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Food Insecurity Is Associated with Obesity among US Adults in 12 States

Liping Pan, MD, MPH [epidemiologist],
Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA

Bettylou Sherry, PhD, RD [senior epidemiologist],
Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA

Rashid Njai, PhD, MPH [epidemiologist], and
Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA

Heidi M. Blanck, PhD, MS [senior epidemiologist]
Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA

Abstract

A redesigned food insecurity question that measured food stress was included in the 2009 Behavioral Risk Factor Surveillance System in the Social Context optional module. The objective of our study was to examine the association between food stress and obesity using this question as a surrogate for food insecurity. Our analytic sample included 66,553 adults from 12 states. Food insecurity was determined by response (always/usually/sometimes) to the question,"Howoften in the past 12 months would you say you were worried or stressed about having enough money to buy nutritious meals?" *T* tests were used to compare prevalence differences between groups, and logistic regression was used to examine the association between food insecurity and obesity. Among the 12 states, the prevalence of obesity was 27.1% overall, 25.2% among food secure adults, and 35.1% among food insecure adults. Food insecure adults had 32% increased odds of being obese compared to food secure adults. Compared with food secure adults, food insecure adults had significantly higher prevalence of obesity in the following population subgroups: adults ages ≥30 years, women, non- Hispanic whites, non-Hispanic blacks, adults with some college education or a college degree, a household income of <$25,000 or $50,000 to $74,999, and adults with none or two children in their households. One in three food insecure adults were obese. Food insecurity was associated with obesity in the overall population and most population subgroups. These findings are consistent with previous research and highlight the importance of increasing access to affordable healthy foods for all adults.

Address correspondence to: Liping Pan, MD, MPH, Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 4770 Buford Hwy, NE, K-26, GA 30341. Lpan@cdc.gov.

STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict interest was reported by the authors.

Keywords

Obesity; Food insecurity; Food security; Adult

Obesity and food insecurity are both public health concerns that have influences at the individual and environmental levels. Approximately one in three US adults are obese,[1] and they are at increased risk of negative health consequences, including premature death, coronary heart disease, hypertension, stroke, type 2 diabetes, and certain types of cancer.[2,3] Food security means "access by all people at all times to enough food for an active, healthy life."[4] In contrast, food insecurity implies a limited ability to secure adequate food due to insufficient household resources.[4] Approximately one in seven (17.4 million) US households were food insecure in 2009.[5] Food insecure adults are more likely to have low nutrient intake, hypertension, diabetes, depression, and other mental health problems.[6,7] Both obesity and food insecurity affect health, which is determined not merely by behavioral, biologic, and genetic factors, but also by a range of environmental and social determinants.[8] These include safe environments, adequate income, meaningful and valued social roles, secure housing, higher levels of education, and social support.[8]

Obesity and food insecurity are more prevalent among low-income populations.[5,8] Food insecure adults may rely on low-cost, high-energy foods,[5] which can lead to overconsumption of energy and result in obesity. In 1995 Dietz[9] proposed a relationship between obesity and hunger, the most severe form of food insecurity, based on a case report; since then, a number of studies[10–15] have examined the association between obesity and food insecurity among US adults. However, only two studies[16,17] have tested this relationship using data from the Behavioral Risk Factor Surveillance System (BRFSS). The food insecurity question included in BRFSS during the 1990s asked whether the respondent worries about having enough food for herself/himself or her/his family. A study based on this question found that food insecurity was associated with obesity in Washington State during 1995–1999.[16] In addition, Laraia and colleagues[17] analyzed the 1999 BRFSS data for Louisiana and New York and found that, at that time, self-reported obesity was not associated with concern about enough food in these two states.

In 2009, a redesigned food insecurity question asking about stress associated with the affordability of nutritious meals was included in the BRFSS Social Context Module, and 12 states collected complete data on this question. The objective of our study was to examine the association between food insecurity and obesity in 12 states using this redesigned module question.

