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The association between food insecurity and diet quality varies by race/ethnicity: an analysis of NHANES 2011-2014

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Abstract

BACKGROUND: Food insecurity is believed to affect the quality and quantity of foods consumed; however, studies examining food insecurity and diet quality have been inconclusive and few studies have explored variability in these associations by sex and race/ethnicity.

OBJECTIVE: This study examined associations between food insecurity and diet quality, and variations by sex and race/ethnicity.

DESIGN: Cross-sectional analysis of data from the 2011–14 National Health and Nutrition Examination Surveys (NHANES).

PARTICIPANTS: The study population was comprised of 4,393 adults (20–65 years) with family incomes ≤300% of the federal poverty level with complete data on household food security and dietary intake via two 24-hour dietary recalls.

MAIN OUTCOME MEASURES: Diet quality was assessed using the Healthy Eating Index (HEI)-2015.

STATISTICAL ANALYSIS PERFORMED: Associations between food security and HEI-2015 total and component scores were examined using linear regression models and generalized linear models. Models adjusted for sociodemographic and health covariates.

RESULTS: Compared to food secure adults, food insecure adults reported a 2.22-unit lower HEI-2015 score (95% CI −3.35, −1.08). This association was most pronounced among Non-Hispanic (NH) Whites and adults of Asian or "Other" races/ethnicities. There were no associations among NH Black or Hispanic adults, and no differences by sex. Among NH Whites, food

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insecurity was associated with lower scores for total protein foods, seafood and plant proteins, and added sugar. Among Asians, food insecurity was associated with lower scores for whole fruit.

CONCLUSION: Food insecurity was associated with lower diet quality primarily among NH Whites, Asians, and "Other" adults, a group compris ed of American Indian or Alaska Natives, Native Hawaiian or Other Pacific Islanders and multi-racial adults. Further research is needed to better understand the nature of this association among understudied racial/ethnic groups.

Keywords

food insecurity; diet quality; race/ethnicity; National Health and Nutrition Examination Surveys

INTRODUCTION

Food insecurity, the household-level condition of limited or uncertain access to adequate and nutritious food, has persisted in the United States since the first national report was released in 1995.[1] Over the past decade, food insecurity levels have increased to 14% in response to the Great Recession, recovering only in recent years to pre-recession levels.[2] In 2017, the national prevalence of food insecurity was estimated at 11.8%, affecting 40 million people.[2] Food insecurity disproportionately affects households with children, adults living alone, and individuals of minority race/ethnicity.[2]

Although food insecurity has been shown to affect numerous health behaviors and health conditions, at the core of the understanding of food insecurity is its impact on disrupted eating patterns and nutritional inadequacy. It is captured in the USDA definition of food insecurity that the "quality, variety, or desirability" of foods co nsumed is reduced.[3] Despite this conceptualization, the evidence of food insecurity and diet quality has been inconclusive. In a systematic review published in 2014, Hanson and Connor found 170 tested associations between food insecurity and dietary intake – of these, 50 s uggested an adverse association, while 97 showed no association.[4] Many of the tested associations focused on macronutrients and micronutrients, and some examined individual foods or food groups. Only four studies included measures of overall diet quality, of which the results were evenly split between an adverse association and no association.[5–8] Since then, few studies have continued to investigate the association between food insecurity and diet quality at the population level, even though there have been recent shifts in national levels of food insecurity and changes to the dietary guidelines that drive the measurement of overall diet quality.[9, 10] Furthermore, no study has investigated how the food insecurity and diet quality association varies by demographic characteristics in a heterogeneous sample of adults.

The objective of this present study was to examine the association between household food insecurity and dietary quality using a recent and nationally representative sample of US adults. Differences in these associations were examined by sex, as many studies have found stronger associations with physical health outcomes among females compared to males.[5, 11, 12] Differences by race/ethnicity were also examined, as national reports have highlighted disparities in levels of food insecurity and poor dietary quality in minority racial/ethnic households.[2, 13, 14] It was hypothesized that household food insecurity would be

inversely associated with diet quality and that this association would be stronger for minority racial/ethnic households.

MATERIALS AND METHODS

Study Population

The National Health and Nutrition Examination Surveys (NHANES) is an ongoing, multistage survey designed to be representative of the civilian, noninstitutionalized US population.[15] Administered by the National Center for Health Statistics, NHANES collects information on demographics, health behaviors, dietary intake, weight, and biomarkers related to major chronic disease using interviews, examinations, and laboratory tests. Data from 2011–12 and 2013–14 were combined in the present study. The analytic population was restricted to 4,393 adults (ages 20–65 years) and family incomes ≤300% of the federal poverty level (FPL).[16] The present analysis focused on non-elderly adults as children and older adults have different nutritional needs and may have different experiences of household food insecurity. The analysis was also restricted to adults with family incomes at ≤300% FPL to be inclusive of the individuals at risk for food insecurity who are known to be in relatively higher income thresholds,[2] and to reduce potential confounding by family income on the association between household food insecurity and dietary quality. Secondary analysis of publicly available NHANES data was considered exempt from further IRB review by the University of Michigan Institutional Review Board – Health Sciences and Behavioral Sciences.

