2021

The Combined Impact of Race and Education on Obesity Among U.S. Adults by Fidelis Okoye

Fidelis Chidi Okoye
Walden University

Walden University

College of Health Professions

This is to certify that the doctoral dissertation by

Fidelis Okoye

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Vasileios Margaritis, Committee Chairperson, Public Health Faculty
Dr. Srikanta Banerjee, Committee Member, Public Health Faculty
Dr. James Rohrer, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2021

Abstract

The Combined Impact of Race and Education on Obesity Among U.S. Adults

by

Fidelis Okoye

MA, Walden University, 2009

BS, Marygrove College, 2001

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2021

Abstract

Obesity has reached epidemic proportions worldwide and is associated with several chronic diseases including cardiovascular disease, cancer, and diabetes, which are the major causes of morbidity, disability, and mortality. Although many researchers have investigated the impact of sociodemographic factors on obesity, there is a paucity of studies on the combined impact of race and education on obesity among U.S. adults. The aim of this cross-sectional study was to first assess the impact of education and race on obesity, as separate variables, controlled for age, gender, healthy diet, and physical activity, and then to investigate the combined impact of race and education (interaction variable) on obesity adjusted for the same control variables and report potential differences between the two different approaches of analysis. The social ecological model was the theoretical framework of this study. Data from 9,971 adults who completed the National Health and Nutrition Examination Survey 2015-2016 were analyzed. Regression analyses revealed that race and education level were statistically significant predictors of obesity, but the education and race interaction effect was not statistically significant. In addition, gender, age, and diet healthiness were significant predictors of obesity. Positive social change may be achieved by developing better policies that make education and healthy diet more accessible to everyone to reduce educational inequalities and help lower the odds of obesity and relevant poor health outcomes.

The Combined Impact of Race and Education on Obesity Among U.S. Adults

by

Fidelis Okoye

MA, Walden University, 2009

BS, Marygrove College, 2001

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2021

Dedication

This dissertation is dedicated to public health, epidemiology researchers and their mentors. My work is dedicated to public health scientists who are formally trained as such and provide the evidence on which we build our professional practice and to aspiring epidemiology researchers in the public health sciences who know there must be a better way and who take actions to test their hypotheses.

My dissertation is also dedicated to the mentors who turn aspiring public health scientists, epidemiologists, and scholars into competent public health professionals and epidemiologists by the example they set, by offering the needed support, and by sharing their knowledge.

Acknowledgments

It is without hesitation that I acknowledge those that supported me through the rigorous process of writing and researching this significant topic. I truly believe that without the collaborative support of those around me the words in this document would never have come together.

First, I would like to acknowledge my family for their contributions to my being here and continuing my academic progress in my doctoral degree. My wife and children showed true confidence in me during those times when I fell short. Their love and compassion for me during times when I could not be available to lend the same level of support will forever inspire me that I can accomplish all things I put my mind to.

Second, I would like to thank my friends for their understanding of my academic endeavors and my limited availability during critical time periods in their lives. For all the weddings, birthdays, celebrations, and paramount moments in their lives that I have missed, I thank those that continued to support me while I pursued this dream of mine. Each one has helped me through utmost difficulty, and I will never forget the strength instilled in me to pursue my goals in completing this research.

Lastly, I would like to thank Dr. Vasileios Margaritis, my able chair; my committee member, Dr. Srikanta Banerjee; and Dr. James Rohrer, my URR member, for their edication to this project. It was by his grace that I was given the privilege to work with them, and this is something I will never forget. I cannot imagine the workload that Dr. Vasileios Margaritis has in his professional career; to guide me through this process is a gift that I will cherish forever. He has fulfilled a vital academic need of mine, and I

hope to always seek guidance in my professional career from him and other staff here at the university.

Table of Contents

List of Tables

Chapter 1: Introduction to the Study

Obesity is defined as abnormal or excessive fat accumulation in the body that may lead to health challenges (Centers for Disease Control and Prevention [CDC], 2014). Obesity is usually assessed by using body mass index (BMI), which, for adults, is calculated by taking the weight in kilograms of an individual and dividing it by their height in meters squared: BMI = total weight (kg)/height^2 (in m^2). Four body composition categories, based upon BMI measurement, have been established: underweight, normal weight, overweight, and obese (CDC, 2014). Individuals are considered underweight if their BMI is in the range of 15 to 19.9, normal weight if the BMI is 20 to 24.9, overweight if the BMI is 25 to 29.9, and obese if the BMI is 30 or higher (CDC, 2014).

I examined the relationship between level of education and obesity for the different racial/ethnic groups in the United States. The data I analyzed were from the National Health and Nutrition Examination Survey (NHANES) 2015-2016 by the National Center for Health Statistics' (NCHS) Division of Health and Nutrition Examination Surveys (DHANES). Every year, approximately 5,000 individuals of all ages are interviewed in their homes and complete the health examination component of the survey (CDC, 2014).

The prevalence of adult obesity among African Americans, Hispanics, and Native Americans is higher than that of White Americans (CDC, 2017). The CDC reported that in 2017 the prevalence of obesity was 40% for non-Hispanic Black adults and 43% for Hispanic adults, compared with 35% for non-Hispanic White adults. The increase in obesity rates since 2012 is particularly evident among non-Hispanic Blacks. Although

many studies have been conducted on obesity in United States, more research is required to optimize management and to prevent the increasing prevalence of overweight and obesity in the United States (CDC, 2017). Specific topics in need of further research include strategies to encourage individuals to participate in active physical activities and the economic and social factors that contribute to obesity, which vary among different racial and ethnic groups (CDC, 2017). According to the CDC, these factors may dictate individuals' level of education and ability to afford healthy food that can prevent obesity.

Background

Overweight and obesity is the fifth leading risk factor for global deaths. According to the World Health Organization (WHO, 2018), 35% and 11% of adults (≥ 20 years) were overweight or obese, respectively, in 2008. More recent data from WHO indicate that by 2016, the percentage of adults who were overweight or obese had increased to 39% and 13%, respectively (WHO, 2020; see also Ritchie & Roser, 2017). Moreover, about 65% of the worldwide population lives in regions where more people are dying from overweight and obesity than from underweight. It is also estimated that by the year 2030, about 57.8%, or 3.3 billion, of the adult population worldwide might be overweight or obese, with higher rates in developing countries than in developed countries (WHO, 2018).

Overweight and obesity rates have been increasing sharply over recent decades in all industrialized countries, as well as in many lower-income countries (Ogden et al., 2015). The rise in obesity has reached epidemic proportions, with over 1 billion adults worldwide estimated to be overweight and at least 300 million of those considered

clinically obese (WHO, 2018). The circumstances in which people have been leading their lives over the past 20-30 years, including the physical, social and economic environments in which they live, have exerted powerful influences on their overall calorie intake; on the composition of their diets; and on the frequency and intensity of their level of physical activity at work, at home, and during leisure time (Ogden et al., 2015). On the other hand, changing individual attitudes, reflecting the long-term influences of improved education and socioeconomic status (SES), have countered to some extent environmental influences (Ogden et al., 2015).

Determinants of Obesity

Obesity is a global health problem that can be caused by many factors, including genetics, age, environmental stimuli, gender, physical inactivity and a sedentary life, insulin resistance, access to high-calorie food, a high fat diet, and dietary manipulation (WHO, 2018). According to WHO (2018), other determinants of obesity are fat mass and physiological factors such as pregnancy. The majority of overweight/obesity is due to lifestyle factors, such as poor nutrition and physical activity behaviors, however (Townsend & Foster, 2013).

Classification of Obesity

There are different categories of obesity. BMI is an index of weight-for-height that is commonly used to classify obesity among adults. It is calculated as the weight in kilograms divided by the square of height in meters (kg/m2) for an individual. Cut-off points for BMI to classify obesity, as proposed by WHO (2018), are as follows:

- < 18.5 kg/m2, underweight

- 18.5-24.9 kg/m2, normal weight
- 25.0-29.9 kg/m2, overweight
- 30.0-39.9 kg/m2, obesity
- > 40.0 kg/m2, morbid obesity

Obesity can also be classified using waist circumference, known as central obesity. Some nontechnical classification uses ethnic-specific waist circumference to classify obesity. This is the principle behind apple- and pear-shaped classifications of obesity. Healthcare providers also use several anthropometric measures to classify obesity. Other classifications of obesity include fat distribution (WHO, 2018).

This study is needed because of the rising prevalence of overweight and obesity in the United States and its impacts on health. Obesity is associated with many serious chronic diseases, including cardiovascular diseases, diabetes, cancers, and respiratory diseases (WHO 2018). Public health officials have declared obesity a major public health problem in the United States (CDC, 2017; NCHS, 2016). According to WHO (2018), overweight and obesity is the fifth-leading risk factor for global deaths.

This study enhances the understanding of factors associated with obesity and may consequently inform the implementation of preventive strategies. Because of the lack of adequate information on the prevalence of obesity and related risk factors in the United States, particularly among subgroups of the population, this study may also inform the creation of a national surveillance system. Such as system should incorporate, at a minimum, measurements of height, weight, and waist circumference significant to the management and control of obesity (CDC, 2017).

Problem Statement

Overweight and obesity is a major public health issue and is one of the 10 leading health indicators (Mazidi & Kengne, 2017; Ogden et al., 2015;). Obesity rates in the United States are escalating with marked disparities among different sociodemographic groups. The prevalence of overweight and obesity is higher among women and men with increasing age. Although the prevalence of overweight and obesity has remained at an increased level in recent years, the prevalence of obesity has increased (Mazidi & Kengne, 2017). Mazidi and Kengne (2017) reported a 40.2% overall obesity rate for adults aged 40–59 years, a 37.0% overall prevalence for older adults aged 60 years and above, and a 32.3% rate for younger adults aged 20–39 years. A 2020 NCHS data brief showed that the 2017-2018 age-adjusted prevalence of obesity in U.S. adult had increased to 42.4% (Hales et al., 2020). In their examination of obesity among the U.S. adult population from 2013-2016, Flegal et al. (2016) found that the overall adjusted prevalence of obesity was about 37.7%, with higher adjusted prevalence among women (40.4%) than men (35.0%). Mazidi and Kengne (2017) reported that all obesity (both general and central) increased across nutrient patterns that mostly consisted of saturated/mono-unsaturated fatty acids. Other researchers have found that nutrient patterns that were more vegetable based and consisted of micronutrients and vitamins were associated with lower odds of obesity (Bullock et al., 2017).

A higher level of education has been found to be associated with a lower likelihood of obesity, especially among women (Bullock et al., 2017). This research sheds light on the nature and the strength of the relationship between education and

obesity (see NCHS, 2016). Researchers have analyzed health survey data from the United States, Canada, England, Australia, Africa, and Korea with the aim of exploring this relationship (WHO, 2018). Social gradients in obesity were assessed across the entire education spectrum, overall and in different population sub-groups. Furthermore, investigations testing for the association of the links observed were undertaken to better understand the underlying mechanisms of the relationship between the racial-ethnic disparities in obesity associated with education among adults in the United States (NCHS, 2016).

The overarching aim of the work reported in this paper is to provide new evidence concerning the relationship between the interaction variable of education*race and obesity and contribute to understanding the nature of such relationship and its implications for health and education policy. I used data from NHANES, in pursuit of the following specific objectives:

- Exploring the gaps between education and obesity, this paper sheds light on the nature and strength of the correlation between education and obesity. Analyses of health survey data from the United States was undertaken with the aim of exploring the gaps and the relationship between education and obesity. Social gradients in obesity were assessed across the entire education spectrum overall and in different population sub-groups. Furthermore, investigations testing for mediation effects and the causal nature of the links were undertaken to better understand the underlying mechanisms of the relationship between education and obesity.

- to assess the extent to which the relationships identified may reflect the influences of factors associated with individual education, such as SES. Participants' reported age in years at time of screening was used for analysis. Physical activity in the population and gender was classified on a binary level as male or female for analysis.
- to assess the extent of the difference in obesity rates, when examining race and education as separate risk factors and then as combined variable.

Analyses of health survey data from United States, exploring the relationship between the level of education and overweight/ obesity shows that there have been other studies in different parts of the world that have studied this as well (NCHS, 2016). Social gradients in obesity were assessed across the entire education spectrum, overall and in different population sub-groups. However, there is lack of studies investigating the combined effect of these two significant risk factors (race and education) on obesity.

Analyzing data from the CDC in United States offers an opportunity to compare the social patterning of overweight and obesity at different levels of overall prevalence. This analysis is timely in the context of the continued global rise of morbid obesity. High education and income are associated with low levels of obesity (CDC, 2017). For this same period, the obesity prevalence rate for women aged 25 years and above who had not attained the level of a bachelor's degree ranged from 39.0% to 43.0% compared to obesity rates of about 25.0% for women with at least a bachelor's degree (CDC, 2017). This relationship was not observed among males. Ogden, Johnson, Carroll, Curtin, & Flegal, (2015), also report that even though the prevalence of obesity varies by income

and education, the pattern is not consistent by gender and racial/ethnic groups age-adjusted obesity prevalence rates were 31.2% among US adults in the highest income bracket and 40.8% among US adults in the other income categories for the period 2011-2014 (NCHS, 2016). For this same period, age-adjusted obesity prevalence rates were lower (27.8%) for college graduates and higher for those with some college degree but had not completed a college degree (40.6%). Again, gender and racial-ethnic disparities were described (NCHS, 2016).

