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Is There an Association Between Supplemental Nutrition Assistance Program Participation and Elevated Body Mass Index in Women?

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Is There an Association Between Supplemental Nutrition Assistance Program
Participation and Elevated Body Mass Index In Women?

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Submitted to the Graduate Faculty of Georgia State University in Partial
Fulfillment of the Requirements for the Degree

MASTER OF PUBLIC HEALTH

Atlanta, Georgia

30303

APPROVAL PAGE

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Acknowledgements

I would like to thank my mother for being understanding and supportive during my educational journey. I would like to thank my friend Dr. Wilson for helping me get past the tough times and reaching my goals. Also, I'd like to acknowledge the Public Health faculty of Georgia State University. And a special thank you to my thesis committee, Dr. Ike Okosun and Dr. Kim Ramsey-White, for their guidance.

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Abstract

Background: The Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program, is the largest nutrition assistance program in the United States. Its objective is to alleviate food insecurity and hunger. Women represent 28% of participants. Low-income individuals and women have the highest rates of obesity.

Objective: Determine if there is an association between participation in SNAP and elevated body mass index (BMI) in low-income women.

Design: A cross-sectional analysis was performed with National Health and Nutrition Examination Surveys (NHANES) 2009-2010 dataset. The study population comprised 788 women between the ages of 18 and 65, who were not pregnant, with household incomes ≤ 130% of the federal poverty level. More than half (57%) of the study population were SNAP participants. Univariate and Multivariate logistic regression models were used to examine the associations between SNAP participation and BMI, as well as selected sociodemographic variables; race, country of birth, education level, marital status, total number in household, insurance coverage, physical activity, and food security.

Results: SNAP participants were more likely to be overweight or obese than non-SNAP participants. There were no statistically significant associations found between SNAP participation and elevated BMI. Having health insurance was associated with elevated BMI in both univariate (OR: 1.339; 95% CI: 1.006, 1.781; $P \leq 0.05$) and multivariate analyses (OR: 1.479; 95% CI: 1.079, 2.2028; $P \leq 0.05$).

Conclusion: Though there was no statistically significant association between SNAP participation and elevated BMI due to limitations of the dataset, some relationship does seem to exist. Health insurance was the only variable positively associated with elevated BMI. Further investigation of obesity in low-income women and other populations is necessary to better align SNAP with dietary guidelines.

Key words: SNAP, participation, obesity, BMI, women.

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Introduction

During the past few decades, obesity (body mass index ≥ 30) has been a growing public health issue in the United States. More than a third of U.S. adults are obese, but particular sub-populations of U.S. adults have greater rates (CDC, 2011;Flegal, K.M., Caroll, M. D., Ogden, C. L. & Curtin, L. R., 2010; Pan L., Galuska, D. A., Sherry, B., Hunter A. S., Rutledge, G. E., Dietz, W. H., & Balluz, L. S., 2009). Results from the (2009) Behavioral Risk Factor Surveillance System (BRFSS) indicate that obesity prevalence among non-Hispanic blacks (35.7%) was much greater than the prevalence for Hispanics (28.7%) and non-Hispanic whites (23.7%) (Pan et al., 2009). According to data from the 2005-2008 National Health and Nutrition Examination Survey, 51% of non-Hispanic black women aged 20 years or older were obese, compared to 43% of Mexican Americans and 33% of whites (CDC, 2011). Low-income individuals, minorities, and women have the highest rates of obesity (Zhang & Wang, 2004). Existing research that confirms low-income and minority groups having a higher prevalence of obesity has led to questions of why those with limited financial resources have problems with being overweight.

The United States Department of Agriculture's Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program, is the largest nutrition assistance program in the U.S. that aids millions of low-income individuals and families with purchasing food (USDA (U.S. Department of Agriculture), 2014a). SNAP was developed as a program to deter food insecurity

