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Impact of Food Assistance Programs on Food Insecurity, Diet Quality and Obesity

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This is to certify that the doctoral study by

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2020

Abstract

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by

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MSW, University of Illinois, 1990

BS, University of Illinois, 1986

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Obesity remains a public health issue in the United States because it contributes to chronic diseases. The Supplemental Nutrition Assistance Program (SNAP) was designed to increase food security, alleviate hunger, and increase access to a healthful diet; however, it may have the opposite effect and contribute to obesity. The purpose of this study was to examine to what extent participation in SNAP impacts food insecurity, diet quality, and obesity in U.S. adults. The social-ecological model guided the study which was conducted using a quantitative a cross-sectional research design and secondary analyses of the 2013-2014 National Health and Nutrition Examination Survey (NHANES). The sample consisted of all adults 25 years and older included in the NHANES. Logistic regression analysis results indicated marginal food security was associated with obesity among SNAP (*OR* = 1.28) and NON-SNAP (*OR* = 1.54). Full food security was associated with obesity (*OR* = 1.65) only among NON-SNAP. Among both groups, the greater the diet quality reported the greater the odds of obesity. Poverty mediated the association between marginal food security and obesity only among NON-SNAP participants. Adjusting for socio-economic factors SNAP modified the effect between food security and obesity (*OR* = 1.30) and diet quality was associated with obesity (*OR* = 1.72). The results of this study may be uses as support for policies and programs to improve the nutritional impact of SNAP and targeted interventions to address food security in low-income adults.

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Dedication

I dedicate this doctoral study to my loving husband and five sons. The support and patience you showed during the undertaking of this study was unconditional. Thank you for your love and support.

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Section 1: Foundation of the Study and Literature Review

Introduction

Public health professionals have monitored the increase in obesity over the past 30 years because of the health risks associated with this disease. Poor nutrition, lack of physical activity, and obesity are listed as some of the biggest public health issues in the United States in all 50 states including the District of Columbia (Centers for Disease Control and Prevention [CDC], 2015-a). Health consequences from obesity include hypertension, coronary heart disease, Type 2 diabetes, certain cancers, arthritis, and mental illnesses (CDC, 2015-a). Examination of the impact the Supplemental Nutrition Assistance Program (SNAP) may have on food insecurity, diet quality, and obesity may contribute to improving food assistance programs and interventions targeted at addressing obesity among adults participating in SNAP. In Section 1, I describe the impact of the inconsistency of SNAP on improving food insecurity and diet quality.

Evidence from research has indicated that participation in SNAP, food insecurity, and the quality of one's diet may be factors for becoming obese (DeBono, Ross, & Berrang-Ford, 2012; Gibson, 2003; Hanson & Connor, 2014; Leung, Epel, Ritchie, Crawford & Laraia, 2014; Townsend, Peerson, Love, Achterberg, & Murphy, 2001). Not having adequate food may increase the risk for obesity (Dinour Bergen, & Yeh, 2007; Laria, 2013; Pan, Sherry, Njai, & Blanck, 2012). The purpose of this study was to examine how participation in SNAP may impact food insecurity, diet quality, and obesity among U.S. adults. To address the obesity epidemic, it is important to understand what obesity is and what the risk factors are for becoming obese.

Obesity is a chronic disease characterized by excess fat in adipose tissue that can damage health (Chan & Woo, 2010). Obesity may be caused by the intake of low-cost palatable, energy-dense foods comprised of refined grains and added fats and sugars. It has been hypothesized that over consumption of these inexpensive, energy-dense, nutrient-poor foods may contribute to obesity (Drewnowski & Specter, 2004). The combination of lack of physical activity with the combination of consumption of energy- dense foods may also contribute to obesity (Swinburn, Caterson, Siedell, & James, 2004). Other risk factors that may increase the risk for obesity include social factors in childhood and adulthood, one's economic status, social environment, neighborhood, genetics, gender, and race (Faith & Kral, 2006; Saunders, Watson, & Tak, 2012).

Problem Statement

SNAP, formerly known as the Food Stamp Program, is the largest anti-hunger government program in the United States (Center on Budget and Policy Priorities [CBPP], 2016; United States Department of Agriculture [USDA], n.d.). The purpose of the SNAP program is to reduce food insecurity and provide benefits to purchase nutritious foods. However, the SNAP program has had the opposite effect. The association between participation in food assistance programs, diet quality, food insecurity, and obesity had mixed results, and the association between household food insecurity and weight gain is inconclusive. (Leung, et al., 2012; USDA, 2013). Food insecurity and participation in food assistance programs may place families at risk for obesity and other chronic illnesses (Dinour et al., 2007; Laraia, 2013; Seligman, Laraia, & Kushel, 2010; Vedovato et al., 2016).

Food insecurity is the inability to obtain nutritious foods in socially acceptable ways (USDA, n.d.). According to the USDA, food security can range from high, marginal, low, and very low. High food security refers to having no difficulty in accessing food whereas marginal food security refers to one to two reports of anxiety over having enough food with no changes in diet and intake of food. Low food security is described as a reduced quality and type of food, with no reduction in food intake. Very low food security is described as multiple reports of changes in eating patterns and reduced consumption of food (USDA, n.d). In 2015, one in seven households reported difficulties in securing food for all family members and 45 million low-income individuals per month received assistance from SNAP (CBPP, 2016; Schnazenbach, Bauer, & Nantz, 2016).

The association between food assistance programs and diet quality is not a direct one and several factors mediate this relationship. Socioeconomic factors impact diet and health including access to healthy foods. As income decreases, energy-dense foods of poor nutritional value are more affordable, and the highest rates of obesity are found among disadvantaged populations. The association between poverty and obesity may be mediated by low-cost palatable energy-dense foods (Drewnowski, 2009). Further research has suggested that improving diet, access to healthy food, and the ability to purchase affordable foods are equally important (Leonard Davis Institute of Health Economics, 2015). Findings from studies comparing SNAP participants to nonparticipants indicate that individuals receiving benefits from government assistance programs have greater food insecurity and poorer diet quality compared to individuals who did not participate in the SNAP program. Leung et al. (2012) found that rather than

having an increased ability to purchase nutritious foods, SNAP participants were more likely to have lower diet quality scores than nonparticipants. Drewnowski and Specter (2004) reported poverty and food insecurity were associated with lower levels of food purchases, decreased fruit and vegetable intake, and lower diet quality. These factors may contribute to chronic diseases (Drewnowski & Specter, 2004). An inverse relationship exists between participation in food assistance programs, health, and health behaviors in those who are food insecure (Pruitt et al., 2016). For example, receiving government (SNAP benefits) or community (food bank) assistance was associated with poor health. Nonparticipation in SNAP or food bank assistance was associated with better health (Pruitt et al., 2016).

There is evidence of both positive associations (markers of adiposity and metabolic risk factors) and negative associations (food insecurity, diet quality) between SNAP participation and obesity (Leung et al., 2012). In addition, Leung et al. (2012) found a positive association between SNAP participation and an increased risk for obesity and metabolic syndrome risk factors (waist circumference, lipids, glucose). Compared to nonparticipants, SNAP participants were 1.58 times more likely to be obese; men were twice as likely (2.04) and women almost three times as likely (2.95) to have higher waist circumference than their nonparticipant counterparts (Leung et al., 2012). SNAP participants were also 1.71 times more likely to have elevated triglycerides, 1.63 times more likely to have elevated fasting glucose (> 110 mg/dL), and 1.49 times more likely to have metabolic syndrome compared to male nonparticipants (Leung et al., 2012).

However, another cross-sectional study examined the associations between SNAP participation and food insecurity, diet quality, and obesity among adults. The researchers found participation in SNAP helped those at risk for food insecurity to have a better diet and body weight (Nguyen, Shuval, Bertmann, & Yaroch, 2015). For example, SNAP participants with marginal food insecurity had lower BMI (1.83kg/m^2; $p < .01$) and lower probability of obesity (9 percentage points; $p < .05$). SNAP participants with marginal (3.46 points; $p < .01$), low (1.98 points; $p < .05$), and very low (3.84 points; $p < .01$) food security had better diets compared to nonparticipants (Nguyen et al., 2015).

The review of literature on the association between participation in food assistance programs, food insecurity, diet quality, and obesity are inconclusive (Food Research & Action Center [FRAC], 2015; Leung et al., 2012; Nguyen et al., 2015). The relationship is complex and is not fully understood, and it varies among different populations (FRAC, 2015; Sirotin, Hoover, Shi, Anastos, & Weiser, 2014).

Food insecurity mediates the relationship between diet quality and obesity. Franklin et al. (2012) examined factors that mediate the relationship between food insecurity and obesity. These factors include mediators such as stressors, marital status, and participation in food assistance programs. The positive associations between food insecurity and obesity had mixed results. Evidence was consistent for women, inconsistent for men, mixed results for children, and growing evidence among adolescents (Franklin et al., 2012). While food insecurity mediates diet quality and obesity, poverty mediates the relationship between food insecurity and obesity. Research to date includes the examination of factors that food assistance programs target diet quality and food insecurity. However, the contextual factors that explain poverty and

food insecurity were not controlled for in these analyses. This study may fill this gap by further examination of the indirect effect of predisposing factors (gender, age, race, and poverty) on food insecurity, and the direct effect of diet quality on obesity among SNAP participants. The remaining question is whether participation in the SNAP impacts food insecurity, diet quality, and obesity among U.S. adults, and the implications for implementing interventions to potentially reduce obesity in this population.

Purpose of the Study

The purpose of this study was to examine the indirect effect of predisposing factors on food insecurity, diet quality, and obesity among adults participating in SNAP. This study is important because of the rates of obesity among adults in the United States. One third of adults are overweight, and two thirds of adults are overweight or obese, (National Institute of Diabetes and Digestive and Kidney Disease [NIDDKD], n.d.). One third of men are overweight and one fourth of women are overweight (NIDDKD, n.d.). Obesity is higher among women with 40% of women obese compared to 35% of men. Furthermore, 3 in 4 men (73.7%) are obese or overweight compared to 2 in 3 women (66.9%) who are considered obese or overweight (NIDDKD, n.d.).

SNAP offers nutrition assistance to low-income individuals and families (CBPP, 2016; USDA, n.d.). In 2011, about 45 million individuals or 1 in 7 participated in SNAP at a cost of $75 billion dollars (Leung, et al., 2012). Although millions of families are assisted through the SNAP program, food insecurity is prevalent and 4 out of 5 low-income food-insecure households receive benefits from food assistance programs, and SNAP participants have a lower diet quality than nonparticipants (Leung et al., 2012; Nord, 2009). Over one third of adults and 17% percent of children are obese in the United

States. Obesity increases the risk of numerous health conditions including hypertension, elevated cholesterol, and Type 2 diabetes (Ogden, Caroll, Fryar, & Flegal, 2015). The prevalence of obesity has increased during the last several decades. Although obesity appears to be tapering off, surveillance to track the prevalence of obesity among adults and children in the U.S. is recommended given the health risks of chronic diseases associated with obesity (Ogden et al., 2015).

Significance

This study is significant because food insecurity in the United States is a problem and 14% percent of households (17.4 million) were food insecure at some point in time in 2014. The association between food insecurity and poor health outcomes for children are well documented; however, there is limited research on food insecurity and chronic disease among adults (Seligman, Laraia & Kushel, 2010). This study can contribute to positive social change by providing a better understanding of the impact food assistance programs may have on food insecurity, diet quality and obesity. The social change implication of this study may include support for programs and policies to improve the nutritional impact of SNAP and target interventions to address food insecurity, diet quality and obesity in this population.

Research Questions and Hypotheses

The following four research questions and their related hypotheses guided this quantitative cross-sectional study on the association between food assistance programs, food insecurity, diet quality, and obesity among adults in the United States.

Research Question 1. Is there an association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants controlling for socioeconomic and demographic factors?

$H_0$1: There is no association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_1$1: There is an association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

Research Question 2. Is there an association between diet quality and obesity among adults participating in SNAP compared to nonparticipants controlling for socioeconomic and demographic variables?

$H_0$2: There is no association between diet quality and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_2$2: There is an association between diet quality and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

Research Question 3. Does poverty mediate the association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants controlling for socioeconomic and demographic variables?

$H_0$3: Poverty does not mediate the association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_3$3: Poverty does mediate the association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

Research Question 4. Is there an association between participating in SNAP, food insecurity, diet quality and obesity controlling for socioeconomic and demographic factors?

$H_0$4: There is no association between participating in SNAP, food insecurity, diet quality and obesity after adjusting for socioeconomic and demographic factors.

$H_4$4: There is an association between participating in SNAP, food insecurity, diet quality and obesity after adjusting for socioeconomic and demographic factors.

Theoretical Foundation for the Study

The conceptual framework for this study is the social-ecological model (SEM). There are multiple versions of the SEM used in various areas of research including public health adapted from research by Bronfenbrenner's ecological systems theory. Bronfenbrenner's 1979 framework examines the complexities of the interaction between individuals and multiple levels of their environment. The levels of the SEM are captured along a continuum from micro to macro levels and each tier of the SEM is interrelated. The basic tenet of the SEM is that there are multiple levels of influence on health

behavior (Bronefenbrenner, 1979). These levels include intrapersonal, interpersonal, organizational, community, and public policy that influence health behaviors (Glanz, Rimer & Viswanath, 2015, p.48). The most effective health behavior change occurs at multiple levels (Boucher, 2011). In this study, application of the SEM enabled me to examine factors that influence diet quality, food insecurity, and obesity at multiple levels of the SEM among participants in food assistance programs.

The intrapersonal/individual level of the SEM includes biological factors that cannot be changed such as age, sex, and genetics. Additional intrapersonal factors are knowledge, attitudes, beliefs, and behaviors. The interpersonal level includes family, peers, and relationships. The organizational level includes rules regulations and policies. The community is comprised of social networks and norms**.** The last level is structures, policies, and systems. This level includes local, state, and federal policies and laws to encourage and support healthy behaviors. The levels of the SEM I operationalized for this research study are the interpersonal/individual, intrapersonal, and structures, policies, and systems. The operational measures of the intrapersonal/individual level include demographic variables (age, sex, race, education) and BMI for obesity. The interpersonal level included household food security and annual household income. The structures, policies and systems incudes participation in SNAP including SNAP eligibility.

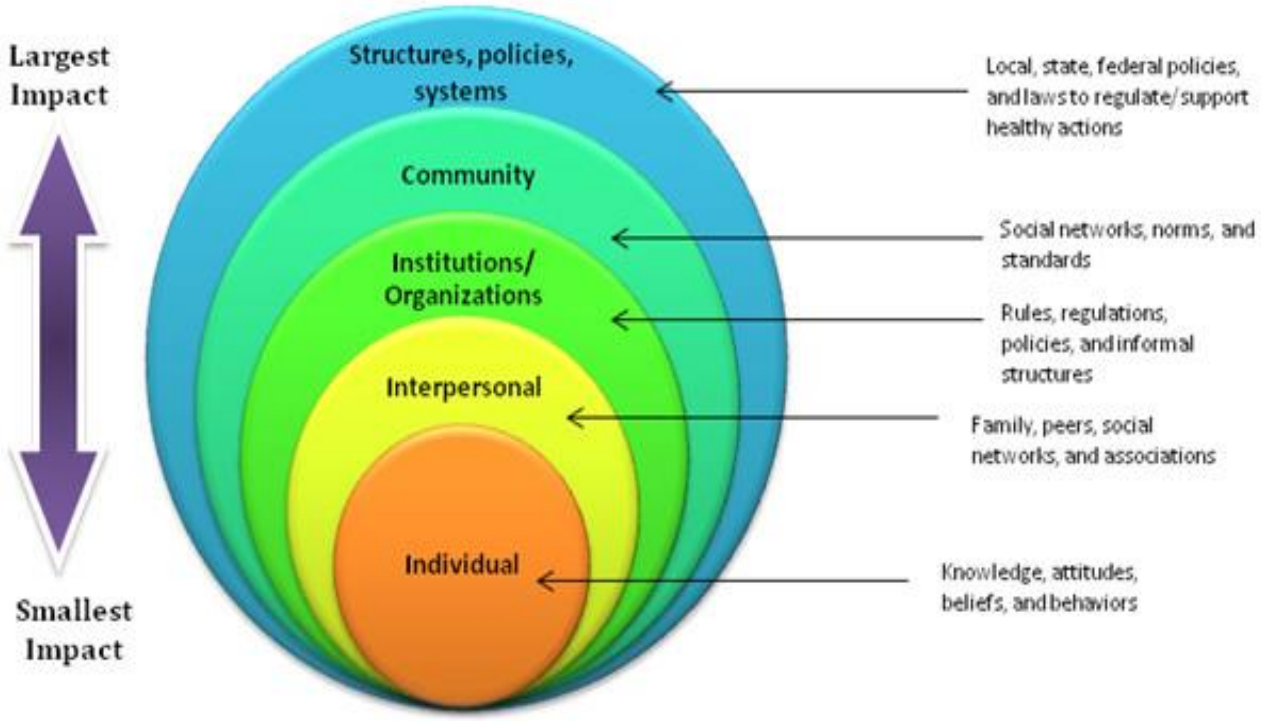

Figure 1. The social ecological model. From "The Social Ecological Model," by Centers for Disease Control and Prevention, n.d. (https://www.cdc.gov/nccdphp/dnpao/state-local-programs/health-equity/index.html).