The available methodologies to estimate the obesity-attributable mortality fraction (OAMF) affect the levels found and hamper the construction of time series. Multivariate models were adjusted for race or ethnic group, level of education, and physical activity. The association between obesity and income or educational level is complex and differs by sex and race/ethnicity (NCHS, 2017). Overall, men and women with college degrees had lower obesity prevalence compared with those with less education. By race/ethnicity, the same obesity and education pattern was seen among non-Hispanic white, non-Hispanic black, and Hispanic women, and also among non-Hispanic white men, although the differences were not all statistically significant. Although the difference was not statistically significant among non-Hispanic black men, obesity prevalence increased with educational attainment. Among non-Hispanic Asian women and men and Hispanic men there were no differences in obesity prevalence by education level. Among men, obesity prevalence was lower in the lowest and highest income groups compared with the middle-income group (NCHS, 2017). This pattern was seen among non-Hispanic white and Hispanic men. Obesity prevalence was higher in the highest income group than in the

lowest income group among non-Hispanic black men. Among women, obesity prevalence was lower in the highest income group than in the middle- and lowest-income groups. This pattern was observed among non-Hispanic white, non-Hispanic Asian, and Hispanic women. Among non-Hispanic black women, there was no difference in obesity prevalence by income (NCHS, 2017).

Purpose of the Study

The primary purpose of this study was to analyze cross-sectional secondary data to examine the relationship between education and obesity among different racial/ethnic groups in United States, controlled for age, gender, healthy diet, and physical activity. Research supports that sociodemographic factors, including education and race, are associated with obesity (NCHS, 2017). My aim in conducting this study was to further investigate the combined impact of race and education on obesity rates and report potential differences in obesity rates when using education and race as separate predictors and then as a combined variable in multivariable models. Public health officials in some U.S. states are concerned about the pace of the increase in overweight and obesity across social groups, particularly those that differ in level of education, SES, and ethnic background. Inequalities across social groups appear to be particularly large in women (WHO, 2018). Health educators and policy makers may use the findings of this study to promote healthy diets and make them more accessible to the U.S. population. Doing so may help to reduce educational inequalities and lower the odds of obesity and related poor health outcomes.

Research Questions and Hypotheses

RQ1. To what extent is there an association between education level and race and obesity level among adults in the United States, controlled for age, gender, healthy diet, and physical activity?

Null Hypothesis ($H_0$1): There is no association between education level and race and obesity level among adults in the United States.

Alternate Hypothesis (H_A1): There is an association between education level and race and obesity level among adults in the United States.

RQ2. To what extent is there an association between the interaction variable of education level *race and obesity level among adults in the United States, controlled for age, gender, healthy diet, and physical activity?

Null Hypothesis ($H_0$2): There is no association between the interaction variable of education level *race and obesity level among adults in the United States.

Alternate Hypothesis (H_A2): There is an association between the interaction variable of education level *race and obesity level among adults in the United States.

Theoretical Framework for the Study

The social ecological model (SEM) was the conceptual framework for this study. SEM stems from the work of Urie Bronfenbrenner, who developed the human ecology theory, which is also referred to as ecological systems theory (Bronfenbrenner, 1979). The human ecology theory and the social ecological model are predicated on the notion that individuals mature not in isolation but within the context of relationships, such as

those involving families, friends, schools, neighborhoods, and society (Bronfenbrenner, 1979).

The Social Ecological Model (SEM) was relevant to this study as it was adopted by the CDC's Nutrition and Physical Activity Program to prevent obesity and other chronic diseases (CDC, 2014). SEM presents graduating but interconnected levels of influence through which society's health behavior and practices can be positively influenced. These levels of influence include individual (biological, psychological), interpersonal groups (cultural influences), organizations, communities (physical environment), and society (policy, laws, regulations), according to the U.S. Department of Health and Human Services (2016).

I sought to highlight the association between education, race, healthy diet, and physical activity as predictors of obesity. It is established in literature that obesity and the listed predictors are, to a great extent, socially constructed and that they are directly influenced by factors intrinsic in Individuals, Relationships, Community, and Society in general (Allen et al., 2007; Caprio et al, 2008; Contento, Basch, &Zybert , 2003, MacArthur, Anguiano, & Gross, 2004; Powell & Kahn, 1995). More specifically, the variables used in this study can be related to the individual (education, race, healthy diet, and physical activity) as well as community/societal (education, race) constructs of the SEM. It is in this light that SEM provides suitable and adequate conceptual and theoretical framework on which to base this study.

Nature of the Study

This study was needed due to the pressing need for criteria for evaluating weight-loss programs stems from the scope of the problem of obesity in United States and the evidence that it is worsening, despite extensive individual and programmatic efforts to achieve weight control (CDC 2014). As shown in recent studies, the prevalence of overweight and obesity is rising, not falling, among most population groups as characterized by gender, age, and race among US adults (CDC, 2014). This is the reason why this research used secondary data to investigate the combined impact of race and education on obesity rates and report potential differences in obesity rates when using education and race as separate predictors and then as combined variable in the multivariable models. I used data from NHANES 2015-2016, to explore the relationship between obesity levels and race and level of education, controlling for possible confounding factors (age, sex, healthy diet and physical activity).In this study the dependent variable was obesity category (binary: not obese vs. obese) as assessed by the BMI; the predictors were education, race, education*race (interaction variable), age, sex, healthy diet and physical activity.

Definitions

Body mass index (BMI): An index of weight-for-height that is commonly used to classify obesity among adults. It is calculated as the weight in kilograms divided by the square of height in meters (kg/m2) for an individual. The WHO (2018) proposed the following cut-off points to classify obesity levels:

- < 18.5 kg/m2, underweight

- 18.5-24.9 kg/m2, normal weight
- 25.0-29.9 kg/m2, overweight
- 30.0-39.9 kg/m2, obesity
- > 40.0 kg/m2, morbid obesity

In this study, I measured obesity as a binary variable as follows: obese (30 or higher BMI) and not obese (< 30 BMI). This measurement also aligns with the CDC's (2020) classification.

Education: The highest grade or level of education completed by participants in the NHANES, 2015–2016. Educational level was categorized as less than ninth grade education, 9-11th grade education (includes 12th grade and no diploma), high school graduate/GED, some college or associate's (AA) degree, and college graduate or higher.

Healthy diet: A variable that was measured using detailed dietary intake information from NHANES participants. The dietary intake data are used to estimate the types and amounts of foods and beverages (including all types of water) consumed during the 24-hour period prior to the interview (midnight to midnight), and to estimate intakes of energy, nutrients, and other food components from those foods and beverages (CITE).

Physical activity: A variable whose definition is based on the Global Physical Activity Questionnaire and includes questions related to daily, leisure time, and sedentary activities.

Race: A variable that is defined in the NHANES 2015-2016 data collection instrument as follows: Mexican American, Other Hispanic, Non-Hispanic White (or

White as a single race), Non-Hispanic Black (or Black as a single race), Non-Hispanic Asian (or Asian as a single race), and Other Race (including multiracial persons).

Assumptions

I used data from NHANES 2015-2016 to explore the relationship between level of education, race, and obesity levels. Researchers tend to make assumptions about the match between the current design situation and one where their chosen technique worked well before (NCHS, 2016). Study participants have been selected from the US population with the important measures like obesity, which was the dependent variable, and I assume that it have been measured objectively with validated instruments (NCHS, 2016). Other important determinants of obesity including the main independent variables, educational level and race, are based on self-report. It is expected that the self-reported data reflect the true educational levels of participants (NCHS, 2016).

Within these resources, it is assumed and expected that all the information or the findings from the study will be accurately reported. For example, if you are conducting a survey, you need to assume that people will answer truthfully. If you are choosing a sample, you need to assume that this sample is representative of the population you wish to make inferences to (Leedy, & Ormrod, 2014)

It is also assumed that this research was conducted under the required ethical principles of research (NCHS, 2016).

Scope and Delimitations

This study reviews and assesses the scope of overweight and obesity among US adults. Overweight and obesity have adverse health consequences, which includes

diabetes mellitus, heart disease, and cancer (NCHS, 2016). To sketch the extent of this problem, I begin with the United States, an appropriate starting point because U.S. dietary styles and food habits have been exported so widely around the world (NCHS, 2016). Delimitations define the research characteristics as selected by the study representing the instrument used for measurement, sample size, variables used for the study and generalizability of the result of the study (Frankfort-Nachmias & Nachmias, 2008). This obesity study is the delimited result of the predictor variables under study (education, race, gender, age, physical activity and healthy diet) and the study sample.

Limitations of Study

Some of the limiting factors of this study was the amount of research solely assessing education, race and obesity among varying populations. These results are cross-sectional and are based on self-report of height and weight; they must be interpreted cautiously. I may be limited with the actual predictive value of education on obesity based on behavioral factors. The use of NHANES data which are validated, and a nationally representative sample makes the predictive value, generalizability, and applicability of the findings credible (NCHS, 2016). Another limitation can be the use of cross-sectional data which cannot estimate causation, because the causality between the independent and the dependent variable may be difficult to establish. However, control variables and appropriate statistical analysis (e.g. regression models) were used to have as valid results as possible.

Significance

Over the last 30 years, low SES and especially lower level of education have caused the most prevalent nutritional problem in the United States and in the world, eclipsing undernutrition and infectious disease as the most significant contributor to ill health and mortality (CDC, 2017). It is a key risk factor for many chronic and non-communicable diseases. Prevention of excessive accumulation of body fat and maintenance of a BMI in the normal range may help to prevent or control obesity (CDC, 2017).

Potential Implications for Positive Social Change

The information in this research can help the community to develop healthy eating habits and aid them in reaching their optimal potential to prevent overweight/ obesity (CDC, 2014: Kelsey, Zaepfel, Bjornstad, & Nadeau, 2014). The higher the individual's level of education relative to his or her peers, the lower is the probability of the individual being obese. Access to resources such as the presence of exercise centers for physical activities, better incomes to purchase healthy foods required for them to maintain a healthy weight may also be driven by an individual's position in the social hierarchy (Bradshaw, Kent, Henderson, &Setar, 2017).The positive social change implications of this study is to use the research questions to identify the gaps associated with the increasing rates of overweight/obesity among different education levels and race groups (Boyseet al.,2016: Bradshaw, Kent, Henderson, &Setar, 2017). This research can increase the awareness of what measures to take to reduce the increasing trends in overweight and obesity, medical costs and promote healthier eating habits, all of which

will support social change that will help to improve nutrition to reduce overweight and obesity in the United State (CDC, 2014). The study can engage expert stakeholders using the outcome of the study to reduce the effects of overweight and obesity among adults in the United States and other parts of the world with similar population characteristics (Gilbert-Diamond, Adachi-Mejia, McClure, &Sargent, 2014). Programs that promote regular participation in physical activity and consumption of healthy diet result in maintenance of healthy weight (CDC, 2014). The U.S. Departments of Health and Human Services and Agriculture provides the dietary guidelines for Americans that contains practical advice and guidance on healthy food choices that translate to better health, by preventing diet-induced chronic diseases. Evidence and information from the dietary guidelines for Americans form the basis of several federal government nutrition policies and programs like Older Americans Act Nutrition Services Programs and the Supplemental Nutrition Assistance Program (SNAP), directed to achieve a heathier nation (Center for Disease Control and Prevention, 2014).

This research can be a valuable research tool for the families, the community, and other health professionals to implement the support to decrease overweight and obesity. The community-based awareness study will use evidence-based practice and social change knowledge to increase healthy nutrition and healthy eating habits (U.S. Department of Agriculture,2014). To facilitate social change, stakeholders need to disseminate the above valuable information to the general population so that people would be better aware of the important factors related to healthy nutrition, overweight and obesity and its effects on the health of affected individuals (CDC, 2014). For

example, knowing the facts that contribute to obesity would make people more conscious and encourage them to take more measures as enumerated in the literature reviews to guide against overweight and obesity (Wright, Duquesnay, Anzman-Frasca &, Langevin, et al., 2016). Furthermore, this will allow the people (in this case, people with lower level of education, and people of lower SES) to be extra cautious of what they eat to prevent overweight and obesity (Lynn, 2012; Olson, Miller, & Troy, 2011). It is time that obesity specialists advocate for establishing the average level of body fat equivalent to the BMI criteria already established to increase understanding of the developing epidemic of obesity and its attendant health risks by race/ethnicity and gender. Obesity is highly related to major types of diseases and contributes to increased health care costs. There is a growing discussion that obesity is a type of disease that has implications for health equity and access to affordable health care in the United States and the world (Boyse, & Kyla, et al.,2016; Miller, & Troy, 2012).