METHODS

Survey Design

BRFSS is an ongoing, state-based, telephone interview survey conducted by the Centers for Disease Control and Prevention and state health departments.[18] The survey is based on a multistage sampling design that uses random-digit dialing of telephone numbers to select a sample that represents the civilian noninstitutionalized adult population in each of the 50

states, the District of Columbia, and three US territories. Post-stratification weights are used to adjust for nonresponse, noncoverage, and disproportionate selection of populations.[18,19]

Study Sample

Fourteen states included the food insecurity module question in their questionnaire. Although Delaware and New Jersey collected data, these states were excluded from our analyses because they used nonstandard response options for the food insecurity question.[20] Our study was deemed exempt by the Centers for Disease Control and Prevention Institutional Review Board because no identifiable data were used.

The overall weighted sample included 75,103 adults from 12 states (Alabama, Alaska, California, Hawaii, Illinois, Kansas, Louisiana, Nebraska, New Mexico, Oklahoma, South Carolina, and Wisconsin). Pregnant women (n=479), subjects who were missing data for food insecurity (n=5,821), as well as subjects who reported extreme values (weight ≥500 lb or height ≥7 ft or <3 ft) and those who had missing values for height or weight (n=2,250) were excluded, yielding a final sample size of 66,553.

Measurements

As the main exposure, food security status was assessed based on the question, “How often in the past 12 months would you say you were worried or stressed about having enough money to buy nutritious meals?” Subjects who responded “always,” “usually,” or “sometimes” were categorized as having food insecurity. Those who responded “rarely” or “never” were considered food secure.

The redesigned food insecurity question is a proxy for the 18-question Household Food Security Survey module developed by the US Department of Agriculture (USDA),[5] modified from the USDA question that asks about worrying about having the money to pay for food. The purpose of this question is to measure the presence of stress associated with household affordability to access nutritious foods. This question assesses a related, but less severe, condition of food insecurity than that measured by the USDA module and used in most related research.[5,21] For simplicity of terminology, we henceforth refer to food stress as food insecurity.

The outcome of interest was obesity. Body mass index (BMI) was calculated based on self-reported weight and height. Weight status was defined as follows: underweight, BMI <18.5; normal weight, BMI 18.5 to 24.9; overweight, BMI 25.0 to 29.9; and obesity, BMI ≥30.0.

Sociodemographic variables were also included in data analyses. There was ~10% missing data on household income among the 12 states. To ensure data quality, “missing” was listed as a separate income category.

Statistical Methods

The statistical analyses were carried out using SAS-Callable SUDAAN (version 9.2, 2008, SAS Institute, Inc). The variances for the estimates were adjusted to the BRFSS complex sampling design, including post-stratification. The estimates were weighted to correspond to the age, sex, and race/ethnic distribution of the state population.

T tests were used to compare the differences in the prevalence of obesity and food insecurity between groups because the response variables were coded as 0/1. To control for the inflated type 1 error rate due to the large sample size, this study set the statistical significance level as $P<0.01$. Logistic regression was conducted to examine the association between food insecurity and obesity controlling for sociodemographic characteristics. In addition to obesity and food insecurity status, our multivariate logistic regression models included age, sex, race/ethnicity, level of education, household income, marital status, employment status, and number of children in the household. No collinear variables were identified based on the criteria that they change the standard error of the coefficient for exposure (food insecurity) by >10%.[22] Although disability and poor or fair health status are associated with obesity,[23] these conditions were not included in the logistic regression models because they could cause or result from obesity.

The final model for the multivariate regression analysis included 57,462 respondents with complete data on covariates. Because sex, education level, and number of children in the household were identified as the significant effect modifiers of the association between food insecurity and obesity, we stratified the logistic regression analyses by these covariates. Furthermore, unadjusted and adjusted odds ratios of obesity for food insecure adults compared with food secure adults were calculated using bivariate and multivariate logistic regression analyses.