Nature of the Study

The nature of this study is a quantitative cross-sectional research design to examine the association between food assistance programs, food insecurity, diet quality, and obesity among adults in the United States. Some advantages of the cross-sectional study design are that measurements for the sample are taken at one point in time, prevalence and behavior of a disease can be measured and compared to intervention studies, cross-sectional studies, and can be completed in less time, and are inexpensive to conduct (Sedgwick, 2014). For this study, I used data from the 2013-2014 NHANES. The survey examined a nationally representative sample of 5,000 individuals annually. The methodology will be discussed further in Section 2.

The independent variables in this study were food insecurity, diet quality, and poverty. Obesity is the dependent variable. Food insecurity experienced by households in SNAP is transient as participants move from security to insecurity (Seligman et al., 2010). The four levels of food security identified and defined by the USDA are very low, low, marginal, and high food security (USDA, 2014). Diet quality was measured by the researchers who administered the NHANES using the Healthy Eating Index (HEI) and 24-Hour Dietary Recalls. Household income was the measure of poverty and BMI the measure for overweight and obese status. Descriptive statistics were used to characterize the sample participants and hypothesis testing was conducted with multivariate analysis to assess the association between SNAP participation, food insecurity, diet quality, and obesity**.**

Literature Search Strategy

A comprehensive search of the literature was conducted to fully examine the impact of food assistance programs on the association between diet quality, food insecurity and obesity in U.S. adults. The broad search strategy included searching the internet for reputable health and research institutions and organizations such as the CDC, the United States Census Bureau, the USDA, and the World Health Organization (WHO). The comprehensive search of the literature to find scientific evidence related to this research topic included searching the Walden University EBSCO databases, dissertation searches, peer-reviewed journal articles, Science Direct, PubMed and Google Scholar. Key words used individually and in combination included food assistance, government programs, SNAP, food insecurity, food security, hunger, poverty, obesity, diet quality, low-income and the National Health and Nutrition Examination Survey (NHANES). No

date limits were placed on the search results. Search results with the key term food insecurity resulted in 1,000 peer-reviewed articles. Search results with the key term food assistance resulted in 416 peer-reviewed scholarly articles. Search results with the key terms food assistance and food insecurity resulted in 16 peer reviewed articles and search results with key terms food assistance, food insecurity, and obesity resulted in two peer reviewed articles. Other publications I examined were doctoral theses, books, and presentations from conferences. I also conducted an abstract review of scientific articles to identify what articles were most relevant to this topic. The articles most applicable to this research were selected.

Literature Review Related to Key Concepts

The literature review for this study focused on adult obesity, prevalence of obesity in the United States and globally, the etiology of obesity and adult health outcomes. Emphasis was placed on studies with data on the association between food assistance programs, food insecurity, diet quality and obesity. I also examined literature on variables that influenced participation in food assistance programs as it relates to food insecurity, diet quality, and obesity among adults. Many of the studies identified common influences that may be linked to the increase of adult obesity including poverty, race, ethnicity**,** food insecurity and diet quality, the built environment, and the neighborhood environment.

The literature review is organized by the variables in the research questions and hypotheses section of this chapter. The variables of interest are SNAP participation, obesity, levels of food insecurity, diet quality, employment status, household income, household size, gender, age, race, and ethnicity. The literature review is organized in six parts. Part 1 examines the history of food assistance programs. Part 2 defines obesity,

adult and child obesity in the United States, the economic impact of obesity, the role of the built environment and obesity, and the role of the neighborhood environment and obesity. Part 3 examines food security, food assistance programs, and food insecurity in the United States. Part 4 examines food assistance programs and diet quality, and food assistance programs and obesity. Part 5 examines food insecurity and obesity, and food insecurity and diet quality. Part 6 examines poverty, income, and health, food security, diet quality, and obesity. The purpose of this study was to examine the impact food assistance programs may have on food stamp participants in relation to food insecurity, diet quality, and obesity among U.S. adults and whether adults who participate in food assistance programs are more likely to be food insecure, have a poor diet quality and become obese.

History of the Supplemental Nutrition Assistance Program

One of the goals of the USDA is to increase food security and reduce hunger (McGuire, 2013). The USDA accomplishes these goals through seven nutrition assistance programs. The program formerly known as the food stamp program is one such program (McGuire, 2013). The food stamp program was established in 1933 as part of the Agricultural Adjustment Act and was called the Federal Surplus Relief Corporation (SNAP to Health, n.d.). The first food stamp plan was called the Food Stamp Plan; food stamps were implemented under the administration of Franklin D. Roosevelt and first were distributed in 1939. Program participants were required to purchase booklets of orange stamps to buy household items. For every $1 in orange stamps that were used, participants were given $0.50 in blue stamps to buy commodity surplus foods (SNAP to Health, n.d.). The program ended in 1939, but in 1961 President John F. Kennedy

reintroduced the food stamp program. President Lyndon Johnson signed the 1964 Food Stamp Act into law, and significant changes were made to the Food Stamp Act in 1977 (SNAP to Health, n.d.).

Budget cuts were made to the Food Stamp Program in 1981 and this began the rise of hunger in America. (SNAP to Health, n.d.). The Food Stamp Program received additional funding in the late 1980's and early 1990 to impact hunger and administration of the program was streamlined. One major change was the introduction of the pilot form of Electronic Benefits Transfer (EBT) card (SNAP to Health, n.d.). Additional changes were introduced in the early 2000s and food stamp participation increased. Eligibility requirements included qualified immigrants and children 18 years of age and younger and the new EBT card was introduced much like a credit or debit card. The purpose of the EBT card was to reduce fraud and stigma associated with using food stamps. Other eligibility requirements for SNAP are based on households that meet a gross monthly income test and household income prior to deductions should be < 130% of the poverty line. Exceptions include older adults and disabled family members (SNAP to Health, n.d.). They are not required to meet the gross monthly income test (Gundersen, 2013). The last test of eligibility for SNAP is the asset test meaning total household assets. Total assets must be < $2,000 though some exceptions to the asset test are considered (Gundersen, 2013). In the 2008 Farm Bill, the program was renamed the Supplemental Nutrition Assistance Program (SNAP). This program is the largest federally funded nutrition assistance program with over 45 million participants. The 2014 Farm Bill also known as the Agricultural Act of 2014 signed by President Obama made more changes. One change was the Food Insecurity Nutrition Incentive (FINI) program which awarded

states small grants to conduct pilot projects targeting SNAP participants to increase their consumption of fruits and vegetables. Another change was the 2014 legislation re-authorizing SNAP, which prohibits the purchase of alcohol, tobacco, hot foods, and food sold for consumption on the premises. Food items such as soda, candy, cookies snack crackers and ice cream may be purchased with SNAP benefits (SNAP to Health, n.d.).

Food Assistance Programs, Food Insecurity, Diet Quality, and Obesity

Obesity is defined as a combination of excess weight and an extreme amount of body fat than normal and can lead to health problems (CDC, n.d.). BMI is used to screen for overweight and obesity and BMI is an index of weight for height defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2); WHO, 2016). A BMI that is less than 18.5 is considered in the underweight range, a BMI 18.5 to less than 25 is within normal range, a BMI 25.0 to less than 30 is in the overweight range, and a BMI equal to 30.0 or higher is within the obese range (CDC, n.d.). Obesity is associated with adverse health risk such as metabolic syndrome, cardiovascular disease, diabetes, high blood cholesterol, cancer, and sleep disorders (CDC, 2015; National Heart Lung and Blood Institute, 2017). The etiological factors that contribute to obesity include genetics, race, ethnicity, cultural and psychological factors, an obesogenic environment, physiology, and human behavior (Apovian, 2010).

Health consequences of being overweight or obese include risk factors for non-communicable diseases such as cardiovascular disease (CVD), musculoskeletal disorders, certain cancers, diabetes, and respiratory problems. The health risk associated with being overweight or obese is heart disease and diabetes which rank first and seventh among the

leading causes of death in the United States (WHO, 2016; National Institute of Health Environmental Health Sciences, n.d.; Heron, 2016).

Obesity in Adults and Children in the United States

In the United States, in 2011-2014, the prevalence of obesity was 36% in adults and 17% in youth (Ogden et al., 2015). No significant changes were seen in adult or childhood obesity in the United States between 2003-2004 and 2011-2012 (Ogden et al., 2015). Women had a higher prevalence of obesity (38.3%) than men (34.4%) and among youth there were no differences by gender (Ogden et al., 2015). The adult obesity rate is higher than 35% in four states, 30% in 25 states and above 20% in all states. Louisiana has the highest adult obesity rate of 36.2% and Colorado has the lowest rate of 20.2% (State of Obesity, 2016). Obesity rates among children ages 10-17 varied from 9.9% in Oregon to 21.7% in Mississippi (Trust for America's Health, 2018).

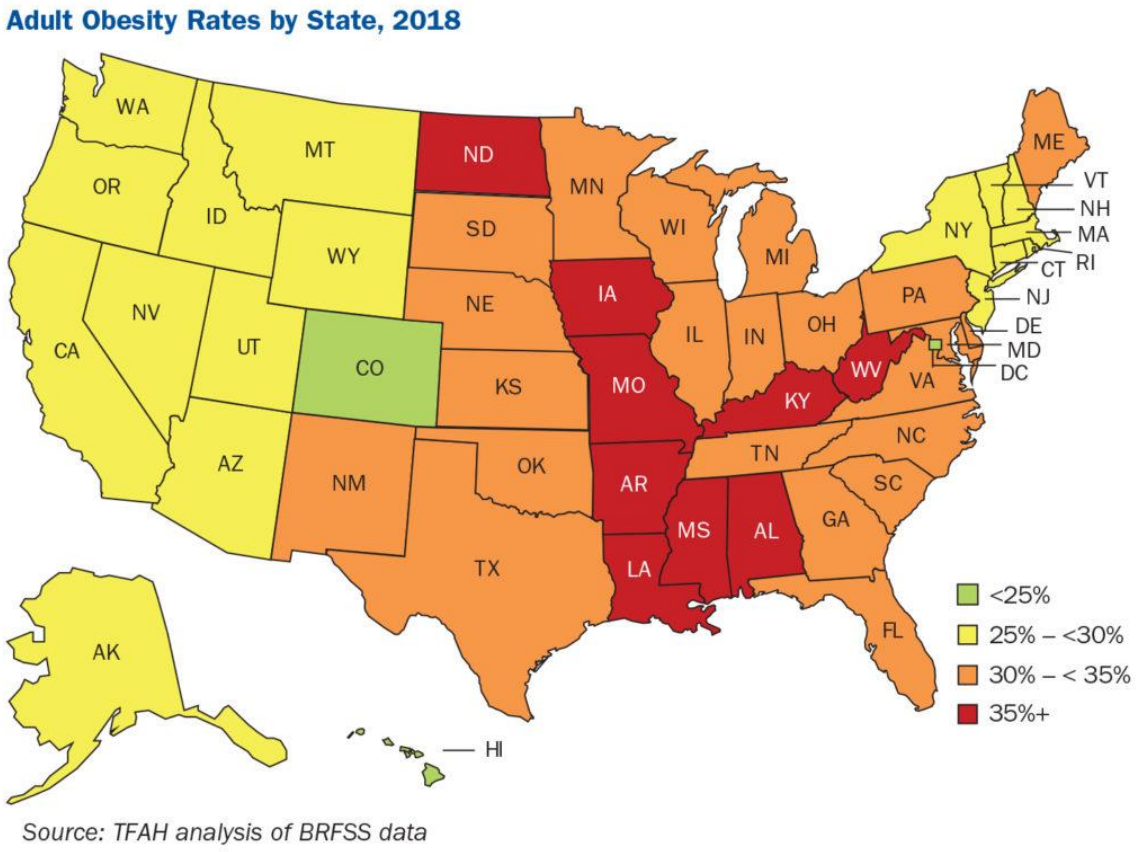

Figure 2. Self-reported obesity rates. From "The Behavioral Risk Factor Surveillance System 2018," by Centers for Disease Control and Prevention, 2018. (https://www.cdc.gov/obesity/data/prevalence-maps.html)

Economic Impact of Obesity

Obesity has become a global threat to the economy; the estimated economic impact of obesity is two trillion dollars per year or 2.8% of the world's GDP (Dobbs & Swinburn, 2015). The global cost of obesity is equivalent to the cost of smoking, armed violence, terrorism, and war combined (Dobbs & Swinburn, 2015). The four categories linked to the economic impact of obesity in the United States include direct medical cost, productivity cost, transportation cost, and human capital cost (Hammond & Levine, 2010). In this study, I focused on direct medical costs and productivity costs related to

obesity in the United States. Some of the diseases associated with overweight and obesity include hypertension, Type 2 diabetes, coronary heart disease, stroke, asthma, and arthritis (Hammond & Levine, 2010; NIDDKD, n.d.). These diseases have health care costs associated with the prevention and treatment of these conditions. The CDC estimates that 86% of the U.S. $2.7 trillion annual health care expenditures are for people with chronic and mental health diseases (CDC, 2017).

The Built Environment and Obesity

The causes of obesity are multifaceted. One explanation of a factor that contributes to obesity is the built environment (Papas et al., 2007). The built environment is defined as the physical surrounding where some individuals live and work that have been changed by individuals including homes, schools, the workplace, parks, and interstates (CDC, 2011; Wakefield, 2004). Engaging in physical activity can be hampered if there are no sidewalks, bike paths, or walking trails which can contribute to a sedentary lifestyle (CDC, 2011). Research on how the built environment contributes to obesity had mixed results among adults (Sallis, Floyd, Rodriguez, & Saelens, 2012). The researchers conducted a systematic review and suggest that neighborhoods where residents can walk may provide protective factors against overweight and obesity, yet other studies found this evidence to be inconclusive (Sallis et al., 2012). Since body fat accumulates over time, a better approach to examine the impact on the built environment are studies of cumulative exposure rather than cross-sectional associations (Sallis et al., 2012). According to Cohen (2008), external changes in the food environment such as increased access to food, the ability to purchase less expensive food, and food salience have contributed to obesity. In addition, Cohen (2008) argues that the marketing and

advertising of food creates food cues that encourage individuals to feel hungry even when they may not be hungry triggering overconsumption of food. Most individuals are unaware of these food cues. Obesity and overweight affects two of three Americans and the causes are complex. Further research on obesity and the built environment is needed to implement effective strategies to address this issue.