The government, media, marketers, non-governmental agencies, and medical and health care personnel can take the advantage of the knowledge in this study to create sufficient awareness of the best ways to fight the overweight and obesity in the United States. The efforts will help to cut down the medical expenses, by reducing the chronic diseases associated with overweight and obesity in the United States (Boyse, & Kyla, 2016).

Summary

Obesity rates in the United States have been increasing over the past few decades (Ogden, Carroll, Kit &Flegal, 2015). However, level of education has become an

emerging determinant of obesity, which requires much attention (Center for Disease Control and Prevention, 2014). The positive effect of education on obesity may be determined by at least three factors: a) greater access to health-related information and improved ability to handle the information; b) clearer perception of the risks associated with lifestyle choices; and, c) improved self-control and consistency of preferences over time. It is essential to consider not just the absolute level of education achieved by an individual, but also how such a level of education compares with peers and among different racial, ethnic groups (NCHS, 2016). The higher the individual's education relative to his or her peers, the lower the probability of the individual being obese (NCHS, 2016).

In this chapter, I have provided some background on the prevalence obesity in United States. As discussed previously, overweight and obesity is main public health issue, and it is disproportionately higher for certain population. I have discussed about the possible impact of education and race effect on BMI and my plan to use the NHANES data set for the study. In collection of NHANES data, people report their self-identified and socially assigned race or ethnicity. I have discussed how the SEM relates to the study and explains relationship between education, race and overweight/obesity. Finally, study assumptions, scope and limitation were discussed in this chapter. In the next chapter the literature review on the variables under study will be provided in detail.

Chapter 2: Literature Review

Obesity is a major public health problem in the United States (CDC, 2017; NCHS, 2016). Obesity is associated with many serious chronic diseases, including cardiovascular disease, diabetes, cancer, and respiratory disease (WHO 2018). Research has shown a link between socioeconomic factors and obesity (WHO, 2018). Although literature on the relationship between obesity and socioeconomic factors like income and social status exists, literature on the combined effect of education and race on obesity is scarce. Researchers generally include education as part of SES when assessing obesity (WHO, 2018). Race is another significant factor shown to be associated with obesity, especially among individuals with lower SES. The purpose of this study was to examine the relationship between the level of education and obesity among different racial/ethnic groups in United States.

In this chapter, I will briefly explain the literature search strategy, and then review previous studies that provide background on the relationship between obesity and race and education. Then, I will discuss the theoretical framework and rationale for choosing it for the study. After doing so, I will further define the main outcome and predictive variables for the study and discuss the race and educational risk factors of obesity.

Literature Search Strategy

I conducted a literature search using the key words *obesity* and *education*. This yielded 29,510 articles published in the last 10 years, which mostly addressed obesity and other chronic diseases but not education. I limited the search by including the phrase *NOT children*, and this reduced the articles to 12,935. Further, I limited the literature

search to those with human subjects. This yielded 10,515 articles, of which 145 studies were observational studies with only two articles addressing obesity and education (Ho et al., 2016; Tyrrell et al., 2016); one of the two (Tyrrell et al., 2016) addressed SES in general (see also NCHS, 2016). A search on Google Scholar for *relationship between the level of education and obesity* yielded 246 articles that addressed the relationship between obesity and other determinants like physical activity (Chau et al., 2012), dietary habits (Kratz et al., 2013), depression stigma (Meltzer et al., 2013), varied clinical characteristics (Jung & Choi, 2014; Meltzer et al., 2013; Nguyen et al., 2015), and some socioeconomic factors (Bullock et al., 2017; Swinburn et al., 2016). A few (< 10 articles) addressed the level of education and obesity specifically (Meltzer, 2013; Nguyen et al., 2015 . Researchers suggested that a more rigorous design is needed to estimate the relationship between obesity and education (Kim et al., 2017).

Theoretical Foundation

The SEM was the theoretical foundation for this work. SEM is predicated on the notion that individuals mature not in isolation but within the context of relationships, such as those involving families, friends, schools, neighborhoods, and society (CDC, 2020).

Researchers have found SEM to be a useful model for developing programs aimed at preventing undesirable societal problems that result from the interplay between individual, relationship, community, and societal factors. Hence, it formed the basis of the design of the CDC's program on violent prevention (CDC, 2020). The violence prevention program aim to investigate the individual, relationship, community, and

societal factors that put people at risk for violence either as perpetrators or as victims (CDC, 2020).

In health-related studies, Whittemore et al. (2004) considered the use of SEM in providing framework for Type 2 diabetes prevention and management. The authors concluded that SEM offers the potential to guide efforts to expand the scope and reach of diabetes prevention and management program. SEM was also used by Quick et al. (2017) to examine weight-related characteristics of the home environment and lifestyles of households.

Theoretical Constructs: SEM Components

The SEM proposes that any individual behavior is supported and influenced by numerous other systems and groups (Wandersman et al., 1996). An underlining tenet of this model is that lasting behavior change requires programs that target multiple levels of influence (Emmons, 2000). Levels of influence include intrapersonal factors, interpersonal processes, institutional factors, community factors, and public policy (McLeroy et al., 1988). There is documented support for the different and interconnected expression and effects of the components of SEM.

Intra-personal Factors

Intra-personal factors refer to factors intrinsic to individuals. It should be noted that such individual factors are influenced by other components of SEM and hence do not develop in isolation. However, there is evidence that personal characteristics and behaviors are critically associated with the development of numerous diseases, including obesity and diabetes (Kaplan et al., 2000).

Interpersonal Factors

Literature indicates that social support and social networks have a positive impact on the health behavior and hence health status of individual members of a network (Emmons, 2000; Kaplan & Toshima, 1990; McLeroy et al., 1988). Brown and Hedges (1994) found social support to be associated with better self-health management and better metabolic control.

Institutional Factors

Sorensen et al. (1998) highlighted the benefits of health promotion programs in places of employment. Research also indicates that work-site smoking policies, cafeteria food choices, and organizational incentives for physical activity support positive health behavior (Kaplan et al., 2000). Religious institutions have also been found to be particularly influential among African Americans in promoting positive health behavior (McNabb et al., 1997; Peterson et al., 2002).

Community

Community here refers to a geographical cluster of families, most of whom share a common cultural background. This could also be likened to what is colloquially referred to as *neighborhood*. The focus on community in this respect is therefore on the cultural influences and beliefs relating to health-promoting behavior (diet and exercise) or leisure activity (watching television or playing video games). Powell and Kahn (1995) studied obesity and the cultural understanding of what may be considered acceptable body image within a racial group. They observed that the perceived ideal body size for African American women is significantly larger than that of their White counterparts and

that African American men are more likely to express a preference for larger body size in women compared to non-Hispanic White men. In similar work, Fitzgibbon et al. (2000) recorded that the mean BMI at which White women typically express body dissatisfaction is significantly lower than that of African American women.

Public Policy

Policy here refers to an enactment of regulations at the local, state or national levels. Mackinley (1993) noted that for a policy instrument to be successful, its implementation needs to be coordinated and sustained overtime. Negative effect of tobacco to health being included in adverts and product content labeling are good examples of public policy they create awareness towards positive health behavior.

Literature Review Related to Key Variables/Concepts

Education and Obesity

The relationship between the level of education and obesity is primarily inverse but the distribution varies by economic status of the country in questions economically (Kim et al., 2017). Generally, in high income states, as the level of education increases obesity decreases. Kim et al., (2017), and colleagues assessed obesity patterns in three middle income individuals in the United States that were transitioning economically (Kim et al., 2017).Kim et al., (2017) explain three possible directions in the relationship between the level of education and health, or obesity in this case: a) a causal where increase in the level of education leads to improved health or decreased obesity rates, b) a reverse causal link, where good health leads to increased education, or in this case a causal link where those who have normal weights or BMI are more likely to complete

education at higher level, or c) no causal relationship may exist but the associations may be because of the intervention of possible unobserved factors that affect both health (or obesity) and level of education in the same direction (Devaux et al., 2012). The level of education was operationalized as years spent in full-time education. Results demonstrated a linear relationship between the number of years of education and the likelihood of obesity. The more an individual is educated, the less likely they were to be obese. This relationship was found to be consistent especially for women. Devaux et al., (2012), raise a relevant point that it is important to also assess how the quality and contents of the level of education that an individual receives relates to obesity direction.

Compared to those with a higher education, the lower educated were more likely to have (odds ratio: 1.33, 95% CI: 1.21-1.47) or had a higher risk for (risk ratio: 1.34, 95% CI: 1.08-1.66) overweight/obesity. These estimates between obesity and level of education lost statistical significance after controlling for publication bias and the associations depended on demographic factors as: study region, age groups, gender and observation period. Trends in adult obesity rates reveal a profound health and social consequence of bad choices originating from individual lifestyle which might be passed down from parents to their offspring. Since the year 1980, approximately 35% of adults between the ages of 20 and 68 years have become either overweight or obese (Barosh, Friel, Engelhardt, & Chan, 2014). Extensive research studies have demonstrated that several factors including genetic, living environment, lifestyle and societal factors are liable for the risk of overweight and obesity (Lynn, 2012;Jones, 2015;Richardson et al., 2017).

The implications of obesity span risks associated with several chronic diseases including cardiovascular disease, type 2 diabetes, hypertension, sleep apnea, mental health problems, and osteoporosis as well as emotional problems associated with stigmatization and low self-esteem (NCHS, 2016). In addition, obesity carries increased risks of earlier mortality (Bradshaw, Kent, Henderson, & Setar, 2017). Public health departments, in conjunction with health care practitioner's, non-profit organization and the community must address this rising prevalence of obesity and overweight (Ogden, Carroll, Kit & Flegal,2012). When the relationship between average BMI and the level of education is observed, the conclusions are like what was previously discussed. No clear and consistent deviation is observed from a linear pattern in those states examined (Coelho et al., 2013; Townsend & Foster, 2013; WHO, 2018).

The literature review of NHANES about severely obese adults participating in many years of lifestyle intervention investigating the associations between the independent variables: change in self-efficacy for physical activity (PA) in the face of psychological barriers, perceived behavioral control over PA, and PA self-identity and the dependent variable of change in objectively assessed PA (NCHS, 2016). The intervention comprised four residential periods in a rehabilitation center and combined diet, physical activity, and cognitive behavioral therapy. The literature review further investigates demographic and lifestyle variables associated with increased BMI (kg/m^2) (NCHS, 2016). Lower levels of education and physical activity, higher levels of diet soda consumption and number of dieting attempts, and likelihood of starting a diet program based on advertising testimonials were predictive of higher BMI (NCHS, 2016).

This research highlights the need for more education emphasizing the importance of increased healthy behaviors versus use of diet products and fad diets to improve success of weight loss efforts (Coelho et al., 2013; Townsend & Foster, 2013; WHO, 2018).Most US obesity epidemiology studies report on other risk factors such as several independent variables that are basis on literatures, related to obesity rates which include health care resources, measures of the built environment and sociodemographic and economic factors. Hierarchical regression analysis must be performed on three sets of independent variables (demographic characteristics, lifestyle variables and consumer response) and one dependent variable (BMI) (NCHS, 2016).

Race and Obesity

In the United States, literature indicates that the prevalence of obesity is disproportionately high for particular populations. Petersen et al (2019) examined combined data for 2015 through 2017 and found that non-Hispanic black adults had the highest prevalence of obesity (38.4%) overall, followed by Hispanic adults (32.6%) and non-Hispanic white adults (28.6%). They noted even when the data were disaggregated to the state level, this racial disparity persisted. Using a cut point of 35% they found that overall, 31 states and the District of Columbia had an obesity prevalence of 35% or higher among non-Hispanic black adults; 8 states had an obesity prevalence of 35% or higher among Hispanic adults; and only 1 state had an obesity prevalence of 35% or higher among non-Hispanic white adults (Petersen et al, 2019).

More recently, Hales et al. (2020) reported similar findings. Using 2017 – 2018 data, they found that overall Non-Hispanic black adults had the highest prevalence of

obesity compared with all other race and Hispanic-origin groups, and lowest among non-Hispanic Asian adults. Prevalence of obesity for non-Hispanic black was 49.6%, Hispanic adults 44.8%, non-Hispanic white (42.2%), and non-Hispanic Asian adults (17.4%). They also found that Non-Hispanic black women had a higher prevalence of obesity (56.9%) than non-Hispanic black men (41.1%).

Effect of Racial Culture on Obesity

Culture here could be defined as a system of shared understandings that shapes and, in turn, is shaped by experience (Caprio et al, 2008). The implication of this definition is that culture is dynamic. Caprio et al (2008) in their study provided ample literature evidence of the effect and relationship between culture and obesity. They noted that among the shared understandings embodied by a culture are those pertaining to obesity, including understanding of its cause, course, and cure, and the extent to which a society or ethnic group views obesity as an illness.

