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Food hardship and obesity in a sample of low-income immigrants

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Introduction

Food insecurity disproportionately affects low-income, minority, and immigrant families [1–4]. In 2013, 14.3% of U.S. households experienced food insecurity due to insufficient financial resources for food for their household [5]. A number of studies have linked food insecurity with low nutrient intake and poorer diet [1,3,6,7]. Recent literature supports the notion that food insecurity is a risk factor for obesity among adults [3,8,9], although results have not always been consistent [10–12].

The association between food insecurity and obesity has, however, varied substantially between subpopulations. For example, a number of studies have found that food insecurity is associated with obesity among women, but not men [8,13–15]. Evidence also suggests that the relationship between food insecurity and body mass index (BMI) is stronger within certain racial/ethnic subgroups [14], such as Hispanics [16–18]. One subgroup of interest is low-income immigrants, who are at an elevated risk for both food insecurity [3,4], and obesity [19]. Dietary acculturation (changes in diet practices occurring among immigrant groups after moving to the U.S.) tend to result in less healthful dietary choices due to an array of barriers to maintaining healthy eating habits [20]. Yet, very little research has examined the link between food insecurity and obesity among immigrant subgroups.

Food insecurity is a multidimensional construct, encompassing the physical and economic access to sufficient, safe, and nutritious foods over time [21]. In the U.S., food insecurity is often measured by an 18-item USDA measure [5]. While this measure is comprehensive and appropriate for surveillance, it has high participant burden, particularly for large community surveys [22]. As an alternative, other metrics have focused on single dimensions of poor food access – for example, psychological concerns about food access [9,12], food insufficiency [6,23] or food hardship, which occurs when households have inconsistent financial resources to buy food [24,25].

The current study relied on a multiracial/ethnic community-based survey of adults living in low-income housing, the majority of whom were born outside the U.S., to examine the relationship between food hardship and obesity risk. The aim was to determine how the relationship between food hardship and obesity might differ across immigrant subgroups.

Methods

Study design

Data were obtained as part of the Health in Common (HIC) study, a cross-sectional study investigating the social determinants of cancer risk in low-income housing residents. Data were collected from 828 residents in 20 low-income housing sites in Cambridge, Chelsea, and Somerville, MA. A multistage cluster design was used to sample households from housing sites and select adults within households [26]. In the smaller housing sites, a census method was used to recruit one participant per household. In the larger housing sites, a random selection of households formed the sampling frame. The response rate averaged 49% across the sites.

All procedures involving human subjects were approved by the Institutional Review Board at *REMOVED FOR BLINDING*. Verbal informed consent was obtained from all participants and formally recorded.

Survey data

Resident surveys were conducted in three languages (English, Spanish, and Haitian-Creole) by trained survey assistants administering interviews in residents' homes between February 2007 and June 2009. The survey assessed an array of social and environmental factors in the home and the housing site, as well as demographic factors.

Anthropometric data

At the time of the survey, participant height and weight were collected using standard methods (WHO 1995 Physical Status). Height without shoes was measured using a Shorr stadiometer (Shorr Productions, Olney, MD) or a wooden fold-out measurement ruler that had been calibrated to the stadiometer. Weight was assessed in light clothes using a portable electronic scale (Seca Model 770), calibrated at regular intervals with standard weights. Self-reported values of height (18%) and weight (13%) were used in cases where survey assistants were either unable to obtain measured weight or the participants refused the measurements.

Outcome variable

BMI was calculated as kg/m². Obesity (BMI ≥ 30.0) was the outcome of interest rather than overweight, as 78% of the sample had a BMI ≥ 25.0 [27] and obesity is a higher-risk outcome [28,29].

Primary explanatory variable

Food hardship was measured with a single item: “In the past 12 months, was there ever a time when there wasn't enough money for food?” The response option was yes/no. This item is similar to other single and 2-item screener questions validated in diverse and low-income samples (e.g., “Within the past 12 months we worried whether our food would run out before we got money to buy more”) which have demonstrated high sensitivity and specificity when compared with the 18 item USDA measure [22,30].