Neighborhood Environments and Obesity

Although the evidence is inconclusive on the contribution the built environment has on obesity, it has been well documented that communities segregated by race, ethnicity, income, neighborhood, and socioeconomic status (NSES) are factors that contribute to health disparities (Dubowitz et al., 2008, Larson, Story, & Nelson, 2009). Low intake of fruits and vegetables are associated with the risk for chronic disease including certain cancers, high blood pressure, heart disease and stroke (Liao et al., 2015). The association between fruit and vegetable consumption and NSES was examined to determine whether NSES explained racial differences in fruit and vegetable consumption (Dubowitz et al., 2008). The NHANES III study design used geocoded residential addresses, individual level data and county census-tract level data to determine whether NSES explained racial differences in fruit and vegetable consumption. Neighborhood socioeconomic status was positively associated with fruit and vegetable intake and for every standard deviation increase in the neighborhood SES index, nearly two additional servings of fruits and vegetables were consumed (Dubowitz et al., 2008). The CDC's Racial and Ethnic Approaches to Community Health (REACH) study was conducted to examine if a multi-community intervention decreased disparities in fruit and vegetable intake (Liao et al., 2015). The researchers found the geometric mean of

combined fruit and vegetable intake in REACH communities increased by 7.4% (p = 0.001) and there was no change in populations in the comparison states (p = 0.050). Furthermore, disparities in fruit and vegetable consumption between comparison white populations and blacks in the REACH communities decreased by 33% from 0.066 to 0.440 times per day (Liao et al., 2015). A cross sectional survey and observational study was conducted by Zenk et al. (2009). The researchers examined the association between the neighborhood retail food environment and fruit and vegetable consumption in a multiethnic urban population using data from a 2002-2003 community survey of urban adults using a 2002 in person audit of food stores, and 2002 mapping of supermarkets in Detroit. Fruit and vegetable consumption was measured using the validated instrument Block 98 a semi quantitative Food Frequency Questionnaire from Berkeley Nutrition Services, Berkeley, California. Statistical analysis was conducted using weighted multilevel regression. The researchers found large grocery stores located within 0.5 miles of the study population were positively associated with fruit and vegetable intake with an average intake of 0.69 more fruit and vegetable servings daily. There were no differences between fruit and vegetable consumption and the food environment between Whites and African Americans. However, Latinos who resided in neighborhoods with a large grocery store consumed 2.20 times more fruit and vegetable servings daily compared to African Americans (Zenk et al., 2009).

Groups most at risk for obesity include individuals who are less educated, poor, and older as well as racial and ethnic minorities specifically women of color (Lopez, 2007). Access to nutritious affordable food contributes to a better diet and such foods are typically found in supermarkets. Evidence suggests fewer supermarkets are found in low-

income neighborhoods of color (Lopez, 2007). A study was conducted using addresses of places to buy food in Mississippi, North Carolina, Maryland, and Minnesota. The addresses were geocoded to census tracts and the average household value was used to estimate neighborhood wealth. The proportion of Black residents was used to measure neighborhood racial segregation (Morland, Wing, Diez-Roux, & Poole, 2002). Neighborhood segregation impacted race and socioeconomic status. There were four times more supermarkets located in White neighborhoods compared to Black neighborhoods (PR = 4.3; 95% CI = 1.5-12.5), and less wealthy neighborhoods had fewer supermarkets than wealthier neighborhoods with wealthier neighborhoods having three times more supermarkets (Morland et al., 2002). Improvement in neighborhood environments including access to supermarkets are needed to address health disparities and obesity particularly among minority populations.

Food Insecurity

Food insecurity has been measured yearly in the United States since 1995 and is defined as a household's inability at some point during the year to obtain enough food to live an active healthy lifestyle for each member of the household **(**Chilton & Rose, 2009; Coleman-Jensen, Rabbitt, Gregory, & Singh, 2016). Food insecurity is measured using an 18-item US household Food Security Scale. A household is considered food secure if survey respondents answer positively to < 3 scale items, food insecure if 3-7 items are answered positively and severely food insecure if survey respondents answer positively to $\geq$ 8 items (Lee, Gundersen, Cook, Laraia & Johnson, 2012). In 2015, 12.7 % or 15.8 million household in the U.S. were food insecure a decrease from 2014 when 14% of households experienced food insecurity and a significant decrease from 2011 when

14.9% of households experienced food insecurity (Coleman-Jensen et al., 2016). Households that experienced very low food security in 2015 were 5.0 percent or 6.3 million households (Coleman-Jensen et al., 2016). Very low food security means food consumption and normal eating patterns were restricted among household members because resources were not available to obtain food. Quantitative studies have suggested food insecurity is associated with depression, anxiety and social isolation among mothers and poor child development outcomes. Chronic diseases among adults such as hypertension and hyperlipidemia which are risk factors for cardiovascular disease have also been associated with food insecurity (Chilton, Rabinowitz & Woolf, 2013; Seligman, Laraia & Kushel, 2010).

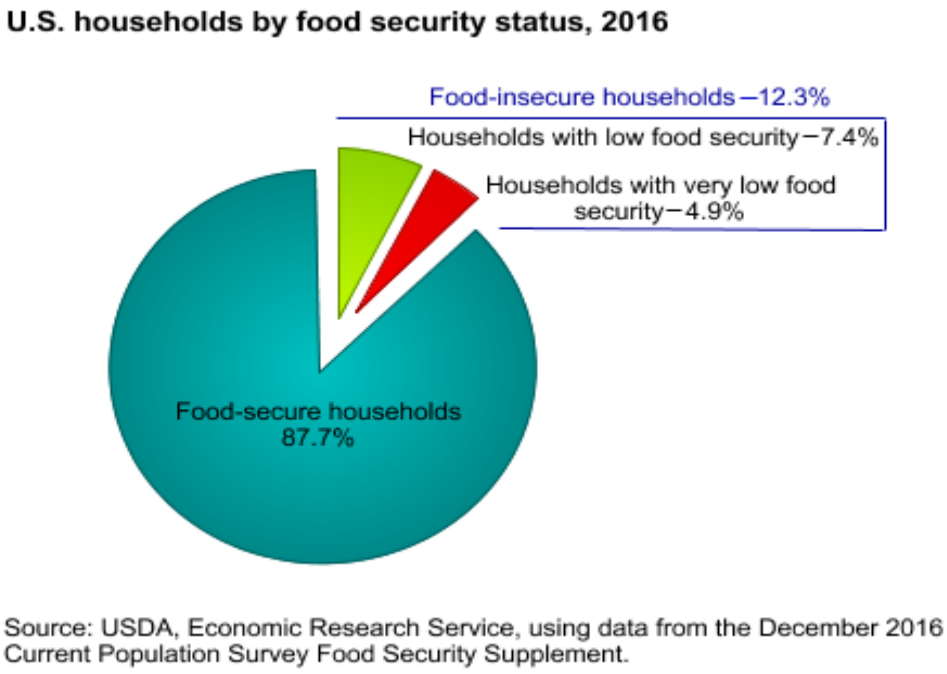

Figure 3. U.S. household by food security status. Source: USDA, Economic Research Service, using data from the December 2016 Current Population Survey Security Supplement. https://www.ers.usda.gov/webdocs/charts/80054/households_ers.png

SNAP Food Assistance and Food Insecurity

Socioeconomic and demographic factors that contribute to food insecurity in the U.S. include being African American or Hispanic, single (never married), divorced or separated, renting versus home ownership, young, and less educated. Another factor related to food insecurity is income. Food insecurity is inversely related to income, the more food insecure one is the less income one has (Gundersen, 2013). The purpose of the SNAP program is to diminish food insecurity among its participants; however, research to measure the effect food assistance programs have on food insecurity is impeded because of voluntary self-selection. SNAP participants who need the benefits more than non-participants are more likely to enroll in the program (Mabli, Ohls, Dragoset, Castner & Santos, 2013; Nord, 2011; Wilde, 2007). Ratcliff, McKernan, and Zhang (2011) examined the effectiveness of SNAP in meeting the goal of reducing food insecurity. They examined participant and non-participant households and how these households differed in systematic ways. For example, households that are most needy and food insecure tend to be eligible for SNAP and receive SNAP benefits and thus have better outcomes compared to non-participant households. Since selection of more needy households are enrolled in SNAP, it is difficult to determine causality between SNAP participation and food insecurity Ratcliff et al. (2011). Using household data from the nationally representative longitudinal 1996, 2001, 2004 Survey of Income and Program Participation (SIPP) panels and data from strong instrumental variables (IV) models approach to control for SNAP selection, the researchers found SNAP participation reduced the likelihood of being food insecure by 16.2 percentage points or 31.2%. The likelihood of being very food insecure was reduced by 3.9 percentage points or 20.2%

and food insufficiency was reduced by 20% which meets the goal of the SNAP program of reducing food insecurity (Ratcliff et al. (2011).

A cross-sectional study was conducted to estimate the effect the SNAP program had on the food security of the program recipients and the effect of self-selection among current SNAP recipients and recent leavers using cross-sectional survey data from the Current Population Survey Food Security Supplements (CP-FSS) was used in December of each year from 2001 to 2009 adjusting for economic and demographic differences using multivariate logistic regression (Nord, 2011). Bivariate associations were assessed by cross-tabulating household food security status and SNAP status in the 30-day period before the food survey and logistic regression models were estimated with very low food security during the 30-d period before the food survey. The odds of very low food security among households that remained on SNAP till the end of the survey year were 28% lower compared to those who left SNAP prior to the 30-day period. When food security was assessed and in 2-year panels controlling for severity of food insecurity in the prior year, the difference in the odds was 45% (Nord, 2011).

SNAP Food Assistance and Diet Quality

The purpose of SNAP is to help alleviate hunger and reduce food insecurity in households and protect the nutrition and health of low-income households by boosting their ability to buy food (Hilmers et al., 2014; United States Department of Agriculture [USDA], 2014). It has been suggested that less nutrient dense foods purchased with SNAP benefits such as sugar sweetened beverages (SSB) contribute to a less healthy diet among SNAP participants (Brownell, & Ludwig, 2011). Other research suggests SNAP participants with marginal food security had lower BMI (1.83 kg/m^2; $p < .01$) and lower

probability of obesity (9 percentage points; $p < .05$). SNAP participants with marginal (3.46 points; $p < .01$), low (1.98 points; $p < .05$), and very low (3.84 points; $p < .01$) food security had better diets, as evidenced by the Healthy Eating Index (Nguyen, Shuval, Bertmann, & Yaroch, 2015). Associations between SNAP participation and improved diet and weight were stronger among Whites compared to Blacks and Hispanics (Nguyen et al., 2015).

It is not fully understood how participation in the SNAP program may increase obesity (Hilmers et al., 2014). Data from the Continuing Survey of Food intake by Individuals (CSFII) from 1994-2004 showed SNAP participants compared to nonparticipants consumed more calories from fats, alcohol and added sugars and made less healthy food choices. For example, low-income Hispanic adult women who participated in SNAP are at an increased risk for poor diet quality and obesity because they consumed a less healthy diet. Hispanic SNAP participants consumed 26% higher amounts of sugar sweetened beverages, (p=0.08) and 38% higher amounts of deserts (p=0.09) compared to non-participants (Hilmers et al., 2014). In addition, SNAP participants also consumed17% more sugars and 36% fewer servings of whole grains and higher intakes of energy dense foods compared to nonparticipants (Hilmers et al., 2014).

Another study examining the diets of low-income adults enrolled in the SNAP program versus nonparticipants was conducted to determine SNAP participation, dietary intake, and diet quality. In a cross-sectional study (n=3835), the diets of nonelderly adult whose household income was $\leq$130% of the federal poverty level diets were examined using the National Cancer Institute's method of dietary intake (Leung et al., 2012). Food groups of interest included total grains, whole grains, refined grains, fruit, 100% fruit

juice, vegetables, eggs, fish/shellfish, nuts/seeds/legumes, red meat, processed meats, high fat dairy products, low-fat dairy products, salty snacks, regular sodas, diet sodas, sports drinks, noncarbonated SSB, all SSB and water. Few low-income adults whether SNAP participants or nonparticipants consumed the recommend amounts of whole grains, fruits, vegetables, fish, legumes, and nuts (Leung et al., 2012). Low-income adults enrolled in the SNAP program consumed more processed meats, sweets, baked goods and sugar sweetened beverages compared to nonparticipants SNAP participants compared to nonparticipants consumed 38% fewer whole grains (95%CI:-57%-15%, 44% more 100% fruit juice (95%CI:0%,107%), 56% more potatoes (95% CI: 18%, 106%, 46% more red meat (95% CK: 4%, 106%), and women consumed 61% more sugar sweetened beverages (95% CI: 3%, 152%) (Leung et al., 2012).

A systematic review of 25 studies on diet quality of Americans who participated in the SNAP program further substantiated low diet quality among SNAP participants (Andreyeva, Tripp & Schwartz, 2015). Daily calories, macronutrient and micronutrient intake did not differ from income eligible nonparticipants, but diet quality did (Andreyeva et al., 2015). Adults in SNAP scored lower on the Healthy Eating Index (HEI) compared to nonparticipants (SNAP HEI Score 49.5, nonparticipant's HEI Score 50.50) and the one area where SNAP participants did better than nonparticipants was their consumption of less sodium and saturated fat (Gregory, Ver Ploeg, Andrews, & Coleman-Jensen, 2013). Children's diets were similar among SNAP participants and low-income nonparticipants. The diets of children who were SNAP participants and nonparticipants were less healthy than the diets of higher income children (Andreyeva et al., 2015). Data on the consumption of sugar sweetened beverages (SSB) had mixed

results and most studies showed a significant increase in consumption of SSB among SNAP participants compared to higher income nonparticipants. However, Todd and Ver Ploeg (2014) found no difference in SSB consumption among SNAP participants compared to income eligible nonparticipants. Although the SNAP program was intended to help low-income individuals achieve a better diet because of increased purchasing power through SNAP benefits, the diets of low-income individuals need to be improved. In particular, SNAP participant's diets need to be improved to meet dietary guidelines.

SNAP Food Assistance and Obesity

The relationship between food assistance programs and obesity is not fully understood and studies have been conducted to examine whether participation in the Food Stamp Program also known as SNAP contributes to obesity among its participants (Townsend et al., 2001; Gibson, 2003). A systematic review of the Food Stamp Program and obesity was conducted, and the findings were inconsistent (DeBono et al., 2012). In general, cross-sectional studies found a sub-population of Food Stamp Program participants were at an increased risk for obesity particularly women who were long term users of the program. However, it was noted that cross-sectional studies are unable to control for selection bias and confounding variables (DeBono et al., 2012). Longitudinal studies were able to control for selection bias, SES, and demographic characteristics. Food stamp participation was associated with weight gain and obesity among women but not men (DeBono et al., 2012). A cross-sectional analysis was conducted with SNAP participants to determine whether SNAP participation was associated with adiposity and metabolic risk factors. Individuals who had participated in the SNAP program within the previous 12 months were positively associated with increased waist circumference in

men and women, metabolic risk factors including elevated triglycerides and lower HDL cholesterol, and metabolic syndrome (Leung et al., 2012). The purpose of the SNAP program is to increase food security and decrease hunger (McGuire, 2013). Studies have shown that the SNAP program had mixed results and SNAP may have the unintended consequence of contributing to obesity in certain sub-populations.