RESULTS AND DISCUSSION

The prevalence of food insecurity is described in Table 1. Among the 12 states, the prevalence of food insecurity was 19.0% overall; 22.5% among underweight, 16.4% among normal weight, 17.2% among overweight, and 24.7% among obese adults. Adults who were obese had significantly higher prevalence than adults of normal weight ($P< 0.0001$). The prevalence was significantly higher among adults aged 18 to 49 years, women, blacks, Hispanics, and adults with lower levels of education ($P<0.01$). As household income decreased, the prevalence of food insecurity increased (linear trend, $P<0.0001$). Among states, the prevalence ranged from 14.1% in Kansas to 24.9% in Alabama. Four states (Alabama, New Mexico, Oklahoma, and South Carolina) had a prevalence of >20% (Table 1).

Overall, the prevalence of obesity was 27.1% among adults ages 18 years and older in the 12 states, 8.8% lower than the estimate from the National Health Examination and Nutrition Examination Survey among US adults ages 20 years and older.[1] The prevalence was significantly higher among food insecure adults than that among food secure adults (35.1% vs 25.2%; $P<0.0001$) (Table 2). Compared with adults who are food secure, food insecure adults had significantly increased prevalence of obesity among the following subgroups: those ages ≥30 years; women; non-Hispanic whites, non-Hispanic blacks, and non-Hispanic other races; adults with some college education or a college degree; those who reported household income <$25,000 or $50,000 to $74,900; adults who were employed or retired, students, and homemakers; and adults with no or two children in their households ($P<0.01$) (Table 2).

In bivariate logistic regression analysis, overall, food insecure adults had 61% increased odds of being obese compared with food secure adults. After controlling for sociodemographic characteristics, the odds were attenuated to32%(Table 3). The bivariate analysis indicated that the food insecure adults had increased odds of obesity among both men and women. However, the multivariate analyses demonstrated significant association between food insecurity and obesity among women, but not men. The results indicated that compared with food secure adults in the same subgroup, food insecure adults had significantly increased odds of being obese in the following population subgroups: women, 1.48; some college education, 1.39; college graduate, 1.83; no children in the household, 1.51; and two children in the household, 1.74 (Table 3).

The prevalence of food stress in this study (19.0%) based on the single individual-level food insecurity question was similar to the prevalence of worrying about having enough money to buy food reported by USDA (19.6%).[5] Of note, based on the USDA study, the overall prevalence of food insecurity obtained from the 18-question module was lower (14.7%).[5] Furthermore, similar to the USDA report,[5,21] this study found variability among population subgroups; for example, adults aged ≤50 years, non-Hispanic blacks, and Hispanics, as well as adults with lower household income, had higher prevalence of food insecurity.

Food insecure adults had a significantly higher prevalence of obesity. After adjusting for selected sociodemographic characteristics, the relationship between food insecurity and obesity was attenuated but remained significant in both the general population as well as many population subgroups. The findings suggest that food insecurity, which represents a modifiable social context, has a relationship with obesity independent of education level and income. Several mechanisms could explain this relationship. First, food insecure individuals could overcompensate when food is available so that overall food intake is greater.[9] For example, studies found that food expenditure and energy intake increased dramatically after food stamps are received.[15,24,25] Cyclical food restriction is associated with an increase in body fat, decrease in lean body muscle mass, and a quicker weight gain.[9] Second, weight cycling due to food insecurity could make the body use the dietary energy more efficiently, such as increasing body fat storage in response to food shortage.[26] Third, energy-dense foods, such as foods high in added sugar and fat, are often less expensive. Food insecurity has been associated with low food expenditure, low fruit and vegetable consumption, and a less-healthy diet.[27] Overconsumption of low-cost, energy- dense foods may result in a greater energy intake and lead to obesity. Finally, food insecurity is associated with negative psychological consequences, such as anxiety and depression, independent of socioeconomic status; some of these negative consequences may also contribute to obesity.[6,28–30]

The multivariate analyses suggested a significant association between food insecurity and obesity among adults with at least some college education, but not adults with lower education levels. In addition, obesity was significantly associated with food insecurity only among those with none or two children in their household. The mechanisms for these discrepancies are unclear.