and increase access to nutrient rich foods (USDA, 2014a), however numerous studies have linked participation in SNAP with higher rates of obesity. The program is available to those in the U.S. that meet the eligibility requirements relating to gross household income (<130% of federal poverty line), limited cash assets (<$2000), immigration status (has lived in the country for 5 years, or receiving disability-related assistance/benefits, or has children under 18), and employment (Able-bodied adults without dependents can get SNAP benefits only for 3 months in a 36-month period if they do not work or participate in a workfare or employment training program other than job search.) (USDA, 2014b; Ver Ploeg & Ralston, 2008). SNAP provides participants with Electronic Benefit Transfer (EBT) cards that can be used to purchase food from supermarkets, grocery stores, convenience stores, and other food retailers (Ver Ploeg & Ralston, 2008). EBT cards allow the purchase of most food and beverages, such as nutrient-rich whole grains, fruit, vegetables, meat, nutrient-poor salty snacks, sweets, baked goods, and sugar-sweetened beverages. Alcohol, tobacco, dietary supplements, and hot or prepared foods are excluded (Leung, C. W., Willett, W. C., & Ding, E. L., 2012b). As of 2014, SNAP serves 46.5 million participants; with the average amount of monthly benefits distributed per person approximately $125, at a total cost of $69.9 billion to the U.S. government (USDA, 2014c). The largest group of participants are children, who accounted for almost 50% of caseloads in 2009; working-age women represented 28% of the caseload compared to working age men who made up 16%, and the elderly aged 60 and older comprised 8% (Debono N. L., Ross, N. A., & Berrang-Ford, L., 2012).

Since women represent a large group of SNAP participants their association with obesity warrants investigation because there is a gap in the literature regarding this population.

Utilizing logistic regression and chi-square tests, the purpose of this study is to examine the association between participation in SNAP and the increased risk of elevated BMI among NHANES participants between 2009 and 2010. The research question proposed for this study is as follows: Is there an association between low-income women between the ages of 18 and 65 who participate in SNAP and being overweight or obese?

Literature Review

Methods

A literature search was conducted in January of 2015 using the PubMed database for published studies within the last 14 years that target non-elderly adults. Selecting the past 14 years ensured that up-to-date research was included in this review. Search terms included "SNAP", "participation" and "obesity". The literature inclusion criteria consisted of papers that were written in English, published from January 2000 to present 2015, performed statistical analyses, samples were adults aged 18 years or older, and compared SNAP participation with BMI or diet quality as the outcome. Following this PubMed search, a hand search of references was performed. Information on the study design, data set, statistical methods, and results was isolated and analyzed.

Results

The primary database search generated a total of 11 potential studies. Four of those studies met the inclusion criteria of this review, and one was a literature review. The literature review and four articles were then used to hand search references that met the inclusion criteria. An additional five relevant studies were found. In all, nine articles that examined the relationship between SNAP participation and BMI or dietary quality (defined in **Appendix**) were chosen. **Table 1.** presents the characteristics of these studies, including sample features, dataset, measurement, and results.

Two of the studies distinctively assessed the relationship between weight gain and food stamp participation in relation to food security (Jones & Frongillo, 2006; Webb, A. L., Schiff, A., Currivan, D., & Villamor, E., 2008). All of the studies used datasets representative of the U.S. population, except for two; Leung & Villamor (2010) used state level data from California, and Webb et al. (2008) used Massachusetts's data. The selected studies were all observational but vary in their design and statistical approach. The reviewed studies were majority cross-sectional (Jilcot S. B., Liu, H., DuBose, K. D., Chen, S., & Kratz, S., 2011; Leung & Villamor, 2010; Leung C.W., Ding, E. L., Catalano, P. J., Villamor, E., Rimm, E. B., & Willet, W. C., 2012a; Leung et al., 2012b; Nguyen, B. T., Shuval, K., Njike, V. Y., Katz, D. L., 2014; Webb et al., 2008); two were longitudinal design (Gibson, 2003; Jones & Frongillo, 2006); and one encompassed both designs by using a longitudinal dataset for cross-sectional estimation (Han, E., Powell, L. M., & Isgor, Z., 2012).

Table 1. Research studies reporting on the relationship between SNAP and obesity

Author	Sample	Dataset (years sampled)	Measures	Results
Gibson (2003)	n = 6731 women-3574 men-3157; low income (≤130% FPL); aged 20-40	NLSY-National Longitudinal Survey of Youth 1979 (1984-1996)	DV- BMI from the waves of 1985-1996 IV- Current and long-term food stamp participation	Current and long-term food stamp participation significantly related to the obesity of low-income women but not men. Current food stamp participation was associated with a 9.1% increase in predicted probability of current obesity; 5yr food stamp participation compared to nonparticipation associated with a 20.5% increase in predicted probability of current obesity.
Jones and Frongillo (2006)	n = 5303 women; low income; aged 18-74	PSID-Panel Study of Income Dynamics (1999 & 2001)	DV- Weight change between 1999 and 2001 IV- Food security status and food stamp participation	Persistent food insecurity was associated with a smaller weight change controlling for other income and health related factors for weight change. Among the persistently food insecure, full food stamp participation offset the weight change.
Webb et al. (2008)	n = 435 adults; low income residents of Massachusetts; aged 18 or older	State phone survey + USDA's Household Food Security Module	DV- Current BMI IV- Food security status, food stamp participation, and food sources	Food stamp participation within the past year associated with a 3-unit increase in BMI. Food insecurity was not associated with BMI.
Leung and Villamor (2010)	n = 7741 adults; low income in California; aged 18 or older	CHIS- Adult California Health Interview Survey (2007)	DV- BMI and obesity IV- Participation in SNAP, Supplemental Security Income (SSI), or California Work Opportunities and Responsibilities to Kids (CalWorks)	Participation in SNAP or SSI was associated with obesity independent of food insecurity or SES. Prevalence of obesity was 30% higher in SNAP participants than non-SNAP, and this association was more pronounced in men than women.