Measures

The primary exposure of interest was household food insecurity, measured using the 18-item US Food Security Survey Module. The module assesses individual and household-level experiences and behaviors related to food purchasing, food availability, and diet over the past 12 months. A score of 0–18 was created by summing the affirmative responses of the 18 questions, with higher scores indicating worse food insecurity. Food insecurity categories were assigned according to USDA guidelines: 0, food secure, 1–2, marginally food secure, and 3 or more, food insecure.[17]

The outcome of interest was overall diet quality, measured by the Healthy Eating Index (HEI)-2015. Among NHANES participants, dietary intake was assessed using one or two 24-hour dietary recalls using the Automated Multiple Pass Method, the first of which was conducted in the Mobile Examination Center and the second over the phone.[18] To reduce the potential for misreporting in dietary intake, recalls with total energy intakes <500 or >5000 kcal were excluded from the analyses (n=288). The application of this approach in studies of diet and health outcomes has been shown to be identical to other methods of accounting for implausible energy intake;[19] however, the criteria applied in the present study were expanded to account for the increased variability that could arise from 24-hour dietary recalls.[20, 21] The HEI-2015 was developed through a collaboration between USDA and the National Cancer Institute to measure adherence to the 2015–2020 Dietary Guidelines for Americans.[22] Scored out of 100 points, the HEI-2015 is comprised of 13 individual components: total fruits, whole fruits, total vegetables, greens and beans, whole grains,

dairy, total protein foods, seafood and plant proteins, fatty acids, refined grains, sodium, added sugars, and saturated fats. With the exception of the last four components which are reverse scored, higher points are awarded for higher consumption of all individual components. Maximum scores for total fruits, whole fruits, total vegetables, greens and beans, total protein foods, and seafood and plant proteins are 5 points; maximum scores for all other components are 10 points. HEI-2015 total and component scores were calculated according to the simple HEI scoring algorithm using publicly-available SAS macros from the National Cancer Institute.[23]

Covariates included in the analysis to adjust for potential confounding included age (in 5-year categories), sex, race/ethnicity (non-Hispanic (NH) White, NH Black, Mexican American or other Hispanic, Asian, or NH other/multi-race), birthplace (US born, foreign born), educational attainment (<12 years, high school diploma or equivalent, some college, college graduate), marital status (married or living with partner, never married, or separated/ widowed/ divorced), family income as a ratio to the federal poverty level (FPL) (in 50% FPL increments), and smoking status (never smoker, former smoker, current smoker). All covariates were self-reported and were selected as potential confounders of the association between food insecurity and dietary quality. Individuals with missing data for family income (n=746) were represented with missing indicators. Individuals with missing data for educational attainment (n=10), marital status (n=4) and smoking (n=3) were excluded from the analysis due to the small number of cases.

Statistical analysis

Complex sampling weights for the dietary subsample were used to account for different sampling probabilities and participation rates across the four-year period. Sociodemographic characteristics by household food insecurity status were compared using χ^2 tests for categorical variables and univariate regression for continuous variables. Multivariable linear regression models were used to examine absolute differences in HEI-2015 total scores by household food insecurity, adjusting for all covariates. Generalized linear models with a gamma distribution and log-link function were used to estimate relative differences of HEI-2015 component scores by food insecurity categories. A gamma distribution was used to accommodate the fact that the dietary component data were non-negative and highly skewed to the right.[24] Relative differences can be interpreted as the percentage difference between groups. All analyses were further stratified by sex and race/ethnicity. Race/ethnicity categories included NH White, NH Black, Mexican American or other Hispanic, Asian, and NH “Other.” Heterogeneity by sex and race/ethnicity was determined using Wald tests of the cross-product terms between sex and race/ethnicity with household food insecurity.

Statistical tests were 2-sided and significance was considered at $P < 0.05$. Statistical analyses were performed with SAS 9.3[25] and Stata/ SE 12.1[26].

RESULTS

Of the 4,393 adults with family incomes ≤300% of the federal poverty level, using weighted proportions from NHANES, 55.7% were food-secure, 14.6% were marginally food-secure, and 29.6% were food-insecure over the past 12 months. Compared to food-secure adults,

marginally food-secure and food-insecure adults were younger, were more likely to be NH Black or Hispanic, had lower educational attainment and family incomes, and more likely to be a current smoker (Table 1).

Associations between household food insecurity and HEI-2015 total scores adjusted for sociodemographic and health covariates are shown in Table 2. Among all adults, food insecurity was associated with a 2.22-point lower HEI-2015 score (95% CI −3.35, −1.08). The adjusted mean HEI-2015 score among food-secure adults was 54.6 (SE 0.6); the adjusted mean HEI-2015 score among food-insecure adults was 52.4 (SE 0.8). Adjusted mean HEI-2015 scores by sex and race/ethnicity are shown in Figure 1. By sex, females had higher mean HEI-2015 scores than males at all levels of food security. However, there were no significant differences in these associations by sex (*P=0.27*).