Place of birth (nativity)

Participants were asked their place of birth, and results were collapsed into the most common categories: U.S., Haiti, Puerto Rico, Latin America, or Other (most commonly from Ethiopia and Somalia or other African countries). Although those born in Puerto Rico are U.S. citizens by birth, we followed the convention of examining them separately [31], as island-born Puerto Ricans may have experiences of language, migration and cultural identity that differ from mainland-born groups and that are relevant to health [32].

Socio-demographic and other participant characteristics

Age, race/ethnicity, gender, marital status, education, survey language, years living at the housing site, number of adults in the household working for pay, self-reported health, poverty status, and acculturation status were obtained from the resident survey. Poverty was determined using Census Bureau 2008 poverty thresholds [33], which vary depending on the number of total individuals in the household and the number of children younger than 18 in the household. Residents were defined as being in poverty if their household income fell below the threshold based on their specific household size and number of children younger than 18 years. Acculturation categories have been described elsewhere [34] and included: (1) “very low” (non-US-born, non-English speakers who had no US schooling); (2) “low” (non-US-born, bilingual individuals who spent none/some of their schooling in the US); and (3) “moderate/high” (those born in the US, as well as non-US-born, English-only speakers who spent some/all of their school years in the US).

Statistical analyses

Univariate and bivariable analyses evaluated the frequency of obesity by socio-demographic and a range of other participant characteristics. Multivariable regression models were run using the GENMOD procedure in SAS 9.3 with a Poisson distribution and log link function to determine the relative risk of obesity [35] with housing site controlled for a random effect. Model building consisted of first investigating the association between BMI and food hardship (Model 1), then including nativity and other resident characteristics as covariates (Model 2). We relied on a previously developed conceptual model to determine relevant resident characteristics to include in Model 2 (age, race/ethnicity, gender, acculturation,

marital status, education, and poverty). In Model 3, an interaction term (nativity*food hardship) was included in order to test whether the relationship between food hardship and obesity differed across immigrant subgroups; a statistically significant overall interaction would indicate that it would be appropriate to calculate a risk ratio and confidence interval estimating the risk of obesity by food hardship status for each group (U.S., Haiti, Puerto Rico, Latin America, and Other). Race/ethnicity was excluded from Model 3 because of difficulties with model convergence due to the collinearity between racial/ethnicity and nativity.

Results

In the study sample, 22% of participants had a BMI <25.0, 36% had a BMI between 25.0 and 29.9, and 42% had a BMI ≥ 30.0. Other participant characteristics and bivariate analyses are presented in Table 1. Over one-third (37%) reported food hardship. Those reporting food hardship were more likely to be obese than those not reporting food hardship (47% vs. 39%, $p = 0.04$). More than two-thirds of the sample (69%) was born outside of the U.S. Nativity was statistically significantly associated with obesity ($p < 0.001$), and obesity was higher among more acculturated individuals ($p < 0.01$). Women were more likely to be obese than men (46% vs. 26%, $p < 0.001$), as were residents who had lived in their housing development longer ($p < 0.01$), and individuals reporting fair/poor self-rated health compared with good/very good/excellent health (53% vs. 36%, $p < 0.001$).

Results of the multivariable analysis are shown in Table 2. Overall, respondents reporting food hardship were 20% more likely to be obese than respondents not reporting food hardship (RR 1.20, 95% CI: 1.08, 1.33). When other participant characteristics were included in the model (nativity, age, race/ethnicity, gender, marital status, education, poverty, and acculturation), the association was slightly attenuated, but still statistically significant (RR 1.17, 95% CI: 1.07, 1.29). Nativity was statistically significantly associated with obesity in this model ($p = 0.04$).