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Author	Sample	Dataset (years sampled)	Measures	Results
Jilcot et al. (2011)	n = 945 adults; low income; aged 20-65	NHANES- National Health and Nutrition Examination Survey (2005-2006)	DV- BMI, waist circumference, and meals away from home (MAFH) IV- Food stamp participation	Food stamp participation associated with fewer MAFH (Meals away from home). Among women, food stamp participation was associated with higher BMI and waist circumference. Also more benefits received from food stamps was associated with lower BMI and waist circumference.
Han et al. (2012)	n = 3742 women-2391 men-1351; low income; aged 18-65	PSID (1999, 2001, 2003)	DV- BMI IV- SNAP participation and economic contextual factors (longitudinal individual fixed effect model)	A simulated 20% reduction in price of fruits and vegetables resulted in a larger decrease in BMI of SNAP participants than non-SNAP for men and women. A simulated 20% increase in availability of supermarkets/grocery stores resulted in a statistically significant difference in change in BMI by female SNAP participants but not men.
Leung et al. (2012a)	n = 2250 adults; low income; aged 18-65	NHANES (2003-2006)	DV- Metabolic risks and adiposity (BMI and waist circumference) IV- SNAP participation	SNAP participation positively associated with obesity and waist circumference in men and women (stronger assoc.) independent of sociodemographic characteristics. SNAP participation related to elevated triglycerides, lower HDL cholesterol, elevated fasting glucose, and metabolic syndrome.
Leung et al. (2012b)	n = 3835 adults; low income; aged 20-65	NHANES (1999-2008)	DV- Dietary intake and dietary quality IV- SNAP participation	SNAP participants consumed 39% fewer whole grains, 44% more fruit juice, 56% more potatoes, 46% more red meat, and in women 61% more sugary beverages. SNAP participants also had lower dietary quality scores. Few of both SNAP and non-SNAP participants consumed recommended whole grains, fruits, vegetables, fish, and nuts/seeds/legumes; but exceeded recommended limits for processed meats, sweets, bakery desserts, and sugary beverages.
Nguyen et al. (2014)	n = 4211 adults; low income; aged 20-64	NHANES (2003-2010)	DV- Healthy Eating Index 2010 score IV- SNAP participation	SNAP participants had lower dietary quality scores overall and lower scores for fruit, vegetables, seafood, plant proteins, and empty calories. The association between SNAP participation and lower dietary quality was statistically significant among women, Hispanics, young adults, and individuals who were food secure.

Cross Sectional Studies

Leung et al. (2012b) and Nguyen et al. (2014) aimed to examine the differences in dietary quality in SNAP participants and non-SNAP participants. Both found SNAP participants had lower dietary qualities than non-participants, which could contribute to obesity formation or exacerbation. Nguyen et al. (2014) used the National Cancer Institute method for calculating the Healthy Eating Index (HEI) 2010 with bivariate and multiple regression; and found SNAP participants had lower scores for fruit, vegetables, seafood, plant proteins, and empty calories. The association between SNAP and lower dietary quality was statistically significant among women, Hispanics, young adults, and individuals who were food secure. Leung et al. (2012b) also used the National Cancer Institute method, but to estimate distributions of dietary intake. Results revealed that both low-income groups exceeded recommended limits for processed meats and sweets, but few consumed recommended amounts of whole grains, fruits and vegetables, and fish. Leung and colleagues (2012b) found that compared to nonparticipants, SNAP participants consumed 39% fewer whole grains, 44% more 100% fruit juice, 56% more potatoes, and 46% more red meat. Additionally, in women, 61% drank more sugar-sweetened beverages. SNAP participants also had lower dietary quality scores, as measured by an Alternate Healthy Eating Index along with the HEI 2005.