Associations between household food insecurity and HEI-2015 total scores varied significantly by race/ethnicity (*P<0.001*). Among NH Whites, the adjusted mean HEI-2015 scores ranged from 50.1 to 53.1. Marginal food security was associated with a 2.95-point lower HEI-2015 score (95% CI −5.58, −0.33) and food insecurity was associated with a 2.92-point lower HEI-2015 score (95% CI −4.49, −1.35). Among NH Asians, the adjusted mean HEI-2015 scores among food-secure adults and food-insecure adults were 55.6 and 50.0, respectively – a difference of 5.64 points (95% CI −10.84, −0.44). Among NH “Other” adults, the adjusted mean HEI-2015 scores among food-secure and food-insecure adults were 60.6 and 55.2, respectively – a difference of 5.37 points (95% CI −10.60, −0.14).

Associations between food insecurity and individual HEI-2015 components were examined further (Table 3). Among NH Whites, food insecurity was associated with a lower score on total protein foods (RD 0.94, 95% CI 0.89, 0.99), seafood and plant proteins (RD 0.83, 95% C 0.70, 0.98), and added sugar (denoting higher intake) (RD 0.88, 95% CI 0.81, 0.95). Among NH Black adults, marginal food security was associated with a lower score on whole grains (RD 0.66, 95% CI 0.52, 0.85). Among Hispanic adults, marginal food security was associated with a higher score on sodium (RD 1.19, 95% CI 1.01, 1.41). Among NH Asian adults, food insecurity was associated with a lower score on whole fruits (RD 0.68, 95% CI 0.50, 0.93). Among NH “Other” adults, marginal food secur ity was associated with a lower score on total fruits (RD 0.31, 95% CI 0.17, 0.56) and whole fruits (RD 0.41, 95% CI 0.19, 0.84). No other associations were observed between food insecurity and individual HEI-2015 components across these racial/ethnic groups.

DISCUSSION

In this nationally representative sample, food insecurity was significantly associated with lower diet quality. These associations were most pronounced among NH Whites, Asians, and adults of “other” race/ethnicity. The primary assoc iation of food insecurity and lower diet quality is similar to previous studies using varied measures. In early studies using the original Healthy Eating Index, Basiotis and colleagues found that women in food-insufficient households scored 3.9 points less than women in food-sufficient households.[5] Bhattarchya and colleagues found that food insecurity was associated with a 2.4 point lower HEI among non-elderly adults, independent of poverty.[6] An analysis of NHANES 1988–

1994 and 2001–2002 data by Montoya and colleagues found that food-insecure adults had lower HEI scores than food-secure adults.[7] A prior analysis of 1999–2008 NHANES data showed a 2.2-point mean difference in HEI-2005 scores between fully food-secure and very low food-secure adults.[10] Finally, in a recent study by Sanjeevi and colleagues, food-insecure women scored 0.9 points lower on the Dietary Guidelines Adherence Index 2015 than food-secure women.[9] This study builds on the current literature by highlighting racial/ethnic differences in these associations, and by demonstrating that the inverse association between food insecurity and diet quality is robust to the changing measurements of food insecurity and overall diet quality over time.

Although the results confirmed the initial study hypothesis that food insecurity would be inversely associated with diet quality, predominantly in minority racial/ethnic groups, the observed inverse associations among NH Asian and “Other” adults were still unexpected, partly due to the heterogeneity of individuals comprising this latter group. “Other” is a category within NHANES that is given to anyone who does not self-identify as NH White, NH Black, Hispanic, or NH Asian. This includes adults of American Indian or Alaska Native (AIAN), and Native Hawaiian or Other Pacific Islander (NHOPI) descent as well as multi-racial adults.[27] Among AIAN households, a few studies using convenience samples have documented the significantly high rates of food insecurity, ranging from 44% to 77%.[28, 29] One of these studies also documented how food-insecure American Indian adults had lower intakes of vegetables and higher intakes of fruit juices, sugar-sweetened beverages, and fried potatoes compared to food-secure American Indian adults, consistent with the results in the present study.[30] Among NHOPI adults, data from the Hawai’i Health Survey found that food insecurity was associated with poorer mental and physical health, higher BMI, and higher prevalence of chronic conditions.[31] Among Asian adults, there have been a few studies of food insecurity and dietary outcomes among Korean adults from the Korea NHANES,[32–34] but there have been no systematic studies of food insecurity among any Asian American groups.