The interaction between food hardship and nativity was statistically significant ($p = 0.04$), indicating potential differences in the relationships between food hardship and obesity among immigrant subgroups. Table 3 presents the risk of obesity in the presence of food hardship by place of birth. Participants from Haiti reporting food hardship were more likely to be obese compared to those not reporting food hardship (RR = 1.58, 95% CI: 1.23-2.04). Among other groups (U.S. born, Puerto Rican, Latin American, Other), there was no statistically significant association between food hardship and obesity.

Discussion

This study found an association between food hardship and increased risk of obesity within a multiracial/ethnic sample of low-income housing residents. Results are consistent with other studies that have found a positive association between food insecurity and weight outcomes in adults [1,3,7,9]. There are a number of plausible mechanisms for this relationship among low-income adults. For example, participation in SNAP has been associated with poorer weight outcomes [36]. Some have argued that the once-a-month

payment of benefits may contribute to a “feast or famine” experience of some families [8,14,37,38], in which periods of limited food intake resulting from food scarcity may encourage an individual to engage in compensatory overeating later, which may contribute to weight gain over the long-term [18].

Previous research has demonstrated that, while immigrants generally arrive in the U.S. in better health than their U.S.-born counterparts, immigrant obesity rates converge with U.S.-born individuals 10-15 years after arrival [39], likely due to behavioral changes associated with the acculturative process [20,40]. Among many immigrant groups, behavioral adaptations experienced shortly after immigrating may shape long-term dietary habits, increasing the risk for obesity [20,41,42]. Preserving a traditional diet may hold nutritional advantages over transitioning to a Western diet [42], but financial constraints may pose challenges to maintaining a traditional diet. Immigrant and refugee families may find culturally-specific foods to be too expensive [43–46], or, when forced to make choices, they may prioritize less healthy foods that were in scarce supply in their home countries (e.g., choosing meat over fruits and vegetables) [3]. Qualitative studies have noted other challenges in selecting healthy foods after immigration, such as language barriers, poor quality food, unfamiliar food, or increased exposure to convenience foods [44,46–48]. In another study of low-income New Yorkers that found no association between food hardship and obesity among foreign-born residents, the authors hypothesize that access to affordable ethnic foods in the New York metropolis could avert food insecurity and “slow the acculturation process” in this unique context [9].

In the current study, Haitian immigrants reporting food hardship were more likely to be obese than those not reporting hardship, but this was not the case among other groups in our study. The diversity in the acculturative process makes it likely that the association between acculturation, low-income status, food hardship and weight outcomes varies among immigrant subgroups. Post-hoc analyses sought to characterize how Haitians may have differed from other groups in the sample; findings indicated that Haitians were more likely to have lived in low-income housing for >5 years, yet they remained the least acculturated group despite their longer tenure. While it is unclear why the observed relationship between food hardship and obesity was only present among Haitians, it is possible that the low-income housing context may have contributed to the increased risk for obesity. Indeed, the low-income housing setting can expose residents to an array of environmental risk factors that influence obesity-related behaviors, including poor access to healthy food and safety concerns [49,50]. Including a housing tenure variable in multivariable models did not, however, substantially alter results (data not shown). Beyond these considerations, previous research supports the notion that excessive work demands and less time for food preparation may be relevant to the Haitian immigrant experience (though not unique to the Haitian experience) and may contribute to obesity-related dietary behaviors [36]. However, these factors were not measured in the current study, and further research is necessary to test specific environmental, psychosocial, or behavioral mechanisms for this relationship among Haitians. It must be noted that the data used in these analyses were collected prior to the 2010 Haitian earthquake. Therefore, the psychosocial consequences of the earthquake [51] are not manifested in these results, nor does the sample include those who arrived in the U.S. following the earthquake.