Culture influences beliefs relating related to health-promoting behavior (diet and exercise) or leisure activity (watching television or playing video games). Allen et al., (2007) noted that culture related to the type of food dominantly consumed have been found to change even among generations of the same race. They recorded that first-generation Asian and Latino adolescents have been found to have higher fruit and vegetable consumption and lower soda consumption than Whites but that fruit and vegetable consumption by Latinos decreases while their soda consumption increases. By the third generation, the nutrition of Latinos was found to be poorer than that of Whites (Allen et al, 2007). The authors suggested that the worsening preventive health behavior

and poorer dietary intake among later generation of Latinos could be attributed to length of exposure to the US mainstream culture. They noted that this finding is consistent with studies that suggest that acculturation has a negative effect on measured health-risk and health behavior among Latino youth. The authors also attributed the disparities in diet and health behaviors among different racial/ethnic immigrant population to the theory of segmental assimilation. They noted that segmental assimilation is usually related to factors such as: average education and job skill levels, the proportion who were documented immigrant or refugees, and proportion living in 2-parents' home.

Powell and Kahn (1995), studied obesity and the cultural understanding of what may be considered acceptable body image within a racial group. They observed that perceived ideal body size for African American women is significantly larger than that of their White counterpart and that African American men are more likely to express a preference for larger body size in women compared to non-Hispanic white men. In similar work Fitzgibbon, Blackman, & Avellone (2000) recorded that the mean BMI at which white women typically express body dissatisfaction is significantly lower than that of African American women. In a related study, Birch and Fisher (2000) observed that in many cultures, mothers play an important role in transmitting culturally accepted body image across generations. For example, "non-Hispanic white mothers' dietary restraint or their perceptions of their daughters' risk of overweight can influence their young daughters' weight and dieting behaviors (Contento, Basch, &Zybert , 2003).

Culture is also known to influence the level of health risk a given culture associates with obesity. Latino mothers of obese children have been known to believe

their child to be healthy and unconcerned about such child's weight (MacArthur, Anguiano, Gross, &2004). On a different dimension, Katz et al. (2004) in their study reported that there is greater awareness of acute health conditions than of obesity, among African American parents and that both obese African American girls and their female caregivers have been reported to be unaware of the potential health consequences associated with their current body size.

Other Factors Affecting Obesity

SES and physical inactivity are associated with obesity in United States (Boyse et al., 2016). The citizens drive to their workplaces, ride in elevators instead of walking the stairways and depend mostly on high-fat foods from fast food restaurants whilst the children stay home, watching television or playing video games (Bolivar Et al., 2012;Boyse, et al.,2016; Lynn, et al., 2012).Wang et al.,(2013) explain that the US citizens currently depend on fast foods both at workplaces and in their homes. This dependence on unhealthy fast foods is the main cause of the increased prevalence of overweight and obesity in China and United States (Wang, Wu, Wilson, et al. 2013). There is an urgent need to create dietary guidelines and provide nutritional education that will help the citizens to make good decisions and have healthy lifestyle choices (WHO, 2018). Having dietary guidelines and nutritional education in place will assist the population to develop useful measures towards reducing the high prevalence of overweight and obesity in United States (WHO, 2018). In the US, it is proposed that, the government can pass laws requiring the built environment plays a significant role in

addressing obesity rates. This will reduce sedentary lifestyles and ultimately decrease the high trends in overweight and obesity (WHO, 2018; Wang, Wu, & Wilson, et al. 2013).

According to CDC (2014), SES is related to obesity and complex ways that need to be explored. Research shows that that obesity rates are high among with low SES, especially poverty and women who have low resources or income are especially vulnerable to obesity (CDC, 2014). In United States and research from other parts of the world shows that People with low income typically spend a substantial portion of their weekly income (about 48% of their weekly income) on healthy food alone (Barosh, Friel, Engelhardt, & Chan, 2014) and may be compelled to live on fast foods which are more affordable and satiable (Alkon et al., 2013). Constant consumption of fast food which is often calorie dense ultimately leads to piling up calories and coupled with low participation in physical activity leads to obesity. People who have food security generally have healthier weights. Research by Pan et al. (2012) shows that people who are food insecure are more likely to be obese and emphasize that it is important to increase access to affordable healthy foods (Pan, Sherry, Njai, & Blanck, 2012).

Summary and Conclusions

Based on current literature in respect to nutrition and excess body weight, there have been consistent findings on the association between increased BMI and poor nutrition habits (CDC, 2014). The recently identified etiological factors related to obesity among adults include lack of exercise, sedentary lifestyle, lack of access to healthy foods and several critical environmental determinants of health in adults (CDC, 2014; NCHS, 2016). Although obesity is a major problem associated with several socioeconomic

factors, there is limited research on the relationship between the level of education and obesity (NCHS, 2016). Also, there is a lack of comprehensive evidence on effective strategies to prevent obesity, especially considering the combined impact of education and race on obesity rates. (Ogden, Carroll, Kit & Flegal, 2012*)*.

Chapter 3: Research Method

Obesity is a major public health problem in the United States, and there is an increased prevalence among ethnic minorities and individuals who are socially disadvantaged. The purpose of this study was to examine the association between the level of education and obesity among different racial/ethnic groups in United States. Specifically, I performed a cross-sectional analysis of the relationship between educational level and measures of obesity stratified by demographic factors, among adults aged 18 years and above who participated in the NHANES 2015–2016.

Unlike most publicly available data, NHANES includes data from interviews and physical examinations. Researchers use these data to assess the health status of the U.S. population as well as produce vital and health statistics for the United States (NCHS, 2016). Since its inception, NHANES has focused on different populations in the United States and provided information on various health topics (CDC, 2014; NCHS, 2016).

In this chapter, I will first restate the RQs and hypotheses. Then, I will discuss the study variables, research methods, and statistical analyses. I will present dependent and independent variables and identify their measurement level to support the choice of the statistical test.

Research Design and Rationale

I used 2015-2016 NHANES data to estimate obesity rates based on BMI and to assess the relationship of obesity with level of education; race; and other socioeconomic factors such as age, gender, categories/level of physical activity, and diet. Also, as discussed in Chapter 2, concerning gaps in research, most researchers have not

concentrated on obesity and education in combination with racial/ethnic groups controlling for relevant demographic and lifestyle factors. I conducted this study to address this gap in the literature.

I used a cross-sectional study design to examine the NHANES data set. A cross-sectional design was suitable for the existing data set as I planned to look into relationship between race and education and obesity at a given point of time. Use of this study design not only provided robust information but also allowed me to stratify the relationship between race and obesity at different level of education. It also allowed me to control age, gender, and other confounding factors while analyzing the relationship between race and obesity.

Methodology

Population

NHANES is a major program of the NCHS, of the CDC, that started in the early 1960s (NCHS, 2016). The NHANES is a program that was designed with the aim of providing information to assess the health and nutritional status of the U.S. population. Using NHANES data, several epidemiologic measures including prevalence of major diseases and risk factors for diseases can be estimated (NCHS, 2016). Findings from NHANES also form the basis for national standards for measurements like height and weight (CDC, 2014; NCHS, 2016).

Importantly, NHANES researchers interview and examine a nationally representative sample (located in different counties across the United States) of about 5,000 people yearly (NCHS, 2016). Each year, 15 representative counties are visited by

the NHANES team and assessed for the survey (NCHS, 2016). Information from NHANES has been used in varied epidemiological studies and health sciences research. For example, prevalence figures on overweight and obesity have resulted in the development of several programs that highlight the need for diet and exercise (NCHS, 2016).

Also, estimates from NHANES have stimulated several research topics. Relevant to this research, NHANES provides information to examine the disparities in obesity based on race/ethnicity while considering the contribution of several risk factors among these racial/ethnic groups for obesity (NCHS, 2016). Results invite further research and help policy makers to develop practical public health policies and programs (CDC, 2014; NCHS, 2016).

The study target population were all adult participants aged 18 years and above who were interviewed and examined for NHANES 2015–2016 (NCHS, 2016).

Sampling and Sampling Procedures

Every year, NCHS researchers interview approximately 5,000 individuals of all ages in their homes and complete the health examination component of the survey. The health examination is conducted in a mobile examination center; the center provides an ideal setting for the collection of high-quality data in a standardized environment (CDC, 2014; NCHS, 2016).

Sample Size and Power Calculation

To estimate the sample size, I used a sample size calculator (G-Power). For this research, I chose commonly accepted rates to estimate the minimum sample size: a 5%

margin of error, a 95% confidence level, a population size of 384 million (reflecting the approximate population size of the United States at mid-year 2017), and an expected response rate of 50%. The minimum sample size calculated was 384 participants. I included all participants who qualified based on the inclusion criteria. These were all participants aged 18 years and above who were interviewed and examined during NHANES 2015 – 2016. Participants aged 17 years and below are excluded from the study. Participants who met the initial inclusion criteria but did not indicate their race/ethnicity, as well as educational levels, were excluded becasue these variables were the focus of the study.

Procedures for Recruitment, Participation, and Data Collection

The sampling frame is all NHANES participants for 2015 – 2016. NHANES uses a sophisticated, multistage probability design to sample the civilian, noninstitutionalized population residing in the 50 states and D.C. Sample selection for NHANES followed these stages, in order: In 2015-2016, 15,327 persons were selected for NHANES from 30 different survey locations (NCHS, 2016). Of those selected, 9,971 completed the interview and 9,544 were examined (CDC, 2014; NCHS, 2016). Specific data file documentation can be found via the link next to the respective data file on the NHANES website (CDC, 2014; NCHS, 2016).

NHANES 2015-2016 survey design and demographic variables are included in the Demographics file in this release (NCHS, 2016). All the NHANES public use data files can be linked by using the common survey participant identification number (variable name: SEQN). Merging information from multiple NHANES 2015-2016 data

files using SEQN ensures that the appropriate information for each survey participant is linked correctly (NCHS, 2016). SEQN should sort all data files before merging (NCHS, 2016).

Instrumentation and Operationalization of Constructs

The NHANES 2015-2016 data and survey instrument were used to address this study's RQs. The data were cleaned via the removal of data entries that were not within the scope of the study that have missing data entries and entries with outliers were also removed at this stage. The dependent variable is obesity levels (binary: not obese vs. obese). Obesity was classified based on BMI values of the sample. NHANES provides information on body measures which allows estimation of prevalence of obesity in US adults ($\geq 30 kg/m^2$). Trained health technicians measured and recorded the body dimensions in a mobile examination center. Height was measured with a stadiometer, using the best measurement possible depending of participants' overall body conformation. Weight was taken using a high-performance digital weight scale built into the examination floor with participants wearing an examination gown. The maximum capacity of the digital weight scale is 600 pounds (about 272.1 kg). The first primary independent variable is level of education (ordinal variable). The level of education was recorded as the highest grade or level of education completed by participants. Participants were asked, "What is the highest grade or level of school {you have/SP has} completed or the highest degree {you have/s/he has} received". Educational level was categorized as: less than 9^{th} grade education, 9-11^{th} grade education (includes 12^{th} grade and no diploma), High school graduate/GED, some college or associates (AA) degree, and

college graduate or higher. The second primary predictor is race which is a nominal variable with the following levels: Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian, Other Race. The third main predictor variable is the interaction term/variable education*race (nominal variable) which was calculated using SPSS software. The other variables included in this study are:

1. Age – Participants' reported age in years at time of screening was used for analysis. NHANES reports individuals aged 17 and above as 65 years of age. Age was classified on a continuous level and categorical levels in different regression models.
2. Gender – NHANES recorded gender as male and female. Gender was classified on a binary level as male or female for analysis.
3. Healthy diet- this was assessed using the DBQ700 nominal variable with the label "How healthy is the diet". This was collected in NHANES (2014-2015) as follows: (1 – Excellent, 2 – Very good, 3 – Good, 4 - Fair, and 5- poor). For the purpose of this study, in order to increase sample size among categories, this variable was recorded into three categories as: 1- Excellent or very good, 2 – Good or Fair, 3 - poor
4. Physical activity- this was assessed based on time spent on physical activity of any sort using the physical activity variable PAQ_H and was included as ordinal variables. These data were collected in NHANES (2014-2015) as follows: Vigorous (PAD615 & PAD660), Moderate (PAD630 & PAD675), and Low (PAD680).

Data Analysis Plan

The RQs and hypotheses were as follows:

RQ1. To what extent is there an association between level of education and race and obesity level among adults in the United States, controlled for age, gender, healthy diet and physical activity?

Null Hypothesis (H_0): There is no association between level of education and race and obesity level among adults in the United States.

Alternate Hypothesis (H_A): There is an association between level of education and race and obesity level among adults in the United States.

RQ2. To what extent is there an association between the interaction variable of level of education*race and obesity level among adults in the United States, controlled for age, gender, healthy diet and physical activity?

Null Hypothesis (H_0): There is no association between the interaction variable of level of education*race and obesity level among adults in the United States.

Alternate Hypothesis (H_A): There is an association between the interaction variable of level of education*race and obesity level among adults in the United States.

