

Food Insecurity Is Inversely Associated with Healthy Food Availability among Adults in the United States



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ABSTRACT

Objective: Food insecurity was associated with metabolic conditions such as obesity and diabetes. The present study examined associations of food security status with the availability of healthy and unhealthy foods in the home using a nationally representative sample from 2007–2010 National Health and Nutrition Examination Surveys (NHANES).

Design: A cross-sectional analysis included 9,100 participants aged 20–65 years. Odds ratios (ORs) and 95% confidence intervals (95% CIs) for associations between food security status and home food availabilities were estimated by logistic regression accounting for survey design and weights. Food availability was measured through self-reported questionnaire regarding the frequency of food items available in the home. Food security status was defined based on ten self-report questions.

Results: Individuals with moderate or high food insecurity had lower availabilities of fruits (OR=0.37; 95%CI=0.27–0.49), dark green vegetables (OR=0.63; 95%CI=0.50–0.79), fat-free/low-fat milk (OR=0.60; 95%CI=0.45–0.81), and salty snacks (OR=0.66; 95%CI=0.51–0.85) compared to those who were food secure adjusting for relevant covariates. The associations were independent of major socioeconomic status indicators including income, education, and race/ethnicity.

Conclusions: Food insecurity was inversely associated with healthy food availabilities in the home, suggesting the need of improving the home food environment related to healthy food availability among individuals who are food insecure.

Keywords: Food insecurity; home food availability; healthy foods; unhealthy foods

INTRODUCTION

Households or individuals are food insecure when they lack the financial ability and resources to regularly obtain nutritious foods.¹ In 2016, 41.2 million people in the U.S. were food insecure.² Prevalence of food insecurity varies among household classifications, with rates higher in low-income households.² It has been suggested that food insecurity is associated with diet-related metabolic conditions such as obesity,³ type 2 diabetes,^{4,5} gestational diabetes,⁶ poor glycemic control among diabetes patients,^{7,8} hypertension⁴ and hyperlipidemia.⁴

Home food availability defined as the presences or absence of healthy or unhealthy food items in the home is an important avenue to investigate since it is likely to reflect an individual's food choices and purchase habits. Self-inventory of household foods may offer a practical method for people to monitor their home food environment,⁹ thereby helping high-risk individuals manage weight, prevent and reduce the onset of diabetes and other chronic diseases and improve glycemic control for diabetes patients. Previous work found homes of obese participants had fewer healthy foods available than homes of non-obese participants.¹⁰ Various factors influence healthy food availability at home. Chai et al. found indicators of socioeconomic status

(SES) such as income, education and neighborhood SES can be important predictors of an individual's home food environment.¹¹ Poverty is a strong predictor of food insecurity.^{12,13} When income is constrained or limited, individuals and households may be forced to make difficult decisions, resulting in poor dietary quality and inadequate nutrition since nutrient density foods such as fruits and vegetables are often more expensive and less accessible in low-income neighborhood.^{14,15} However, research also suggests food insecurity may acts as a chronic stressor independent of poverty.^{16,17} Therefore, food insecure individuals may consume more energy-dense, highly palatable foods such as foods high in fat, sugar or salt as a coping strategy.¹⁶ Previous work reported food insecurity was associated with poor dietary patterns⁸ and quality with high intake of unhealthy foods and beverages such as high-fat dairy products, salty snacks, sugar-sweetened beverages, and red and processed meats, and low intake of healthy foods such as vegetables.¹⁶ However, there is no nationwide research evidence on whether a person's food security status is associated with home food availability that reflects an individual's food purchase habits and food choices. Furthermore, the study by Chai

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et al. suggests comparing to economic resources such as income, an individual's education background appears to be a more significant predictor for healthy food availability at home.¹¹ This speaks to the importance of including multiple SES indicators when elucidating the underlying mechanism that contributes to healthy or unhealthy home food environments. Thus, it would be valuable to determine whether the availability of healthy or unhealthy foods in the home can be explained by one's food security status beyond economic resources and education level. The objective of the current study was to examine the association of food security status with the availability of healthy (fruits, dark green vegetables, and fat-free/low-fat milk) and unhealthy food items (salty snacks and sugary drinks) in the home among U.S. adults aged 20-65 years using a nationally representative sample from 2007-2010 National Health and Nutrition Examination Surveys (NHANES). We hypothesize that food insecure was inversely associated with the availability of healthy foods and positively associated with the availability of unhealthy foods in the home and these associations were independent of other SES indicators such as income, education and race/ethnicity. If our results confirm the above hypothesis, one may inform policy and preventive strategies to reduce the prevalence and incidence of obesity and metabolic diseases by targeting the home food environment and purchase habits of individuals with food insecurity.