Food Insecurity and Obesity

Food insecurity is a public health issue and individuals who reside in households that are food insecure have poorer diets, increased abdominal fat and weight gain (Lee, Gundersen, Cook, Laraia, & Johnson, 2012; Morales & Berkowitz, 2016). Food insecure means the inability to obtain adequate food because of limited resources (Coleman-Jensen, Gregory & Rabbitt, 2016). A cross-sectional study was conducted utilizing a food insecurity questions measuring food stress from data in the 2009 Behavioral Risk Factor Surveillance System in 12 states in the U.S. (n=66,553) (Pan, Sherry, Njai, & Blanck, 2012). Weight gain was measured by BMI and calculated based on self reports of weight and height. Weight status was defined as underweight, BMI <18/5; normal weight BMI 18.5-24.9; overweight, BMI 25.0-29.9; and obesity, BMI $\geq$30.0. The prevalence of obesity was 27.1% overall, 25.2% among food secure adults and 35.1% among food insecure adults; ($p < 0.0001$), (Pan et al., 2012). Furthermore, food insecure adults had 32% increased odds of being obese compared to food secure adults (Pan et al., 2012). The population subgroups with the highest prevalence of obesity were adults 30 years and older, women, non-Hispanic whites, non-Hispanic blacks, adults with some college education or a college degree and a household income of less than $25,000 or $50,000-$74,999 (Pan et al., 2012). The association between household food insecurity and weight

gain is inconclusive. There are gender differences on whether food insecurity is associated with weight gain, where the evidence is inconsistent for men but consistent for women. Food insecurity is more prevalent among women and women are more likely to be obese compared to men (Franklin et al., 2012; Martin, & Lippert, 2012). The association between food insecurity and weight gain among children is also inconclusive (Laraia, 2013).

Further studies indicated there is conclusive evidence on the association between food insecurity and increased BMI among young women. A cross-sectional study was conducted using data from Wave 4 of the (2007-2008) National Longitudinal Study of Adolescent Health (Gooding, Walls & Richmond, 2012; Laraia, 2013). The association between food insecurity and BMI in a gender stratified model of young women and men (age 24-32) was analyzed controlling for age, race//ethnicity, income, education, physical activity, smoking, alcohol use, the presence of children in the home and food stamp use in young adulthood and adolescence. Food insecurity was more common in young adult women (14%) than young adult men (9%). After controlling for individual variables, food insecure women had an increased BMI of 0.9kg/m^2 compared to women who were food secure (β =0.89, DDDSE = 0.44, $p < 0.05$), (Gooding et al., 2012; Laraia, 2013).

Cross-sectional studies cannot determine causality; therefore, longitudinal studies have been conducted to determine the relationship between food insecurity and weight gain (as measured by BMI > 27.3kg/m^2 for women and 27.8 kg/m^2 for men (Ivers & Cullen, 2011). Using data from the 1994 1995 Continuing Survey of Food Intake by Individuals (CSFII), food insecurity was related to overweight in women (n= 4509, $p \leq$ 0.0001 but not for men (n = 4970, $p = 0.44$), (Townsend, Peerson, Love, Achterberg, &

Murphy, 2001). As the prevalence of overweight increased, more women were food insecure from 34% for those who were food secure (n=3447) to 41% for those who were mildly food insecure (n=966) and 52% for those moderately food insecure (n=86), (Townsend et al., 2001). Although some studies suggest there is an association between food insecurity and obesity, there have been mixed results and the strongest evidence to support the association between food insecurity and obesity is among women who were food insecure. Pregnant women in North Carolina who lived at a poverty level of less than 400% and were food insecure were associated with severe obesity before pregnancy and greater weight gain during pregnancy (Townsend et al.,). In Texas, female baby boomers and older adults who were food insecure were 1.4 times likely to have higher BMI's than women who were food secure (FRAC, n.d.).

Food Insecurity and Diet Quality

Most individuals in the U.S. have enough food to feed themselves. For example, in 2015, most U.S. households had enough food to feed household members and 87.3% of households were food secure (Coleman-Jensen, Rabbitt, Gregory & Singh, 2016). Although most U.S. households are food secure, 12.5% of households or 15.8 million individuals were food insecure. Food secure means having stable economic and social conditions to obtain adequate food for one's household to live an active and healthy lifestyle (Weinfield et al., 2014) and food insecure means households have limited resources to acquire enough food at some time during the year to feed household members (Weinfield et al., 2014). Approximately 4.6% of individuals in households experienced hunger in 2015 (FRAC, 2016). Poverty and food insecurity are factors that

influences poor nutrition among adults and older adults (Bhattacharya, Currie, & Haider, 2004).

The association between food insecurity and diet quality is not fully understood. To gain a better understanding of this association Hanson and Conner (2014) conducted a systematic review of food insecurity and diet quality among children and adults. The purpose of the review was to assess the overall association between food insecurity and diet quality and further examine these associations among adults and children to determine if there were any differences (Hanson & Connor, 2014). Peer reviewed studies of 170 associations were tested on food insecurity and diet quality in adults. Fifty associations (29%) were negatively associated with food insecurity and diet quality. For children, 130 associations were tested on food insecurity and diet quality and 21 associations were negatively associated with food insecurity and diet quality (Hanson & Connor, 2014). Food insecurity has adverse effects on diet quality in adults, because adults consume less fruits, vegetables and dairy product compared to food secure adults. The association of food insecurity and diet quality is less understood among children which may be a result of parents providing children with food at their own expense when food is scarce (Hanson & Connor, 2014).

Additional studies on food insecurity and diet quality have also been conducted. An adverse association between food insecurity and diet quality was found (Leung, Epel, Ritchie, Crawford & Laraia, 2014). For example, a cross-sectional study was conducted to examine the differences in dietary intake and diet quality by household food security. Low-income food insecure adults consumed more high fat dairy foods (p *trend* = <0.001) and salty snacks (p trend = 0.01) compared to low-income food secure adults (Leung et

al., 2014). Food insecurity was associated with the consumption of more sugar-sweetened beverages (*p* trend = 0.03); more red/processed meat (*p* trend = 0.05); more nuts seeds and legumes (*p* trend = 0.0006); fewer vegetables (*p* trend = 0.000); and fewer sweets and bakery deserts (*p* trend = 0.0002). Food insecurity was inversely associated with a poor diet quality which increased the risk for developing chronic diseases (Leung et al., 2014).

Food insecurity is also associated with lower intakes of energy and nutrients and populations most affected by food insecurity are low-income individuals, racial and ethnic minorities, households with children and older adults (Mello, Gans, Risca, Kirtania, Strolla & Fornier, 2010; Rose & Oliveria, 1997). The diets of three groups of children ages 1-5 years, adult women 19-50 years and older adults 65 years and older were analyzed with a 24-hour food recall from the Continuing Survey of Food Intake by Individuals (CSFII) (Rose & Oliveria, 1997). Logistic regression analysis was used to study the association of self-reported household food insufficiency and nutrient intakes below 50% of the recommended daily allowance (RDA). Among adult women, food insufficiency was significantly associated with low intake of seven nutrients including energy, magnesium, and vitamins A, E, C, and B_6 (Rose & Oliveria, 1997). Older adults who were food insufficient had low intake of eight nutrients including proteins, calcium, and vitamins A and B_6 (Rose & Oliveria, 1997). There were no differences in the intake of nutrients between food sufficient preschoolers and food insufficient preschoolers (Rose & Oliveria, 1997). Of the three groups studied, older adults that were food insufficient were most at risk for having low intakes of nutrients, proteins, and certain vitamins (Rose & Oliveria, 1997).

Food insecurity and dietary behaviors have also been studied among low income adults (n=1874, 55% Hispanic). A randomized controlled trial funded by the National Cancer Institute (Your Healthy Life/Su Vida Saludable) was conducted to examine the relationship between food insecurity and dietary behaviors such as food choices and preparation methods. Study participants were encouraged to increase fruit and vegetable intake and decrease fat intake using culturally proper nutrition education information. Demographic questions were collected by telephone and dietary measures were collected with the Fruit and Vegetable Frequency Questionnaire. Fat intake behaviors were assessed using the Food Habits Questionnaire (FHQ) an instrumented developed by Kristal and adapted for the study participants (Mello et al., 2010). Twenty-four questions were asked of participants regarding their food intake over the past month and 35 behavioral questions were asked with response options of 0=almost always, 1=often, 2=sometimes, 3=rarely, 4=never. Food insecurity was measured from a question from the Behavioral Risk Factors Surveillance System regarding food security in the past 30 days. Food insecure participants had greater FHQ scores compared to food secure participants and greater fat intakes ($p < .05$). In addition, consumption of fruit (with juice) was greater in food insecure participants compared to food secure participants ($p < 0.05$), (Mello et al., 2010).

Poverty and Income Inequality

The average household income in the United States in 2015 was $56,516 and income increased by 5.2% from the average household income in 2014 (Proctor, Semega, & Kollar, 2016). Average household incomes increased for all regions in the U.S. (Northeast, Midwest, South, and West) between 2014 to 2015 (Proctor et al., 2016). The

average income for men and women who were full-time workers between 2014 and 2015 increased by 1.5 and 2.7 percent. This marks the first yearly increase for men and women since 2009 (Proctor et al., 2016).

Although earnings for men and women have increased, income inequality is high in many states, urban areas, and counties in the U.S. The top one percent of families earn 25.3 times more than the bottom 99 percent (Sommeiller, Price, & Wazeter, 2016). Nine states had income gaps greater than the national gap, 54 of 916 metropolitan areas had gaps greater than the national gap and 165 of 3,064 counties had gaps greater than the national gap (Sommeiller et al., 2016).

Despite increasing income inequality, poverty in America is decreasing. The 2015 poverty rate in the U.S. was 13.5% a decrease from 14.8% in 2014 and this equals 43.1 million people who live in poverty (University of Wisconsin-Madison, 2016). Most demographic groups have seen a decrease in poverty from 2015 to 2014. The three dominant age groups which saw a decrease in poverty were children less than 18 years, individuals 18-64 and individual's age 65 and older (Proctor et al., 2016). Although poverty is decreasing in the U.S. poor health and poverty are closely associated.

Poverty and Health

Poorer health outcomes have been linked to low incomes among every age group compared to those who are near poor. Factors that influence health include access to care. Almost 9% of poor children were uninsured in 2014 compared to 3.5% of children whose household income was over $100,000 (University of Wisconsin-Madison, 2015). Individuals who are poor are more likely to put off basic medical services such as filling prescriptions and obtaining dental care compared to individuals with middle or upper

incomes (21.8% vs 5.1%) (University of Wisconsin-Madison, 2015). Children up to age 18 and adults 18-59 have marked differences in health status according to income. The poorer one is the lower one's health status becomes (University of Wisconsin-Madison, 2015). Addressing poor health outcomes and health disparities are important because the health of all America should be improved to reduce the cost of health care expenditures. Health care costs are estimated to account for 30% of direct medical disparities among minority populations in particular Blacks, Hispanics, and Asians (Ubri & Artiga, 2016). Suggested interventions to address health disparities and access to care include training more health providers such as nurse practitioners (NP's) and physician assistants (PA's), primary care technicians and expanding community health centers (University of Wisconsin-Madison, 2015).

Poverty and Obesity

Some researchers have argued that obesity in industrialized nations is the result of the overconsumption of sugary drinks, and energy dense foods. In the United States, obesity has been linked to added fats and sugar in foods, snacking, fast food consumption and eating more meals away from home (Drewnowski, 2009). It has been well documented that low-income communities have more fast-food chains and convenience stores versus full-service grocery stores compared to higher-income communities that have better restaurants and grocery stores (Drewnowski, 2009). Socioeconomic factors impact diet and health including access to healthy foods. As income decreases, energy dense foods of poor nutritional value are more affordable, and the highest rates of obesity are found among disadvantaged populations. The association between poverty and obesity may be mediated by low cost palatable energy-dense foods (Drewnowski, 2009).

Access to healthy food is important to improve diet but access to affordable foods is equally important (Leonard Davis Institute of Health Economics [LDI], 2015). In addition, a healthy diet must incorporate nutrient rich foods that are affordable and palatable to the American diet (Drewnowski & Eichelsdoerfer, 2010).

Definitions of Terms

The terms below have been defined for the purpose of this study:

Body mass index A measure of body fat calculated by the ratio of bodyweight in kilograms divided by square height in meters (Centers for Disease Control and Prevention [CDC], 2015).

Calorie: The unit of energy supplied by food from carbohydrates, fats, sugars proteins (CDC, 2015).

Food access: Limited ability of grocery stores, shopping centers or other places to obtain healthy economical foods (United States Department of Agriculture [USDA], 2017).

Food Insecurity: The inability during the past twelve months to obtain adequate food to feed all members of the household because of limited resources (Whitmore Schanzenbach, Bauer, & Nantz, 2016).

Food Security: Having enough food at all times to live a healthy active life which includes access, availability, and utilization of food (World Food Programme, n.d.).

Low food security: Reports of reduced quality, variety, and desirability of diet with no signs of reduced food intake (USDA, 2015).

Very low food security: Reports of numerous indications of disrupted eating patterns and reduced food intake (USDA, 2015).

High food security: The absence of food access problems or limits in the household (USDA, 2015).

*Hunge*r: The uncomfortable and aching feeling caused by having no food over a period of time that may be caused by food insecurity (Bickel et al., 2000).

Marginal Food Security: Having up to two reports of becoming uneasy, worried, or nervous over enough food or scarcity of food in the household with no change in diet or food consumption (USDA, 2015).

Obesity: An abnormal accumulation of too much body fat that affects adults and children. A person with a body mass index (BMI) more than or equal to 30 is considered obese (Ellulu, Abed, Rahamat, Ranneh, & Ali, 2014; National Institute of Environmental Health [NIEH], 2015; World Health Organization [WHO], 2016).

Overweight: A person with a body mass index (BMI) more than or equal to 25 (WHO, 2016).

Poverty/Federal Poverty Level: The least amount of income needed for a household to obtain food, shelter, and other basic needs. The 2017 federal poverty guidelines for a family of four is $24,600. A family income less than $24,600 is considered at the threshold for poverty (Feeding America 2014; Families USA, n.d.).

Social ecological model: A health behavior framework that explains how health behaviors are impacted by multiple levels including the intrapersonal, interpersonal, institutional, community and policy levels (Kumar et al., 2012)

Supplemental Nutrition Assistance Program: A U.S. food assistance and anti-hunger program formerly known as the food stamp program which has helped more than 45 million individuals per month consume a nutritious diet. The majority of individuals

on SNAP have children (70 percent) and one in three individuals are older adults and or people with disabilities (Center on Budget and Policy Priorities, 2016).

Assumptions

Assumptions are features of a research study the researcher does not have control over (Simon, 2011). This research study and data analysis were guided by the following assumptions. The study used NHANES survey data to examine the impact of food assistance programs on the association between diet quality, food insecurity and obesity among U.S. adults and the survey instruments were valid tools for survey collection. I assumed the survey participants understood the survey questions, provided honest responses to the survey questions, NHANES participants are representative of the U.S. population. The NHANES is a compilation of studies designed to evaluate the health and nutrition of adults and children in the United States by utilizing in home interviews and clinical physical examinations. The program began in the 1960's and the surveys focus on various populations and health topics. NHANES is a primary program of the National Center for Health Statistics (NCHS) of CDC. Federal law requires NCHS employees and other individuals associated with NCHS employees that have access to study participant's personal information must de-identify the information. Employees and others that have access to personal data must also take an oath to keep all information private and intentionally disclosing personal information may result in prosecution, jail, and or fines (CDC, n.d.).

Scope and Delimitations

Delimitations are characteristics of the research study the researcher chooses to focus on in a study (Johnson, 2012). This study is delimited by the examination of the

impact of food assistance programs on food security and diet quality among participants in the SNAP program. The NHANES program assesses the health and nutrition status of adults and children. This study is delimited by focusing on male and female adults ages 20-60. The cross-sectional study design has the ability to evaluate large sample data and assess outcomes; however, causality cannot be determined.

Significance, Summary, and Conclusions

The purpose of this research study is to examine the indirect effects of predisposing factors on the association between food insecurity, diet quality, and obesity among adults participating in food assistance programs in the United States. This study is significant because of the increased rates of obesity among children and adults over the past three decades, the burden of obesity related deaths per year and the direct and indirect costs of obesity in the U.S. Information on food insecurity, obesity and diet quality is mainly available for women and less information is available for men and children. This literature review supports there is inconclusive evidence on the association between food assistance programs, food insecurity, diet quality and obesity among U.S. adults. This study is significant because it may provide a better understanding of the impact of food assistance programs on diet quality, food insecurity and obesity which can potentially aid in reducing obesity and other chronic diseases among low income adults while building upon the existing research on this topic.