In this study, I used SPSS software v24 to perform all analysis. After obtaining Institutional Review Board (IRB) approval from Walden University, I accessed the NHANES 2015-2016 data, extracting the data sets that were required for this study. Descriptive univariate analysis was performed for all variables. Then one binomial logistic regression was conducted for each RQ. For RQ1 the predictor variables were educational level, race, age, gender, physical activity and healthy diet and the outcome

variable was obesity level (Obese vs. Non-Obese). For RQ2 the outcome variable was the same but the predictor variables were the interaction variable of educational level*race, age, gender, physical activity and healthy diet. Statistical significance level was set at $p<0.05$ to determine whether a null hypothesis can be accepted or rejected. In addition, I used complex samples logistic regression and in order to derive the weighing amounts, certain calculations were made first. For example, the final probability was determined by calculating the product of the probability of an individual. Odds ratios and 95% confidence intervals was also reported and interpreted for each regression model.

Threats to Validity

The potential threat to internal validity is the measurement of variables like educational level, participation in physical activity and recall of dietary behaviors associated with self-reports. However, the use of data, limits issues of threat to internal validity since NHANES data collection processes were validated. It must be noted that, because this is a cross sectional study, I was only able to assess associations and not causality. I planned to control for relevant confounding variables to increase the precision of my estimates. The threat to external validity may be related to generalizability of results. NHANES selects a nationally representative sample, and I applied the relevant weights to account for oversampled populations. The results of this study apply to US adults aged 18 years and above. My research does not include children or institutionalized individuals, and I did not generalize the findings to these populations.

Ethical Procedures

In Walden University research following the criteria for IRB is needed for approval which indicates the institution's official assessment that the potential risks of the study are outweighed by the potential benefits. The purpose of this IRB review is to collect enough specific information to document that the study's benefits outweigh the costs and that the procedures are following federal regulations and university policies. I understand that noncompliance with IRB instructions and policies can result in consequences including but not limited to invalidation of data, revocation of IRB approval, and dismissal from Walden University. If the revisions do not adequately address the ethical concerns, then an additional round of revisions and review might be necessary.

Summary

This study examined the association between the level of education and obesity among different racial/ethnic groups in the United States using the NHANES 2015–2016 cross sectional secondary data. An important consideration was given to the use of ethical research principals when conducting this study, and the conceptual theory should be applied to the design. Descriptive statistics were conducted for all the variables under study. Binomial logistic regression was applied to address both RQs and odds ratios and 95% CIs were reported and interpreted.

Chapter 4: Results

Introduction

Obesity has reached epidemic proportions worldwide and is associated with several chronic diseases including cardiovascular disease, cancer, and diabetes, which are the major causes of morbidity, disability, and mortality worldwide (Bender et al., 2006; de Mutsert et al., 2014). Although many researchers have investigated the impact of several sociodemographic factors on obesity there is a paucity of studies on the combined impact of race and education on obesity among U.S. adults, according to my review of the literature. The purpose of this study was to assess the impact of education and race on obesity, as separate variables, while controlling for the effects of age, gender, healthy diet, and physical activity. I also wanted to investigate the combined effects of race and education (interaction effects) on obesity while adjusting for the effects of the same control variables mentioned in the previous sentence and compare the potential differences between the two approaches. Therefore, the RQs and the associated hypotheses were

RQ1: To what extent is there an association between education level and race and obesity level among adults in the United States, controlled for age, gender, healthy diet, and physical activity?

$H_0$1: There is no association between education level and race and obesity level among adults in the United States.

H_A1*:* There is an association between education level and race and obesity level among adults in the United States.

RQ2. To what extent is there an association between the interaction variable of education level *race and obesity level among adults in the United States, controlled for age, gender, healthy diet and physical activity?

$H_0$2: There is no association between the interaction variable of education level *race and obesity level among adults in the United States.

H_A2: There is an association between the interaction variable of education level *race and obesity level among adults in the United States.

In this chapter, I present a brief description of the source of the secondary data used, the descriptive statistics of the variables used in the study, the inferential analyses and their assumptions, and the results of hypotheses tests.

Data Collection

After obtaining Walden University IRB approval (#08-20-20-0113010), I collected the data from NHANES. NHANES involves the interview and examination of a nationally representative sample (located in different counties across the United States) every year (NCHS, 2016). In my research study, the target population were all adult participants aged 17 years and above who were interviewed and examined during NHANES 2015–2016 (NCHS, 2016). Therefore, all participants aged 17 years and above who were interviewed and examined as part of NHANES 2015–2016 are included in this study.

I obtained the needed data from NHANES as described in Chapter 3. There were no data discrepancies or deviation from the previously laid out plans. The obtained data were representative of the population of interest because the sample selection for

NHANES was designed to be representative of the population; researchers use a multistage sampling protocol (CDC, 2014; NCHS, 2016).

Descriptive Statistics

The sample size was 9,971. Approximately half of the study participants were men and the remaining half women (50.7% and 49.3% respectively; see Table 1). Study participants who were 17-34 years old (27.7%) and >54 years old (28.9%) were the majority of the sample. Nonetheless, the other age groups were also adequately represented: Individuals who were 34-44 years old accounted for 24.6% of the study participants, and individuals who are 45-54 years old accounted for 18.9% of the study participants. In a similar way, the sample adequately represented people of different races, as well as people with different education background. About one fourth (26.8%) of the study participants had a healthy diet that was very good or excellent, and two thirds (66.0%) were found to have fair diets, while approximately one tenth (7.2%) had poor diets (see Table 1).

Table 1

*Descriptive Statistics of the Studied Sample (*N = *9,971)*

Category	Frequency	Percentage (%)
Gender		
Male	5,053	50.7
Female	4,918	49.3
Age (years)		
17-34	2,758	27.7
35-44	2,448	24.6
45-54	1,888	18.9
> 54	2,877	28.9
Race/Hispanic		
Mexican American	1,921	19.3
Other Hispanic	1,308	13.1
Non-Hispanic White	3,066	30.7
Non-Hispanic Black	2,129	21.4
Other race (including multiracial)	1,547	15.5
Education level[a]		
Less than 9th grade	688	12.0
9-11th grade (includes 12th grade with no diploma)	676	11.8
High school graduate/GED or equivalent	1,236	21.6
Some college or associate's degree	1,692	29.6
College graduate or above	1,422	24.9
Healthiness of participants' diets[b]		
Excellent/very good	1,697	26.8
Good/fair	4,174	66.0
Poor	455	7.2
Physical activity level		
Low	4,929	49.4
High	5,042	50.6
Obesity level[c]		
Not obese	6,009	71.4
Obese	2,410	28.6
Total	9,971	100.0

[a] 4,257 missing cases. [b] 3,645 missing cases. [c] 1,552 missing cases.

Results

To address the RQs of the study, binary logistic regression was applied. The first assumption for the use of binary logistic regression is that the dependent variable should be a categorical variable measured at two levels (i.e. binary categorical variable). The dependent variable in the current study was obesity level and it was a binary categorical variable. The second assumption for the use of binary logistic regression required the observations to be independent of each other. This assumption was also met because the data were collected from independent study participants whose selection from the population was done through multi-stage independent random sample protocol.

In addition, in binary logistic regression, it was assumed that there is little or no multicollinearity between the continuous independent variables. This assumption was not applicable in this study and thus not violated because all the independent variables used in this study were categorical. Furthermore, it was assumed that continuous independent variables are linearly related to log odds. This assumption was also not applicable in this study and thus not violated because no continuous independent variables were used in this study.

RQ1 Results

The results of the binary logistic regression analysis showed that race and educational level were found statistically significant ($p < 0.01$, Table 2) in the model. More specifically, compared to the Non-Hispanic White (which is the reference category), Mexican Americans were 1.6 times more likely ($OR = 1.603$, 95% [1.336, 1.924], $p < 0.01$, Table 2) to be obese. In a similar way, Other Hispanics had 1.3 times

and statistically significant higher odds (*OR* = 1.274, 95% CI [1.056, 1.536], $p < 0.05$, Table 2) of obesity compared to their Non-Hispanic White counterparts. With an odds ratio of 1.319, a statistically significant higher odds of obesity were observed among the Non-Hispanic Black (*OR* = 1. 319, 95% CI [1.127, 1.545], $p< 0.01$, Table 2) compared to their Non-Hispanic White. On the other hand, the Other Race/Multi-Racial were about 56% less likely (*OR* = 0.438, 95% CI [0.359, 0.535], $p < 0.01$, Table 2) to be obese compared to their Non-Hispanic White counterparts. These results showed that except for Other Race/Multi-Racial category which had statistically significant lower odds of obesity, all the other race categories had statistically significant higher odds of obesity than the Non-Hispanic White category.

For education level, those with some college or AA degree education level had statistically significant higher odds of obesity (*OR* = 1.422, 95% CI [1.152, 1.755], $p < 0.01$, Table 2) compared to their counterparts with less than 9th grade education level. These results show only those with some college or AA degree education level had statistically significant higher odds of obesity compared to the reference category.

In conclusion for RQ1, I rejected the null hypothesis and accepted the alternative hypothesis and conclude that that there is a statistically significant relationship between race and education level and the level of obesity among adults in the United States after controlling for the effects of gender, age, physical activity, and diet.

Table 2

Binomial Logistic Regression for Obesity Level (Dependent Variable) With Predictors Gender, Age, Race, Education Level, Diet, and Physical Activity

						95% C.I. for OR	
	B	S.E.	Wald	*p* value	Odds Ratio	Lower	Upper
Gender (Reference: Male)	.119	.060	3.984	.046	1.126	1.002	1.266
Age (Reference: 17-34 years)			20.529	.000			
35-44 years	.419	.098	18.364	.000	1.520	1.255	1.841
45-54 years	.258	.094	7.497	.006	1.294	1.076	1.556
>54 years	.292	.081	12.878	.000	1.340	1.142	1.571
Race/Hispanic Origin (Reference: Non-Hispanic White)			146.124	.000			
Mexican American	.472	.093	25.755	.000	1.603	1.336	1.924
Other Hispanic	.242	.096	6.427	.011	1.274	1.056	1.536
Non-Hispanic Black	.277	.081	11.723	.001	1.319	1.126	1.545
Other Race/ Multi-Racial	-.825	.102	65.743	.000	.438	.359	.535
Education Level (Reference: Less than 9th grade)			30.741	.000			
9-11th grade (Includes 12th grade with no diploma)	-.080	.122	.433	.511	.923	.727	1.172

High school graduate/GED or equivalent	.133	.110	1.462	.227	1.143	.921	1.418
Some college or AA degree	.352	.107	10.766	.001	1.422	1.152	1.755
College graduate or above	-.018	.114	.025	.875	.982	.785	1.228
How Healthy is Your Overall Diet? (Reference: Excellent/ very good)			111.405	.000			
Good/fair	.600	.071	70.629	.000	1.822	1.584	2.095
Poor	1.181	.126	88.163	.000	3.258	2.546	4.170
Physical Activity Level (Reference: Low)	-.120	.066	3.285	.070	.887	.779	1.010
Constant	-1.182	.149	63.360	.000	.307		

RQ2 Results

The results of the binary logistic regression modelling involving the interaction effects show that education*race interaction effect was not statistically significant (p = 0.277, Table 3) in the model. The rest of the results are very similar to the ones of the regression model of RQ1 (e.g., education and race were found statistically significant as single variables), so it can be concluded that the interaction variable of education*race did not change the significant predictors of the RQ1 model. Therefore, I failed to reject the null hypothesis and concluded that that there is no statistically significant (p = 0.227, Table 3) relationship between education*race interaction effect and the level of obesity

among adults in the United States after controlling for the effects of gender, age, physical activity and diet.

