11-13-2020

Diet Behaviors, Physical Activity, and Sociodemographic Factors in a Sample of Racially Diverse Adults: A Secondary Analysis of NHANES (2017-2018) Data

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A Dissertation Submitted to The Graduate School at the University of Missouri-St. Louis in partial fulfillment of the requirements for the degree Doctor of Philosophy in Nursing

December, 2020

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Abstract

Background: The prevalence of obesity is increasing among adults in the United States and is related to a high risk to health. Obesity has been linked to lifestyle behaviors such as diet behaviors and physical activity.

Purpose: This study aimed to determine if an association exits between foods prepared outside of the home, walking or biking, vigorous/moderate recreational activities, sociodemographic factors and the outcomes, body mass index, percentage of body fat, and waist circumference.

Method: A secondary analysis was conducted using data from 3942 adults from the U.S. aged 20 years, as recorded in the National Health and Nutrition Examination Survey (NHANES) from 2017-2018. This study used an independent t-test and two-way MANOVA.

Results: Statistically significant findings are as follows. Walking or biking and vigorous recreational activities were associated with body mass index, percentage of body fat, and waist circumference (*P*<0.0001). Moderate recreational activities were associated with percent of body fat (*P*<0.0001). Hispanic and non-Hispanic Black men had a higher frequency of eating foods outside of the home compared to Hispanic and non-Hispanic Black women (*P*<0.0001), but the difference is small and not clinically significant.

Conclusion: Using lifestyle change to prevent obesity remains the cornerstone of wellness. Further study on lifestyle change that is population based is warranted.

Key Words: Diet, behavior, physical activity, sociodemographic, body mass index, Percent of body fat, waist circumference

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CHAPTER ONE

INTRODUCTION

In this chapter, the problem, problem statement, purpose, background, and significance of the diet behavior, physical activity, sociodemographic factors, body mass index (BMI), percentage of body fat, and waist circumference (WC) in a sample of racially diverse adults are discussed. In addition, associated assumptions and the hypotheses for this study are presented. The aim of this secondary study is to add new knowledge to the existing literature in hope of using this knowledge in precision health for reducing disparity in obesity and prevention of obesity.

Problem

Obesity has become a major public health problem and affects more than 600 million people globally and over 90 million Americans (Severin et al., 2019). Obesity is associated with multiple chronic diseases such as heart disease, type 2 diabetes, stroke, cancer, and psychosocial problems. This group also has the highest rates of morbidity and mortality (Pantalone et al., 2017). The estimated medical cost of obesity in the United States is $147 billion; the estimated medical cost for each obese person is $132, which is higher than people who have a “medically reasonable BMI.” The medical cost of obesity and obesity related diseases is estimated to increase to $48 to $66 billion/year in the U.S. by 2030 (Cawley & Meyerhoefer, 2012; Centers for Disease Control and Prevention, 2019; Wang et al., 2011).

According to the Centers for Disease Control and Prevention (CDC), the prevalence of obesity is highest among non-Hispanic black (49.6%) and Hispanic adults (44.8%) compared with non-Hispanic White (42.2%) and non-Hispanic Asian adults (17.4%). Non-Hispanic Black and Hispanic adults had the highest prevalence of obesity compared to all the other groups. The frequency of obesity was 40% among younger adults aged 20-39 years, 44.8% among middle aged adults from 40-59 years, and 42.8% among older adults aged 60 and over (Hales et al., 2017 & 2020); no *P* values were reported. The common explanations for disparities in obesity include differences in sociodemographic factors such as level of education, income, stress, genetics, and exposure to racism and environmental factors such as unhealthy eating behavior and physical inactivity (Burris et al., 2012; Karlamangla et al., 2010; King & Redwood, 2016; Krueger et al., 2015; Krueger et al., 2011). Additionally, obesity is the most prevalent chronic disease and a leading cause of morbidity and mortality in the U.S. and worldwide (Byrd et al., 2018).

Problem Statement

There is a paucity of research conducted on diet behavior, physical activity, and sociodemographic factors as they relate to BMI, percentage of body fat, and WC in diverse adults.