As the results of the current study showed, the associations between food insecurity and diet quality were driven by different components among different racial/ethnic groups. Among NH Whites, the association between food insecurity and diet quality was driven by lower intakes of total protein foods, seafood and plant proteins, and higher intakes of added sugars. Among NH Asians and “Other” adults, food insecurity was only associated with the fruit component of the HEI-2015 score. This suggests there may be synergistic effects of other dietary components among food-insecure adults driving the inverse association with diet quality. At this time, more research is needed to understand the experiences of food insecurity among Asian, AIAN, NHOPI, and multi-racial individuals, in addition to risk factors, health consequences, and psychosocial factors that could buffer these effects. In addition, large economic and health surveys should adopt the racial/ethnic categories proposed by the Office of Management and Budget (OMB) in order to better understand the heterogeneous needs of the “Other” group.[35]

It was also of interest that no associations were observed between food insecurity and diet quality among NH Black and Hispanic adults. Although for both racial/ethnic groups, the effect estimates were negative, suggesting lower overall diet quality related to food

insecurity, they did not reach statistical significance. In this study, NH Black adults demonstrated the lowest mean diet quality compared to other racial/ethnic groups, corroborating previous research showing that NH Black adults generally lag behind NH White and Hispanic adults with respect to diet quality.[36]. Qualitative studies have identified multiple barriers to healthy eating among NH Black adults, including personal preferences, limited household resources, inability to access to healthful grocery stores, and poor communication with health care providers.[37–39] These factors may overshadow the association of food insecurity and diet quality among NH Black adults.

Among Hispanic adults, some studies have examined the role of acculturation status as a modifier of the association between food insecurity and diet-related health outcomes. In two studies with body mass index (BMI) as the outcome, greater acculturation among food-insecure children and adults were associated with higher BMI, but lower acculturation among food-insecure children and adults had no association.[40, 41] Greater acculturation may be associated with higher total energy intake and increased consumption of junk foods with little nutritional value.[42–44] Although acculturation was not measured in the present study, ignoring the modifying role of acculturation may have led to nonsignificant results between food insecurity and diet quality among Hispanic adults.

This research highlights the continued need for research to identify and evaluate potential strategies to promote food security and healthful eating behaviors across all racial/ethnic groups. At the federal level, the Supplemental Nutrition Assistance Program (SNAP) is the primary safety net that serves to reduce food insecurity and improve access to nutritious foods for low-income families. Because SNAP allows individuals to choose the foods they buy for their households, SNAP is able to serve individuals across diverse cultural backgrounds, preferences, and dietary needs.[45] Despite this strength, minority racial/ethnic groups and immigrant populations, particularly Hispanic and Asian families, have the lowest participation rates in SNAP and this may contribute to disparities in diet quality and eating behaviors.[45–47]

This study is primarily limited by the cross-sectional nature of the data, which doesn’t allow us to examine duration of food insecurity and its impact on diet quality, or concurrent changes in food insecurity and diet quality over time. Household food insecurity was assessed over the past 12 months, while dietary intake was assessed at the time of the survey. This may have resulted in misclassification, as food insecurity is a transient condition and can vary over the course of the season, month, or even week. Future studies may want to consider using a measure that captures food insecurity over the past 30 days, to better understand associations with dietary intake. Finally, HEI-2015 scores were also calculated using the simple scoring method, which uses the average of two 24-hour dietary recalls. This method may not approximate usual dietary intakes of the individual. However, this analytic method is currently recommended by the National Cancer Institute for analyses relating HEI components to a health outcome.[48]

CONCLUSION

In this national sample of adults with family incomes ≤300% of the federal poverty level, food insecurity was associated with lower diet quality primarily among NH Whites and Asian, NHOPI, AIAN, and multi-racial adults. No differences were observed between males and females. Future food insecurity research should focus on understudied racial groups, including Asian, NHOPI, AIAN, and multi-racial adults, to better understand how food insecurity adversely affects health outcomes. This research will useful in informing interventions to improve diet quality among groups most vulnerable to food insecurity.

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RESEARCH SNAPSHOT

RESEARCH QUESTION:

How is food insecurity associated with overall diet quality, and do these associations vary by individual's sex or race/ethnicity?

KEY FINDINGS:

In the study population of 4,393 adults, food insecurity was associated with a 2.2-lower Healthy Eating Index (HEI)-2015 score (95% CI −3.35, −1.08), after adjusting for sociodemographic and health characteristics. Further investigation by race/ethnicity demonstrated that this association was most pronounced among Non-Hispanic White, Non-Hispanic Asian, and adults of "Other" races/ethnici ties. No association was observed among Non-Hispanic Black or Hispanic adults, nor did the association vary by sex.