Previous longitudinal and cross-sectional studies suggested that food insecure women are more likely to be overweight or obese[10,31–33]; however, research on the association between

food insecurity and obesity has produced mixed results among men.[14] Although two studies found a positive association in men,[13,33] the majority of studies suggested no evidence for such a direct link.[15,17,34–36] Consistent with most research, this study found an association among women but not among men. Although the reasons for this sex difference are inconclusive, two potential explanations include maternal deprivation and differences in psychosocial consequences. Dinor and colleagues[12] hypothesized that some women may sacrifice their own nutrition resources to protect their children from hunger or malnutrition. In addition, the prevalence of physiologic consequences of food insecurity, such as stress and depression, is higher among women,[37] and some of these physiologic consequences are associated with obesity only among women. For example, sex has been consistently shown to modify the association between obesity and depression, with most studies demonstrating a positive relationship for women and a null or inverse relationship for men.[38,39]

The prevalence of food insecurity varied by state. Numerous factors, such as differences in income, social systems, food prices, access to healthful foods, health status, and other policy and environmental factors, may have contributed to these variations.

The findings are subject to several limitations. First, this was a cross-sectional study, which limits the ability to draw a conclusion about cause and effect. Second, BMIs are based on self-reported weight and height. Although self-reported and measured BMIs are highly correlated (r>.9),[40] height is typically over-reported and weight is typically under-reported, particularly by women.[41–44] Therefore, the prevalence of obesity in this study was likely to be underestimated. The underestimations could vary by age, sex, race/ethnicity, education, and weight status.[43–45] For example, self-reported bias increased with age after age 45 years,[44] Hispanics were more likely to underreport their overweight status than non-Hispanics,[45] misreporting of weight and height increased among adults with higher educational levels;[43] and severely obese adults tended to underreport their weights more.[44] Furthermore, the findings in this study may have underestimated the true effect of food insecurity on obesity because misclassification of weight status is likely to lead to a bias toward the null hypothesis. Third, food insecurity was measured based on a single question related to food stress rather than multiple questions to address more components of food insecurity. Fourth, the findings may not be representative of all adults in the United States because data from only 12 states were included, and eight of these states have a proportion of persons in poverty below the national average percentage in 2009.[46] Fifth, the 2009 BRFSS excluded persons who do not have landline telephones. Adults who live in wireless-only households are likely to be younger, men, Hispanic, and to have lower incomes.[47] The influence of this noncoverage bias on the association between food insecurity and obesity is unclear.

CONCLUSIONS

Based on self-reported data from 12 states, one in three food insecure adults are also obese. Furthermore, food insecurity and obesity were found be associated in the general population and many population subgroups, especially women. These findings corroborate the relationship between food insecurity and obesity found in previous research. Although the association between obesity and food insecurity found in this study was cross-sectional,

contributing factors to obesity and food insecurity suggest a need to address the importance of increasing access to affordable healthy foods for all adults. Continuing research is needed to further develop the understanding of causal pathways, disparities among population subgroups, and effective intervention strategies.

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The findings and conclusions reported here are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Table 1

Proportion[a] of adults who reported food insecurity in 12 states, by selected sociodemographic characteristics and body mass index (BMI), Behavioral Risk Factor Surveillance System, 2009