Purpose

The purpose of the current study is to explore the association among diet behaviors, physical activity, and sociodemographic factors and BMI, percentage of body fat, and WC in diverse adults aged 20 years and over.

Background

Evidence has shown that lifestyle patterns such as eating habits, lack of physical activity, sleep patterns, stress, social status, level of education, occupation, and income all contribute to the development of obesity. The fundamental cause of obesity is an energy imbalance between calories consumed and calories expended that increase the rates of obesity due to positive energy. Energy imbalance is very likely due to the changes in society and behavioral patterns of people over the past few decades (Kelly et al., 2008; Jarvis, 2017; Vliet-Ostaptchouk et al., 2012). In fact, it is well known that multiple factors contribute to obesity, including urbanization, economic growth, and most importantly, changes in lifestyle. For example, eating habits have changed as a result of greater consumption of energy-dense foods that are high in sugars and fat, and sedentary lifestyle behavior (Kelly et al., 2008). The study by Kelly et al. (2008) indicated that 23.2% of the adult population in 2005 was overweight (22.4% in women and 24.0% in men), and 9.8% was obese (11.9% in women and 7.7% in men).

The prevalence of sitting or sedentary behavior in leisure time has increased due to the increased use of media technologies. Physical activity both in leisure time and work has decreased (Young et al., 2018). Studies show that there is an association between hours of watching TV an increased risk of obesity due to lower energy expenditure, an increased consumption of meals with high energy density, and unhealthy eating habits (Hamilton et al., 2007; Heinonen et al., 2013; Young et al., 2018), and sedentary behaviors such as watching TV were significantly related to higher WC and BMI, both in women and men. One additional hour of TV watching daily was significantly related to higher WC in both women and men (both $P<0.0001$). Observational and epidemiologic studies have shown that the major environmental risk factors for obesity are unhealthy eating habits such as a diet low in vegetables and fruits and high in fat, and low physical activity. The frequency of fast food consumption among participants was significantly lower among participants who were following the dietary intake instruction for energy consumption ($P=0.001$). The consumption of fast food more than once per week reduced the overall quality of the diet ($P<0.001$). BMI was also significantly related to fast food consumption (P=0.025) (Schroder et al., 2007).

A study by Bullo et al. (2011) has shown that there is a negative association between a healthy lifestyle that includes regular physical activity and healthy diet and general and abdominal obesity across elderly at high risk of heart disease. There is a significant association between healthy lifestyle, WC, and BMI ($P<0.001$). Abdominal obesity was significantly lower among participants who met healthy lifestyle than in those who did not ($P<0.001$).

The CDC has a significant role in tracing data of obesity disparity according to racial groups. These data highlight areas where state and local action could best be applied. The CDC has found that self-reported data of height and weight are the best sources for understanding where the highest rate of obesity is among diverse populations. In fact, these data show that the incidence of obesity disparity is increasing in adults in the U.S. (Petersen et al., 2019). Additionally, racial disparities in the U.S. continue to affect disadvantaged populations, leading to large inequalities in morbidity, mortality, and chronic diseases (Obama, 2016; Vick & Burris, 2017). Racial disparities are defined as daily life in which people are born, live, grow, work, age, and the inequalities in power, resources, money are all responsible for health inequality. Other issues can contribute to health issues, such as inequality of employment opportunities, education, and environmental pathogens that are symptoms of racial disparities in obesity and obesity related to diseases (Marmot, 2018).

The types of diet behaviors examined for this study were eating foods prepared outside of the home. The study of physical activity included using a bike or taking a walk—vigorous and moderate recreational activities—in the past 7 days. Sociodemographic factors included level of education and annual family income.

Furthermore, body mass index (BMI) is defined as weight divided by square of height (kg/m^2). BMI is a common tool that is used to determine overweight and obesity in adults. In contrast, one major drawback of BMI is that it fails to consider the percent of body fat throughout the body. Abdominal obesity can be determined by waist circumference (WC) (Qian et al., 2019). Diagnostic tools used in overweight and obesity classification include percentage of body fat, BMI, and WC. This study examines these variables in a sample of racially diverse adults.

Significance

This study expands knowledge and demonstrates the importance of measuring BMI, percentage of body fat, and WC. Results from this study may facilitate the conduct of individualized treatment or precision health to reduce racial differences in obesity.