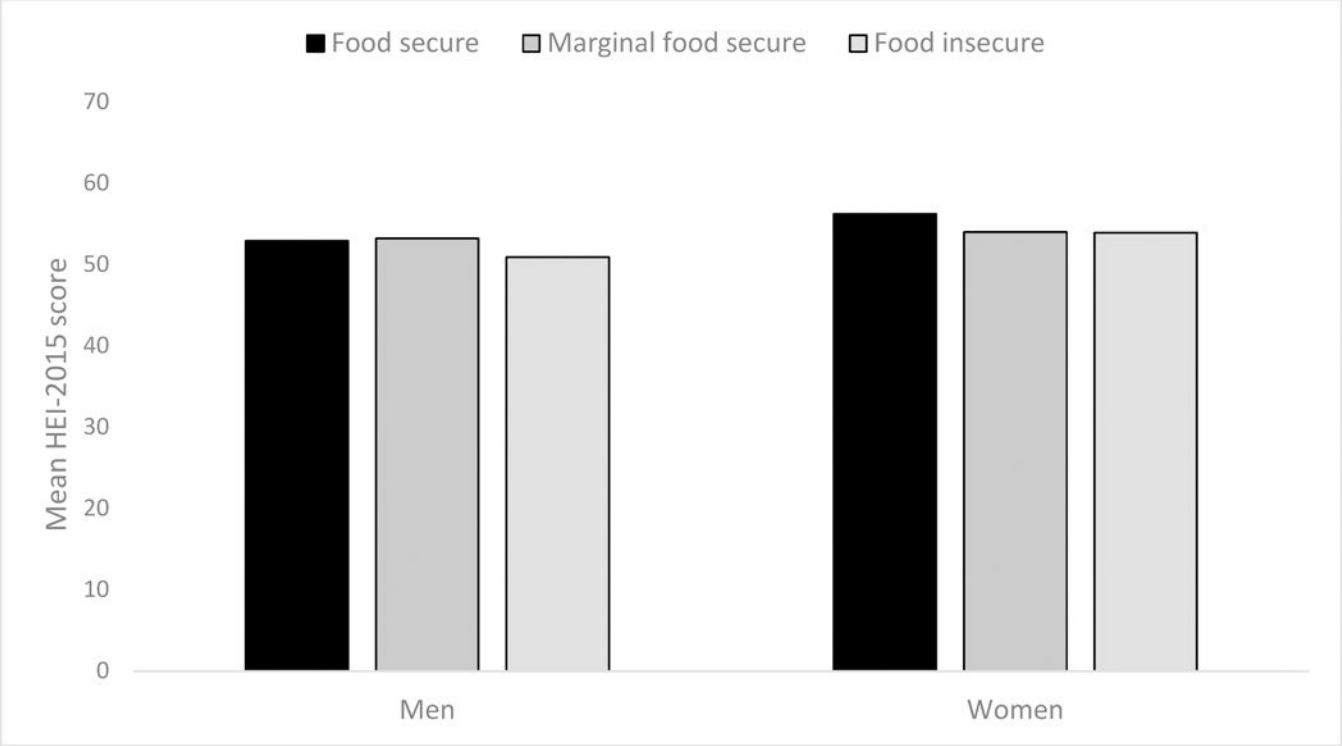

Figure 1a:
Adjusted mean Healthy Eating Index (HEI)-2015 total scores by sex of 4,393 adults – NHANES 2011–2014.