Section 2: Research Design and Data Collection

Introduction

The purpose of this quantitative study was to examine the impact food assistance programs may have on the association between food insecurity, diet quality and obesity among low-income U.S. adults. The research questions and hypotheses examined included socioeconomic factors in relationship to food insecurity, diet quality and obesity. Food security is measured by dimensions such as availability, access and how one utilizes food which may determine the outcome of one's nutritional status, physical health, and cognitive abilities (Leroy, Ruel, Frongillo, Harris, & Ballard, 2015). In this chapter, I describe the context of the research design and rationale, methodology, sample and sampling procedures, sample size and power calculation, instrumentation and operationalization of the constructs, data collection, data analysis plan, threats to validity, and ethical procedures.

Research Design and Rationale

The research design was a quantitative cross-sectional study. The quantitative approach was selected rather than qualitative approach to examine the relationship between the variables of interest. The goal of quantitative research is to examine the relationship between an independent and dependent variable in a population (Creswell, 2009). Cross-sectional studies are mainly used to determine prevalence of disease and are helpful in identifying associations (Mann, 2003). The advantages of cross-sectional studies are that they are inexpensive to conduct, there is no follow-up, the study can be done quickly, and many outcomes can be studied. The disadvantages of cross-sectional studies are that causation cannot be determined and rare conditions cannot be studied

(Mann, 2003). For this study, I used secondary data from the 2013-2014 NHANES to examine the impact food assistance programs may have on the association between food insecurity, diet quality and obesity among U.S. adults.

NHANES is a multistage, cross-sectional group of studies designed to evaluate the health and nutritional status of adults and children in the United States. The survey utilizes interviews and physical examinations to determine the health and nutritional status of the U.S. population and is a program of NCHS (Nguyen et al., 2015). NCHS is part of CDC, which is responsible for producing the health and vital statistics of the United States. Specifically, I used data from NHANES 2013-2014 surveys for this research study. NHANES was selected because it is a nationally representative sample of the U.S. population of all ages. Groups that have been oversampled to obtain more reliable estimates in the population are African Americans, Asians, Mexican Americans, low-income Whites, older adults (80 and older), and pregnant women. The response rate for the NHANES examination is approximately 70-80% (Ahluwalia, Dwyer, Terry, Moshfegh, & Johnson, 2016).

NHANES combines interviews and physical examinations to determine the prevalence of diseases and risk factors for disease. A household screening interview is conducted using a computer-assisted personal interview to identify eligible household members for NHANES (Ahluwalia et al., 2016). Once appropriate individuals are identified, informed consent is obtained, and a detailed interview is conducted. Questions are asked about demographic, socioeconomic, dietary, and health information (Ahluwalia et al., 2016). Various researchers have used NHANES to examine food assistance programs and the prevalence of food insecurity and the association to chronic diseases

and diet quality in the U.S. adult population (Gowda, Hadley, & Aiello, 2012; Jernigan et al., 2017; Leung et al., 2014; & Nguyen et al., 2015). The independent variables in this study were food insecurity, diet quality, and poverty. The dependent variable was obesity. Despite some of the limitations of cross-sectional studies, I selected the cross-sectional study design because it is ideal for describing variables and their distribution. I also selected the cross-sectional research design and secondary data of NHANES because of its relevance to my research questions and public access availability.

Methodology

The purpose of the methods section is to describe how the research study was conducted. A description of the methodological design, rationale for the study design, methods to gather information, data collection, and justification for why the methods are appropriate for the research topic should be given. In addition, an explanation of how the data analyses and results should be included in the methodology (Walden University Writing Center, n.d.). Methodology is important because scholarly research should be conducted well to avoid wasting time and money and conducting good research can fill the gap in the literature and contribute to the body of knowledge and future publications (Nayak, 2009). As previously stated, the cross-sectional research design using secondary data of NHANES were used in my study. Several secondary analyses of NHANES have utilized logistic regression to examine the associations between food insecurity and chronic diseases. Some studies have examined the associations between food assistance programs, food insecurity, and chronic diseases (Davy et al., 2015; Gowda et al., 2012). Other researchers have examined the association between food insecurity and diet quality (Hilmers et al., 2014; Leung et al., 2012). Few studies have examined the association

between food assistance programs, food insecurity, diet quality, and obesity (Nguyen et al., 2015). In this study, I examined the independent variables of food insecurity, diet quality, and poverty and the dependent variable of obesity. Other covariates examined included sociodemographic characteristics: employment status, income, gender, age, race/ethnicity, and education.

Population

The target population of NHANES is noninstitutionalized civilians of the United States. Over the years, larger number of samples of certain subgroups have been selected that are of interest to public health as this increases the reliability to estimate the precise health status of the subgroups from NHANES 2011-2014. The study population for this research was adults aged 25-65 an older residing in the United States. The rationale for selecting this population is because from 1999-2000 and through 2013-2014 a substantial increase in obesity has been observed in adults and children and more than a third of adults were obese in 2011-2014 (Ogden et al., 2015).

Sample and Sampling Procedures

Sampling is a process of selecting or choosing units from a population of interest and studying the population to make generalizations about the population from which the sample is selected (Trochim, 2006). The NHANES study is not a simple random sample. It is a complex multistage probability sampling design that derives its participants from the civilian, non-institutionalized population of the United States. The study is complex because the sample is drawn from four stages. The first stage selects primary sampling units (PSUs) from all counties in the United States (NHANES, 2013-2014). The second stage consists of dividing the PSUs into segments into city blocks. The third stage of the

sample selection is from residences that are non-institutionalized (NHANES, 2013-2014). The fourth stage of sample selection comprises everyone in the household, and each person is assigned a sample weight. The purpose of the sample weights is to obtain unbiased national estimates of the sample population. The survey sample design 2011-2014 publication of NHANES provides further information on how the sample populations is selected and weighted.

Sample Size and Power Calculation

The population of interest in this study as previously mentioned, were adults (20-60 years) residing in the United States. Since the sample size must be determined, a power calculation should be conducted. As a researcher tests a hypothesis, two types of errors can be made. A Type I error which is falsely rejecting the null hypothesis when it is true, and a Type II error which is acceptance of the null hypothesis that is false (Gerstman, B. 2015; Frankfort-Nachmias & Nachmias, 2008). Both Type I and Type II errors can be reduced by increasing the sample size (Banerjee, Chitnis, Jadav, Bhawalkar, & Chaudhury, 2009). Although calculating the sample size is not necessary, a power calculation is necessary in this study because the final sample size is known. Power is the likelihood that the null hypothesis is rejected if the alternative hypothesis is true and beta represents a Type II error or the probability of not rejecting the null hypothesis when the alternative hypothesis is true (Penn State University, n.d.). The formula for power is $1-\beta$ = Power.

G*Power software was used to determine the power of this study. Power and sample size estimation are important because they assist the researcher in determining how many subjects are needed in a study to answer the research question(s) and null

hypothesis to avoid a Type II error (Jones, Carley & Harrison, 2003). Hypothesis testing should have a minimum of 80% power, yet many studies are designed to have 90-95% power (Gerstman, 2015; Penn State University, n.d.). The various factors that affect power are the alpha (α), beta (β), effect size, variability, baseline incidence, and *n* or sample size (Penn State University). Alpha (α) is the level of significance and is typically set at 5% percent or 1% percent, the level the researcher is willing to state the null hypothesis is false when it is really true. The effect size is the departure from the null hypothesis the researcher wants to detect, and the effect size should be significant and may be based on the results of previous studies. Variability may be expressed as a standard deviation or an appropriate measure of variability for the statistic and the researcher must know the variability to calculate power. Estimates may be obtained from historical data, pilot studies, or the literature (Penn State University, n.d.). Baseline incidence is related to the effect size. Three of the four criteria must be known to determine the fourth (Hunt, n.d.). If the researcher hypothesizes that the rates increased or decreased, the baseline rate and effect size must be known to calculate power to determine the change (Penn State University, n.d.). There is a direct relationship between the power of a study, effect size sample size and significance level. An increase in the effect size, sample size, and significance level will increase the statistical power of the study (Penn State University, n.d.). High power in a study and no significant effect means the effect is small (Penn State University, n.d.).

Instrumentation and Operationalization of Constructs

NHANES is a group of studies that is part of the NCHS and the CDC. NHANES has two components: household survey interviews and a physical examination. The

dependent variables for this study is obesity. The independent variables are food insecurity and diet quality depending on the research question. The measures that operationalize the variables are described in the rest of the section.

SNAP and Food Stamp Program Benefits. In NHANES, all data for the SNAP/Food Stamp benefits questions are collected at the household level. One adult responds to the questions for the household during the interview. Questions included whether anyone in the household received SNAP/Food Stamp benefits in the last 12 months; the amount of time since benefits were last received, the amount of benefits the household last received, and whether someone in the household is a current SNAP/Food Stamp benefit recipient. For this study, SNAP participation is operationalized as a binomial variable.

Household Food Security. In NHANES, household food security is measured at the household level. One adult responds to the U. S. Food Security Survey Module (US FSSM) questions. There are 18 items for households with children under the age of 18 years and 10 items for households without children. Questions pertain to all household members. Four categorical household level variables were created to capture the overall food security status of adults in the household (secure, low food security, or very low food security). A question on household member's use of emergency foods from food banks, soup kitchens, or other agencies in the last 12 months is also asked. Food Security was operationalized as an ordinal variable. The Household Food Security Survey Module (HFSSM) is a valid measure of food security and hunger in populations and individuals in the United States and was adapted to measure food security in low income countries (Jones, Ngure, Pelto, & Young, 2013). The HFSSM is an 18-item questionnaire

administered to families to report their subjective experiences with food security including anxiety about obtaining food, views on accessibility of the quantity and quality of food, decreased food consumption in adults, and decreased food consumption in children. The household is classified as food secure, moderately food secure, low food security, and very low food security based on the number of food insecure conditions and behaviors reported (Jones, et al., 2013). A study on household food security in the Lower Mississippi Delta was conducted utilizing the HFSSM to examine the relationship between household food insecurity and adult health status. Health status (mental and physical health) was assessed using the SF-12 (a condensed version of the SF-36) a validated instrument with 12 items. Adults in food insecure household were more likely to rate their health as poor and fair and scored low on the mental and physical health scales in the SF-12. Household food insecurity is associated with adult health status (Stuff et al., 2004).

Obesity. Obesity is calculated from the standard formula of weight (kg) divided by height squared (m^2) from the clinical measure obtained from the medical examination center. Obesity was operationalized as a binomial variable.

Diet Quality. Dietary intake in NHANES is collected through in-person, interviewer-administered 24-hour dietary food recall. The 24-hour dietary recall information is utilized to determine the HEI score. The HEI measures diet quality and assesses adherence to the U.S. Dietary Guidelines for Americans (United States Department of Agriculture Center for Nutrition Policy and Promotion, n.d.). The association between diet and chronic disease is well documented and consuming nutrient dense foods like fruits, vegetables, nuts, seeds, and whole grains and limiting the over

consumption of high energy foods such as sugar, starch, and fat can reduce the risk of certain cancers and cardiovascular disease (WHO, 2003).

Dietary assessments may be objective or subjective. The 24-hour dietary recall is a subjective assessment commonly used in large surveys. Dietary intake in NHANES is collected through in-person, interviewer-administered 24-hour dietary food recall. Each NHANES participant is eligible for two 24 dietary recalls. The first 24-hour dietary recall is collected in person at the Mobile Examination Center (MEC) and the second recall is conducted by telephone. The dietary recall information is used to determine the HEI-2010. HEI measures diet quality that assesses adherence to the U.S. Dietary Guidelines for Americans (United States Department of Agriculture Center for Nutrition Policy and Promotion, n.d.). Research supports, the 24-hour dietary recall method as a reliable measure of nutrient intake (Ahluwalia et al., 2016; Sun, Roth, Ritchie, Burgio, & Locher, 2010). The 24-hour dietary recall is an assessment method that assesses an individual's dietary intake. A trained interviewer administers an open-ended questionnaire to obtain detailed dietary information over the previous 24 hours (Shim, Oh, & Kim, 2014). The advantage of the 24-hour dietary recall is it is not burdensome for the respondent and it is an appropriate tool for individuals with low literacy. The disadvantages of the 24-hour dietary recall are possible recall bias, trained interviewers are required, there may be possible interviewer bias, and the 24-hour dietary recall can be expensive and time consuming (Shim, et al., 2014). The 24-hour diet recall is a valid method of assessing dietary intake, however, it is short term and it is recommended that a combination of the Food Frequency Questionnaire and multiple 24-hour recalls are the best methods to assess dietary intake (Webb et al., 2013).

The HEI is also a measure of diet quality that measures adherence to the Dietary Guidelines for Americans. This tool can be used for monitoring populations, in epidemiological research, evaluating the food landscape, determining food assistance packages, informing nutrition interventions, and to determine the association between diet cost and diet quality (Guenther et al., 2014). The HEI-2010 is an updated version of the HEI. There are 12 parts that comprise the HEI-2010. Nine of the parts of the HEI-2010 assess adequacy of the diet including total fruit, whole fruit total vegetables, greens and beans, whole grains, dairy proteins, seafood, and plant-based protein, and added fat. The other three parts assess adequacy of the diet regarding refined grains, sodium, and empty calories and are recommended to be consumed sparingly. The twelve components haves scores assigned to them and a total score of 100 is the maximum value (Gunenther et al., 2014).

To test the validity and reliability of the HEI-2010, menus from the USDA Food Patterns, DASH Eating Plan, Harvard medical School Guide to Healthy Eating, and the American Heart Association's No-Fad Diets were scored. Two 24-hour food recalls from individuals two years of age and older from NHANES 2003-2004 were also conducted. The dietary recalls were used to estimate multivariate intake distributions and assess whether the HEI-2010 had a wide distribution. The dietary recalls were also designed to identify meaningful differences in diet quality and differentiate between group with known difference in diet quality utilizing t tests and to measure diet quality independent of energy intake utilizing Pearson correlation. This method helps determine a greater than one underlying dimension using principal component analysis (PCA) and assess the internal consistency by calculating Cronbach's coefficient α (Gunether et al., 2014).

Validity for the HEI-2010 scores for the 4 menus ranged from 87.8 to 100. Distribution scores among the population were wide (5^{th} percentile = 31.7; 95^{th} percentile = 70.4) and differences were detected in the diets of the population. Men's mean diet quality score was (49.8) compared to the women's score (52.7). Younger adults diet quality was (45.5) compared to older adults (56.1). Smokers had lower scores (45.7) compared to non-smokers (53.3) ($p < 0.01$) (Gunether et al., 2014). There was low correlation with energy and component scores ($|r| \leq 0.21$) and the Cronbach coefficient α was 0.68 confirming the reliability of HEI-2010 (Gunether, et al., 2014).

Sociodemographic Characteristics. Sociodemographic data analyzed included poverty level, income gender, age race/ethnicity and education.

Operational Measures. Table 1 depicts the survey items and operational measures for the dependent, independent, and control variables. The dependent variable is obesity. Obesity was calculated using the formula for height and weight. In the NHANES questionnaire, the measure is self-reported. Food insecurity, diet quality, and poverty are the independent variables. Food insecurity is operationalized as a binomial variable measured as ever food insecure and food secure. Respondents answered "always, usually, sometimes, rarely, never" when asked the question "How often in the past 12 months would you say you were worried or stressed about having enough money to buy nutritious meals? Diet quality is operationalized from a self-reported question on dietary behavior. Poverty is operationalized using family monthly poverty level.