NHANES Database

Overview of the NHANES Database

The National Health and Nutrition Examination Survey (NHANES), as a part of the CDC, has conducted a survey about health and nutrition every year since the 1960s. 5000 individuals of all ages are randomly selected and interviewed in their homes and complete the health examination of the survey. In fact, NHANES is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The mode of data collection by NHANES is based on face-to-face interviews and physical examinations. The health examination is conducted in a mobile examination center. The participants are recruited by posting a video about the survey and the benefits of participation in the survey. The video is distributed to randomly selected families living in the U.S. If participants are eligible, then they receive a health exam based on age, gender, current medical condition; exam results are provided at no cost and participants receive compensation for their time. The interviewer from NHANES contacts the selected family in-person and asked questions regarding the participant’s health at home and schedules a time for a medical exam by mobile facility. The interviewer assures the participant that NHANEs keeps his or her information secure and explaines how the data from the survey would help researchers understand health problems such as diabetes, obesity, and high blood pressure in the U.S. population.

Dual-energy x-ray absorptiometry (DXA) is the most widely method used to measure body composition with lower radiation exposure. Whole-body DXA scans were applied from 1999-2006 and 2011-2018. The NHANES DXA examination provides data on body composition by sex, age, and race/ethnicity group to study the association between body composition and health conditions. The DXA scans provide bone and soft tissue measurements for the percentage of body fat (CDC, 2020; NHANES codebook, 2017-2018).

Use of the NHANES Data

A secondary analysis was conducted of NHANES data (N=3942: male=1887, female=2055) from a racially diverse sample (Hispanic, non-Hispanic Black, non-Hispanic White). The variables for this study are age in years, sex, race/ethnicity, foods prepared outside of the home, walking or biking, vigorous recreational activities, moderate recreational activities, level of education, and level of annual family income, which are all independent variables. BMI, percentage of body fat, and WC are dependent variables. The outline of this secondary analysis is presented in Figure 1.

Assumptions

The following assumptions underlie the current study:

1) Secondary data analysis is valuable.

2) Data were collected in an organized and systematic way according to protocol.

Hypotheses

The hypotheses are:

1) Younger adults are more likely to eat foods prepared outside of the home and to have higher BMI, percentage of body fat, and WC compared with middle-aged and older adults.

2) Men who eat foods prepared outside of the home have higher BMI, percentage of body fat, and WC compared to women who eat foods prepared outside of the home.

3) Men who perform physical activities (walk or bike or vigorous recreational activities [VRA] or moderate recreational activities [MRA]) have lower BMI, percentage of body fat, and WC compared to women who perform physical activities (walk or bike or VRA or MRA).

4) Non-Hispanic Black and Hispanic men are more likely to eat foods prepared outside of the home compared to Non-Hispanic Black and Hispanic women.

5) Hispanic and non-Hispanic Blacks eat more foods prepared outside of the home and have lower physical activity and higher BMI, percentage of body fat, and WC compared to non-Hispanic Whites.

6) Hispanic and non-Hispanic Blacks have a lower annual family income and less education and higher BMI, percent of body fat, and WC compared to non-Hispanic Whites.

The hypotheses are based on the following evidence:

Hypotheses	Research articles
1) Age	Bullo et al., 2011; Flegal et al., 2009, Boneva-Asiova, & Boyanov,2011; Wang et al., 2017
2) Sex	Flegal et al., 2009; Duffy et al., 2007; Hales et al., 2017, 2020; Pulit et al., 2017
3) Race	Goedecke et al., 2011; Acheampong & Haldeman, 2013; Seguin et al., 2016; Young et al., 2018; Ross et al., 2000; Ekelund et al., 2011; Hales et al., 2020; Wang et al., 2017

Summary

Studies revealed that dietary habits and sedentary behaviors are the major risk factors for obesity, including foods prepared outside the home, along with low physical activity (Bullo et al., 2011; Samblas et al., 2019; Schroder et al., 2007). Because of the multifactorial nature of obesity, it is important to consider the lifestyle factors that contribute to the development of obesity (Byrd et al., 2018). Observational studies indicated that obesity does not influence all groups in the same way and that racial disparities should be taken into consideration for individualized intervention and obesity treatment (Byrd et al., 2018; Hales et al., 2017).This study increases our knowledge of precision health for reducing disparity and obesity-related diseases.