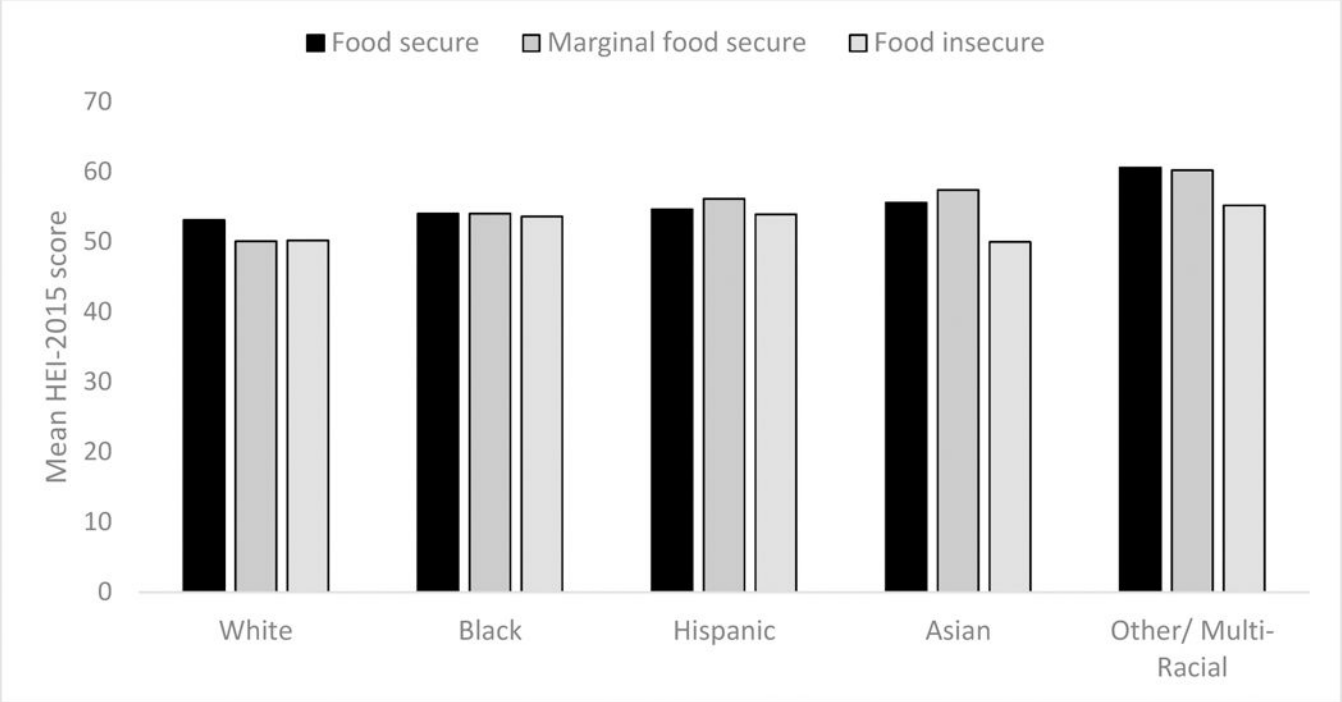

Figure 1b:
Adjusted mean Healthy Eating Index (HEI)-2015 total scores by race/ethnicity of 4,393 adults – NHANES 2011–2014

Table 1:

Sociodemographic and health characteristics of 4,393 adults with family incomes ≤300% of the federal poverty level - NHANES 2011–14

	Food secure (n=2292)		Marginally food secure (n=697)		Food insecure (n=1404)		*P-value*[a]
	n	Weighted %[b]	n	Weighted %[b]	n	Weighted %[b]	
Age in years, mean (SE)	40.7 (0.8)		39.6 (0.8)		39.3 (0.7)		*0.007*
Sex							*0.87*
Men	1097	47.8	312	46.8	640	46.6	
Women	1195	52.2	385	53.2	764	53.4	
Race/ethnicity							*<0.001*
Non-Hispanic White	849	58.8	205	45.6	490	47.5	
Non-Hispanic Black	570	14.6	189	16.5	381	18.1	
Hispanic	542	18.2	214	27.7	426	28.4	
Asian	263	5.8	56	4.6	49	2.0	
Other[c]	68	2.6	33	5.8	58	3.9	
Birthplace							*0.58*
US born	1579	78.2	468	75.3	1006	76.5	
Foreign born	713	21.8	229	24.7	398	23.5	
Educational attainment							*<0.001*
<12 years	528	17.6	195	23.9	447	29.8	
High school diploma or equivalent	546	26.3	186	27.6	391	29.3	
Some college	796	35.3	240	36.5	460	33.6	
College graduate	422	20.9	76	12.0	106	7.3	
Marital status							*0.14*
Married or living with partner	1254	56.5	368	51.0	706	51.2	
Never married	611	26.8	176	28.6	393	27.4	
Separated, divorced, or widowed	427	16.7	153	20.4	305	21.4	
Poverty income ratio							*<0.001*
0–50% federal poverty level	186	7.5	95	12.9	257	16.2	
50.1–100% federal poverty level	403	15.6	188	25.1	435	29.6	
100.1–150% federal poverty level	477	19.4	167	22.4	350	24.4	

	Food secure (n=2292)		Marginally food secure (n=697)		Food insecure (n=1404)		*P-value*[a]
	n	**Weighted %**[b]	**n**	**Weighted %**[b]	**n**	**Weighted %**[b]	
150.1–200% federal poverty level	340	14.5	96	17.0	132	11.2	
200.1–250% federal poverty level	282	15.4	52	7.6	89	7.7	
250.1–300% federal poverty level	285	15.7	54	9.9	62	4.9	
Smoking status							*<0.001*
Never smoker	1306	56.2	377	52.6	694	47.5	
Former smoker	442	19.2	131	19.0	217	13.6	
Current smoker	544	24.6	189	28.3	493	38.9	

[a] P-values derived from χ^2 tests for categorical variables and univariate regression for continuous variables

[b] Indicates weighted proportion

[c] "Other" race/ethnicity refers to Non-Hispanic indi viduals identifying as American Indian or Alaska Native, and Native Hawaiian or Other Pacific Islander, and adults who identify as multi-racial.