Jilcot et al. (2011) and Leung et al. (2012a) investigated SNAP participation's association with BMI and waist circumference (WC). In addition, Jilcot and colleagues further added meals away from home (MAFH) as a study outcome. They found no associations between MAFH and BMI or WC, and food stamp participation was associated with fewer MAFH. Results among females revealed that participation in food

stamps associated with higher BMI and WC were statistically significant. Results on females reporting food stamp benefits received in the previous month, indicated that more benefits received were associated with lower BMI. Leung et al. (2012a) added metabolic risk factors {according to National Cholesterol Education Program ATP III guidelines (≥3 of the following: elevated waist circumference, triglycerides, blood pressure, fasting glucose, and lower HDL cholesterol)} to their study outcomes. The authors found SNAP participation was positively associated with obesity and waist circumference in both men and women, independent of sociodemographic characteristics, but stronger association with women. Also, SNAP participation was related to elevated triglycerides, lower HDL cholesterol, elevated fasting glucose and metabolic syndrome.

Leung and Villamor (2010) and Webb et al. (2008) investigated food stamp participation and food security's affect on BMI using state level data from California and Massachusetts. Leung and Villamor (2010) included additional public assistance programs, Supplemental Security Income (SSI) and California Work Opportunities and Responsibilities to Kids (CalWorks), in their obesity research. BMI distribution and obesity prevalence were compared by participation in each program using weighted linear and binomial regression models. The results showed the prevalence of obesity was 30% higher in SNAP participants than in non-participants after adjusting for sociodemographic characteristics, food insecurity, and participation in other programs. SSI participation was related to an adjusted 50% higher prevalence of obesity compared to non-participation. Also, CalWorks participation was not associated with obesity after multivariable adjustment. Webb et al. (2008) assessed how food security, food stamp participation, and food sources affected BMI. They found, after adjusting for age, sex,

sociodemographic characteristics and food insecurity, prolonged participation in the food stamp program was associated with a higher BMI of 3 units compared to nonparticipants. Conversely, in the subset of current food stamp participants, participation for ≥ 6 months was associated with an 11.3 unit lower BMI compared with participation for < 6 months. Those who consumed fast foods in the previous month had mean BMI 2.4 units higher than those who did not. Also, food insecurity was not found to be associated with BMI.

Longitudinal Studies

Jones and Frongillo (2006) targeted modifying effects of food stamp participation on the relation between food insecurity and weight change. They used longitudinal data and dynamic and lagged regression models to estimate the effect of changing food insecurity and changing program participation on weight change in women only. The authors' results indicated that persistent food insecurity was associated with a smaller weight change, controlling for other income and health-related risk factors. No significant associations between change in food insecurity status and weight change was found.

Gibson (2003) examined obesity models that included current and long-term food stamp participation and individual fixed effects. Individual fixed effects took into account unobserved differences across individuals that did not vary over time. Results indicated that, in women, current food stamp participation was associated with a 9.1% increase in predicted probability of current obesity. Gibson (2003) also found that prolonged food stamp participation of 5 years, compared to non-participation, was associated with a 20.5% increase in predicted probability of current obesity.

Hanes et al. (2012) explored the extent to which economic contextual factors controlled the association of SNAP participation with BMI using longitudinal data for

cross-sectional estimation. In addition to cross-sectional estimation, a longitudinal individual fixed effects model was used to control for unobserved individual differences. The authors found for both men and women, SNAP participants' BMI was statistically significantly lower if an increased number of supermarkets/grocery stores were available in the longitudinal model. A larger decrease in BMI among SNAP participants was found when a simulated 20% reduction in the price was placed on fruits and vegetables, while a simulated 20% increase in supermarkets/grocery stores availability found a statistically significant change in BMI by SNAP women but not men.

Selection Bias

Cross-sectional studies are notably restricted in their ability to show the causal effect of food stamp participation on body weight. Though helpful for understanding broad trends, they only observe individuals at one point in time and do not account for selection bias. Selection bias can be positive or negative in the case of food stamp participation and obesity, given that poverty is linked with a higher risk of obesity among certain population groups (white women) but lower risk of obesity among other groups (Hispanic and non-Hispanic black men) (Ver Ploeg and Ralston, 2008). Properly accounting for selection bias produces different results, higher or lower risk of obesity, than estimates that do not account for selection bias. None of the cross-sectional studies in this review report BMI of SNAP participants prior to use so any association may suggest reverse causality from obesity to SNAP. The tendency of cross-sectional surveys to include individuals who have been participating in SNAP for longer periods of time possibly biases the results (Debono et al., 2012).