Table 3

*Binomial Logistic Regression for Obesity Level (Dependent Variable) With Predictors Education*Race Interactions While Controlling for the Individual Effects of Gender, Age, Race, Education Level, Diet, and Physical Activity*

						95% C.I. for OR	
	B	S.E.	Wald	*p* value	Odds Ratio	Lower	Upper
Gender (Reference: Male)	.118	.060	3.885	.049	1.125	1.001	1.265
Age (Reference: 17-34 years)			19.228	.000			
35-44 years	.409	.098	17.351	.000	1.506	1.242	1.826
45-54 years	.255	.095	7.253	.007	1.290	1.072	1.552
>54 years	.282	.082	11.804	.001	1.325	1.129	1.556
Race/Hispanic Origin (Reference: Non-Hispanic White)			23.650	.000			
Mexican American	.566	.291	3.767	.052	1.761	.994	3.117
Other Hispanic	.263	.318	.685	.408	1.301	.697	2.428
Non-Hispanic Black	.378	.388	.948	.330	1.459	.682	3.121
Other Race/ Multi-Racial	-1.078	.424	6.453	.011	.340	.148	.782

Education Level (Reference: Less than 9th grade)			7.199	.125			
9-11th grade (Includes 12th grade with no diploma)	-.050	.318	.024	.876	.952	.510	1.775
High school graduate/GED or equivalent	.275	.286	.929	.335	1.317	.752	2.305
Some college or AA degree	.428	.279	2.357	.125	1.535	.888	2.652
College graduate or above	-.100	.284	.125	.724	.904	.518	1.579
How Healthy is Your Overall Diet? (Reference: Excellent/ very good)			107.632	.000			
Good/fair	.589	.072	67.433	.000	1.802	1.566	2.074
Poor	1.169	.126	85.921	.000	3.219	2.514	4.122
Physical Activity Level (Reference: Low)	-.122	.066	3.374	.066	.885	.777	1.008
Education Level (Reference: Less than 9th grade) * Race/Hispanic Origin (Reference: Non-Hispanic White)			18.848	.277			
9-11th grade *by* Mexican American	.003	.376	.000	.994	1.003	.480	2.097

9-11th grade *by* Other Hispanic	-.065	.424	.024	.877	.937	.408	2.150
9-11th grade *by* Non-Hispanic Black	-.153	.459	.112	.738	.858	.349	2.108
9-11th grade *by* Other Race/ Multi-Racial	.301	.544	.306	.580	1.352	.465	3.929
High school graduate/GED or equivalent *by* Mexican American	-.355	.344	1.062	.303	.701	.357	1.377
High school graduate/GED or equivalent *by* Other Hispanic	-.049	.377	.017	.896	.952	.455	1.991
High school graduate/GED or equivalent *by* Non-Hispanic Black	-.310	.420	.546	.460	.733	.322	1.669
High school graduate/GED or equivalent *by* Other Race/ Multi-Racial	.299	.488	.376	.540	1.348	.518	3.507
Some college or AA degree *by* Mexican American	-.036	.344	.011	.917	.965	.492	1.893
Some college or AA degree *by* Other Hispanic	-.117	.360	.106	.745	.889	.439	1.802
Some college or AA degree *by* Non-Hispanic Black	-.256	.410	.390	.532	.774	.346	1.729

Some college or AA degree *by* Other Race/ Multi-Racial	.369	.461	.638	.424	1.446	.585	3.572
College graduate or above *by* Mexican American	-.155	.389	.158	.691	.857	.400	1.835
College graduate or above *by* Other Hispanic	.181	.381	.225	.635	1.198	.568	2.529
College graduate or above *by* Non-Hispanic Black	.407	.424	.925	.336	1.503	.655	3.446
College graduate or above *by* Other Race/ Multi-Racial	.257	.458	.316	.574	1.293	.527	3.171
Constant	-1.207	.284	18.029	.000	.299		

Additional Significant Results

Besides the results relevant to the main independent variables of the RQs, regression analysis revealed some additional significant results. First, gender was found statistically significant ($p < 0.05$, Table 2 &3) in both models. Females were 1.126 times more likely to be obese than their male counterparts (*OR* = 1.126, 95% [1.002, 1.266], $p < 0.05$, Table 2).

In addition, age was also found to be a statistically significant predictor of BMI. More specifically, using "17-34 years" age group as the reference category, the results show that those who are in the "34-44 years" age group have about one and a half times higher odds (*OR* = 1.520, 95% CI [1.255, 1.841], $p < 0.01$, Table 2) of been obese than

their "17-34 years" age group counterpart. Similar number are obtained for the people within the "45-54 years" (*OR* = 1.294, 95% CI [1.076, 1.556], $p < 0.01$, Table 2), and ">54 years" (*OR* = 1.340, 95% CI [1.142, 1.571], $p < 0.01$, Table 2) age groups.

Furthermore, the overall diet healthiness is found to be statistically significant ($p < 0.01$, Table 2) in the model. Using "Excellent/very good" dietary group as the reference category, the results show that those who are in the "Good/fair" dietary group have almost two times higher odds (*OR* = 1.822, 95% CI [1.584, 2.095], $p < 0.01$, Table 2) of been obese than their counterpart who fall in the "Excellent/very good" dietary group; and the those who are in the "Poor" dietary group have almost more than three times higher odds (*OR* = 3.258, 95% CI [2.546, 4.170], $p < 0.01$, Table 2) of been obese than their counterpart who fall in the "Excellent/very good" dietary group. These show that obesity and diet are, indeed, strongly linked.

Summary

Race and education level were found to be statistically significant predictors in the RQ1 binary logistic regression model. This led to the rejection of the first null hypothesis, the acceptance of the first alternative hypothesis and the conclusion that there is a statistically significant relationship between race and education level and the level of obesity among adults in the United States after controlling for the effects of gender, age, physical activity and diet. On the other hand, the results of the binary logistic regression modelling involving the interaction effects showed that education*race interaction effect was not statistically significant in the model. Therefore, I failed to reject the second null hypothesis and concluded that that there is no statistically significant relationship

between education*race interaction effect and the level of obesity among adults in the United States even after controlling for the effects of gender, age, physical activity and diet.

In Chapter 5, I will present a broader interpretation of the study findings in the context of as well as in comparison to other existing work. I will also present the limitations of the current study, the recommendations that can be drawn from the findings, and their implications as well as the overall conclusions that can be drawn from this study.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The obesity epidemic is a challenging problem, and it is associated with several chronic diseases such as cancer, cardiovascular disease, and diabetes, which are the major causes of morbidity, disability and mortality worldwide (Bender et al., 2006; de Mutsert et al., 2014). The purpose of this study was to assess the impact of education and race on obesity, as separate variables, while controlling for the effects of age, gender, healthy diet, and physical activity. I also sought to investigate the combined effects of race and education (interaction effects) on obesity while adjusting for the effects of the same control variables mentioned in the previous sentence and compare the potential differences between the two approaches. Although many researchers have investigated the impact of several sociodemographic factors on obesity there is a paucity of studies on the combined impact of race and education on obesity among U.S. adults. This the gap that I attempted to fill with this study.

The results of the present study revealed that there was a statistically significant relationship between race and education level and the level of obesity among adults in the United States after controlling for the effects of gender, age, physical activity, and diet. Furthermore, there was no statistically significant relationship between education*race interaction effect and the level of obesity among adults in the United States even after controlling for the effects of gender, age, physical activity, and diet. Finally, gender, age and diet were also found to be significant predictors of obesity in the sample of the study,

I begin this chapter by interpreting the study findings. The limitations of the current study, recommendations that can be drawn from the findings, and the social change implications of the research follow. I also provide the overall conclusions that can be drawn from this study.

Interpretation of the Findings

The hypothesis test relating to the first RQ showed that there was a statistically significant relationship between race and education level and the level of obesity among adults in the United States after controlling for the effects of gender, age, physical activity, and diet. I was observed that compared to Non-Hispanic Whites, Mexican Americans were 1.6 times more likely to be obese. Furthermore, Other Hispanics had 1.3 times and statistically significant higher odds of obesity compared to their Non-Hispanic White counterparts. With a odds ratio of 1.319, a statistically significant higher odds of obesity was observed among Non-Hispanic Blacks compared to Non-Hispanic Whites. On the other hand, individuals in the Other Race/Multi-Racial segment were twice less likely to be obese compared to their Non-Hispanic White counterparts. Except for the Other Race/Multi-Racial category, which had statistically significant lower odds of obesity, all the different race categories had statistically significant higher odds of obesity than the Non-Hispanic White category.

These findings are in agreement with the core findings of previous studies indicating that the prevalence of obesity is disproportionately high among some particular population groups (Hales et al., 2020; Petersen et al., 2019) and the situation is worsening (Hales et al., 2020). For example, Petersen et al. (2019) found that, in the United States,

non-Hispanic Black adults have the highest prevalence of obesity (38.4%), followed by Hispanic adults (32.6%) and non-Hispanic White adults (28.6%). These racial differences in the prevalence of obesity persisted even when Petersen et al. considered each of the states alone. Furthermore, with a cutoff prevalence set to 35%, 31 states and Washington, DC, had an obesity prevalence of at least 35% among non-Hispanic Black adults, eight states had an obesity prevalence of at least 35% among Hispanic adults, and one state had an obesity prevalence of at least 35% among non-Hispanic White adults (Petersen et al, 2019). These findings show very striking racial disparities in obesity and are in line with the findings of the current study.

These racial disparities in the prevalence of obesity can be partly explained by cultural influences and beliefs relating to engagement in or lack of health-promoting behavior such as eating (or not eating) appropriate diets and having (or not having) regular and adequate exercise, as well as cultural understanding of what are considered acceptable body images within a given racial group (Blackman & Avellone, 2000; Powell & Kahn, 1995).

The racial disparities observed in the prevalence of obesity (Hales et al., 2020; Petersen et al., 2019) in the United States such that the prevalence of obesity is disproportionately high among the non-Hispanic Black adults (38.4%) and the Hispanic adults (32.6%) may also be linked to the racial disparities in wealth and access to resources that has affected the United States for several decades and continue to be the case even up to the present day (Sykes & Maroto, 2016). The racial disparities and minority stress in wealth and access to resources have been shown to have long-standing

effects on people's life choices, dietary choices, level of physical activities, and lifestyle (Yu et al., 2017). These in turn have considerable health consequences including on the individual's BMI and on the odds of obesity, as well as on the person's overall health condition.

In a similar way, the results of this study regarding the inverse relationship between level of education and obesity are also in agreement with the findings of previous studies. Researchers have found that the more an individual is educated, the less likely they are to be obese (Devaux et al., 2012; Kim et al., 2017). This relationship between the level of education and obesity is highly consistent, most especially for women (Devaux et al., 2012).

The educational disparities observed in the prevalence of obesity may be explained by the generally considered increased tendency of individuals with higher levels of education to select healthier dietary choices than their less educated counterparts. It has also been shown that people with higher levels of education are more likely to have access to environments that facilitate physical activities and healthier lifestyles in general (Howitt et al., 2016; Sharkas et al., 2016). The combination of these factors can explain the observed lower odds of obesity in individuals with higher education levels.

The statistically significant effect of gender on obesity, wherein female individuals are 1.126 times more likely to be obese than their male counterparts, may be due to basic physiological and hormonal differences that exist between the two genders as established by previous studies (Brown et al., 2010; Ingram et al., 1989; Lovejoy,

1998). Furthermore, it is also known that child-bearing process and gestational weight gains can contribute to higher odds of obesity most especially in women of child-bearing age and those who have had children in the past. In addition, inherent differences exist in the level of physical activities between men and women (Azevedo et al., 2007; Baranowski et al., 1993; Trost et al., 2002), and these may further contribute to differences in the odds of obesity between the different genders.

Furthermore, the statistically significant effect of age on obesity wherein older people have one and a half times higher odds to be obese than the people in the 17-34 years age group is supported by previous studies (Trost et al., 2002) and may be partly attributed to the tendency of the basal metabolic rate to reduce with age which makes the body require fewer calories than was needed at younger age (Stavres et al., 2018). This can also be coupled with reduction in the levels of physical activity with age. Such reductions in the needed calories (if not matched by a reduction in calorie intake) can lead to weight gain and obesity over the years.

All the findings discussed above are in line with the SEM conceptual framework (Bronfenbrenner, 1979). The Human Ecology Theory and hence Social Ecological Model is predicted on the fact that individuals are seen as maturing not in isolation but within the context of relationships, such as those involving families, friends, schools, neighborhoods, and society (Bronfenbrenner, 1979). For example, the maturation and development of an individual is not an isolated process; rather it is influenced by the educational facilities that the individual's environment offers him/her. It is further influenced by the person's access to resources in relation to the social-economic

dynamics within which the individual falls and lives, the perception of and opportunities (or lack of it thereof) offered to the individuals by his/her society in relation to the individual's race, gender, age, and so on. These essential aspects of the SEM conceptual framework (Bronfenbrenner, 1979) are in line with, help in the interpretations of, and justifies the findings from this study (discussed above), as regards racial disparities observed in the prevalence of obesity, the inverse relationship between the level of education and obesity, and the significant effect of gender and age on obesity.

Limitations of the Study

Although this study has made use of high-quality data set from the NHANES and has applied highly rigorous statistical techniques for testing the hypothesis and for answering the research questions posed, it is still important to recognize that this study still has a number of limitations. For example, although the NHANES data used in this study have been previously are validated and are known to be a good and representative sample of the target population (NCHS, 2016) which should make the obtained results generalizability, and make the applicability of the findings credible, one must also recognize that some parts of the data points in the NHANES data set (such as height and body weight) are self-reported variables. The values of the self-reported variables can, in general, be more prone to errors. In addition, the use of NHANES data which are essentially cross-sectional data means that the study cannot establish causal relationships, because the establishment/proving of causal relationships between the independent variables and the dependent variable require temporal information that are not available in NHANES data that is cross-sectional data.

Furthermore, this study made use of gender, age, race/Hispanic origin, education level, dietary score, and physical activity level as the independent variables/predictors for modelling obesity, the dependent variable of interest. While this is generally good, it also reveals the potential limitation of not accounting for all the possible factors that can potentially influence obesity, the dependent variable of interest.

Recommendations

Although the current study and other previous studies have shown statistically significant relationships between race and the level of education and obesity, more studies are needed to develop more complicated multivariable models that can reveal more potential patterns of the impact of these variables on obesity. Therefore, these future studies could look into the possibility of establishing causal relationships between these independent variables and obesity with an increased level of validity and reliability. It is also recommended that future studies examine more independent variables and potential confounders so as to have a better understanding of and a more wholistic view of the factors that potentially influence obesity.