MATERIAL AND METHODS

Sample

Data used in this study were from the 2007-2010 waves of the continuous NHANES, which assesses the health and nutritional status of adults and children in the United States (U.S.). Since 1999, the survey has examined a nationally representative sample of about 5,000 people each year. NHANES uses a complex, multistage, probability sampling design to select participants who are representative of the civilian, noninstitutionalized US population.¹⁸ The 2007-2010 data were used since questions regarding home food availability were only available during these waves. The 2007-2010 NHANES had 9,252 age-eligible respondents (20-65 years). Sequential exclusions included missing food availability data and missing food security data, with overlap from participants who had missing data in both (N=152). Missing family income-to-needs ratios (N=763) were imputed. There were no missing data for the remaining variables of interest included in the analyses. Participants with and without these missing values had similar

sociodemographic characteristics (age, sex, race/ethnicity, income-to-needs ratio, education, marital status, and family size). The final sample size included 9,100 adults including 4,435 men and 4,665 women.

Variables of Home Food Availability

The home food availability questions from NHANES measure the frequency of availability of fruits (fresh, dried, canned, and frozen fruits), dark green vegetables (fresh, dried, canned, and frozen vegetables), fat-free/low-fat milk (1%, skim or fat-free; excluding 2%), salty snacks (such as chips and crackers; excluding nuts) and sugary drinks (soft drinks, fruit-flavored drinks, or fruit punch; excluding diet drinks, 100 percent juice or sport drinks) in the home. A five-point scale with responses of "always, most of the time, sometimes, rarely, or never available" is used for survey responses and is coded on a scale of 1-5 with "1" referring to "always" and "5" referring to "never available".¹⁸ The outcome variables (the frequency of home food availabilities) were further categorized into two categories stressing the importance of contrasting the two values in the outcome: 1) "always/most of the time available" for participants who responded with "always" or "most of the time available"; and 2) "not always/most of the time available" for participants who responded with "sometimes", "rarely", or "never available."

Variables of Food Security

The food security variable uses ten items from the NHANES food security questionnaire to assess food security in adult populations. The questions address issues such as anxiety about running out of food before having the money to obtain more; not being able to afford a balanced meal; cutting the size of the meal or skipping meals due to financial restrictions; whether they are feeling hunger or losing weight. A description of the development and validation of the food security survey was reported elsewhere.¹⁹ A four-level categorical variable was created based on the standard scale for adults: 0-2, 3-5, 6-8, or 9-10 affirmative.¹⁹ The National Center for Health Statistics (NCHS) made two changes to the standard scale: 1) collapsing the two most severe levels of food insecurity (6-8 and 9-10 affirmative responses) into a single category (6-10 affirmative responses) because few participants reported having the most severe level of food insecurity (9-10 affirmative responses); and 2) creating a new category of marginal food insecurity (1-2 affirmative responses). Thus, data released from NCHS has the following categories: 0, 1-2, 3-5, or 6-10 affirmative responses, referring food

security (0 affirmative response); marginal food insecurity (1-2 affirmative responses), moderate food insecurity (3-5 affirmative responses), and high food insecurity (6-10 affirmative responses).⁵ Moderate food insecurity and high food insecurity were further combined to create the moderate/high food insecurity category.

Statistical Analyses

Associations between food security status and home food availability were assessed using logistic regression modeling accounting for the complex survey design and sample weighting methodology of NHANES.²⁰ The outcome variables (home food availability variables) were characterized as dichotomous (always/most of the time available vs. not [reference group]). Food security was treated as a three-category variable: food security (reference), marginal food insecurity, and moderate/high food insecurity. Analyses were adjusted for relevant covariates including age (continuous), sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), education (college graduates or non-college graduates), family income-to-poverty ratio (continuous), marital status (married/cohabiting or not), and family size (number of people in the household; continuous). These covariates were determined based on previous literature.¹¹ Income-to-poverty ratio was computed by NHANES staff

using annual family income divided by the federal poverty threshold for the appropriate family size, location, and year.²¹ The models were also adjusted for dichotomous variables of imputed income status. SAS 9.4 was used for all statistical analyses. A two-sided *p* value of <0.05 was considered statistically significant.