Longitudinal data is important because current body weight represents the accumulation of past behaviors with respect to diet and exercise, also, because SNAP participation itself is a dynamic process (Ver Ploeg and Ralston 2008). Longitudinal studies' temporal sequencing aids in the exploration of the directionality between food stamp participation and weight change. By reducing the effects of unmeasured factors and estimating relations of change with other factors, longitudinal data can provide the best means to confirm observed associations are not due to confounding and are causal (Frongillo, 2003). Gibson (2003) and Han et al. (2012) controlled for selection bias using fixed-effects modeling; models that change in body weight corresponding to a change in program participation status while controlling for time-invariant characteristics of each individual (Ver Ploeg and Ralston, 2008). However, Gibson (2003) did not account for BMI prior to SNAP so the results of this study may still be biased. Jones and Frongillo (2006) controlled for selection bias using lagged and dynamic models that estimated the effect of changing food stamp participation and changing food security status on subsequent changes in BMI, while controlling for BMI prior to food stamp participation. Both studies' results show that more control for confounding and bias decreases the association between weight and SNAP participation

Causal Pathways

The two hypothesis found in this literature review, that potentially explain the higher prevalence of obesity in SNAP participants compared to non-participants, were the food stamp cycle and the propensity to purchase energy dense food (Gibson, 2003; Jones and Frongillo, 2006; Leung and Villamor (2011); Leung et al., 2012b; Webb et al. (2008). The food stamp cycle refers to a period of abundance and binge eating brought on

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by the renewal or onset of available food stamps and money, followed by periods of deprivation towards the end of the month when resources are depleted; which results in weight gain over time. Debono et al. (2012) and Dinour and colleagues (2007) reference studies that have shown families who receive food stamps use their monthly ration before the end of the month. Additionally, both reviews mention that cyclical food restriction has been associated with promoted fat storage, a decrease in lean muscle mass, and quicker weight gain with response to feeding. However, the food stamp cycle hypothesis of weight gain has not been clearly tested.

The second hypothesis suggests that the lower cost of unhealthy food leads SNAP participants to choosing high-energy and fat dense foods to maximize their budgets. Leung et al. (2012b) and Nguyen et al. (2014) found lower dietary quality scores among SNAP participants than non-participants. Specifically, Leung et al. (2012) revealed that increasing evidence has shown SNAP benefits are too low to ensure meals consistent with USDA nutrition guidelines; and rather than purchasing nutrient-rich foods, SNAP participants tend to consume inexpensive nutrient poor foods, high in fat and sugar, in order to increase household purchasing power. Webb et al. (2008) adds to this hypothesis by mentioning studies that showed increases in income for low-income households did not increase the purchase of fruits and vegetables. Instead, extra funds were allocated to other foods and household needs of higher priority. Inverse association between energy density and food costs suggests that food insecurity may cause obesity (Gibson, 2003; Jones and Frongillo, 2006; Leung and Villamor, 2010). Low prices for unhealthy food may be one-pathway through which SNAP users are consuming excess calories that contribute to obesity.

Gaps in the Literature

The key finding of the research is the association between SNAP participation and obesity is stronger in women than men. Numerous studies have found women's association with SNAP participation and BMI statistically significant (Gibson, 2003; Han et al., 2012; Jilcot et al., 2011; Leung & Villamor, 2010; Leung et al., 2012b; Nguyen et al., 2014). While the focus of existing research on the association between SNAP participation and obesity among U.S. adults has been widely examined, the associations aren't consistent and factors that account for differences by sex, race, and environment aren't examined. Less attention has been given to groups most at risk for obesity; women, minorities, and those in poor foodscapes (defined in **Appendix**). The aim of this study is to investigate if there is an association between SNAP participation and elevated BMI in low-income women.

Methods

Study population

Data for this analysis was obtained from the 2009-2010 wave of the National Health and Nutrition Examination Surveys (NHANES). NHANES is an ongoing cross-sectional survey of the civilian, non-institutionalized US population that assesses health and nutritional status. The analytic sample was restricted to non-pregnant women between the ages of 18 and 65, in households whose incomes fall at or below 130% of the federal poverty level. This comprised 788 women, 451 were SNAP participants and 337 were income eligible but nonparticipants. SNAP eligibility is determined by gross household income (<130% of federal poverty line), assets (<$2000), immigration status, and employment status (USDA, 2014b). Since the NHANES data does not contain all

these factors, eligibility for the program was determined using the poverty-income ratio (PIR).