The results of this study should be considered within its limitations. The temporal association between food hardship and obesity could not be determined in this cross-sectional study. Repeated periods of food hardship were not measured. Furthermore, although the results may be related to the time since immigration or immigration status, we were not able to explore these factors in the analysis. Our question assessing food hardship is considerably less nuanced than the 18-question USDA Household Food Security Survey. Although our measure addresses the financial constraints related to food purchasing, it does not capture food quality, psychological concerns about lack of food, or the intensity of food hardship. Additionally, self-reported height and weight values were used for some participants, which tend to slightly underestimate BMI [52]. However, this measurement error would only be relevant in cases where BMI was misclassified as normal/overweight instead of obese and vice versa. Another limitation is that we did not account for SNAP participation. SNAP eligibility and participation may have varied across our sample of immigrants based on citizenship status, household characteristics, and duration of residence in the U.S. Since SNAP participation has been associated with obesity [36], it could be that SNAP participation accounts to some extent for the observed results. Finally, our models focus on the role of food hardship in obesity, but do not include other known risk factors for obesity, including physical activity.

Despite these limitations, our study has a number of strengths. Our measure of height and weight used anthropometric rather than self-reported measures, reducing the potential for bias [48]. In addition, our study included a multi-racial/ethnic low-income housing sample, which allowed for an investigation of the association between BMI and food hardship across multiple social groups.

Conclusions

The results of this study add to the limited body of research investigating the effect of constrained food access among immigrant subgroups. Results suggest that the relationship between food hardship and weight may vary among immigrant subgroups. Such differences may partially explain previous inconsistent findings in cross-sectional and longitudinal studies of food hardship and obesity [3,8–12]. These findings call for additional studies investigating the determinants and coping strategies related to food hardship across different cultural communities. In future work, it will also be important to consider the ways in which food insecurity might have a cumulative or interactive effect with other environmental, psychosocial, and sociodemographic factors that might put some groups at an elevated risk of poor obesity-related behaviors or outcomes.