Table 1

Description of Operational Measures for Key Independent and Dependent Variables

Variables	Description/Specific measures	Response category	Type of variable
SNAP Supplemental Nutrition Assistance Program	In the past 12 months did you or any member of your household receive food stamp benefits?	1 = Yes 0 = No	Binomial
Food Security	USDA Food Security Module	1 = Adult very low food security 2 = Adult low food security 3 = Adult marginal food security 4 = Adult full food security	Ordinal
Obesity	Body Mass Index (BMI) Derived from km/m^2	1 = BMI $\geq$ 30 0 =Everyone else	Binomial
Diet Quality	Self-reported dietary behavior	1 = Poor 2 = Fair 3 = Good 4 = Very Good 5 = Excellent	Ordinal
Gender	Participant's self-identified gender	1 = Male 2 = Female	Nominal
Age	Age in Years	1 = 18-24 2 = 25-34 3 = 35-44 4 = 45-54 6 = 55-64 7 = 65-older	Ordinal
Race Ethnicity	Group best represents race	1 = White 2 = Black or African American 3 = Hispanic White or Black 4 = Asian 6 = Other	Nominal
Education	Level of education	1 = less than 9^{th} grade 2 = 9^{th}-11^{th} grade 3 = High School graduate/GED 4 = Some College or AA Degree 5 = College graduate 6 = Post College Graduate	Nominal

Data Collection

NHANES is a continuous survey that uses complex multi-staging probability design. In 2013-2014, 14,332 individuals were selected from 30 survey locations. Of the individuals selected, 10,175 completed the interviews and 9,813 were examined.

To increase reliability, certain populations were oversampled including African Americans, Asians, Mexican Americans, low-income whites, older adults (80 and older) and pregnant women. A NHANES interviewer comes to the participant's home to conduct a household questionnaire. Family information such as occupation, smoking, demographics, and food consumption are asked. A sample person questionnaire is conducted, and information is collected on health insurance, medical history, dietary behavior, and weight history. Data concludes with a free health examination in the MEC. The entire health exam for an adult takes approximately 3.5 hours; however, examination time varies depending on the age of the participant.

Data Analysis Plan

The statistical analysis performed for this research study was conducted with SPSS software for windows (SPSS Version 25.0). The analytic approach most appropriate for the four research questions in this study was logistic regression.

Research Question 1. Is there an association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants controlling for socioeconomic and demographic factors?

$H_0$1: There is no association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_1$1: There is an association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

Statistical Plan for hypothesis 1: Independent Variable = Food Security. Dependent Variable = Obesity. Statistical Test: Logistic Regression

Control Variables = Gender and Education. Mediating Variable = Income. The null hypothesis was rejected if the significance level associated with the beta coefficient is $p <= .05$

Research Question 2. Is there an association between diet quality and obesity among adults participating in SNAP compared to nonparticipants controlling for socioeconomic and demographic variables?

$H_0$2: There is no association between diet quality and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_2$2: There is an association between diet quality and obesity among adults participating in SNAP compared to nonparticipants after adjusting socioeconomic and demographic factors.

Statistical Plan for Hypothesis 2: The Independent Variable = Diet Quality. The Dependent Variable = Obesity. Mediating Variable = Income. Statistical Test: Logistic Regression. The null hypothesis was rejected if the significance level associated with the beta coefficient is $p <= .05$

Research Question 3. Does poverty mediate the association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants controlling for socioeconomic and demographic variables?

$H_0$3: Poverty does not mediate the association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_3$3: Poverty does mediate the association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

Statistical Plan for Hypothesis 3: The Independent Variable = Income. The Dependent Variable = Obesity. Predictor Variable = Food Security. The statistical test was logistic regression. The null hypothesis was rejected if the significance level associated with the beta coefficient $p <= .05$.

Research Question 4. Is there an association between participating in SNAP, food insecurity, diet quality and obesity?

$H_0$4: There is no association between participating in SNAP, food insecurity, diet quality, and obesity adjusting for socioeconomic and demographic factors.

$H_4$4: There is an association between participating in SNAP, food insecurity, diet quality and obesity adjusting for socioeconomic and demographic factors.

Statistical plan for Hypothesis 4: The Independent Variable = Food Insecurity and Diet Quality. The Dependent Variable = Obesity. The statistical test was multivariate logistic regression. The null hypothesis was rejected if the significance level associated with the beta coefficient is $p <= .05$.

To determine whether a variable mediates or moderates an outcome the test to determine this is through multiple regression. Mediation means how an effect occurs. For example, what impact does A have on C, it is assumed A causes, B, and B causes C, (Holmbeck 2006).

Threats to Validity

Validity is the extent to which a test measures what it was intended to measure (Heale & Tywcross, 2015). The types of validity include content validity the extent to which a research instrument correctly measures all aspects of the construct. Construct validity is the extent to which the research instrument measures the construct it was intended to measure and criterion validity, the extent to which the research instrument is related to other instruments that measure the same variables (Heale & Twycross, 2015). There are two types of threats to validity that may impact a researcher's ability to conduct an intervention that affects an outcome. These threats are internal and external validity. Internal validity are the procedures, treatment, and experiences of the participant that threaten the researcher's ability to conclude with certainty the correct inferences from the data about the population under study and is only relevant when trying to establish a causal relationship (Creswell, 2009; Trochim, 2006). External validity threats occur when the researcher makes incorrect inferences from the sample data regarding other persons, other settings, and past or future situations. The threats the researcher generalizes goes beyond the groups in the experiment to other racial or social groups not in the study and the setting is not studied for past and future situations (Creswell, 2009).

Ethical Procedures

Secondary data collected by NCHS were obtained from NHANES a conglomeration of studies designed to assess the health and nutritional state of adults and children through interviews and physical examinations. Data were analyzed from NHANES 2013-2014 for adults ages 25-65 and older. Stiles and Boothroyd (2011) posits four principles must be employed when researchers are using administrative data. These principles include security, confidentiality, permission, and the appropriate use of data. The most critical of the four principles for the researcher is the appropriate use of data. Appropriate use of data means the researcher has sufficient capacity to access the data, ensure the data is valid, or able to answer the research question and understand under what circumstances the data was collected so research results are interpreted appropriately (Stiles and Boothroyd, 2011). Walden University's Institutional Review Board (IRB) approval was sought to ensure all research was in compliance with the ethical standards of human subject research and the IRB approval number is 05-31-18-0516608. With respect to NHANES, to protect personal information, numerous federal laws require all information collected be kept confidential. The federal laws to protect confidential information used by the NHANES are as follows: Section 308(d) of the Public Health Service Act (42 U.S.C. 242m), the Confidential Information Protection and Statistical Efficiency Act (CIPSEA, Title 5 of Public Law 107-347), and the Privacy Act of 1974 (5 U.S.C. 552a). In addition, each employee, contractor, research partner, and agent, takes a sworn oath to keep research participants information confidential. Consequences of violation of the oath may result in imprisonment, fines, or both. Last, the NCHS also complies with the Federal Cybersecurity Enhancement Act a federal law

to protect computer networks (CDC, n.d.). Results of this study will be shared with the dissertation committee and review boards.

Summary and Transition

The purpose of this research design and methodology chapter was to provide a roadmap for examining the impact of food assistance programs on the association between food insecurity, diet quality and obesity among U.S. adults. I used descriptive statistics and logistic regression to gain a better understanding of how the impact of food assistance programs may contribute to the association between food insecurity, diet quality and obesity in adults. The research design of this study utilized a quantitative cross-sectional approach using secondary data analysis to test the hypotheses. Information on participants of the 2013-2014 NHANES was utilized for this study. Data analyses was performed to examine the impact SNAP had on food insecurity, diet quality, and obesity. In Section 3, I present the study results and findings.

Section 3: Presentation of the Results and Findings

Introduction

The purpose of this study was to examine the association between participation in the SNAP program and obesity among adults in the United States. Each research question was designed to determine these associations. A description of the weighted characteristics of the sample and the results of each hypothesis tested are presented. The hypotheses for Research Questions 1-3 were tested using effect modification and multivariate logistic regression controlling for socioeconomic and demographic variables to evaluate if there was a relationship between food insecurity, diet quality, poverty, and obesity among adults participating in SNAP compared to NON-SNAP participants. The hypothesis for Research Question 4 was tested using multivariate logistic regression controlling for socioeconomic and demographic variables to evaluate if there was a relationship between food and insecurity and obesity among adults participating in SNAP compared to non-SNAP participants.

In this section, I present the results of the statistical analyses. The section is divided into three parts. In the first section, I describe the data management and descriptive analyses. In the second section, I describe the descriptive characteristics of the study population including the frequency distribution by demographic characteristics and bivariate analyses by obesity and snap participation strata. In the third section, I answer each of the research questions by testing the associated hypotheses.

Data Management and Descriptive Analyses

The data for this cross-sectional study was obtained from the NHANES 2013-2014 survey. NHANES uses a multistage, cross-sectional sampling design to collect data

on the health and nutritional status of a subset of adults and children in the United States. The subset of adults and children are representative of the civilian, non-institutionalized U.S. population. NCHS sponsors the survey gathering data through interviews, laboratory, and physical examinations (Nguyen et al., 2015).

Data Analysis Plan

The data analysis plan consisted of a four-part plan. The plan included (a) a missing value analysis; (b) univariate analysis to explore and describe the data; (c) bivariate analysis to identify associations (OR), potential effect modifiers, and confounders; and (d) multivariate analysis (logistic regression).

Management of Missing Data

The variables of interest were obesity (dependent variable), adult food security, diet quality, and SNAP participation status (independent variables). Covariates included gender, race, age, education, monthly family income, and family monthly poverty level. The original NHANES personal interview data resulted in 10,175 respondents. There was a pattern of missing data on diet, education, BMI, and income. People who have missing data, do not want to answer interview questions or do not handle responses accurately, are considered poor responders. The gender and age variables had complete data. In all, the missing data were as follows: There were 249 cases with missing data for BMI, one missing case for diet, 76 missing cases for adult food security; 275 missing cases for household income, seven missing cases for education, and no missing cases for gender, age, diet, and education.

Age and BMI were continuous variables and examined for outliers. Outliers can be caused by errors in data collection and recording, misreporting by participants,

sampling errors, research methodology, or misinterpretation of the distribution of data (Kovach & Ke, 2016). It is important to address outliers for several reasons including increasing error in variance and reducing the power of statistical tests. Identification of outliers may include estimating the data and/or examining data points, and if the data point is three or greater standard deviations the researcher may want to remove these data. To decide whether the data point should be removed, it must be determined why the outlier is in the data initially (Osborne & Overbay, 2004). Participants who were 80 years and older at the time of screening were "topcoded" as 80 years of age. There were no outliers for continuous age or BMI.

Univariate analysis was conducted on the missing values for the variables of age, BMI, race, education, diet, adult food security, household food stamp benefits and gender. In particular, there was a large number of missing values for household food stamp benefits (2417 missing cases or 41.9%). Next, the missing data were analyzed to determine whether they were Missing Completely at Random [MCAR], Missing at Random [MAR], or Not Missing at Random [NMAR]. The missing data pattern was not MCAR since the Little's MCAR test was significant [$\chi^2 = 774.072$, $df = 6$, $p < .000$] and multiple imputation could be conducted. Multiple imputation resulted in a reduction of missing data for household food stamp benefits (SNAP) from 41.9% to 7%. Figure 4 illustrates the results for multiple imputation.

Descriptive Characteristics of the Study Population

A univariate analysis was conducted to describe the study population. Females comprised the majority (52.2%), about a fourth (22.2%) were 65 years and older, and about a third had some college or an AA degree. Most study participants were not obese

(61.9%), considered themselves to have a good diet, were SNAP recipients (62.6%), and had very low food security (71.1%). Table 2 contains the demographic characteristics.

Table 2

Frequency Distribution of Demographic Characteristics and Adult Food Security

Characteristics	Frequency	Percent
Gender		
Male	16548	47.8
Female	18066	52.2
Obesity/BMI		
Not obese (BMI < 30)	21414	61.9
Obese BMI 30 and Greater	13200	38.1
Race/Ethnicity		
White	4602	13.3
Black African American	3048	8.8
Hispanic White or Black	14832	42.8
Asian	7062	20.4
Other	4002	11.6
Other/Multiracial	1068	3.1
Educational Level		
Less than 9th grade	2736	7.9
9th to 11th grade	4752	13.7
High School Graduate or/GED	7830	22.6
Some College AA Degree	10626	30.7
College Graduate	8670	25.0
Diet Quality		
Poor	2934	8.5
Fair	7206	20.8
Good	14784	42.7
Very Good	7872	22.7
Excellent	1818	5.3
Age		
20-24	3066	8.9
25-34	5826	16.8
35-44	6126	17.7
45-54	5784	16.7
55-64	5976	17.3
65 and older	7836	22.6
Adult Food Security		
Adult Very Low Food Security	24624	71.1
Adult Low Food Security	3564	10.3
Adult Marginal Food Security	3780	10.9
Adult Full Food Security	2446	7.6
HH Food Security Benefits		
Yes	20145	62.6
No	12047	37.4

Note. Weighted N to U.S. population, NHANES

A bivariate analysis was conducted with obesity as the dependent or outcome variable to identify potential associations among the independent or predictor variables and covariates. Females were more obese than males, and the most obese age group were individuals 35-44 years old. Individuals with some college education or an AA degree were more likely to be obese. Adults with marginal food security were the most obese, and those who considered they had an excellent diet were also the most obese. Key findings from the bivariate analysis were statistically significant at $p < .01$ and are shown in Table 3.

Table 3

Demographic Characteristics, Adult Food Security, SNAP Participant Status by Obesity

Key independent characteristics	Obesity %	Chi-square value	p-value
Gender		44.375	<.01
Male	33.7		
Female	42.2		
Age		39.545	<.01
18-24 years	27.6		
25-34 years	36.1		
35-44 years	41.9		
45-54 years	39.9		
55-64 years	41.7		
65 years and older	36.8		
Race		224.857	<.01
White	46.8		
Black or African American	36.8		
Hispanic White or Black	37.6		
Asian	47.3		
Other	14.5		
Education level		81.505	<.01
Less than 9th grade	38.6		
9th to 11th grade	41.0		
High School graduate/GED	41.1		
Some College or AA Degree	42.5		
College Graduate	28.3		
Monthly family income		32.936	<.01
$0 -- $1649	39.6		
$1650 -- $4599	42.3		
$4600 -- Highest	33.1		
Poverty level category		17.523	<.01
< 1.31	41.1		
1.31 to 1.85	41.9		
> 1.85	35.7		
Adult food security		40.135	<.01
Adult very low food security	35.7		
Adult low food security	41.2		
Adult marginal food security	46.3		
Adult full food security	45.1		
Diet quality		238.858	<.01
Poor	25.6		
Fair	26.2		
Good	37.3		
Very Good	51.8		
Excellent	53.1		
SNAP		41.604	<.01
Participant	41.3		
Non-Participant	30.4		

Multivariate Results

Research Questions 1 through 3 were answered using multivariate logistic regression including testing effect modification and controlling for socioeconomic and demographic variables. The reason for testing effect modification was to ensure confounding was eliminated. Effect modification was tested through interaction terms. Research Question 4 was tested with only multivariate logistic regression but no effect modification.

Research Questions and Hypotheses

Research Question 1. Is there an association between food insecurity and obesity among adults participating in SNAP compared to non-SNAP participants controlling for socioeconomic and demographic variables?

$H_0$1. There is no association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_1$1. There is an association between food insecurity and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

To answer Research Question 1, whether SNAP participation modified the effect of food insecurity on obesity, an interaction term between Adult Food Security*SNAP was created. The interactions were not significant; however, the interaction between full food security and SNAP participation was significant (p = .066; Table 4).