CHAPTER TWO

INTRODUCION

This chapter discusses the theoretical definitions, review of the literature on obesity, eating foods prepared outside of the home, physical activity, sociodemographic factors, racial disparity in obesity, sex differences in obesity, racial disparity in obesity, BMI, percentage of body fat, and WC. A conceptual model for this study is presented in figure 2.

Theoretical Definition

Obesity

Obesity is defined as an abnormal accumulation of fat that contributes to the development of many associated chronic diseases such as cardiovascular diseases, type 2 diabetes, and cancer (Samblas et al., 2019). In addition, obesity is a consequence of an energy imbalance between caloric input and output in which energy imbalance is affected by lifestyle choices such as eating habits, sedentary behavior, sleep patterns, and stress and social status such as level of education, occupation, and income (Biddle et al., 2017; Jarvis, 2017; Kanwal et al., 2014).

Diet Behavior

Diet behaviors are defined as actions of individuals related to eating that affect their health condition**.** Diet has a significant role in the development of obesity. Foods that are not enriching to the body, such as foods with high salt, high sugar, high fat, low fiber, and low vitamins content are contributing to the development of obesity

(Denny, 2012). The type of diet behavior examined was foods prepared outside of the home.

Physical activity

Physical activity is defined as any body movement that requires energy expenditure, such as playing, working, traveling, carrying out household chores, and engaging in regular physical activity (World Health Organization [WHO], 2018). Regular physical activity of vigorous recreational activities, (e.g., swimming or jogging, activities that cause increased heart rate or breathing for 10 minutes continuously) or moderate recreational activities (e.g., brisk walking that causes a small increase in heart rate, biking, or doing sports) have significant benefits for health (WHO, 2018). This study of physical activity included walking or biking in the past 7 days and vigorous/moderate recreational activities.

Sociodemographic factors

Sociodemographic factors are defined as the facts and experiences that influence an individual's lifestyle, attitude, and personality, such as level of education, level of income, family size, occupation, and community support. The type of sociodemographic factors examined for this study are level of education and level of annual family income.

Weight

Body weight is defined as how heavy someone is and can be measured in kilograms or pounds.

Height

Body height is defined as the measurement from the base to the top of a standing person or from head to foot.

Body Mass Index

BMI is defined as weight divided by square of height and is the commonly used index to determine overweight and obesity in adults (CDC, 2011). BMI provides the most useful population-level measure of differentiate between overweight and obesity for all ages of adults and both sexes (WHO, 2013).

Percentage of Body Fat

Body fat distribution is distribution of human adipose tissue mainly around the trunk and upper body, such as the abdomen, shoulder, hip, and chest. Percentage of body fat is a better predictor for obesity and obesity-related diseases than BMI (Jamy, 2006). The type of body fat distribution examined is percent of body fat.

Waist Circumference

WC provides an estimate of body girth at the level of the abdomen and is usually used to measure abdominal fat during weight management intervention (Klein et al., 2007; National Heart, Lung, and Blood Institute, 2011).

Racial Disparity

A racial disparities perspective considers a daily life where people are born, live, grow, work, age, and inequalities in money, resources, and power that are responsible for health inequities. Health inequalities include inequality of employment opportunities, education, and environmental pathogens, which are all responsible for health disparities among minority and disadvantaged groups (Marmot, 2018).

Literature Review on Obesity

Obesity is the second major cause of death among adults worldwide and is associated with obesity-related diseases such as heart diseases, type 2 diabetes, hypertension, some cancers, and reduced quality of life (CDC, 2019). Obesity remains one of the most significant public health problems (Hamdy, 2013).

Classification of Obesity

BMI is a common measure of weight that is used to distinguish between overweight and obesity in adults (WHO, 2013). It provides an estimation of body fat distribution and the risk for diseases that can take place with additional body fat. The most widely used classifications of BMI are from the WHO (2013). For this study, a BMI of 18.5-24.9 kg/m^2 was considered normal weight, a BMI of 25-29.9 kg/m^2 was considered overweight (grade I), a BMI of 30-39.9 kg/m^2 was considered obese (grade II), and a BMI of greater than 40 kg/m^2 was considered severe obesity (grade III).