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References

1. Rose D. Economic determinants and dietary consequences of food insecurity in the United States. *J Nutr.* 1999; 129:517S–520S. [PubMed: 10064321]
2. Coleman-Jensen, A., Nord, M., Carlson, S. Household Food Security in the United States in 2010. U.S. Department of Agriculture; 2011.
3. Dharod JM, Croom JE, Sady CG. Food insecurity: Its relationship to dietary intake and body weight among Somali refugee women in the United States. *J Nutr Educ Behav.* 2012
4. Hadley C, Zoghbi-Satter A, Sellen DW. Acculturation, economics and food insecurity among refugees resettled in the USA: a case study of West African refugees. *Public Health Nutr.* 2007; 10:405–12. [PubMed: 17362537]
5. [cited 2013 Sep 24] USDA Economic Research Service - Measurement [Internet]. Available from: http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.aspx#.UkHVXqy_zjw
6. Dixon LB, Winkleby MA, Radimer KL. Dietary intakes and serum nutrients differ between adults from food-insufficient and food-sufficient families: Third National Health and Nutrition Examination Survey, 1988-1994. *J Nutr.* 2001; 131:1232–46. [PubMed: 11285332]
7. Mello JA, Gans KM, Risica PM, Kirtania U, Strolla LO, Fournier L. How is food insecurity associated with dietary behaviors? An analysis with low-income, ethnically diverse participants in a nutrition intervention study. *J Am Diet Assoc.* 2010; 110:1906–11. [PubMed: 21111099]
8. Wilde PE, Peterman JN. Individual weight change is associated with household food security status. *J Nutr.* 2006; 136:1395–400. [PubMed: 16614436]
9. Yaemsiri S, Olson EC, He K, Kerker BD. Food concern and its associations with obesity and diabetes among lower-income New Yorkers. *Public Health Nutr.* 2012; 15:39–47. [PubMed: 21810285]
10. Whitaker RC, Sarin A. Change in food security status and change in weight are not associated in urban women with preschool children. *J Nutr.* 2007; 137:2134–9. [PubMed: 17709454]
11. Jones SJ, Frongillo EA. Food insecurity and subsequent weight gain in women. *Public Health Nutr.* 2007; 10:145–51. [PubMed: 17261223]
12. Laraia BA, Siega-Riz AM, Evenson KR. Self-reported overweight and obesity are not associated with concern about enough food among adults in New York and Louisiana. *Prev Med.* 2004; 38:175–81. [PubMed: 14715209]
13. Townsend MS, Pearson J, Love B, Achterberg C, Murphy SP. Food insecurity is positively related to overweight in women. *J Nutr.* 2001; 131:1738–45. [PubMed: 11385061]
14. Dinour LM, Bergen D, Yeh MC. The food insecurity-obesity paradox: a review of the literature and the role food stamps may play. *J Am Diet Assoc.* 2007; 107:1952–61. [PubMed: 17964316]
15. Power ML, Schulkin J. Sex differences in fat storage, fat metabolism, and the health risks from obesity: possible evolutionary origins. *Br J Nutr.* 2008; 99:931–40. [PubMed: 17977473]
16. Leung CW, Williams DR, Villamor E. Very low food security predicts obesity predominantly in California Hispanic men and women. *Public Health Nutr.* 2012; 15:2228–36. [PubMed: 22463949]
17. Bhattacharya J, Currie J, Haider S. Poverty, food insecurity, and nutritional outcomes in children and adults. *J Health Econ.* 2004; 23:839–62. [PubMed: 15587700]
18. Kaiser LL, Townsend MS, Melgar-Quiñonez HR, Fujii ML, Crawford PB. Choice of instrument influences relations between food insecurity and obesity in Latino women. *Am J Clin Nutr.* 2004; 80:1372–8. [PubMed: 15531689]
19. Goel MS, McCarthy EP, Phillips RS, Wee CC. Obesity among US immigrant subgroups by duration of residence. *JAMA-J Am Med Assoc.* 2004; 292:2860–7.
20. Popovic-Lipovac A, Strasser B. A review on changes in food habits among immigrant women and implications for health. *J Immigr Minor Health Cent Minor Public Health.* 2015; 17:582–90.
21. Jones AD, Ngure FM, Peltó G, Young SL. What are we assessing when we measure food security? A compendium and review of current metrics. *Adv Nutr Bethesda Md.* 2013; 4:481–505.
22. Urke HB, Cao ZR, Egeland GM. Validity of a Single Item Food Security Questionnaire in Arctic Canada. *Pediatrics.* 2014; 133:E1616–23. [PubMed: 24864166]