Table 2:

Associations between household food insecurity and Healthy Eating Index (HEI)-2015 total scores – NHANES 2011–2014

	All adults[a]			Non-Hispanic White			Non-Hispanic Black		
	Mean (SE)	**β[c]**	**95% CI**	**Mean (SE)**	**β[c]**	**95% CI**	**Mean (SE)**	**β[c]**	**95% CI**
Food secure	54.6 (0.6)	Ref.		53.1 (1.5)	Ref.		54.0 (0.7)	Ref.	
Marginally food secure	53.4 (0.7)	−1.19	−2.87, 0.50	50.1 (2.0)	−2.95	−5.58, −0.33	54.0 (1.7)	−0.02	−3.15, 3.11
Food insecure	52.4 (0.8)	−2.22	−3.35, −1.08	50.2 (1.6)	−2.92	−4.49, −1.35	53.6 (1.0)	−0.34	−1.76, 1.09
P-trend		*0.0002*			*0.0002*			*0.64*	
	Hispanic			**Non-Hispanic Asian**			**“Other” Race/Ethnicity** [b]		
	Mean (SE)	**β[c]**	**95% CI**	**Mean (SE)**	**β[c]**	**95% CI**	**Mean (SE)**	**β[c]**	**95% CI**
Food secure	54.6 (1.2)	Ref.		55.6 (1.5)	Ref.		60.6 (2.7)	Ref.	
Marginally food secure	56.1 (1.8)	1.45	−1.69, 4.59	57.4 (2.2)	1.80	−3.75, 7.35	60.2 (2.2)	−0.44	−5.31, 4.42
Food insecure	53.9 (1.0)	−0.68	−2.73, 1.36	50.0 (2.3)	−5.64	−10.84, −0.44	55.2 (2.7)	−5.37	−10.60, −0.14
P-trend		*0.54*			*0.15*			*0.048*	

[a] P value from Wald test for heterogeneity of β were: 0.36 for sex and 0.002 for race/ethnicity

[b] “Other” race/ethnicity refers to Non-Hispanic indi viduals identifying as American Indian or Alaska Native, and Native Hawaiian or Other Pacific Islander, and adults who identify as multi-racial

[c] β coefficient estimated using linear regression models adjusted for age, sex, race/ethnicity (except for stratified models), birthplace, educational attainment, marital status, poverty income ratio, and smoking status

Table 3:

Associations between household food insecurity and Healthy Eating Index (HEI)-2015 component scores – NHANES 2011–2014

	Non-Hispanic White		Non-Hispanic Black		Hispanic		Asian		"Other" Race/Ethnicity[a]	
	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI
Total vegetables[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	1.01	0.91, 1.12	1.01	0.90, 1.12	1.12	1.03, 1.22	1.03	0.85, 1.25	0.93	0.56, 1.52
Food insecure	0.99	0.91, 1.07	0.97	0.90, 1.05	1.05	0.97, 1.14	0.94	0.78, 1.15	0.98	0.77, 1.23
P-trend	*0.76*		*0.46*		*0.18*		*0.66*		*0.82*	
Greens and beans[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.97	0.72, 1.32	0.92	0.64, 1.33	0.98	0.78, 1.23	0.87	0.64, 1.19	0.59	0.19, 1.80
Food insecure	1.13	0.88, 1.44	1.06	0.84, 1.34	1.01	0.83, 1.23	0.90	0.67, 1.20	1.03	0.44, 2.43
P-trend	*0.37*		*0.66*		*0.90*		*0.36*		*0.79*	
Total fruits[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.80	0.63, 1.01	1.02	0.80, 1.32	1.21	1.04, 1.41	1.31	0.96, 1.79	0.31	0.17, 0.56
Food insecure	0.81	0.64, 1.04	1.03	0.84, 1.25	1.06	0.89, 1.26	0.75	0.53, 1.06	0.64	0.35, 1.19
P-trend	*0.07*		*0.78*		*0.46*		*0.41*		*0.08*	
Whole fruits[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.92	0.70, 1.21	1.24	0.92, 1.67	1.19	0.98, 1.43	1.31	0.92, 1.86	0.41	0.19, 0.84
Food insecure	0.78	0.60, 1.01	1.03	0.80, 1.33	1.05	0.87, 1.26	0.68	0.50, 0.93	0.51	0.24, 1.09
P-trend	*0.06*		*0.77*		*0.58*		*0.22*		*0.05*	
Whole grains[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.99	0.71, 1.39	0.66	0.52, 0.85	1.22	0.84, 1.76	0.94	0.51 1.76	0.51	0.14, 1.83
Food insecure	1.02	0.81, 1.27	1.07	0.88, 1.31	0.92	0.71, 1.21	0.53	0.26, 1.11	0.87	0.42, 1.83
P-trend	*0.88*		*0.64*		*0.56*		*0.17*		*0.69*	