The Percentage of Body Fat and Obesity

The percentage of body fat is the total body fat divided by total mass, multiplied by 100. Body fat includes essential body fat and storage body fat. Essential body fat is necessary for body functions. Women have a greater percentage of essential body fat because of hormonal functions. Storage body fat includes adipose tissue, part of which protects internal organs in the abdomen and chest

(Jackson et al., 2002; Philips et al., 2013). The percentage of body fat is the only body measurement that calculates an individual's body composition. BMI offers a measure that allows comparison of the adiposity of persons of different heights and weights. Individuals with greater lean or larger bones will have a higher BMI. Therefore, while BMI is a useful tool to measure a population's level of overweight and obesity for both sexes and for all ages of adults, BMI lacks the ability to determine the health of an individual, and it may not relate to the same percentage of body fat in diverse groups (Jackson et al., 2002; WHO, 2015).

Waist Circumference and Obesity

BMI is an adequate tool to measure population level; however, WC is a better tool to represent body shape and differentiate between overweight and obese individuals (Després, 2012; Janssen et al., 2002). Researchers have found that the combination of WC and BMI explained significantly higher abdominal fat and body fat than did either WC or BMI alone ($P<0.05$). Furthermore, an increase in WC was significantly related with a rise in body fat ($P<0.05$). Evidence has shown that WC is an effective tool to measure the intra-abdominal fat mass (Pouliot et al., 1994). A study by Flegal et al. (2009) compared BMI, WC, and waist/stature ratio (WSR) with percentage of body fat in a sample of 12,901 adults. BMI, WSR, and WC were significantly more related to each other than with percentage body fat ($P<0.0001$) for both age and sex groups. Percentage of body fat tended to be significantly more related to WC than with BMI in men but significantly more related to BMI than with WC in women ($P<0.0001$) (Flegal et al., 2009). In the study by Ekelund et al. (2011), physical activity was significantly associated with WC in men and women ($P<0.001$). Physical activity also was significantly and inversely associated with a change in WC in men ((B = –0.044, $P<0.001$) and women (B = –0.02, $P=0.01$). BMI was significantly reduced by 10% among men and 7% among women ($P=0.001$). Furthermore, the National Heart, Lung, and Blood Institute (2013) suggests WC be used as an applicable measure to detect obesity and obesity related to diseases such as cardiovascular disease and type 2 diabetes.

Age and Obesity

Obesity in young adults might be related to a higher risk of developing obesity-related diseases later in life in women and men (Reis et al., 2013; The et al., 2013). Evidence suggests that the risk of diabetes is higher in individuals who were obese as adolescents than in those beginning obesity in adulthood (The et al., 2013). A study by Boneva-Asiova & Boyanov (2011) indicated that age influenced by fat mass (FM), free fat mass (FFM), subcutaneous adipose tissue (SAT), and visceral adipose tissue (VAT) differently in both sexes for normal weight and overweight/obese individuals. The normal weight age group was significantly associated with VAT ($P=0.033$, F = 7.06, R^2 = 0.502) and overweight age group ($P=0.016$, F = 6.31, R^2 = 0.136). SAT (cm^2) is associated with age in the normal weight group ($P=0.040$, F = 6.33, R^2 =0.475). In men, FM and FFM were influenced by age, whereas SAT and VAT were not significantly influenced by age ($P>0.05$). FM was among men (R^2 = 0.278, $P=0.01$) and women (R^2 = 0.299, $P=0.049$). FFM was among men (R^2 = 0.223, $P=0.029$) and women (R^2 = 0.218, $P=0.09$). A significant link was found between aging and the body composition changes. Aging is associated with increase percent body fat and decrease free fat mass. A study by Wang et al. (2017) revealed that there was a 22% prevalence of obesity among Whites, a 33.6% prevalence among Latinos, 36.1% prevalence among African Americans, and a 9.8% prevalence among Asians. There was also 25.8% prevalence of obesity among males and 23.9% prevalence of obesity among females. There was a 21.8% prevalence of obesity among the age group of 18 to 44 years, a 30.1% prevalence among the age group of 45 to 64 years, and a 23.1% prevalence among the age group of 65 and older, all with $P<0.0001$. Obesity in females was more prevalent among African Americans (odds ratio [OR] = 1.43, 95% confidence interval [CI] = 1.05–1.94) compared to Whites (OR = 0.80, 95% CI = 0.74–0.87). The prevalence of obesity was higher among the male age group of 45 to 64 years due to unemployment, lack of physical activity, past smoking, arthritis, and diabetes medicine intake (all $P < 0.001$).