SNAP Participation

Current SNAP participation was defined as answering, "yes" to the survey question, "In the last 12 months, were you or any members of your household authorized to receive Food Stamps?" (2009-2010 NHANES). Individuals were classified as non-participants if they gave a negative response to receiving Food Stamps within the previous 12 months (2009-2010) or ever having received Food Stamp benefits (2011-2012 NHANES).

Outcomes

The outcome variable for analysis was body mass index (BMI). NHANES uses height (in m) and weight (in kg) measured by trained personnel. BMI was calculated as weight divided by the square of height and further collapsed into categories: normal weight (BMI 18.5-24.9), overweight (BMI 25-29.9), and obese (BMI $\geq$ 30). In order to make BMI dichotomous, overweight and obese were put together in a category and compared to normal weight.

Statistical Analysis

A comparison of sociodemographic characteristics (race, country of birth, education level, marital status, total number in household, insurance coverage, physical activity, and food security) along with the distribution of BMI and prevalence of obesity, between SNAP participants and nonparticipants were conducted using chi-square tests. Univariate logistic regression was used to evaluate the association between elevated BMI and each sociodemographic characteristic. Then multivariate logistic regression was used

to evaluate the association between SNAP participation and elevated BMI, controlling for age, race, country of birth, education level, marital status, household size, health insurance coverage, physical activity, and food security.

Results

Of the 788 women in the study population, 57% reported participation in SNAP within the past year. About 43% of the SNAP participants and nonparticipants were between 18 and 34. Compared with nonparticipants, SNAP participants were more likely to be born in the United States (76.9%, 58.5%), to be African American (24.2%, 13.1%), to have a high school education or below (73%, 57.7%), not participate in vigorous physical activity (78.9%, 72.7%), and to experience some food insecurity. The prevalence of overweight and obese individuals was slightly higher among SNAP participants (Overweight- 24.6%, 23.7% and Obese- 26.8%, 23.7), and the prevalence of normal weight was higher among the SNAP nonparticipants (52.5%, 48.6%). **Table 2**. provides a comparison of the sociodemographic characteristics of SNAP participants and nonparticipants.

The result of the univariate logistic regression analysis is shown in **Table 3.** Women with insurance coverage were 34% more likely to have an elevated BMI (OR: 1.339; 95% CI: 1.006, 1.781; $P \leq .05$). Health insurance coverage was the only variable found statistically significant with having an association with elevated BMI. The result of the multivariate logistic regression analysis is shown in **Table 4.** After adjustment for sociodemographic characteristics, the odds of an elevated BMI were 25% higher among SNAP participants than among nonparticipants but not statistically significant (OR: 1.248; 95% CI: 0.904, 1.723; $P = 0.178$). Women born in Spanish speaking countries

other than Mexico had nearly twice the odds of an elevated BMI, but this was not statistically significant (OR: 1.74; 95% CI: 0.826, 3.665; $P = 0.145$). Unexpectedly, for women with a college education or more, the odds of an elevated BMI were almost twice as high also, but this was not statistically significant either (OR: 1.642; 95% CI: 0.858, 3.141; $P = 0.134$). The only variable found significant in the multivariate analysis was health insurance coverage as well (OR: 1.479; 95% CI: 1.079, 2.028; $P = 0.015$).

Table 2. Sociodemographic characteristics of low-income women by participation in SNAP