Table 4

Effect Modification of SNAP Participation Between Food Security and Obesity

Variables			Obesity (BMI ≥30)		
	X^2 Wald	*p* value	OR	95% CI for OR Lower	Upper
Adult Food Security					
Low food security	3.521	.178	1.369	.859	2.184
Marginal food security	13.870	.003	1.848	1.250	2.731
Full food security	10.947	.002	2.004	1.287	3.123
Household Food Security Beneficiary (SNAP)					
SNAP	35.671	.002	1.487	1.192	1.855
Adult Food Security*SNAP					
Low food security by SNAP	1.435	.527	.830	.452	1.525
Marginal food security by	2.813	.200	.734	.455	1.185
Full food security by SNAP	4.050	.066	.620	.372	1.032

Note. *Adult Food Security SNAP Interaction Variable

SNAP participation modified the effect of adult food security on obesity; however, since the *p* -value for the interaction between full food security and SNAP showed a marginal association, I assumed that SNAP participation modified the effect of food security on obesity and reported multivariate logistic regression results by SNAP participation strata.

Next, multivariate logistic regression was conducted with the predictor variable adult food security and the outcome variable obesity including both SNAP and NON-SNAP participants and controlling for socioeconomic and demographic variables. There is evidence that SNAP modifies the effect of adult food security and obesity in the category full food security controlling for socioeconomic and demographic variables. Table 5 shows there is no association between full food security category (OR= 1.091,

95%CI 0.846-1.405, p = .503) in SNAP strata obesity. An association was found between full food security and obesity in the NON-SNAP strata (OR = 1.648, 95%CI 1.014-2.677, p = .044). An association was found association between marginal food security and obesity in both the SNAP strata (SNAP: OR = 1.283 95%CI 1.020-1.613, p = .033) compared to NON-SNAP (OR = 1.536 95%CI 1.015-2.325, p = .042).

In summary, the null hypothesis was not rejected. SNAP does modify the effect of adult food security and obesity in the participants who reported having full food security compared to very low food security controlling for socioeconomic and demographic variables. In addition, in both SNAP and NON-SNAP participants, there was an association between marginal food security and obesity.

Table 5

Multivariate Logistic Regression Adult Food Security Among SNAP and NON-SNAP Participants and Obesity

	SNAP Obesity (BMI ≥30)					NON-SNAP Obesity (BMI ≥30)				
				95% CI for OR					95% CI for OR	
	X^2	*p*	OR	Lower	Upper	X^2	*p*	OR	Lower	Upper
Crude										
Adult Food										
Low food	1.704	.291	1.137	.894	1.446	3.521	.178	1.369	.859	2.184
Marginal food	9.073	.005*	1.357	1.099	1.676	13.870	.003*	1.848	1.250	2.731
Full food	3.505	.067	1.242	.985	1.566	10.947	.002*	2.004	1.287	3.123
Adjusted										
Adult Food										
Low food	0.212	.825	1.029	.800	1.322	0.825	.589	1.138	.703	1.842
Marginal food	4.960	.033*	1.283	1.020	1.613	5.634	.042*	1.536	1.015	2.325
Full food	0.490	.503	1.091	.846	1.405	4.737	.044*	1.648	1.014	2.677
Gender										
Male	41.944	.000	.632	.545	.734	5.678	.052	.796	.632	1.002
Age										
25-34 years	19.613	.000	1.896	1.390	2.586	2.074	.288	1.380	.754	2.527
35-44 years	33.436	.000	2.322	1.697	3.177	10.110	.014	2.075	1.172	3.675
45-54 years	28.323	.000	2.192	1.621	2.962	5.895	.040	1.754	1.026	2.999
55-64 years	36.542	.000	2.429	1.754	3.364	9.714	.018	2.053	1.142	3.691
65 years and	16.841	.000	1.801	1.349	2.405	6.182	.027	1.762	1.066	2.913
Race										
Black or African	10.624	.006	.632	.456	.875	4.827	.088	.599	.332	1.083
Hispanic	6.738	.016	.748	.591	.947	7.696	.010	.630	.443	.895
White or Asian	0.159	.967	1.006	.771	1.312	0.244	.889	.971	.639	1.476
Other	68.153	.000	.231	.161	.333	54.782	.000	.179	.109	.293
Education level										
9th to 11th	0.232	.701	1.060	.788	1.426	0.347	.847	1.074	.512	2.256
High School	1.724	.207	1.197	.905	1.584	0.526	.615	1.181	.614	2.273
Some College	2.466	.659	.928	.664	1.296	2.087	.316	1.441	.694	2.992
College	0.272	.659	.928	.664	1.296	0.414	.730	.888	.446	1.768
Poverty level										
1.31 to 1.85	1.675	.222	1.148	.919	1.433	3.430	.131	1.356	.911	2.019
> 1.85	0.072	.919	1.009	.845	1.205	3.377	.131	1.282	.926	1.775

Note: *Associations were found

Research Question 2. Is there an association between diet quality and obesity among adults participating in SNAP compared to non-participants controlling for socioeconomic and demographic variables?

$H_0$2. There is no association between diet quality and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

$H_2$2. There is an association between diet quality and obesity among adults participating in SNAP compared to nonparticipants after adjusting for socioeconomic and demographic factors.

To answer Research Question 2, I tested whether SNAP participation modified the effect of diet quality on obesity. I created the Diet Quality*SNAP variable to test if SNAP modified the effect of diet quality on obesity. Results indicated, there was no significant association between variables (Fair*SNAP p = .344, Good*SNAP p = .245, Very good*SNAP p = .410, excellent*SNAP p = .281). Table 6 shows participation in SNAP does not modify the effect of the association between diet quality and obesity.

Table 6

Multivariate Logistic Regression Testing Effect Modification Between Diet Quality and Obesity

Variables			Obesity (BMI ≥30)		
				95% CI for OR	
	X^2 Wald	p value	OR	Lower	Upper
Diet Quality					
Fair	1.368	.286	1.276	.814	2.000
Good	13.672	.000	2.113	1.406	3.175
Very good	37.173	.000	3.647	2.330	5.708
Excellent	25.576	.000	4.389	2.261	8.519
Household Food Security Beneficiary					
SNAP	6.307	.013	1.768	1.130	2.767
Diet Quality*SNAP					
Fair by SNAP	1.221	.344	.760	.429	1.346
Good by SNAP	1.503	.245	.746	.454	1.224
Very good by SNAP	0.963	.410	.793	.455	1.382
Excellent by SNAP	1.909	.281	.641	.283	1.454

Footnote: *Diet Quality SNAP Interaction Variable

Multivariate logistic regression was conducted between the predictor variable diet quality and the outcome variable obesity to test the hypothesis for Research Question 2 controlling for socioeconomic and demographic variables. The results indicated there was an association between good diet, very good diet, and excellent diet (good diet: *OR* = 1.562 95% CI 1.182-2.065, $p < .01$; very good diet: *OR* = 2.881 95% CI 2.136-3.887, $p < .01$; excellent diet: *OR*= 2.666 95%CI 1.794-3.962, $p < .01$) compared to NON-SNAP (good diet: *OR* = 2.162 95%CI 1.408-3.319, $p < .01$; very good diet: *OR* = 3.53795%CI 2.225-5.624, $p < .01$ and excellent diet: *OR* = 3.85795% CI 1.883-7.901.Table 7 shows the results of the logistic regression model for diet quality, SNAP and NON-SNAP participation, and obesity.

In summary, the null hypothesis was rejected. There is an association between diet quality, and obesity, although this association was not modified by SNAP controlling for socioeconomic and demographic variables.

Table 7

Multivariate Logistic Regression and Diet Quality Among SNAP and NON-SNAP Participants and Obesity

	SNAP Obesity (BMI ≥30)					NON-SNAP Obesity (BMI ≥30)				
			OR	95% CI for OR				OR	95% CI for OR	
	X^2 Wald	P		Lower	Upper	X^2	P		Lower	Upper
CRUDE										
Diet Quality										
Fair	.122	.847	.970	.711	1.323	.206	.286	1.276	.814	2.000
Good	7.242	.001	1.575	1.204	2.060	10.329	.000	2.113	1.406	3.175
Very good	61.638	.000	2.891	2.168	3.856	30.601	.000	3.647	2.330	5.708
Excellent	23.803	.000	2.815	1.928	4.109	20.268	.000	4.389	2.261	8.519
ADJUSTED										
Diet Quality										
Fair	.000	.876	.975	.707	1.343	.890	.228	1.331	.835	2.120
Good	7.932	.002	1.562	1.182	2.065	9.975	.000	2.162	1.408	3.319
Very good	52.136	.000	2.881	2.136	3.887	25.775	.000	3.537	2.225	5.624
Excellent	19.619	.000	2.666	1.794	3.962	10.849	.000	3.857	1.883	7.901
Gender										
Male	34.687	.000	.623	.535	.726	3.724	.018	.752	.594	.951
Age										
25-34 years	13.441	.000	2.018	1.474	2.762	.033	.367	1.324	.709	2.472
35-44 years	17.957	.000	2.474	1.803	3.395	2.967	.018	2.041	1.138	3.662
45-54 years	15.401	.000	2.404	1.772	3.262	1.540	.032	1.811	1.056	3.108
55-64 years	18.274	.000	2.685	1.935	3.727	2.891	.014	2.116	1.173	3.818
65 years and	10.441	.000	2.216	1.648	2.980	3.113	.009	1.973	1.185	3.285
Race										
Black or	3.001	.018	.669	.481	.933	.406	.280	.715	.384	1.331
Hispanic White	1.503	.108	.822	.648	1.044	4.274	.073	.716	.497	1.032
Asian	.003	.584	1.078	.823	1.412	.127	.743	1.072	.701	1.640
Other	18.008	.000	.282	.194	.410	26.721	.000	.206	.123	.346
Education level										
9th to 11th	.146	.549	1.096	.813	1.477	.010	.868	1.065	.500	2.269
High School	.367	.153	1.234	.925	1.646	.593	.657	1.164	.590	2.297
Some College	1.322	.098	1.315	.950	1.821	2.196	.301	1.479	.691	3.169
College		.628	1.087	.776	1.523		.892	.954	.477	1.908
Graduate	.008					.003				
Poverty level										
1.31 to 1.85	.719	.306	1.127	.895	1.419	2.836	.137	1.376	.899	2.105
> 1.85	.091	.881	1.013	.855	1.200	4.036	.132	1.269	.929	1.734

Research Question 3. Does poverty mediate the association between food insecurity and obesity among adults participating in SNAP compared to non-participants controlling for socioeconomic and demographic variables?

$H_0$3. Poverty does not mediate the association between food insecurity and obesity among adults participating in SNAP compared to non-participants after adjusting for other risk factors.

$H_3$3. Poverty does mediate the association between food insecurity and obesity among adults participating in SNAP compared to non-participants after adjusting for other risk factors.

To answer Research Question 3, I tested whether Adult Food Security modifies the effect of poverty on obesity. I created the Adult Food Security*Poverty variable to test if Adult Food Security modified the effect of poverty on obesity among adults participating in SNAP compared to NON-SNAP participants. I found a significant interaction between full food security and poverty level > 1.85 (p = .031). There is evidence that the poverty level > 1.85 modifies the association between full food security and obesity. Table 8 shows the results of the logistic regression model testing effect modification.

Table 8

Multivariate Logistic Regression Testing Effect Modification of Poverty on Obesity

Predictors			Obesity (BMI ≥30)		
			OR	95% CI for OR	
	X^2 Wald	P value		Lower	Upper
Adult Food Security					
Low food security	0.603	.450	1.103	.855	1.423
Marginal food security	6.852	.010	1.366	1.078	1.730
Full food security	8.848	.003	1.485	1.141	1.934
Poverty level category					
1.31 to 1.85	0.926	.343	1.111	.894	1.379
> 1.85	3.224	.077	.869	.743	1.015
Adult Food Security * Poverty level					
Low food security*1.31 to 1.85	0.086	.825	.942	.553	1.605
Low food security*> 1.85	1.795	.213	1.324	.850	2.063
Marginal food security*1.31 to 1.85	0.047	.947	.981	.555	1.734
Marginal food security*> 1.85	2.711	.129	1.411	.904	2.202
Full food security*1.31 to 1.85	0.120	.784	1.081	.620	1.884
Full food security*> 1.85	4.763	.031*	.472	.239	.934

Note: Adult Food Security Poverty Variable and association of Full Food Security*> 1.85

Several multivariate logistic regressions were conducted stratified by SNAP and NON-SNAP and poverty levels. Results were stratified by poverty level category adjusting for demographic and socioeconomic variables by SNAP and NON-SNAP. No associations were found in the SNAP strata in the poverty levels < 1.31 and 1.31 to 1.85. The multivariate analysis further showed there were no significant interactions in the NON-SNAP strata for poverty levels < 1.31 and 1.31 to 1.85.

Finally, an association was found between marginal food security and obesity in poverty level > 1.85 compared to very low food security in the NON-SNAP category compared to the SNAP category controlling for socioeconomic and demographic variables. The results showed (SNAP: *OR* = 1.652 95%CI 0.984-2.774, $p = 0.058$ compared to (NON-SNAP: *OR* = 1.932 95%CI 1.022-3.653, $p = 0.043$). Table 9 shows the result for the multivariate logistic regression poverty level > 1.85. In summary the

null hypothesis was rejected. There is evidence that the poverty level category (> 1.85) is associated with marginal food security and obesity in NON-SNAP participants compared to SNAP participants.

Table 9

Multivariate Logistic Regression Results for Poverty Level Category >1.85 Stratified by SNAP

	SNAP Obesity (BMI ≥30)					NON-SNAP Obesity (BMI ≥30)				
			OR	95% CI for OR				OR	95% CI for OR	
	X^2	P		Lower	Upper	X^2	P		Lower	Upper
CRUDE										
Adult Food										
Low food security	0.891	.483	1.205	.711	2.041	5.452	.083	1.815	.921	3.575
Marginal food	5.034	.050*	1.677	.999	2.815	8.904	.011*	2.202	1.206	4.022
Full food security	3.993	.058	.465	.210	1.026	0.890	.502	1.642	.373	7.236
ADJUSTED										
Adult Food										
Low food	0.915	.538	1.200	.662	2.177	1.994	.337	1.417	.681	2.950
Marginal food	4.086	.058	1.652	.984	2.774	5.480	.043*	1.932	1.022	3.653
Full food	3.268	.088	.489	.215	1.111	0.377	.829	1.182	.246	5.668
Gender										
Male	4.815	.041	.782	.618	.990	0.605	.539	.921	.707	1.200
Age										
25-34 years	2.983	.112	1.554	.902	2.677	1.142	.353	1.414	.679	2.947
35-44 years	6.777	.038	1.925	1.038	3.570	4.904	.072	2.039	.935	4.447
45-54 years	12.072	.004	2.381	1.327	4.270	1.367	.355	1.428	.665	3.065
55-64 years	14.700	.002	2.611	1.440	4.735	4.856	.103	2.011	.861	4.699
65 years and	5.803	.025	1.800	1.076	3.011	2.506	.183	1.649	.786	3.460
Race										
Black or African	6.543	.060	.542	.285	1.028	1.371	.414	.729	.335	1.583
Hispanic White	7.229	.030	.588	.364	.949	3.428	.145	.662	.378	1.160
Asian	0.534	.777	.924	.523	1.632	0.432	.855	1.061	.549	2.051
Other	37.981	.000	.183	.096	.350	29.115	.000	.213	.107	.428
Education level										
9th to 11th	1.861	.188	1.553	.807	2.987	0.411	.958	.961	.208	4.431
High School	3.629	.065	1.778	.964	3.280	0.663	.546	.689	.203	2.333
Some College	4.304	.056	1.837	.985	3.427	0.397	.771	.831	.233	2.961
College	1.331	.270	1.428	.758	2.690	1.246	.357	.578	.178	1.873

Note. *Associations found

Research Question 4. Is there an association between participating in SNAP, food insecurity, diet quality, and obesity?

$H_0$4. There is no association between participating in SNAP, food insecurity, diet quality and obesity adjusting for other risk factors.