A study by Reis et al. (2013) identified that abdominal obesity in young individuals was correlated with heart diseases during adulthood, independent of the degree of adiposity (no *P* value reported). Another study found that an increase in BMI in young adults may be more important in affecting obesity biomarkers such as total cholesterol, high-density lipoprotein (HDL), hemoglobin A1c, and C-reactive protein (CRP) compared adult-onset obesity ($P<0.05$) (Montonen et al., 2011).

Race/Ethnicity and the Percentage of Body Fat

Race/ethnicity might have an influence on adipose tissue and body fat distribution (Goedecke et al., 2011; Joffe et al., 1979; Tittelbach et al., 2004). Joffe et al. (1979) identified adipose tissue cell size and significant regional variations in

African American women ($P<0.001$). African American women had more abdominal fat than White women. The authors found that there was a lower expression of adipogenic and lipogenic genes among African American women with obesity compared to White women ($P<0.05$). In African American women, the expression of these genes was significantly related to abdominal fat ($P<0.05$), and they found that the gluteal adipocytes were larger in both non-obese and obese women (Goedecke et al., 2012). These genes are involved in adipogenesis in gluteal and abdominal fat in White and African American women. They also were downregulated in obesity in African American compared with White women. Additionally, the expression of these genes was significantly related to insulin sensitivity, independent of age and fat mass ($P<0.05$). African American women had more abdominal fat ($P=0.01$) compared to White women (Goedecke et al., 2011).

Diet Behaviors

Literature Review on Diet Behaviors

Dietary patterned behavior and food components contribute to an increased risk of obesity development and other metabolic disorders across racial groups. Researchers found that choices of a small number of healthy foods among African American and Hispanic adults are not a result of a shortage of understanding about healthy foods, but instead may be due to the cost of the healthy foods. Foods that are more nutritious and relate to a lower risk of obesity, such as those high in dietary fiber, beta carotene, folate, iron, calcium, potassium, magnesium, and vitamins A, C, D, E and B-12 often cost more than foods with added sugar or that are high in fat and saturated fats (Acheampong & Haldeman, 2013). The study by Acheampong and Haldeman (2013) used the combination data from three separate studies to detect nutrition awareness, beliefs, attitudes, and self-efficacy among low-income Hispanic and African American women. The findings from the study showed that African Americans had good knowledge of healthy foods compared to Hispanics. Attitudes toward eating healthy foods were significantly related to low-fat consumption among Hispanics and high fiber intake among African Americans (P=0.016, R^2=0.007). However, attitudes and beliefs about healthy foods related to BMI among Hispanics (P=0.016). African Americans had significantly more knowledge than Hispanic (P=0.013). Hispanic participants had a significant positive attitude toward healthy foods compared with African Americans (P<0.001). In addition, Hispanic populations significantly believed that eating higher quality, healthy, and nutritious foods keep them healthy compared with African American populations (P=0.008) (Acheampong & Haldeman, 2013).