		Proportion	
Characteristic/BMI	**n**	**%**	**95% CI**
Total	66,553	19.0	(18.2–19.9)
Age group (y)			
18–29	4,298	22.6[w]	(19.8–25.6)
30–49	18,406	22.2[w]	(21.0–23.6)
50–69	28,858	16.5	(15.4–17.6)
≥ 70	14,754	9.6	(8.5–10.8)
Sex			
Male	25,809	16.9	(15.6–18.2)
Female	40,744	21.2	(20.3–22.2)
Race/ethnicity			
White, non-Hispanic	47,812	14.6	(13.9–15.3)
Black, non-Hispanic	7,057	25.3[w]	(23.2–27.4)
Hispanic	4,259	30.1[w]	(26.9–33.5)
Other, non-Hispanic	5,655	19.1	(16.3–22.4)
Education level			
<High school	6,249	34.4	(31.1–37.8)
High school	19,870	22.5[w]	(20.9–24.2)
Some college	18,467	20.4[w]	(18.7–22.3)
College graduate	21,905	10.3	(9.4–11.3)
Household income			
<$25,000	17,234	38.1	(35.9–40.3)
$25,000–$49,999	16,812	20.7[w]	(19.1–22.5)
$50,000–$74,999	9,764	12.0	(10.6–13.5)
≥$75,000	15,435	6.3	(5.5–7.3)
Missing	7,308	16.7[w]	(13.9–19.9)
State			
Alabama	5,919	24.9	(23.2–26.6)
Alaska	2,171	17.5	(15.1–20.2)
California	4,561	18.9	(17.1–20.8)
Hawaii	6,128	19.4	(17.9–20.9)
Illinois	5,401	18.8	(17.3–20.4)
Kansas	8,223	14.1	(13.1–15.2)
Louisiana	8,025	18.3	(17.1–19.6)
Nebraska	4,778	16.4	(14.2–18.9)
New Mexico	5,304	21.1	(19.5–22.9)

		Proportion	
Characteristic/BMI	**n**	**%**	**95% CI**
Oklahoma	3,360	21.6	(19.7–23.7)
South Carolina	8,711	20.8	(19.3–22.4)
Wisconsin	3,972	15.8	(14.1–17.7)
BMI			
<18.5	1,111	22.5^{wxy}	(15.8–31.1)
18.5–24.9	22,344	16.4^{wz}	(14.9–18.1)
25–29.9	23,946	17.2^{xz}	(16.0–18.4)
≥30	19,152	24.7^{y}	(23.1–26.3)

[a] Weighted percentage.

[wxyz] Values for all the groups except for “state” sharing a common superscript (w, x, y, z) are not statistically different from each other at $P<0.01$; state-to-state comparison results are not shown in this Table because too many groups were compared.

Table 2

Prevalence[a] of obesity among adults in 12 states, by food security status and selected sociodemographic characteristics, Behavioral Risk Factor Surveillance System, 2009

	Food Secure Adults		Food Insecure Adults		
Characteristic	**%**	**95% CI**	**%**	**95% CI**	**Prevalence Difference (%)[b]**
Total (n=66,553)	25.2	(24.4–26.1)	35.1	(32.9–37.4)	9.9***
Age group (y)					
18–29	17.7	(15.4–20.3)	26.0	(20.1–32.8)	8.3
30–49	28.0	(26.6–29.6)	37.1	(34.0–40.3)	9.1***
50–69	29.3	(28.0–30.5)	41.0	(37.4–44.7)	11.7***
≥70	18.2	(16.9–19.5)	28.7	(23.8–34.3)	10.5***
Sex					
Male	27.4	(26.1–28.8)	32.5	(28.6–36.7)	5.1
Female	22.8	(21.8–23.9)	37.2	(34.7–39.7)	14.4***
Race/ethnicity					
White, non-Hispanic	24.5	(23.7–25.4)	32.6	(30.5–34.9)	8.1***
Black, non-Hispanic	35.3	(32.3–38.4)	46.1	(41.9–50.4)	10.8***
Hispanic	26.8	(23.6–30.2)	35.7	(29.7–42.1)	8.9
Other, Non-Hispanic	18.0	(15.1–21.4)	30.6	(23.6–38.5)	12.6**
Education level					
<High school	30.5	(26.6–34.7)	37.2	(31.9–42.8)	6.7
High school	28.1	(26.3–29.9)	31.7	(28.5–35.1)	3.6
Some college	28.7	(27.1–30.4)	38.2	(33.4–43.3)	9.5***
College graduate	19.6	(18.6–20.8)	33.8	(29.4–38.4)	14.2***
Household income					
<$25,000	27.4	(25.3–29.7)	35.9	(32.6–39.4)	8.5***
$25,000–$49,999	28.3	(26.3–30.4)	34.0	(30.0–38.3)	5.7
$50,000–$74,999	25.9	(24.1–27.9)	38.3	(32.3–44.7)	12.4***