	Non-Hispanic White		Non-Hispanic Black		Hispanic		Asian		"Other" Race/Ethnicity[a]	
	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI
Dairy[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.99	0.82, 1.21	1.09	0.92, 1.29	0.95	0.82, 1.09	0.88	0.65, 1.19	1.12	0.82, 1.53
Food insecure	1.00	0.93, 1.09	1.05	0.93, 1.18	0.96	0.86, 1.08	0.92	0.64, 1.34	1.01	0.69, 1.48
P-trend	*0.93*		*0.39*		*0.51*		*0.55*		*0.92*	
Total protein foods[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.97	0.89, 1.05	0.99	0.95, 1.02	0.99	0.96, 1.02	1.03	0.98, 1.08	1.06	0.88, 1.28
Food insecure	0.94	0.89, 0.99	0.98	0.96, 1.01	0.97	0.93, 1.02	0.93	0.80, 1.07	1.13	0.90, 1.41
P-trend	*0.02*		*0.27*		*0.21*		*0.39*		*0.29*	
Seafood and plant proteins[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.82	0.66, 1.01	1.03	0.85, 1.24	1.00	0.89, 1.12	0.99	0.80, 1.22	0.80	0.28, 2.26
Food insecure	0.83	0.70, 0.98	0.99	0.83, 1.17	0.95	0.84, 1.07	0.79	0.56, 1.12	0.74	0.41, 1.36
P-trend	*0.02*		*0.89*		*0.39*		*0.22*		*0.30*	
Fatty acids[c]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.92	0.75, 1.12	0.99	0.82, 1.18	1.03	0.89, 1.19	1.12	0.94, 1.34	0.81	0.58, 1.15
Food insecure	1.01	0.90, 1.14	0.93	0.83, 1.05	1.06	0.93, 1.21	0.92	0.73, 1.16	0.93	0.65, 1.32
P-trend	*0.99*		*0.24*		*0.34*		*0.75*		*0.66*	
Sodium[d]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.91	0.77, 1.09	1.14	0.95, 1.35	1.19	1.01, 1.41	1.09	0.54, 2.21	1.05	0.67, 1.65
Food insecure	1.05	0.93, 1.18	0.98	0.84, 1.15	1.06	0.93, 1.20	0.89	0.42, 1.90	0.80	0.49, 1.29
P-trend	*0.50*		*0.83*		*0.34*		*0.86*		*0.34*	
Refined grains[d]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	

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	Non-Hispanic White		Non-Hispanic Black		Hispanic		Asian		"Other" Race/Ethnicity[a]	
	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI	RD[b]	95% CI
Marginally food secure	0.94	0.80, 1.12	1.10	0.98, 1.23	0.98	0.83, 1.17	1.06	0.78, 1.43	1.07	0.72, 1.58
Food insecure	0.92	0.84, 1.01	1.02	0.93, 1.11	0.94	0.79, 1.12	0.81	0.46, 1.42	1.14	0.80, 1.61
P-trend	*0.08*		*0.67*		*0.45*		*0.54*		*0.46*	
Saturated fat[d]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.93	0.78, 1.11	0.99	0.90, 1.09	1.01	0.92, 1.11	0.94	0.83, 1.05	1.00	0.81, 1.23
Food insecure	0.95	0.87, 1.05	0.95	0.87, 1.04	1.03	0.93, 1.13	1.07	0.99, 1.16	0.84	0.61, 1.15
P-trend	*0.31*		*0.25*		*0.56*		*0.31*		*0.27*	
Added sugar[d]										
Food secure	Ref.		Ref.		Ref.		Ref.		Ref.	
Marginally food secure	0.95	0.84, 1.08	0.90	0.74, 1.10	0.99	0.87, 1.11	1.08	0.94, 1.24	0.82	0.37, 1.85
Food insecure	0.88	0.81, 0.95	1.01	0.87, 1.17	0.96	0.89, 1.02	0.95	0.77, 1.17	0.90	0.53, 1.52
P-trend	*0.002*		*0.93*		*0.19*		*0.82*		*0.68*	

[a]"Other" race/ethnicity refers to Non-Hispanic individuals identifying as American Indian or Alaska Native, and Native Hawaiian or Other Pacific Islander, and adults who identify as multi-racial.

[b]Relative difference (RD) estimated using generalized linear models adjusted for age, sex, birthplace, educational attainment, marital status, poverty income ratio, and smoking status. RDs are interpreted as the percentage difference between groups (e.g. a RD of 0.90 is 10% difference between the food security category and the reference group).

[c]Adequacy components indicates higher points for greater consumption. Maximum points and standards for maximum score per 1,000 kcal are as follows: total fruits, 5 points for ≥0.8 C equiv.; whole fruits, 5 points for ≥0.4 C equiv.; total vegetables, 5 points for ≥1.1 C equiv.; greens and beans, 5 points for ≥0.2 C equiv.; whole grains, 10 points for ≥1.5 oz equiv.; dairy, 10 points for ≥1.3 C equiv.; total protein foods, 5 points for ≥2.5 oz equiv.; seafood and plant proteins, 5 points for ≥0.8 oz equiv.; fatty acids, 10 points for (polyunsaturated fat + monounsaturated fat)/ saturated fat ≥2.5

[d]Moderation components indicates higher points for lower consumption. Maximum points and standards for maximum score per 1,000 kcal are as follows: refined grains, 10 points for ≤1.8 oz equiv.; sodium, 10 points for ≤1.1 g; added sugars, 10 points for ≤6.5% of energy; saturated fats, 10 points for ≤8% of energy