Implications

In this study, I have shown that having a higher education level is associated with relative lower odds of obesity, and the findings are in agreement with previous studies (Devaux et al., 2012; Kim et al., 2017). I have also shown, through this study, that except for the Other Race/Multi-Racial category which had statistically significant lower odds of obesity, all the different race categories had statistically significant higher odds of obesity than the Non-Hispanic White category, which is in agreement with the findings of other

researchers that racial disparities is a very important factor in obesity (Hales et al., 2020; Petersen et al., 2019). These findings have important implications for positive social change at the societal/policy level. Given the overwhelming evidence that possessing a higher education level is associated with relatively lower odds of obesity (and other poor health outcomes), it becomes important that the society should look into developing better policies that would make education more accessible to everyone – the rich and the poor – alike. This can help in reducing educational inequalities and help in lower the odds of obesity and other poor health outcomes.

Furthermore, the manifestations of racial disparities in the odds of obesity shows that there is still a long way to go in ensuring the development of all the nationals of the United States. These findings also have important implications for positive social change at the societal/policy level, and it would help in informing the need for increase in societal efforts towards making and executing policies that would be targeted at lifting up and facilitating the development of the races are constantly being left behind. Such policies should also include improved cultural re-orientation targeted at ensuring that people are deeply aware of the health issues associated with obesity and the need to work towards not been obese.

Conclusion

There is a growing body of evidence that obesity increasingly constitutes a challenging problem as its prevalence continues to reach new highs. The concern is compounded by the association of obesity with several chronic diseases such as cancers,

cardiovascular diseases, and diabetes which are the major causes of morbidity, disability and mortality worldwide.

Overall, I have (through this study) found and established that there is a statistically significant relationship between race and education level and the level of obesity among adults in the United States even after controlling for the effects of gender, age, physical activity and diet.

It is concluded that, except for Other Race/Multi-Racial category which had statistically significant lower odds of obesity, all the different race categories had statistically significant higher odds of obesity than their Non-Hispanic White counterpart.

On the other hand, there is no statistically significant relationship between education*race interaction effect and the level of obesity among adults in the United States even after controlling for the effects of gender, age, physical activity and diet. This suggest that education and race do act individually to influence the odds of obesity, but further research is needed to reveal the potential impact of these variables acting together in an interaction manner, so to develop more customized and targeted preventive programs for obesity.

References

Allen, M. L., Elliott, M. N., Morales, L. S., Diamant, A. L., Hambarsoomian, K., & Schuster, M. A. (2007). Adolescent participation in preventive health behaviors, physical activity, and nutrition: differences across immigrant generations for Asians and Latinos compared with Whites. *American Journal of Public Health, 7*, 337–343. https://doi.org/10.2105/AJPH.2005.076810

Alkon, A. H., Block, D., Moore, K., Gillis, C., DiNuccio, N., & Chavez, N. (2013). Foodways of the urban poor. *Geoforum, 48*, 126-135. https://doi.org/10.1016/j.geoforum.2013.04.021

Azevedo, M. R., Araújo, C. L. P., Reichert, F. F., Siqueira, F. V., da Silva, M. C., & Hallal, P. C. (2007). Gender differences in leisure-time physical activity. *International Journal of Public Health, 52*(1), 8-15. https://doi.org/10.1007/s00038-006-5062-1

Baranowski, T., Thompson, W. O., Durant, R. H., Baranowski, J., & Puhl, J. (1993). Observations on physical activity in physical locations: Age, gender, ethnicity, and month effects. *Research Quarterly for Exercise and Sport, 64*(2), 127-133. https://doi.org/10.1080/02701367.1993.10608789

Barosh, L., Friel, S., Engelhardt, K., & Chan, L. (2014). The cost of a healthy and sustainable diet - who can afford it? *Australian & New Zealand Journal of Public Health, 38*(1), 7-12. https://doi.org/10.1111/1753-6405.12158

Bender, R., Zeeb, H., Schwarz, M., Jöckel, K. H., & Berger, M. (2006). Causes of death in obesity: Relevant increase in cardiovascular but not in all-cancer

mortality. *Journal of Clinical Epidemiology*, *59*(10), 1064-1071. https://doi.org/10.1016/j.jclinepi.2006.01.006

Birch L. L., & Fisher, J. O. (2000). Mothers' child-feeding practices influence daughters' eating and weight. *American Journal of Clinical Nutrition, 71,* 1054–1061. https://doi.org/10.1093/ajcn/71.5.1054

Blondin, S. A., Cash, S. B., Goldberg, J. P., Griffin, T. S., & Economos, C. D. (2017). Nutritional, economic, and environmental costs of milk waste in a classroom school breakfast program. *American Journal of Public Health*, *107*(4), 590-592. https://doi.org/10.2105/AJPH.2016.303647

Boyse, C., Kyla, A., Ekelund, U., Sardinha, L. B. (2016). University of Michigan Health System.*Obesity & Overweight:* Web. Retrieved fromhttp://www.mqic.org/guidelines.htm

Bowen, R. (n.d.). *Control of food intake and body weight*. Vivo Pathophysiology. http://www.vivo.colostate.edu/hbooks/pathphys/digestion/pregastric/foodintake.html

Bradshaw, M., Kent, B. V., Henderson, W. M., & Setar, A. C. (2017). Subjective social status, life course SES, and BMI in young adulthood. *Health Psychology, 36(*7), 682-694. https://doi.org/10.1037/hea0000487

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design.* Harvard University Press.

Brown, L. M., Gent, L., Davis, K., & Clegg, D. J. (2010). Metabolic impact of sex hormones on obesity. *Brain Research, 1350*, 77-85. https://doi.org/10.1016/j.brainres.2010.04.056Get

Brown, S. A., & Hedges, L. V. (1994). Predicting metabolic control in diabetes: A pilot study using meta-analysis to estimate a linear model. *Nursing Research, 43*, 362 - 368

Bullock, A., Sheff, K., Moore, K., & Manson, S. (2017). Obesity and Overweight in American Indian and Alaska Native Children, 2006-2015. *American Journal of Public Health, 107*(9), 1502-1507

Caprio, S., Daniels, S. R., Drewnowski, A., Kaufman, F. R., Palinkas, L. A., Rosenbloom, A. L., & Schwimmer, J. B. (2008). Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment: a consensus statement of Shaping America's Health and the Obesity Society. *Diabetes care*, *31*(11), 2211–2221. https://doi.org/10.2337/dc08-9024

Calle, E. E., Thun, M. J., Petrelli, J. M., Rodriguez, C., & Heath Jr, C. W. (1999). Body-mass index and mortality in a prospective cohort of US adults. *New England Journal of Medicine, 341*(15), 1097-1105.

Centers for Disease Control and Prevention, & Statistics, N. C. f. H. (2012). Higher education and income levels keys to better health, according to annual report on nation's health [Press release]. Retrieved from https://www.cdc.gov/media/releases/2012/p0516_higher_education.html

Centers for Disease Control and Prevention, & Statistics, N. C. f. H. (2014). Higher education and income levels keys to better health, according to annual report on nation's health [Press release]. Retrieved from https://www.cdc.gov/media/releases/2014/p0716_higher_education.html

Centers for Disease Control and Prevention, & Statistics, N. C. f. H. (2017). Higher education and income levels keys to better health, according to annual report on nation's health [Press release]. Retrieved from https://www.cdc.gov/media/releases/2018/p0916_higher_education.html

Centers for Disease Control and Prevention (2020). Overweight & Obesity. Retrieved from https://www.cdc.gov/obesity/adult/defining.html

Centers for Disease Control and Prevention (2020): Violence Prevention. Retrieved from https://www.cdc.gov/violenceprevention/publichealthissue/social-ecologicalmodel.html

Chau, J. Y., van der Ploeg, H. P., Merom, D., Chey, T., & Bauman, A. E. (2012). Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. *Preventive Medicine, 54*(3-4), 195-200.

Choi, H., & Marks, N. F. (2013). Socioeconomic Status, Marital Status Continuity and Change, Marital Conflict, and Mortality. *Journal of Aging and Health, 23*(4), 714-742.

Coelho, M., Oliveira, T., & Fernandes, R. (2013). Biochemistry of adipose tissue: an endocrine organ. *Archives of Medical Science : AMS, 9*(2), 191-200. doi:10.5114/aoms.2013.33181

Cohen, A. K., Rai, M., Rehkopf, D. H., & Abrams, B. (2013). Educational attainment and obesity: a systematic review. *Obesity Reviews*, *14*(12), 989-1005.

Collins, C. E., Okely, A. D., Morgan, P. J., et al. (2012). Parent diet modification, child activity, or both in obese children: An RCT. *Pediatrics,* 127, 619-627.

Contento IR, Basch C, & Zybert P (2003). Body image, weight, and food choices of Latina women and their young children. *Journal of Nutrition Education Behavior, 35,* 236–248

Creswell, J. W. (2015). *Research design: Qualitative, quantitative, and mixed methods approaches. Sage. (3rd edition)*. Thousand Oaks, CA.

de Mutsert, R., Sun, Q., Willett, W. C., Hu, F. B., & van Dam, R. M. (2014). Overweight in early adulthood, adult weight change, and risk of type 2 diabetes, cardiovascular diseases, and certain cancers in men: a cohort study. *American journal of epidemiology*, *179*(11), 1353-1365.

Dinsa, G. D., Goryakin, Y., Fumagalli, E., & Suhrcke, M. (2012). Obesity and socioeconomic status in developing countries: a systematic review. *Obesity Reviews, 13*(11), 1067-1079.

Dobbs R., Sawers C., Thompson F., Manyika J., Woetzel J.R., Child P., . . . A., S. (2014). *Overcoming Obesity: An Initial Economic Analysis. McKinsey Global Institute; Jakarta, Indonesia* Retrieved from https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Economic%20Studies%20TEMP/Our%20Insights/How%20the%20world%20could%20better%20fight%20obesity/MGI_Overcoming_obesity_Full_report.ashx

Emmons, K. E. (2000). Health behaviors in a social context. In L. F. Berkman & I. Kawachi (Eds.), Social ep- idemiology (pp. 242-266). Oxford, England: Oxford University

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2013). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39* (2), 171-191.

Fitzgibbon ML, Blackman LR, & Avellone ME (2000). The relationship between body image discrepancy and body mass index across ethnic groups. *Obesity Research, 8,* 582–589.

Frankfort-Nachmias, C., & Nachmias, D. (2014). Types of variables provides guidelines for developing research hypotheses and reviews the major guides to published research. *Research Methods in the Social Sciences*. (7th ed.). New York: Worth.

Hales, C., Carroll, M., Fryar, S., & Ogden, S. (2020). Prevalence of Obesity and Severe Obesity Among Adults: United States, 2017–2018. Retrieved from https://www.cdc.gov/nchs/data/databriefs/db360-h.pdf

Hannah Ritchie and Max Roser (2017) - "Obesity". *Published online at OurWorldInData.org.* Retrieved from: 'https://ourworldindata.org/obesity' [Online Resource]

Ho, Y.-T., Kao, T.-W., Peng, T.-C., Liaw, F.-Y., Yang, H.-F., Sun, Y.-S., . . . Chen, W.-L. (2016). Role of educational status in explaining the association between body mass index and cognitive function. *Medicine, 95*(5).

Howitt, C., Brage, S., Hambleton, I. R., Westgate, K., Samuels, T. A., Rose, A. M., & Unwin, N. (2016). A cross-sectional study of physical activity and sedentary behaviours in a Caribbean population: combining objective and questionnaire data to guide future interventions. *BMC Public Health, 16*(1), 1036.

Ingram, D., Nottage, E., Ng, S., Sparrow, L., Roberts, A., & Willcox, D. (1989). Obesity and breast disease. The role of the female sex hormones. *Cancer, 64*(5), 1049-1053.

Jones, A. (2015). Residential instability and obesity over time: The role of the social and built environment. *Health and Place, 32*, 74-82. doi:10.1016/j.healthplace.2015.01.001

Jung, U. J., & Choi, M.-S. (2014). Obesity and its metabolic complications: the role of adipokines and the relationship between obesity, inflammation, insulin resistance, dyslipidemia and nonalcoholic fatty liver disease. *International journal of molecular sciences, 15*(4), 6184-6223.

Kaplan, G. A., Everson, S. A., & Lynch, J. W. (2000). The contribution of social and behavioral research to an understanding of the distribution of disease in a multi-level approach. In L. F. Berkman & I. Kawachi (Eds.), Social epidemiology (pp. 32-80). Oxford, England: Oxford University Press

Katz ML, Gordon-Larsen P, Bentley ME, Kelsey K, Shields K, & Ammerman A (2004). "Does skinny mean healthy?" Perceived ideal, current, and healthy body sizes among African-American girls and their female caregivers. *Ethnicty and Disease 14*, 533–541.

Kelsey M, M, Zaepfel A, Bjornstad P, & Nadeau K, J. (2014). Age-Related Consequences of Childhood Obesity. *Gerontology, 60*, 222-228. doi: 10.1159/000356023

Kim, T., Roesler, N., & Knesebeck, O. (2017). Causation or selection–examining the relation between education and overweight/obesity in prospective observational studies: a meta□analysis. *Obesity Reviews, 18*(6), 660-672.

