts per week)	5.8 ± 0.1	5.3 ± 0.2	**0.044**
Males	**Food secure**	**Food insecure**	***P* value**
Age	29.0 ± 0.1	29.1 ± 0.2	0.414
Race/ethnicity[a]			**<0.001**
White	91%	9%	
African American	86%	14%	
Hispanic	93%	7%	
American Indian	86%	14%	
Asian	95%	5%	
Multiracial	69%	31%	
Highest education[b]			**<0.001**
Less than high school	81%	19%	
High school graduate	89%	11%	
Some college	89%	11%	
College graduate	96%	4%	
Income (thousands)	65.2 ± 1.1	37.8 ± 1.6	**<0.001**
Recent public assistance	78%	22%	**<0.001**
Food stamps in adolescence	86%	14%	**<0.001**
Children in household	89%	11%	0.059
Smoker	86%	14%	**<0.001**
Alcohol use	92%	8%	**0.022**
Physical activity (#bouts per week)	7.1 ± 0.1	6.9 ± 0.4	0.506

[a]African Americans and American Indians differed significantly from whites ($P < 0.001$). [b]High-school graduates, participants with some college education, and college graduates all differed significantly from those without a high school diploma ($P < 0.001$). Bold face values indicates a *P* value < 0.05.

and the average household income was $60,000. Forty-five percent of participants had at least one child living in their household. Thirty-two percent were smokers, 31% consumed alcohol on a weekly basis, and participants reported an average of 6 physical activities/week.

The demographic characteristics of those participants who did and did not report food insecurity are listed in **Table 1**, stratified by gender. Significantly more female participants reported food insecurity than male participants ($P < 0.001$). Food insecurity was more prevalent in African Americans and American Indians compared to whites. Food insecurity was also associated with lower income and lower educational attainment and a greater likelihood of having received public assistance or food stamps. Food insecurity was significantly more likely to be reported by women with children in their household and by individuals who smoked and who did not consume regular alcoholic beverages. *P* values for most associations were <0.001.

Among female participants, food insecurity was positively associated with BMI (**Table 2**). Those who reported food insecurity had BMIs that were on average 2.39 kg/m^2 higher than those who did not report food insecurity (**Table 2**, model 1). This relationship was attenuated to 0.9 kg/m^2 but remained significant after controlling for other demographic and health behavior variables associated with both food insecurity and BMI including age, race/ethnicity, education, household income, smoking status, alcohol use, and physical activity (**Table 2**, model 2). However, among male participants we found no association between food insecurity and BMI (**Table 3**).

Food insecurity was significantly associated with receipt of public assistance in adolescence and in young adulthood ($P < 0.001$, **Table 1**). However, neither recent receipt of public assistance/food stamps nor past receipt of food stamps in adolescence modified the relationship between food insecurity and BMI in either females or males (**Tables 2** and **3**, model 3). Although the presence of dependent children in the household was associated with a lower BMI in young adult women (**Table 2**, model 4), the interaction between food insecurity and the presence of children was nonsignificant (**Table 2**, model 4). Given reports in the literature regarding increased effects of food insecurity on low-income individuals (32), we restricted our analysis to those reporting a household income <200% of the federal poverty level and found no significant change in the associations (data not shown). There was also no effect modification of the relationship between food insecurity and BMI by educational attainment or race/ethnicity for either gender (data not shown).