RESULTS

This study included 9100 participants (aged 20-65 years) of which 48.7% were men and 51.3% were women. On average, individuals who were characterized as being food insecure were more likely to be younger (38.2 vs. 42.7 years), ethnic minority (Non-Hispanic Blacks: 20.8% vs. 9.5%; Hispanics: 28.9% vs. 10.2%) and non-college graduates (33.6% vs. 5.6%), live alone (52.0% vs. 67.8%) and have lower family income to poverty ratio (1.4 vs. 3.5) and larger family size (3.7 vs. 3.1 persons) (Table 1).

Table 2 shows associations between food security status and home food availability. Individuals with high (6-10 affirmative responses) or moderate (3-5 affirmative responses) food insecurity had lower availabilities of fruits (odds ratio [OR]=0.37; 95% confidence interval [95%CI]=0.27-0.49; *P* < 0.0001), dark green vegetables (OR=0.63; 95%CI=0.50-0.79; *P* = 0.0003), fat-free or low fat

Table 1 Sociodemographic characteristics of adults aged 20 to 65 years in the United States participating in NHANES* 2007-2010 by food security status (N=9100)

Characteristics	Food security		Marginally food insecurity		Moderate/high food insecurity		P [‡]
	Mean	SE [†]	Mean	SE [†]	Mean	SE [†]	
N	6112		1060		1928		
Age (year)	42.7	0.3	38.9	0.5	38.2	0.5	<.0001
Sex (%)							0.07
Male	49.9	0.5	45.3	1.9	47.6	1.2	
Female	50.1	0.5	54.7	1.9	52.4	1.2	
Race/ethnicity (%)							
Non-Hispanic black	9.5	0.9	19.2	2.9	20.8	2.1	<0.0001
Non-Hispanic white	73.0	2.2	45.3	4.9	44.3	3.9	<0.0001
Hispanic	10.2	1.3	29.5	3.9	28.9	3.7	<0.0001
Other	7.4	0.9	6.0	1.9	5.9	0.9	0.15
Family income-to-needs ratio	3.5	0.1	1.9	0.1	1.4	0.1	<0.0001
College graduates (%)	33.6	1.5	10.7	1.2	5.6	0.6	<0.0001
Married/cohabitating (%)	67.8	1.0	55.5	2.5	52.0	1.8	<0.0001
Number of people in the household, mean	3.1	0.1	3.6	0.1	3.7	0.1	<0.0001

*NHANES, National Health and Nutrition Examination Survey

[†] SE, standard error of the mean

[‡] *P* values for differences between food secure participants and participants with moderate/high food insecurity by t-test (for continuous variables) and chi-square test (for categorical variables).

Table 2 Association of food security status with home food availability among adults aged 20 to 65 years in the United States participating in NHANES* 2007-2010 (N=9,100)

Food insecurity status	Food availability (always/most of the time available)	
	OR (95% CI) [†]	P [†]
Fruits		
Food security	1.00	
Marginal food insecurity	0.59 (0.40-0.86)	0.008
Moderate/high food insecurity	0.37 (0.27-0.49)	<.0001
Dark green vegetables		
Food security	1.00	
Marginal food insecurity	0.80 (0.58-1.11)	0.17
Moderate/high food insecurity	0.63 (0.50-0.79)	0.0003
Fat-free/low-fat milk		
Food security	1.00	
Marginal food insecurity	0.69 (0.51-0.94)	0.02
Moderate/high food insecurity	0.60 (0.45-0.81)	0.001
Salty snacks		
Food security	1.00	
Marginal food insecurity	0.69 (0.54-0.90)	0.006
Moderate/high food insecurity	0.66 (0.51-0.85)	0.002
Sugary drinks		
Food security	1.00	
Marginal food insecure	0.98 (0.75-1.29)	0.90
Moderate/high food insecurity	1.14 (0.94-1.38)	0.16