	Food Secure Adults		Food Insecure Adults		
Characteristic	**%**	**95% CI**	**%**	**95% CI**	**Prevalence Difference (%)[b]**
≥$75,000	22.6	(21.3–23.9)	29.7	(23.9–36.3)	7.1
Missing	21.5	(18.9–24.4)	36.8	(26.2–48.9)	15.3
Marital status					
Married	26.0	(25.0–27.0)	37.2	(34.3–40.2)	11.2***
Single	22.7	(20.6–25.0)	30.7	(25.7–36.3)	8.0**
Divorced/separated/widowed	25.9	(24.1–27.7)	37.1	(34.1–40.3)	11.2***
Employment status					
Employed	26.0	(24.9–27.1)	35.6	(32.6–38.7)	9.6***
Unemployed	29.6	(25.6–33.8)	31.2	(24.9–38.4)	1.6
Retired	23.9	(22.6–25.2)	33.0	(27.9–38.6)	9.1**
Student/homemaker	18.0	(15.5–20.7)	31.2	(24.1–39.3)	13.2**
Unable to work	37.9	(33.5–42.5)	43.3	(38.4–48.3)	5.4
No. of children in household					
0	24.7	(23.7–25.7)	38.1	(34.9–41.5)	13.4***
1	26.4	(23.9–29.0)	27.9	(23.4–32.9)	1.5
2	22.6	(20.6–24.8)	35.9	(31.1–41.0)	13.3***
3	30.7	(26.6–35.0)	34.1	(27.5–41.3)	3.4
≥4	32.3	(26.2–39.0)	37.4	(29.0–46.7)	5.1

[a] Weighted percentage.

[b] The prevalence difference equals the prevalence of obesity among food insecure adults minus the prevalence among food secure adults.

** Statistically significant, $P<0.01$.

*** Statistically significant, $P<0.001$.

Table 3

Logistic regression estimates of unadjusted and adjusted odds ratios of obesity for food insecure adults compared with food secure adults in 12 states, by sex, education level, and number of children in the household, Behavioral

Characteristics	Unadjusted odds ratio	95% CI	Adjusted odds ratio	95% CI
Total[a]	1.61[b]	(1.44–1.79)[b]	1.32[b]	(1.17–1.50)[b]
Sex				
Male[c]	1.28[b]	(1.05–1.55)[b]	1.14	(0.93–1.40)
Female[c]	2.00[b]	(1.77–2.26)[b]	1.48[b]	(1.27–1.72)[b]
Education level				
<High school[d]	1.35	(1.00–1.83)	1.12	(0.80–1.59)
High school[d]	1.19	(1.00–1.42)	1.03	(0.84–1.26)
Some college[d]	1.54[b]	(1.23–1.92)[b]	1.39[b]	(1.11–1.76)[b]
College graduate[d]	2.09[b]	(1.68–2.58)[b]	1.83[b]	(1.44–2.33)[b]
No. of children in household				
0[e]	1.88[b]	(1.62–2.19)[b]	1.51[b]	(1.28–1.79)[b]
1[e]	1.08	(0.82–1.41)	0.85	(0.63–1.14)
2[e]	1.92[b]	(1.50–2.45)[b]	1.74[b]	(1.30–2.33)[b]
3[e]	1.17	(0.81–1.69)	1.06	(0.71–1.60)
≥4[e]	1.25	(0.77–2.03)	1.21	(0.70–2.07)

[a]The overall model adjusted for age, sex, race/ethnicity, education level, household income, marital status, employment status, and number of children in the household.

[b]Confidence intervals do not include 1.

[c]The two models by sex adjusted for age, race/ethnicity, education level, household income, marital status, employment status, and number of children in the household.

[d]The four models by education level adjusted for age, sex, race/ethnicity, household income, marital status, employment status, and number of children in the household.

[e]The five models by number of children in the household adjusted for age, sex, race/ethnicity, education level, household income, marital status, and employment status.