23. Okechukwu CA, El Ayadi AM, Tamers SL, Sabbath EL, Berkman L. Household food insufficiency, financial strain, work-family spillover, and depressive symptoms in the working class: the Work, Family, and Health Network study. *Am J Public Health*. 2012; 102:126–33. [PubMed: 22095360]
24. Food Research and Action Center. [cited 2013 Oct 25] Food Hardship 2008–2012: Geography and Household Composition [Internet]. 2013. Available from: http://frac.org/pdf/food_hardship_geography_household_composition_2008-2012.pdf
25. Food Research and Action Center. [cited 2014 Mar 7] Food Hardship in America 2012 [Internet]. 2013. Available from: http://frac.org/pdf/food_hardship_2012.pdf
26. Kish, L. Survey Sampling. New York: Wiley & Sons, Inc.; 1965.
27. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report [Internet]. National Heart, Lung, and Blood Institute/National Institute of Diabetes and Digestive and Kidney Diseases; 1998 Sep. Report No.: NIH Publication No. 98-4083. Available from: http://www.nhlbi.nih.gov/files/docs/guidelines/ob_gdlns.pdf
28. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. *Jama-J Am Med Assoc*. 2005; 293:1861–7.
29. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *Jama-J Am Med Assoc*. 1999; 282:1523–9.
30. Hager ER, Quigg AM, Black MM, Coleman SM, Heeren T, Rose-Jacobs R, et al. Development and validity of a 2-item screen to identify families at risk for food insecurity. *Pediatrics*. 2010; 126:e26–32. [PubMed: 20595453]
31. Taylor, P., Lopez, MH., Martínez, J., Velasco, G. [cited 2013 Nov 17] When Labels Don't Fit: Hispanics and Their Views of Identity [Internet]. Pew Hisp Cent. Available from: <http://www.pewhispanic.org/2012/04/04/when-labels-dont-fit-hispanics-and-their-views-of-identity/>
32. Roy AL, Hughes D, Yoshikawa H. Intersections between nativity, ethnic density, and neighborhood SES: using an ethnic enclave framework to explore variation in Puerto Ricans' physical health. *Am J Community Psychol*. 2013; 51:468–79. [PubMed: 23314837]
33. US Census Bureau DIS. [cited 2015 Jun 15] US Census Bureau Poverty main page [Internet]. Available from: <http://www.census.gov/hhes/www/poverty/data/threshld/thresh08.html>
34. Allen JD, Caspi C, Yang M, Leyva B, Stoddard AM, Tamers S, et al. Pathways between acculturation and health behaviors among residents of low-income housing: The mediating role of social and contextual factors. *Soc Sci Med* 1982. 2014; 123C:26–36.
35. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004; 159:702–6. [PubMed: 15033648]
36. Leung CW, Villamor E. Is participation in food and income assistance programmes associated with obesity in California adults? Results from a state-wide survey. *Public Health Nutr*. 2011; 14:645–52. [PubMed: 20701819]
37. Bhargava A. Socio-economic and behavioural factors are predictors of food use in the National Food Stamp Program Survey. *Br J Nutr*. 2004; 92:497–506. [PubMed: 15469654]
38. Gibson D. Food stamp program participation is positively related to obesity in low income women. *J Nutr*. 2003; 133:2225–31. [PubMed: 12840184]
39. Antecol H, Bedard K. Unhealthy assimilation: Why do immigrants converge to American health status levels? *Demography*. 2006; 43:337–60. [PubMed: 16889132]
40. Kaplan MS, Huguet N, Newsom JT, McFarland BH. The association between length of residence and obesity among Hispanic immigrants. *Am J Prev Med*. 2004; 27:323–6. [PubMed: 15488363]
41. Sanou D, O'Reilly E, Ngnie-Teta I, Batal M, Mondain N, Andrew C, et al. Acculturation and Nutritional Health of Immigrants in Canada: A Scoping Review. *J Immigr Minor Health*. 2014; 16:24–34. [PubMed: 23595263]
42. Désilets MC, Rivard M, Shatenstein B, Delisle H. Dietary transition stages based on eating patterns and diet quality among Haitians of Montreal, Canada. *Public Health Nutr*. 2007; 10:454–63. [PubMed: 17411465]
43. Patil CL, Hadley C, Nahayo PD. Unpacking dietary acculturation among new Americans: results from formative research with African refugees. *J Immigr Minor Health Cent Minor Public Health*. 2009; 11:342–58.