DISCUSSION

This is the first study to demonstrate that food insecurity is associated with increased BMI in a nationally representative racially diverse sample of young adult women after controlling for age, race/ethnicity, education, income, physical activity, smoking, and alcohol use. Furthermore, this relationship persists after controlling for food stamp use and the presence of children in the household. Although other studies have found

Table 2 Associations between food insecurity and BMI in females

	Model 1	Model 2	Model 3	Model 4
	β[a] (s.e.)	β[a] (s.e)	β[a] (s.e)	β[a] (s.e)
Food insecure[b]	2.39 (0.45)***	0.87 (0.44)*	1.04 (0.49)*	0.89 (0.44)*
Age		0.20 (0.08)**	0.17 (0.07)***	0.20 (0.08)**
Race/ethnicity[c]				
Black		2.58 (0.37)***	2.51 (0.39)***	2.55 (0.36)***
Hispanic		0.70 (0.41)	0.45 (0.45)	0.67 (0.41)
Asian		–2.61 (0.71)***	–3.41 (0.53)***	–2.71 (0.68)***
American Indian		1.95 (1.13)	1.39 (1.09)	1.91 (1.10)
Multiethnic		–4.84 (1.90)**	–3.66 (1.92)	–4.67 (1.84)*
Education[d]				
HS graduate		2.07 (0.66)**	2.00 (0.74)**	2.02 (0.65)**
Some college		1.00 (0.54)	1.07 (0.56)	0.95 (0.54)
College graduate		–0.90 (0.57)	–0.89 (0.62)	–1.27 (0.61)*
Household income[e]		–0.32 (0.07)***	–0.34 (0.07)***	–0.41 (0.06)***
Smoker[f]		–0.76 (0.30)*	–0.73 (0.33)*	–0.77 (0.30)**
Alcohol[g]		–1.88 (0.33)***	–1.82 (0.35)***	–2.19 (0.32)***
Physical activity		–0.04 (0.02)	–0.05 (0.02)*	–0.05 (0.02)*
Food stamps adolescence[h]			–0.53 (0.55)	
Food stamps young adulthood[h]			–0.39 (0.37)	
FS adolescence × FI			NS	
FS young adulthood × FI			NS	
Children in household[i]				–1.60 (0.36)***
Children in household × FI				NS

FI, food insecurity; FS, food stamps; HS, high school; NS, nonsignificant.
[a]β indicates change per one unit BMI difference. [b]Reference group is food secure. [c]Reference group is white. [d]Reference group is no high school diploma. [e]Household income measured as percent relative to the poverty level. [f]Reference group is nonsmokers. [g]Reference group is <1 alcoholic drink per week. [h]Reference group is no food stamp use reported. [i]Reference group is no children in the household.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

that food insecurity differentially affects individuals from various racial and ethnic backgrounds (16,19) or only those below the federal poverty level (32), we did not find an interaction between food insecurity and race/ethnicity nor income in this population. This study does not find an association between food insecurity and BMI among young adult men.

This differential association in men and women is consistent with findings from previous studies in other populations (6) but the reason for the differential association between food insecurity and weight status in men and women remains unclear. Although others have hypothesized that food insecure women preferentially give available nutritious food to their children and are thus more apt to consume lower quality foods or alternate between overeating and hunger (7), we did not find an interaction between food insecurity and the presence of children in the home in this large cohort of participants of childbearing age. While women are more likely to participate in SNAP or other supplemental nutrition programs, we also did not find evidence of an association between food stamp use and BMI, nor a differential effect of food insecurity on BMI in those participants who did and did not report food stamp use in adolescence or young adulthood. It is possible that food insecure women make different nutritional choices than food insecure men and other food secure adults. There may also be genetic or hormonal differences that lead food insecure women to increase their adiposity stores in response to alternating periods of food scarcity and abundance (33). These remain areas for future research.

There are several important limitations to this study. First, this study used a single-item question to assess food insecurity. The USDA publishes both the full 18-item US Household Food Security Scale and a validated 6-item short form for the assessment of food insecurity in adults (30). Our measure is the first item on both of these forms and is considered the most inclusive question. While it is the least severe measure of food insecurity (34), recent work has demonstrated that this one question has a sensitivity of 93% and a specificity of 85% for detecting food insecurity as measured by the gold standard 18-item US Household Food Security Scale (35). Furthermore, using only this question is likely to underreport food insecurity so results