Literature Review on Eating Outside of the Home

Several studies reported that foods prepared outside of the home were more likely to be energy-dense foods with higher amounts of sugar and fat than foods prepared at home (Bowman & Vinyard, 2004; Isganaitis & Lustig, 2005; Orfanos et al., 2009; Seguin et al., 2016; Todd et al., 2010). The portion sizes at restaurants and fast-food establishments also could be another factor that contributes to the consumption of excess energy because portion sizes have increased over the past 30 years. For example, the current size for hamburgers, French fries, and sodas are 2 to 5 times larger than their original sizes (Young & Nestle, 2002). A survey study by Seguin et al. (2016), among a sample of 2001 adult women and men aged 18 years to over 54 years reported that higher frequency of consuming foods prepared outside of the home was significantly related to higher BMI (P<.0001) after adjusting for age, education, race, income, marital status, smoking, and physical activity. Frequency of eating outside of the home was significantly higher among males (54%) compared to females (43.1%) (P<0.001). Females have a higher frequency of eating fruits and vegetables than do males (P<0.001). This study has also found that individuals eat more when they are served larger servings (P<0.0001) compared to regular portions. Portion sizes in meals prepared outside the home may contribute to excess energy intake and may lead to weight gain over time without reducing caloric intake (Seguin et al., 2016).

A study by Bezerra & Sichieri (2009) revealed that that the frequency of the consumption of certain food groups (soft drinks, deep-fried snacks, fast foods, sweets, and sit-down meals) was positively associated with overweight and obesity. Being overweight or obese is positively associated with sit-down meals and soft drinks (P<0.05). Eating away from home was increased among men compared to women (46.8% v. 34.5%, P<0.0001). Both sit-down meals and soft drinks were significantly associated with overweight and obesity among men and women (P<0.05).

A study by Ayala et al. (2008) used a survey questionnaire among parents of children (N= 708) in grades K-2 from 13 elementary schools in Southern California. The study found that the frequency of eating outside of the home at least once a week or more significantly correlated with increased risk of obesity among parents and their children versus eating outside of the home less than once a week ($P<0.05$).

Despite the benefits of eating meals at home, the overall number of meals made in the U.S. has decreased in the latter half of the twentieth century and the first part of the twenty-first century, which may be due to increased food cost and decreased time available for cooking at home (no *P* values reported) Caraher et al., 1998; Jabs & Devine, 2006; Smith et al., 2013). Foods prepared outside of the home may increase the WC and percentage of body fat among diverse groups, and the effects of eating out, as they relate to body weight or body fat, are different between sexes and races.

Increased consumption of food away from home has been identified as one of the causes for the obesity epidemic (Binkley et al.,2000). Some cross-sectional and longitudinal studies have shown an association between eating outside of the home or the frequency of eating foods outside of the home and BMI (Duffey et al., 2007). However, this association was found only among men (Burns et al., 2002) or only among women (Kant & Graubard, 2004).

The effect of nutrition and unhealthy eating behavior, such as consuming ready-to-eat foods or fast food, among Hispanic and African American women during pregnancy and pre-pregnancy periods increases the risk of obesity in children later in life (Vandijk et al., 2015). Additionally, nutrition deficiency in early and mid-gestation can develop a metabolic disorder later in life in offspring and has been associated with obesity, type 2 diabetes, and cardiovascular disease (Vandijk et al., 2015; no significant value reported). Fast foods and pizzas have a higher energy that contributes to weight gain and obesity (Prentice & Jebb, 2003). Evidence suggested the consumption of fast food or pizzas was associated with increase weight or BMI in both women and men (Bezerra et al., 2012) ($P<0.05$). Fast food consumption is an important determining factor of dietary intake and higher risk of obesity. Evidence has been reported that fast foods are less nutritious, contain more calories per portion than other foods, are higher in saturated fat and sodium, and contain lower levels of fiber, calcium, and iron ($P<0.05$) (Ayala et al., 2008; Guthrie et al., 2002). Therefore, the frequency of eating fast foods or pizzas is related to greater risk of higher BMI and the percentage of body fat based on racial groups and sex differences.

The U.S. Department of Agriculture (USDA) defines a processed food as "procedures that can change foods from their natural state, such as washing, cleaning, milling, cutting, chopping, heating, pasteurizing, blanching, cooking, canning, freezing, drying, dehydrating, mixing, packaging." Processed foods may include the addition of other ingredients such as flavors, salt, sugars, preservatives, and fats. Several studies indicated that increased consumption of processed foods or ready-to-eat foods is associated with higher risk of obesity and increased BMI (Malik et al., 2013; Mozaffarian et al., 2011) ($P<0.05$). Ultra-processed foods are defined as formulations of food substances often altered by chemical processes that are then pulled together into ready-to-eat foods. Ultra-processed foods have common ingredients such as high-fructose corn syrup, flavoring agents, hydrogenated oils, emulsifiers, and other cosmetic additives. They are inexpensive and more convenient than making a meal from whole foods. These ultra-processed meals, which can include frozen dishes, reconstituted meat products, savory snacks, and soft drinks, are high in calories, salt, sugar, and fat (Hall et al., 2019) (P<0.05).