44. Vahabi M, Damba C. Perceived barriers in accessing food among recent Latin American immigrants in Toronto. *Int J Equity Health*. 2013; 12:1. [PubMed: 23286318]
45. Tovar A, Must A, Metayer N, Gute DM, Pirie A, Hyatt RR, et al. Immigrating to the US: What Brazilian, Latin American and Haitian Women Have to Say About Changes to Their Lifestyle That May be Associated with Obesity. *J Immigr Minor Health*. 2013; 15:357–64. [PubMed: 22736266]
46. Munger AL, Lloyd TDS, Speirs KE, Riera KC, Grutzmacher SK. More than Just Not Enough: Experiences of Food Insecurity for Latino Immigrants. *J Immigr Minor Health Cent Minor Public Health*. 2015; 17:1548–56.
47. Dubowitz T, Subramanian SV, Acevedo-Garcia D, Osypuk TL, Peterson KE. Individual and neighborhood differences in diet among low-income foreign and US-born women. *Womens Health Issues*. 2008; 18:181–90. [PubMed: 18222706]
48. Sussner KM, Lindsay AC, Greaney ML, Peterson KE. The Influence of Immigrant Status and Acculturation on the Development of Overweight in Latino Families: A Qualitative Study. *J Immigr Minor Health*. 2008; 10:497–505. [PubMed: 18373200]
49. Caspi CE, Kawachi I, Subramanian SV, Adamkiewicz G, Sorensen G. The relationship between diet and perceived and objective access to supermarkets among low-income housing residents. *Soc Sci Med* 1982. 2012; 75:1254–62.
50. Caspi CE, Kawachi I, Subramanian SV, Tucker-Seeley R, Sorensen G. The social environment and walking behavior among low-income housing residents. *Soc Sci Med* 1982. 2013; 80:76–84.
51. Martinez LS, Reich AJ, Ndulue UJ, Dalembert F, Gute DM, Perea FC. Employing a Community Based Participatory Research Approach to Bear Witness: Psycho-Social Impact of the 2010 Earthquake on Haitians in Somerville, MA. *J Immigr Minor Health*. 2014; 16:1201–7. [PubMed: 23515968]
52. Stommel M, Schoenborn CA. Accuracy and usefulness of BMI measures based on self-reported weight and height: findings from the NHANES & NHIS 2001–2006. *Bmc Public Health*. 2009; 9:421. [PubMed: 19922675]

Table 1
Participant characteristics and bivariate results by body mass index (BMI)

	Total frequency in each category n (%)	Frequency in each category with BMI 30 n (%)	Chi-Square p-value ^a
Food hardship			
No	495 (63%)	194 (39%)	0.04
Yes	296 (37%)	138 (47%)	
Nativity			
USA	251 (31%)	118 (47%)	<0.001
Haiti	185 (23%)	79 (43%)	
Puerto Rico	93 (12%)	50 (54%)	
Latin America	170 (21%)	64 (38%)	
Other	98 (12%)	23 (23%)	
Age			
18-29	147 (18%)	53 (36%)	0.12
30-39	208 (26%)	83 (40%)	
40-49	166 (21%)	74 (45%)	
50-59	139 (17%)	70 (50%)	
60+	137 (17%)	54 (39%)	
Gender			
Male	164 (20%)	42 (26%)	<0.001
Female	636 (80%)	293 (46%)	
Race/ethnicity			
Hispanic	332 (42%)	140 (42%)	0.25
Non-Hispanic White	88 (11%)	44 (50%)	
Non-Hispanic Black	303 (38%)	126 (42%)	
Other	73 (9%)	25 (34%)	
Income below poverty line			
No	316 (42%)	130 (41%)	0.44
Yes	430 (58%)	189 (44%)	
Survey language			
English	432 (54%)	176 (41%)	0.56
Spanish	217 (27%)	90 (41%)	
Creole	151 (19%)	69 (46%)	
Acculturation status			0.01
Very low	253 (32%)	88 (35%)	
Low	257 (32%)	110 (43%)	
Moderate/High	286 (36%)	135 (47%)	
Education			
Grade school	148 (21%)	62 (42%)	0.08
Some HS	118 (17%)	58 (49%)	
High School	197 (28%)	87 (44%)	

	Total frequency in each category n (%)	Frequency in each category with BMI 30 n (%)	Chi-Square p-value ^a
More than high school	249 (35%)	89 (36%)	
Years living at housing site			
0-5 years	368 (48%)	142 (39%)	
5-10 years	179 (23%)	69 (39%)	0.01
More than 10 years	218 (29%)	110 (50%)	
Adults Work for Pay			
0	279 (35%)	125 (45%)	0.21
1	359 (46%)	152 (42%)	
2+	150 (19%)	54 (36%)	
Currently Married			
Yes	267 (33%)	103 (39%)	0.18
No	531 (67%)	231 (44%)	
Self-reported health			
Fair-Poor	276 (35%)	146 (53%)	<0.001
Good-Excellent	524 (66%)	189 (36%)	