* NHANES, National Health and Nutrition Examination Survey

[†] Odds ratio (OR), 95% confidence interval (CI) and *P* values were estimated using logistic regression adjusting for age, sex, race/ethnicity, income-to-needs ratio, education, marital status, and family size.

milk (OR=0.60; 95%CI=0.45-0.81; *P* = 0.001) and salty snacks (OR=0.66; 95%CI=0.51-0.85; *P* = 0.002) as compared to food secure individuals (0 affirmative response) after the adjustment for covariates. The associations were independent of primary SES indicators including income, education, and race/ethnicity. Food security status was not associated with the availability of sugary drinks in the home.

DISCUSSION

To our knowledge this is the first study to examine the association of food security with home food availability using a large-scale, nationally representative sample in U.S. The current results showed that moderate or high food insecurity (3-10 affirmative responses) was associated with lower availability of healthy foods such as fruits, vegetables, and fat-free or low-fat milk in the home independent of other important SES indicators such as income, education and race/ethnicity. The only exception to this pattern was the observed association between food insecurity and lower snack availability. Our

findings are in agreement with two prior studies using NHANES data that found family income to poverty ratio was positively associated with availabilities of healthy foods such as fruits²² and vegetables¹¹ and fat-free or low-fat milk,^{11,22} as well as unhealthy foods such as salty snacks^{11,22} in the home among US children²² and adults.¹¹ The current findings are consistent with previous work examining income-related household food purchases, which suggests that high-income households spent more dollars per person on both healthy and unhealthy foods compared to low-income households.²³

It is well established that healthy foods are considerably more expensive than unhealthy foods.²⁴⁻²⁷ When examining the price of soda versus milk, one study found that for equivalent fluid ounces, price of soda was always cheaper than that of milk by a large margin across all geographic areas.²⁷ In addition, although unhealthy foods cost less than healthy foods,²⁴⁻²⁷ prices vary among unhealthy foods; some are more affordable and preferable than others. Thus, relative to salty snacks, sugary drinks may be a more affordable and preferable choice for food

insecure individuals. This may partially explain why food insecurity corresponded to lower availability of fruits, vegetables, fat-free/low fat milk, and salty snacks in the home and no association was observed between food insecurity and sugary drink availability. Furthermore, food deserts are areas that do not have easy access to healthy foods. The United States Department of Agriculture defines food deserts as low income tracts with at least 500 people or 33 percent of residents in the tract living more than a mile from a supermarket, super center or large grocery store (for rural census tracts, the distance is more than 10 miles).²⁸ It has been suggested that neighborhood residents who have better access to supermarkets and limited access to convenience stores tend to have healthier diets and lower obesity rates^{29,30} since affordable, high quality foods are more likely to be found in supermarkets than in convenience stores.³¹ However, Chai et al. reported that food desert status was not associated with the availability of healthy foods such as fruits, green vegetables and fat-free/low-fat milk in the home from a nationally representative sample.¹¹ Therefore, we did not include food desert status as a potential confounder in the models for assessing the relationship between food insecurity and home food availability.

The present study has a number of strengths, including the use of data from a large population-based study with a nationally representative sample. However, there were limitations to our study. One limitation is the nature of cross-sectional design of NHANES study, which prevent us from drawing causal relationships. Second, due to the self-report measures utilized, recall bias and misreporting may occur. Finally, the home food availability measures only assessed five food and beverage items in the NHANES surveys, which may not be able to fully evaluate healthy food availabilities in the home.

In conclusion, this study provides national-level evidence that food insecurity was associated with lower availability of healthy foods such as fruits, vegetables and fat-free or low fat milk in the home independent of other relevant SES indicators. With regard to unhealthy foods, food insecurity was associated with lower availability of salty snacks but not with sugary drink availability. As literature shows that food insecurity was associated with adverse health consequences such as obesity, diabetes, CVD and poor glycemic control. The current results suggest that one may prevent these adverse conditions through improving the home food environment and purchase habits among food insecure individuals. Self-inventory of household foods by providing these individuals

with useful and practical tools to monitor their food purchase habits and food choices may help them with weight control and disease management and enhance quality of life for high-risk populations.

CONFLICT OF INTEREST

Authors do not have conflict of interest.

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