Variable	SNAP participants (n=451)	SNAP nonparticipants (n=337)	P value
Age groups [n(%)]			
18-34	193 (42.8)	144 (42.7)	0.438
35-49	152 (33.7)	102 (30.3)	
50-65	106 (23.5)	91 (27)	
Race [n(%)]			
Non-Hispanic white	175 (38.8)	127 (37.7)	0
Non-Hispanic black	109 (24.2)	44 (13.1)	
Mexican American	98 (21.7)	95 (28.2)	
Other/Multi Racial	69 (15.3)	71 (21.1)	
Country of Birth [n(%)]			
US	347 (76.9)	197 (58.5)	0
Mexico	61 (13.5)	69 (20.5)	
Other Spanish speaking country	25 (5.5)	35 (10.4)	
Other Non-Spanish speaking country	18 (4)	36 (10.7)	
Education Level [n(%)]			
High school or below	305 (73)	179 (57.7)	0
Some College	101 (24.2)	92 (29.7)	
College grad or above	12 (2.9)	39 (12.6)	
Marital Status [n(%)]			
Married/Living with partner	177 (42.3)	153 (49.2)	0.173
Single	113 (27)	77 (24.8)	
Widowed, divorced, separated	128 (30.6)	81 (26)	
Health Insurance Coverage [n(%)]			
Yes	278 (61.6)	192 (57)	0.186
No	173 (38.4)	145 (43)	
Household size [n(%)]			
1-3	194 (43)	159 (47.2)	0.245
4-7	257 (57)	178 (52.8)	
Moderate PA [n(%)]			
No	213 (47.2)	169 (50.1)	0.417
Yes	238 (52.8)	168 (49.9)	
Vigorous PA [n(%)]			
No	356 (78.9)	245 (72.7)	0.042
Yes	95 (21.1)	92 (27.3)	
Food Security1 [n(%)]			
Often	119 (26.4)	54 (16.1)	0
Sometimes	159 (35.3)	101 (30.1)	
Never	173 (38.4)	181 (53.9)	
Food Security 2 [n(%)]			
Often	59 (13.1)	33 (9.8)	0.019
Sometimes	141 (31.3)	83 (24.6)	
Never	251 (55.7)	221 (65.6)	
BMI categories [n(%)]			
Normal	219 (48.6)	177 (52.5)	0.5
Overweight	111 (24.6)	80 (23.7)	
Obese	121 (26.8)	80 (23.7)	

SNAP = Supplemental Nutrition Assistance Program; BMI = Body Mass Index.
PA indicates physical activity, work or recreational. Food security 1 indicates if the household has ever worried about running out of food in the last 12 months. Food security 2 indicates if the household couldn't afford balanced meals.
Significant at $P< 0.05$.

Table 3. Univariate logistic regression analysis of the association between each sociodemographic characteristic and elevated BMI among low-income women

Variable	Odds Ratio	95% C.I. for OR		P value
Age groups [n(%)]		Lower	Upper	
18-34	Reference			
35-49	1.375	.992	1.906	0.056
50-65	1.211	.851	1.721	0.287
Race [n(%)]				
Mexican American	Reference			
Other/Multi Racial	1.26	.813	1.943	0.304
Non-Hispanic White	1.106	.777	1.588	0.585
Non-Hispanic Black	1.136	.743	1.736	0.557
Country of Birth [n(%)]				
US	Reference			
Mexico	0.925	.631	1.357	0.801
Other Spanish speaking country	1.633	.945	2.821	0.079
Other Non-Spanish speaking country	0.753	.428	1.325	0.325
Education Level [n(%)]				
High school or below	Reference			
Some College	0.942	.674	1.315	0.724
College grad or above	1.307	.730	2.34	0.367
Marital Status [n(%)]				
Married/Living with partner	Reference			
Single	0.97	.698	1.426	0.989
Widowed, divorced, separated	1.275	.901	1.805	0.171
Health Insurance Coverage [n(%)]				
No	Reference			
Yes	1.339	1.006	1.781	0.045
Household size [n(%)]				
1-3	Reference			
4-7	0.808	.610	1.070	0.137
Moderate PA [n(%)]				
No	Reference			
Yes	0.941	.712	1.245	0.672
Vigorous PA [n(%)]				
No	Reference			
Yes	1.028	.740	1.427	0.87
Food Security1 [n(%)]				
Often	Reference			
Sometimes	0.743	0.505	1.093	0.131
Never	0.822	.571	1.183	0.291
Food Security 2 [n(%)]				
Often	Reference			
Sometimes	0.716	.439	1.170	0.183
Never	0.641	0.408	1.008	0.054

OR = Odds Ratio; BMI = Body Mass Index.
PA indicates physical activity, work or recreational. Food security 1 indicates if the household has ever worried about running out of food in the last 12 months. Food security 2 indicates if the household couldn't afford balanced meals. Significant at $P< 0.05$.