Kratz, M., Baars, T., & Guyenet, S. (2013). The relationship between high-fat dairy consumption and obesity, cardiovascular, and metabolic disease. *European journal of nutrition, 52*(1), 1-24.

Leedy, P. D. & Ormrod, J. E. (2014) *Practical research: Planning and design* (9th ed.). Merril.

Lovejoy, J. C. (1998). The influence of sex hormones on obesity across the female life span. *Journal of Women's Health, 7*(10), 1247-1256.

Lynn, L, et al. (2012). Mediasegment: RSCH 8100 Transcript: Doctoral Research: Social Change.

MacArthur LH, Anguiano R, & Gross KH (2004). Are household factors putting immigrant Hispanic children at risk for becoming overweight: a community-based study in eastern North Carolina. *Journal of Community Health 29,* 387–404.

Masters, R. K., Reither, E. N., Powers, D. A., Claire Yang, Y., Burger, A. E., & Link, B. G. (2013). The Impact of Obesity on US Mortality Levels: The Importance of Age and Cohort Factors in Population Estimates. *American Journal of Public Health, 103*(10), 1895-1901. doi:10.2105/AJPH.2013.301379

Mazidi, M., & Kengne, A. P. (2017). Nutrient patterns and their relationship with general and central obesity in US adults. *European Journal of Clinical Investigation*. https://doi-org.ezproxy.shsu.edu/10.1111/eci.12745

Mazidi, M., Banach, M., Kengne, A. P., & Lipid and Blood Pressure Meta-analysis Collaboration Group (2018). Prevalence of childhood and adolescent overweight and obesity in Asian countries: a systematic review and meta-analysis. *Archives of medical science, 14*(6), 1185–1203. https://doi.org/10.5114/aoms.2018.79001

McCrum-Gardner E. (2012). Power, effect and sample size using GPower: Practical issues for researchers and members of research ethics committees. *Evidence Based Midwifery, 5*(4),132–136

McKinlay, J. B. (1993). The promotion of health through planned sociopolitical change: Challenges for re- search and policy. S*ocial Science Medicine, 36,* 109-117.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly, 15,* 351-377.

McNabb, W., Quinn, M., Kerver, J., Cook, S., & Karrison, T. (1997). The Pathways church-based weight loss program for urban African-American women at risk for diabetes. D*iabetes Care, 20,* 1518-1523.

McGaffey, A. A., Hughes, K. K., Fidler, S. K., D'Amico, F. J., & Stalter, M. N. (2010). Can Elvis Pretzley and the Fitwits improve knowledge of obesity, nutrition, exercise, and portions in fifth graders? *International Journal of Obesity(2010), 34,* 1134-1142, Retrieved from https://www.nature.com/articles/ijo201058.pdf

Meltzer, A. L., Novak, S. A., McNulty, J. K., Butler, E. A., & Karney, B. R. (2013). Marital Satisfaction Predicts Weight Gain in Early Marriage. *Health Psychology, 32*(7), 824-827. doi:10.1037/a0031593

Michigan Department of Community Health. Our Health Begins with: The Michigan Health and Wellness 4x4 Plan. June 2012. http://tinyurl.com/a6ouuvg

Murray, C. J. L., Barber, R. M., Foreman, K. J., Ozgoren, A. A., Abd-Allah, F., Abera, S. F., . . . Vos, T. Global, regional, and national disability-adjusted life years (DALYs) for 306 diseases and injuries and healthy life expectancy (HALE) for 188 countries, 1990–2013: quantifying the epidemiological transition. *The Lancet, 386*(10009), 2145-2191. doi:10.1016/S0140-6736(15)61340-X

National Center for Health Statistics, Data Brief 288, 2017. https://www.cdc.gov/nchs/products/databriefs/ db288.htm (accessed May 1, 2018)

National Institute of Health (2017). Overweight & Obesity Statistics. Retrieved from https://www.niddk.nih.gov/health-information/health-statistics/overweight-obesity

National Institutes of Health. (2012). What is a healthy weight? Retrieved from http://www.nhlbi.nih.gov/health/public/heart/obesity/wecan/healthy-weight-basics/healthy-weight.htm

National Center for Health Statistics. (2016). *Nutrition and Weight Satus: Healthy People 2020 Midcourse Review*. Retrieved from United Sttates: https://www.cdc.gov/nchs/healthy_people/hp2020/hp2020_midcourse_review.htm

Nguyen, B. T., Shuval, K., Bertmann, F., & Yaroch, A. L. (2015). The Supplemental Nutrition Assistance Program, Food Insecurity, Dietary Quality, and Obesity Among US Adults. *American Journal of Public Health, 105*(7), 1453-1459. doi:10.2105/AJPH.2015.302580

Ogden, C. L., Carroll, M. D., Fryar, C. D., & Flegal, K. M. (2O15). Prevalence of obesity among adults and youth: United States, 2011–2014. NCHS data brief, N0 219. Hyattsville, MD: National Center for Health Statistics.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Journal of the American Association, 311*(8), 806-814.

Ogden, C. L., Lamb, M. M., Carroll, M. D., Flegal, K. M., & National Center for Health, S. (2012). *Obesity and Socioeconomic Status in Children and Adolescents: United States, 2005-2008. NCHS Data Brief. Number 51* (1941-4927). Retrieved from http://ezproxy.gsu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=ED530165&site=eds-live&scope=site

Pan, L., Sherry, B., Njai, R., & Blanck, H. M. (2012). Research: Food Insecurity Is Associated with Obesity among US Adults in 12 States. *Journal of the Academy of Nutrition and Dietetics, 112*, 1403-1409. doi:10.1016/j.jand.2012.06.011

Peterson, J., Atwood, J. R., & Yates, B. (2002). Key elements for church-based health promotion programs: Outcome-based literature review. *Public Health Nursing, 19*, 401-411.

Petersen R, Pan L,& Blanck HM (2019). Racial and Ethnic Disparities in Adult Obesity in the United States: CDC's Tracking to Inform State and Local Action. Prevention of Chronic Diseases, *16.18*0579. DOI: http://dx.doi.org/10.5888/pcd16.180579

Powell AD, & Kahn AS (1995). Racial differences in women's desires to be thin. I*nternational Journal of Eating Disorder, 17*.191–195.

Preiss, K., Brennan, L., & Clarke, D. (2013). A systematic review of variables associated with the relationship between obesity and depression. *Obesity Reviews, 14*(11), 906-918.

Protecting Human Research Participants. (2013). NIH Office of Extramural Research. Retrieved February 9, 2017, from http://phrp.nihtraining.com/index.php.

Renewbariatrics. (2017). *Report: Obesity Rates by Country – 2017*. Retrieved from https://renewbariatrics.com/obesity-rank-by-countries/

Richardson, A. S., Troxel, W. M., Ghosh-Dastidar, M., Hunter, G. P., Beckman, R., Colabianchi, N., . . . Dubowitz, T. (2017). Pathways through which higher neighborhood crime is longitudinally associated with greater body mass index. *International Journal of Behavioral Nutrition & Physical Activity, 14*, 1-10. doi:10.1186/s12966-017-0611-y

Sharkas, G. F., Saheb, T., Arqoub, K., & Haddadin, R. (2016). Sedentary lifestyle among adults in Jordan, 2007. *Family Medicine and Community Health, 4*(3), 4-8.

Sorensen, G., Emmons, K., Hunt, M. K., & Johnston, D. (1998). Implications of the results of community in- tervention trials. *Annual Review Public Health, 19*, 379-416

Stavres, J., Zeigler, M. P., & Pasternostro Bayles, M. (2018). Six weeks of moderate functional resistance training increases basal metabolic rate in sedentary adult women. *International Journal of Exercise Science, 11*(2), 32-41.

Swinburn, B. A., Sacks, G., Hall, K. D., McPherson, K., Finegood, D. T., Moodie, M. L., & Gortmaker, S. L. The global obesity pandemic: shaped by global drivers and local environments. *The Lancet, 378*(9793), 804-814. doi:10.1016/S0140-6736(11)60813-1

Sykes, B. L., & Maroto, M. (2016). A wealth of inequalities: Mass incarceration, employment, and racial disparities in US household wealth, 1996 to 2011. *RSF: The Russell Sage Foundation Journal of the Social Sciences, 2*(6), 129-152.

The Obesity Collaboration, Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., . . . Gakidou, E. (2014). Global, regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. *Lancet (London, England), 384*(9945), 766-781. doi:10.1016/S0140-6736(14)60460-8

Townsend, N., & Foster, C. (2013). Developing and applying a socio-ecological model to the promotion of healthy eating in the school. *Public health nutrition, 16*(6), 1101-1108.

Trost, S. G., Pate, R. R., Sallis, J. F., Freedson, P. S., Taylor, W. C., Dowda, M., & Sirard, J. (2002). Age and gender differences in objectively measured physical activity in youth. *Medicine and science in sports and exercise, 34*(2), 350-355.

Troy, L. M., Miller, E. A., & Olson, S. (2011). *Hunger and obesity: Understanding a food insecurity paradigm: Workshop summary*. Washington, D.C.: National Academies Press.

Tyrrell, J., Jones, S. E., Beaumont, R., Astley, C. M., Lovell, R., Yaghootkar, H., . . . Hirschhorn, J. N. (2016). Height, body mass index, and socioeconomic status: mendelian randomisation study in UK Biobank. *British Medical Journal,352*, i582.

Quick, V., Martin-Biggers, J., Povis, G. A., Hongu, N., Worobey, J., & Byrd-Bredbenner, C. (2017). A Socio-Ecological Examination of Weight-Related Characteristics of the Home Environment and Lifestyles of Households with Young Children. *Nutrients*, *9*(6), 604. https://doi.org/10.3390/nu9060604

Unger JB, Reynolds K, Shakib S, Spruijt-Metz D, Sun P, & Johnson CA (2004). Acculturation, physical activity, and fast-food consumption among Asian-American and Hispanic adolescents. *Community Health 29,* 467–481.

US Department of Health and Human Services, & US Department of Agriculture. (2015). *2015-2020 Dietary Guidelines for Americans,* . Retrieved from Washington, DC: Dept of Health and Human Services; : http://www.health.gov/DietaryGuidelines.

U.S. Department of Agriculture, Food and: school-meals Nutrition Service (2014). Nutrition standards and school meals. Retrieved fromhttp://www.fns.usda.gov/schoolmeals/nutrition-standards-

U. S. Department of Education. National Center for Education Statistics. (2012) U. S. Department of Education; Washington D.C.: Projections of education statistics. http://www.nces.ed.gov/pubs2002/2002030.pdf

U.S. Department of Health and Human Services. (2016). *The Surgeon General's vision for a healthy and fit nation.* Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General. Retrieved from http://www.surgeongeneral.gov.function, and academic achievement. *BMC Public Health.* 2016; 16(1):1078

US Department of Health and Human Services, & US Department of Agriculture. (2015). *2015-2020 Dietary Guidelines for Americans,* . Retrieved from Washington, DC: Dept of Health and Human Services; : http://www.health.gov/DietaryGuidelines

Wandersman, A., Valois, R., Ochs, L., de la Cruz, D. S., Adkins, E., & Goodman, R. M. (1996). Toward a social ecology of community coalitions. *American Journal of Health Promotion, 10(*4), 299-307. doi:10.4278/0890-1171-10.4.299

Wang, Y., Wu, Y., Wilson, R. F., et al. (Apr. 2013). *Childhood obesity prevention programs: A comparative effectiveness review and meta-analysis.* Rockville, MD: Agency for Healthcare Research and Quality

Wang, Y., Touboulic, A., & O'Neill, M. (2017). An exploration of solutions for improving access to affordable fresh food with disadvantaged Welsh

communities. *European Journal of Operational Research*. doi:10.1016/j.ejor.2017.11.065

Walden University criteria for Institutional Review Board (IRB), (2015). Guidelines. https://academicguides.waldenu.edu/doctoralcapstone/write

Whittemore, R., D'Eramo Melkus, G., & Grey, M. (2004). Applying the Social Ecological Theory to Type 2 Diabetes Prevention and Management, *Journal of Community Health Nursing, 21*, 2, 87-99, DOI: 10.1207/s15327655jchn2102_03

Wilson, S. E. (2012). Marriage, gender and obesity in later life. *Economics and HumanBiology, 10*, 431-453. doi:10.1016/j.ehb.2012.04.012

World Health Organization. (2018). *Obesity and Overweight.* Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organization. (2020). *Fact Sheets – Obesity and Overweight*. Retrieved from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

Wright, C.M., Duquesnay, P.J., Anzman-Frasca, S. et al. (2016). Study protocol: the Fueling Learning through Exercise (FLEX) study – a randomized controlled trial of the impact of school-based physical activity programs on children's physical activity, cognitive function, and academic achievement. *BMC Public Health 16,* 1078. https://doi.org/10.1186/s12889-016-3719-0

Yu, Q., Scribner, R. A., Leonardi, C., Zhang, L., Park, C., Chen, L., & Simonsen, N. R. (2017). Exploring racial disparity in obesity: a mediation analysis considering geo-coded environmental factors. *Spatial and spatio-temporal epidemiology, 21*, 13-23.