Table 3 Associations between food insecurity and BMI in males

	Model 1	Model 2	Model 3	Model 4
	β[a] (s.e.)	β[a] (s.e)	β[a] (s.e)	β[a] (s.e)
Food insecure[b]	0.05 (0.41)	0.01 (0.39)	–0.17 (0.39)	0.03 (0.39)
Age		0.10 (0.07)	0.12 (0.07)	0.09 (0.07)
Race/ethnicity[c]				
Black		0.24 (0.30)	0.15 (0.36)	0.27 (0.30)
Hispanic		0.74 (0.36)*	0.95 (0.36)*	0.73 (0.37)*
Asian		–0.94 (0.76)	–0.61 (0.78)	–0.90 (0.75)
American Indian		1.57 (1.46)	1.13 (1.62)	1.61 (1.45)
Multiethnic		0.21 (2.30)	2.05 (2.25)	0.17 (2.24)
Education[d]				
HS graduate		–0.21 (0.47)	–0.31 (0.54)	–0.21 (0.47)
Some college		0.41 (0.42)	0.45 (0.45)	0.41 (0.42)
College graduate		–1.36 (0.43)**	–1.40 (0.47)**	–1.30 (0.43)**
Household income[e]		0.03 (0.05)	0.03 (0.05)	0.05 (0.05)
Smoker[f]		–1.65 (0.23)***	–1.80 (0.25)***	–1.61 (0.23)***
Alcohol[g]		–1.31 (0.20)***	–1.48 (0.22)***	–1.28 (0.21)***
Physical activity		–0.05 (0.02)**	–0.05 (0.02)*	–0.05 (0.02)**
Food stamps adolescence[h]			0.16 (0.42)	
Food stamps young adulthood[h]			–0.13 (0.38)	
FS adolescence × FI			NS	
FS young adulthood × FI			NS	
Children in household[i]				0.48 (0.22)*
Children in household × FI				NS

FI, food insecurity; FS, food stamps; HS, high school; NS, nonsignificant.
[a]β indicates change per one unit BMI difference. [b]Reference group is food secure. [c]Reference group is white. [d]Reference group is no high school diploma. [e]Household income measured as percent relative to the poverty level. [f]Reference group is nonsmokers. [g]Reference group is <1 alcoholic drink per week. [h]Reference group is no food stamp use reported. [i]Reference group is no children in the household.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

remain conservative (Mark Nord, Economic Research Service, USDA, personal communication). Second, questions regarding participation in the SNAP differed across waves, referencing imprecise lengths of time and sometimes including exposure to other public assistance programs, and data were collected before important revisions to the program in 2008. Finally, this is a cross-sectional study and therefore a causal relationship between food insecurity and BMI in young women cannot be demonstrated by this analysis. We were unable to investigate the longitudinal effects of food insecurity as this measure was only added in Wave 4 of data collection. Analyzing longitudinal effects of food stamp exposure was also not possible due the measure changing as noted above. Future waves of Add Health should retain the food insecurity question in order to assess the effect of ongoing, new-onset, or resolved food insecurity on weight gain as participants continue to age into adulthood.

In conclusion, food insecurity is related to BMI in this sample of diverse young adult women, but not in young adult men. Providers should ask patients about food insecurity when assessing and treating overweight and obesity, especially in women. A simple two-question screen is likely adequate with affirmative responses to either question concerning for food insecurity (35). Providers should refer patients with identified food insecurity to appropriate social services and should also provide information regarding how to choose healthy foods from these programs. Recent innovations in food assistance programs, such as the doubling of SNAP benefits if used at farmers markets or the elimination of sugar sweetened beverages from some food banks, may help to mitigate the adverse effects of food insecurity on weight. Future policy initiatives aimed at combating overweight and obesity should address the role of food insecurity with similar creative solutions that preferentially subsidize nutritious over unhealthy foods. Further studies are needed to assess the longitudinal relationship between food insecurity and weight status throughout the lifespan and to elucidate the mechanisms by which food insecurity impacts BMI.

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DISCLOSURE

The authors declared no conflict of interest.

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