Table 4. Multivariate logistic regression analysis of the association between SNAP participation and elevated BMI among low-income women

Variable	Odds Ratio	95% C.I. for OR		P value
		Lower	Upper	
SNAP participation				
No	Reference			
Yes	1.248	.904	1.723	0.178
Age groups [n(%)]				
18-34	Reference			
35-49	1.344	.924	1.955	0.122
50-65	1.181	.76	1.834	0.46
Race [n(%)]				
Mexican American	Reference			
Other/Multi Racial	1.235	.577	2.640	0.587
Non-Hispanic White	1.137	.615	2.102	0.681
Non-Hispanic Black	1.283	.656	2.510	0.467
Country of Birth [n(%)]				
US	Reference			
Mexico	1.048	.536	2.047	0.891
Other Spanish speaking country	1.74	.826	3.665	0.145
Other Non-Spanish speaking country	0.739	.381	1.431	0.369
Education Level [n(%)]				
High school or below	Reference			
Some College	0.975	.677	1.406	0.894
College grad or above	1.642	.858	3.141	0.134
Marital Status [n(%)]				
Married/Living with partner	Reference			
Single	1.008	.675	1.504	0.97
Widowed, divorced, separated	1.159	.792	1.696	0.448
Health Insurance Coverage [n(%)]				
No	Reference			
Yes	1.479	1.079	2.028	0.015
Household size [n(%)]				
1-3	Reference			
4-7	0.863	.616	1.210	0.393
Moderate PA [n(%)]				
No	Reference			
Yes	0.838	.609	1.152	0.276
Vigorous PA [n(%)]				
No	Reference			
Yes	1.156	.793	1.685	0.451
Food Security 1[n(%)]				
Often	Reference			
Sometimes	0.91	.573	1.447	0.691
Never	1.178	.713	1.946	0.522
Food Security 2 [n(%)]				
Often	Reference			
Sometimes	0.752	.42	1.345	0.336
Never	0.573	.313	1.049	0.071

Multivariate logistic regression model controlling for age, race, country of birth, education level, marital status, household size, health insurance coverage, physical activity, and food security.
SNAP = Supplemental Nutrition Assistance Program; OR = Odds Ratio; BMI = Body Mass Index.
PA indicates physical activity, work or recreational. Food security 1 indicates if the household has ever worried about running out of food in the last 12 months. Food security 2 indicates if the household couldn't afford balanced meals. Significant at $P < 0.05$.

Discussion

The objective of the USDA's Supplemental Nutrition Assistance Program is to help low income individuals combat food insecurity and hunger. However, questions have been raised about obesity being an inadvertent consequence of SNAP for adults, especially women. This study was necessary because the majority of existing research on SNAP targets U.S. adults overall, with no particular focus on women. Since women represent a substantial group of SNAP participants, this population deserves deeper investigation.

The major strength of this study was the use of a representative sample of nonelderly, non-pregnant, low-income women. The NHANES datasets provide measures that were collected by trained personnel, instead of being self-reported by the participants, so possible misclassification of BMI was minimized. A number of limitations may account for the statistically insignificant results of the analyses performed. Including alcohol consumption and smoking status with the sociodemographic characteristics would have been suitable variables for this investigation, but they had too many missing values. Another limitation was the use of one time wave of NHANES data, 2009-2010. Additional, more current, time waves would have increased the sample size and maximized the detection of an association between SNAP participation and obesity, but the 2011-2012 dataset did not address food stamp use. A substantial limitation of this study was its cross-sectional nature, which makes causal pathways inadequately understood. Future research should be done using longitudinal data, controlling for selection bias, in order to focus on SNAP participation

duration. This will provide a better perspective on the direction of weight gain and food stamp use for women.

Conclusion

Though there was no statistically significant association between SNAP participation and elevated BMI, due to limitations of the dataset, some relationship does seem to exist. Other noticeable relationships include, women born in Spanish speaking countries other than Mexico and women with a college education or more having higher odds of an elevated BMI. Health insurance was the only variable positively associated with elevated BMI in both univariate and multivariate analyses. This association is unclear and could be driven by Medicaid. Further, according to Kelly & Markowitz (2009), overweight or obese individuals experience health problems associated with excess weight and are more likely to have health insurance.

The food stamp cycle and propensity of SNAP participants to purchase energy dense foods represent a starting point for further SNAP improvement research. In terms of policy, these hypotheses suggest SNAP rations should increase so low-income individuals can purchase more nutrient-rich foods, or the allocations should be more frequent than once a month. Also, more aggressive nutrition education for SNAP participants and financial incentives for the consumption of healthy-foods could improve their dietary quality and decrease obesity prevalence. Investigating the triggers in different populations can provide a more effective solution for better aligning SNAP with dietary guidelines in order to reduce the prevalence of obesity in the United States.

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Appendix 1

<u>Dietary quality</u>- assesses overall diet in order to see the extent to which an individual's eating behavior is healthy

<u>Foodscapes</u>- places where one acquires food; urban food environments