^a Chi-square p-value testing for significant differences in the frequency of obesity between participant characteristics

Table 2

Modeling risk ratios and 95% confidence intervals for obesity ^a

	Model 1: food hardship		Model 2: food hardship + participant characteristics		Model 3: food hardship + participant characteristics + food hardship nativity	
	RR (95% CI)	p-value	RR (95% CI)	p-value	RR (95% CI)	p-value
Food hardship						
Yes	1.20 (1.08-1.33)	0.01	1.17 (1.07-1.29)	0.02	1.15 (0.91-1.45)	0.28
No (ref.)	1.00		1.00		1.00	
Nativity						
Haiti			1.05 (0.60-1.84)	0.04	1.29 (0.78-2.12)	0.03
Puerto Rico			1.51 (0.93-2.46)		1.30 (0.84-2.04)	
Latin America			1.01 (0.62-1.65)		0.89 (0.59-1.36)	
Other			0.50 (0.24-1.05)		0.56 (0.29-1.06)	
U.S. (ref.)			1.00		1.00	
Age						
18-29			1.03 (0.75-1.41)	0.20	0.99 (0.71-1.39)	0.12
30-39			1.17 (0.82-1.66)		1.14 (0.82-1.60)	
40-49			1.23 (0.89-1.71)		1.21 (0.86-1.71)	
50-59			1.27 (0.96-1.70)		1.34 (1.00-1.79)	
60+ (ref.)			1.00		1.00	
Race/ethnicity						
Hispanic			0.77 (0.54-1.11)	0.37	<i>removed</i>	
Non-Hispanic Black			1.08 (0.79-1.48)			
Other			0.90 (0.61-1.33)			
Non-Hispanic White (ref.)			1.00			
Gender						
Male			0.69 (0.55-0.86)	0.01	0.67 (0.52-0.87)	0.01
Female (ref.)			1.00		1.00	
Acculturation status						
Very low			0.92 (0.57-1.48)	0.88	0.84 (0.56-1.26)	0.70
Low			0.90 (0.55-1.47)		0.84 (0.54-1.29)	
Moderate/High (ref.)			1.00		1.00	

	Model 1: food hardship		Model 2: food hardship + participant characteristics		Model 3: food hardship + participant characteristics + food hardship * nativity	
	RR (95% CI)	p-value	RR (95% CI)	p-value	RR (95% CI)	p-value
Currently Married						
Yes			1.01 (0.82-1.25)	0.95	1.00 (0.82-1.22)	0.98
No (ref.)			1.00		1.00	
Education						
Grade school			1.15 (0.86-1.55)	0.65	1.14 (0.85-1.52)	0.63
Some HS			1.21 (0.92-1.60)		1.19 (0.87-1.61)	
High School			1.17 (0.94-1.47)		1.19 (0.94-1.51)	
> High school			1.00		1.00	
Income below the poverty line						
Yes			1.03 (0.84-1.27)	0.78	1.05 (0.86-1.28)	0.68
No (ref)			1.00		1.00	
Food hardship * nativity						0.04

* Log -binomial regressions where the risk of being obese is predicted with site controlled for as a random effect

Table 3
Risk of obesity for those reporting food hardship vs. those not reporting food insecurity,
by place of birth^a

	RR	95% CI	P-value
US (hardship vs. no hardship)	1.22	(0.96 - 1.56)	0.11
Haiti (hardship vs. no hardship)	1.58	(1.23 - 2.04)	<0.001
Puerto Rico (hardship vs. no hardship)	0.91	(0.63 - 1.32)	0.62
Latin America (hardship vs. no hardship)	1.02	(0.67 - 1.54)	0.93
Other (hardship vs. no hardship)	1.13	(0.42 - 3.06)	0.78

^aLog -binomial regressions controlling for age, gender, marital status, acculturation, education, and poverty