$H_4$4. There is an association between participating in SNAP, food insecurity, diet quality and obesity adjusting for other risk factors.

To answer Research Question 4, multivariate logistic regression was conducted. In summary, SNAP is associated with obesity (*OR* = 1.298 95%CI 1.054-1.597, p = 0.018) controlling for adult food security diet quality, gender, age, race, education, and poverty level. In addition, adult food security is associated with obesity (marginal food security: *OR* = 1.245 95%CI 1.028-1.507, p = 0.025) adjusted by SNAP, diet quality, gender, age, race, education, and poverty level. Finally, diet quality is associated with obesity (Good: *OR* = 1.721 95%CI 1.369-2.163, $p < 0.01$; Very good: *OR* = 2.990 95%CI 2.342-3.817, $p < 0.01$; Excellent: *OR* = 2.918 95%CI 2.122-4.014, $p < 0.01$) compared to poor diet quality adjusted by SNAP, adult food security, gender, age, race, education, and poverty level. In summary, the null hypothesis was rejected. There is an association between participating in SNAP, food insecurity, diet quality and obesity controlling for socioeconomic and demographic variables. Table 10 shows the results.

Table 10

Multivariate Logistic Regression by SNAP

Predictors	X^2 Wald	P value	OR	Obesity (BMI ≥30) 95% CI for OR Lower	Upper
Household Food Security Beneficiary SNAP	16.517	.018	1.298	1.054	1.597
Adult Food Security					
Low food security	0.015	.907	1.012	.833	1.228
Marginal food security	5.041	.025	1.245	1.028	1.507
Full food security	0.229	.634	1.056	.845	1.318
Diet Quality					
Fair	0.280	.597	1.070	.833	1.374
Good	21.604	.000	1.721	1.369	2.163
Very good	77.535	.000	2.990	2.342	3.817
Excellent	43.454	.000	2.918	2.122	4.014
Gender					
Male	47.764	.000	.668	.596	.750
Age					
25-34 years	22.262	.000	1.811	1.415	2.318
35-44 years	48.536	.000	2.383	1.866	3.044
45-54 years	39.947	.000	2.218	1.732	2.841
55-64 years	55.856	.000	2.561	1.998	3.283
65 years and older	41.279	.000	2.216	1.737	2.827
Race					
Black or African American	10.301	.001	.671	.525	.858
Hispanic White or Black	5.601	.019	.799	.662	.964
Asian	0.712	.404	1.090	.891	1.333
Other	93.800	.000	.253	.191	.334
7 (?)	1.643	.201	.792	.553	1.132
Education level					
9th to 11th grade	0.452	.504	1.093	.843	1.416
High School graduate/GED	2.652	.107	1.229	.957	1.578
Some College or AA Degree	7.038	.009	1.395	1.088	1.788
College Graduate	0.097	.831	1.031	.778	1.367
Poverty level category					
1.31 to 1.85	4.469	.039	1.214	1.010	1.459
> 1.85	1.937	.170	1.108	.957	1.282

Summary of Results

The purpose of this study was to examine the association between participation in SNAP, food insecurity, diet quality, poverty, and obesity among adults in the United States controlling for socioeconomic and demographic variables. Results indicated SNAP modifies the effect of adult food security and obesity in participants who reported having full food security compared to very low food security. In both SNAP and NON-SNAP participants, there was an association between marginal food security and obesity. There was also an association between diet quality and obesity, although SNAP did not modify this association. There is evidence that the poverty level category (> 1.85) is associated with marginal food security and obesity in NON-SNAP compared to SNAP. Finally, there is an association between participating in SNAP, food insecurity, diet quality, and obesity controlling for socioeconomic and demographic variables. Moreover, all four of the null hypotheses were rejected. The interpretation of the results of this study are presented in Section 4 including the limitations of the study, recommendations, implications for professional practice, social change, and the conclusion.

Section 4: Application to Professional Proactive and Implications for Social Change

Introduction

The purpose of this study was to examine the association between the indirect effect of predisposing factors on food insecurity, diet quality, and obesity among adults participating in SNAP. I examined these associations from data obtained from the NHANES 2013-2014 dataset utilizing SPSS Version 25. Interpretation of the research findings, limitations, and recommendations of the study results, as well as implications for social change, and the conclusion are presented below.

Interpretation of Findings

Research Question 1. Is there an association between food insecurity and obesity among adults participating in SNAP compared to NON-SNAP participants controlling for socioeconomic and demographic variables? SNAP modifies the effect of adult food security and obesity in the participants who reported having full food security compared to very low food security controlling for socioeconomic and demographic variables, and in both SNAP and NON-SNAP participants, there was an association between marginal food security and obesity. The null hypothesis was rejected.

In general, cross-sectional studies have found a sub-population of Food Stamp Program participants that were at an increased risk for obesity particularly women who were long term users of the program. However, it was noted that cross-sectional studies are unable to control for selection bias and confounding variables (DeBono et al., 2012). Longitudinal studies have been able to control for selection bias, SES, and demographic characteristics. Food stamp participation was associated with weight gain and obesity among women but not men (DeBono et al., 2012). Studies have shown that SNAP

participation had mixed results and SNAP may have the unintended consequence of contributing to obesity. A cross-sectional study was conducted to estimate the effect SNAP had on the food security and the effect of self-selection among current SNAP recipients and recent leavers using cross-sectional survey data from the Current Population Survey Food Security Supplements (CP-FSS). This survey was used in December of each year from 2001 to 2009 and adjusted for economic and demographic differences. Multivariate logistic regression was also utilized (Nord, 2011). Bivariate associations were assessed by cross-tabulating household food security status and SNAP status in the 30-day period before the food survey and logistic regression models were estimated with very low food security during the 30-day period before the food survey. The odds of very low food security among households that remained on SNAP until the end of the survey year were 28% lower compared to those who left SNAP prior to the 30-day period. When food security was assessed and in 2-year panels controlling for severity of food insecurity in the prior year, the difference in the odds was 45% (Nord, 2011). A cross-sectional study was conducted utilizing a food insecurity questionnaire measuring food stress from data in the 2009 Behavioral Risk Factor Surveillance System in 12 states in the U.S. (n = 66,553; Pan et al., 2012). Weight gain was measured by BMI and calculated based on self-reports of weight and height. Weight status was defined as underweight, BMI <18.5; normal weight BMI 18.5-24.9; overweight, BMI 25.0-29.9; and obesity, BMI $\geq$30.0. The prevalence of obesity was 27.1% overall, 25.2% among food secure adults and 35.1% among food insecure adults; ($p < 0.0001$; Pan et al., 2012). Furthermore, food insecure adults had 32% increased odds of being obese compared to food secure adults (Pan et al., 2012). The population subgroups with the highest

prevalence of obesity were adults 30 years and older, women, non-Hispanic whites, non-Hispanic blacks, adults with some college education or a college degree, and a household income of less than $25,000 or $50,000-$74,999 (Pan et al., 2012). Food insecurity is a public health issue, and individuals who reside in households that are food insecure have poorer diets, increased abdominal fat, and weight gain (Lee et al., 2012; Morales & Berkowitz, 2016). Food insecure means the inability to obtain adequate food because of limited resources (Coleman-Jensen et al., 2016). The association between household food insecurity and weight gain is inconclusive.

Research Question 2. Is an association between diet quality and obesity among SNAP participants and NON-SNAP participants controlling for socioeconomic and demographic variables? The results indicated that there was an association between diet quality and obesity when compared to poor diet There is an association between diet quality and obesity among SNAP and NON-SNAP participants.

The null hypothesis was rejected. It is not fully understood how participation in the SNAP program may increase obesity (Hilmers et al., 2014). Data from the CSFII from 1994-2004 showed SNAP participants compared to nonparticipants consumed more calories from fats, alcohol, and added sugars and made less healthy food choices. For example, low-income Hispanic adult women who participated in SNAP were at an increased risk for poor diet quality and obesity because they consumed a less healthy diet. Hispanic SNAP participants consumed 26% higher amounts of sugar sweetened beverages, ($p = 0.08$) and 38% higher amounts of desserts ($p = 0.09$) compared to non-participants (Hilmers et al., 2014). In addition, SNAP participants also consumed 17%

more sugars and 36% fewer servings of whole grains and higher intakes of energy dense foods compared to nonparticipants (Hilmers et al., 2014).

A systematic review of 25 studies on diet quality of Americans who participated in SNAP further substantiated low diet quality among SNAP participants (Andreyeva et al., 2015). Daily calories, macronutrient and micronutrient intake did not differ from income eligible nonparticipants, but diet quality did (Andreyeva et al., 2015). Adults in SNAP scored lower on the HEI compared to nonparticipants (SNAP HEI Score 49.5, nonparticipants' HEI Score 50.50) and the one area where SNAP participants did better than nonparticipants was their consumption of less sodium and saturated fat (Gregory et al., 2013).

Research Question 3.Does poverty mediate the association between food insecurity and obesity among adults participating in SNAP compared to NON-SNAP participants controlling for socioeconomic and demographic variables? Poverty does mediate the association between food insecurity and obesity among adults participating in SNAP compared to NON-SNAP participants. I found evidence that poverty level mediates the association between marginal food security and obesity in NON-SNAP participants compared to SNAP participants. The null hypothesis was rejected. It has been well documented that the association between poverty and obesity may be mediated by low-cost palatable energy-dense foods (Drewnowski, 2009). It has been hypothesized that over consumption of inexpensive, energy-dense, nutrient-poor foods may contribute to obesity (Drewnowski & Specter, 2004).The relationship between food assistance programs and obesity is not fully understood and studies have been conducted to examine

whether participation in the Food Stamp Program also known as SNAP contributes to obesity among its participants (Gibson, 2003; Townsend et al., 2001).

Research Question 4. Is there an association between participation in SNAP food security diet quality and obesity? There is an association between participating in SNAP, food insecurity, diet quality, and obesity adjusting for other risk factors. The null hypothesis was rejected. Cross-sectional studies identified sub-populations of SNAP recipients (women) who were likely to be obese if they were long-term users of the SNAP, however, longitudinal studies found women who were on food stamps were more likely to be obese than men (DeBono et al., 2012). There is an association between participation in SNAP and obesity, but, the results of this association are inconclusive.

The relationship between food assistance programs and obesity is not fully understood and studies have been conducted to examine whether participation in the Food Stamp Program also known as SNAP contributes to obesity among its participants (Townsend et al., 2001; Gibson, 2003). The findings of a systematic review of the Food Stamp Program and obesity were inconsistent (DeBono et al., 2012). In general, cross-sectional studies found a sub-population of Food Stamp Program participants were at an increased risk for obesity particularly women who were long-term users of the program. However, it was noted that cross-sectional studies are unable to control for selection bias and confounding variables (DeBono et al., 2012). Longitudinal studies were able to control for selection bias, SES, and demographic characteristics. Food stamp participation was associated with weight gain and obesity among women but not men (DeBono et al., 2012). A cross-sectional analysis was conducted with SNAP participants to determine whether SNAP participation was associated with adiposity and metabolic

risk factors. Individuals who had participated in SNAP within the previous 12 months were positively associated with increased waist circumference in men and women, metabolic risk factors including elevated triglycerides, lower HDL cholesterol, and metabolic syndrome (Leung et al., 2012). The purpose of SNAP is to increase food security and decrease hunger (McGuire, 2013). Studies have shown SNAP had mixed results and SNAP may have the unintended consequence of contributing to obesity in certain sub-populations.

Limitations of the Study

There are several limitations to this study. These limitations include the nature of cross-sectional studies and causality, the use of self-reported data, and the complexity of the relationships between food insecurity, diet quality, poverty, and obesity related to SNAP participation are discussed. The data for the current study was obtained from NHANES 2013-2014. NHANES is a multistage, cross sectional group of studies designed to evaluate the health and nutritional status of adults and children in the United States. It is noted that cross-sectional studies are not able to control for selection bias and confounding variables (DeBono et al., 2012). Since selection of more needy households are enrolled in SNAP, it is difficult to determine causality between SNAP participation and food insecurity Ratcliff et al. (2011).

Another limitation to this study was the use of self-reported data. NHANES utilized interviews and physical examinations to access the health of the U.S. population. Study participants may not understand questions or do not accurately remember times or dates of information and this can lead to inaccurate information or response bias.

Self-reported data is utilized in behavioral and health research and response bias can be a problem particularly in the evaluation of programs and research (Rosenman, Tennekoon & Hill, 2011).

One other limitation of significance of the current study is the complexity of the relationships between SNAP participation, food insecurity, diet quality, poverty, and obesity. It is clearly reiterated over and over in the literature that the evidence is inconclusive related to food insecurity, SNAP participation, and obesity.

Recommendations

The current study sheds light on the need for further studies to address in tandem the complexity of the relationship between food insecurity, diet quality, poverty, and obesity related to SNAP participation. The majority of the studies were conducted separately and examined one or two independent variables and one dependent variable. For example, SNAP participation and diet quality, SNAP and poverty, food stamp participation and obesity, or food insecurity and obesity. I recommend further studies are needed to examine the relationship between food insecurity, SNAP participation, diet quality, poverty, and obesity.

In addition, the various studies conducted were mainly cross-sectional and many of the results were inconclusive. It was noted that cross-sectional studies are unable to control for selection bias and confounding variables (DeBono et al., 2012). The disadvantages of cross-sectional studies are causation cannot be determined and rare conditions cannot be studied (Mann, 2003). I also recommend more longitudinal studies be conducted to address this issue. Some longitudinal studies were able to control for selection bias, SES, and demographic characteristics (DeBono et al., 2012).

Implications for Professional Practice and Social Change

Obesity continues to be an issue in the United States and from 2013-2019 over thirty states had substantial increases in adult obesity (Trust for America's Health, 2019). Food insecurity also continues to be an issue with over 37 million Americans being food insecure (Hunger and Health Feeding America, 2018). It has been well documented that low-income communities have more fast-food chains and convenience stores versus full-service grocery stores compared to higher-income communities that have better restaurants and grocery stores (Drewnowski, 2009). Socioeconomic factors impact diet and health including access to healthy foods. As income decreases, energy dense foods of poor nutritional value are more affordable, and the highest rates of obesity are found among disadvantaged populations. Low income individuals who qualify for SNAP may benefit from full-service grocery stores with healthier food options. Also, SNAP participants may benefit from incentive programs such as Wholesome Wave that doubles the value of SNAP benefits when fresh fruits or vegetables are purchased to encourage healthier food choices.

In addition, urban gardening and mobile farmer's markets are springing up in lower income communities. SNAP recipients are able to purchase items from mobile farmers markets and are also taught how to grow vegetables for individual consumption.

Conclusion

This study examined the association between participation in SNAP food insecurity diet quality poverty and obesity. Examination of the impact SNAP may have on food insecurity, diet quality, and obesity may contribute to improving food assistance programs and interventions targeted at addressing obesity among adults participating in

SNAP. This study is important because of the rates of obesity among adults in the United States. One third of adults are overweight and two thirds of adults are overweight or obese according to data from the 2013-2014 NHANES. One third of men are overweight and one fourth of women are overweight (NIDDKD, n.d.). Obesity is higher among women with 40% of women who are obese compared to 35% of men. Furthermore, 3 in 4 men (73.7%) are obese or overweight compared to 2 in 3 women (66.9%) who are considered obese or overweight (NIDDKD, n.d.).

Results indicated SNAP modifies the effect of adult food security and obesity in participants who reported having full food security compared to very low food security. There is an association between diet quality and obesity, although this association was not modified by SNAP compared to poor diet (reference category. There is also evidence that the poverty level category (> 1.85) is associated with marginal food security and obesity in NON-SNAP compared to SNAP. Finally, there is an association between participating in SNAP, food insecurity, diet quality, and obesity controlling for socioeconomic and demographic variables. The social change implications of this study may include support for policies and programs to improve the nutritional impact of SNAP and targeted interventions to address food insecurity in low-income adults.

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