Eating healthy meals that are made up of whole grains, fruits, vegetables, low-fat dairy products, poultry, meat, lean fish, eggs, nuts, beans, and limited in trans fats, saturated fat, salt, and added sugar can reduce the risk of obesity and obesity-related diseases (Hall et al., 2019). Studies suggest there is a link between processed foods or ready-to-eat foods and health problems. The randomized controlled study by Hall et al. (2019) found that ultra-processed diets cause extra calorie intake and higher BMI (P=0.0001). People with increased consumption of fats (230 ± 53 kcal/day; P=0.0004) and carbohydrates (280 ± 54 kcal/day; P<0.0001) but less protein (–2 ± 12 kcal/day; P=0.85) tended to have a higher BMI. In fact, people who spent 2 weeks eating highly processed meals consumed more calories and gained a couple of pounds (P=0.009) compared to when they ate a diet rich in whole foods and lost weight (P=0.007). Additionally, convenience, pre-prepared foods, or processed meals contribute to the obesity and increasing incidence of obesity-related diseases. Based on the available research, individuals who tend to eat prepared foods outside the home may have a higher risk of increasing their BMI, percentage of body fat, and WC.

Literature Review on Physical Activity

Obesity and physical inactivity are established as risk factors for several diseases, including cardiovascular disease, type 2 diabetes, and cancer (Allender & Rayner, 2007). Because weight is regulated by genes monitoring energy homeostasis, dietary habits and sedentary behavior may influence DNA methylation (Young et al., 2018). They may contribute to developing obesity through epigenetic mechanisms. Physical activity, both at work and in leisure time, has diminished over time (Young et al., 2018). Studies have reported that there is a relationship between hours of watching TV and higher risk of obesity due to lower energy expenditure, an increase in consumption of high energy density foods, and a rise in unhealthy eating habits ($P<0.0001$) (Hamilton et al., 2007; Heinonen et al., 2013; Young et al., 2018). Physical activity also varies in intensity, and different intensities may have different associations with body fat and distribution (Slentz et al., 2009). One possible reason for this is that different intensities of activity have different effects on metabolic processes that, in turn, influence an individual's propensity to put on weight (Wells, 2013). In addition, moderate/vigorous recreational activities may not lead to weight loss overall, may be associated with increase in lean mass instead of fat mass, and may lead to changes in body fat distribution (Ekelund et al., 2011). Furthermore, epidemiologic and observational studies have shown that the major environmental risk factors for obesity are unhealthy eating lifestyles such as a diet low in fruits and vegetables and high in fat and alcohol consumption, along with lack of physical activity (Schroder et al., 2007).

A study by Bullo et al. (2011) showed that there is a negative association between a healthy lifestyle (defined as including regular physical activity, moderate alcohol intake, and healthy foods) and abdominal obesity across elderly individuals with a high risk of heart disease (*P*<0.001). Several studies indicated that moderate amounts of physical activity can lead to reducing BMI and an even more significant reduction of fat mass (Houmard et al., 2004; McTiernan et al., 2007). Slentz et al. (2009) suggested that visceral adipose tissue is a marker of increased risk of obesity, cardiovascular diseases, and type 2 diabetes. The 12-week exercise intervention study in overweight men by Ross et al. (2000) reported that physical activity increased energy expenditure by 700 kcal/day for 12 weeks, resulting in 7.5 kg of weight loss. This study suggests that there is a relationship between the amount of exercise and BMI changes and changes in the lipoprotein variables of low-density lipoprotein (LDL) and HDL. For example, an exercise amount of > 4 miles/week for reducing fat mass (*P*<0.001) and 7 miles/week for LDL changes, and > 8 miles/week for losing weight (*P*=0.003) and increasing HDL. Abdominal fat also decreased in the physical activity intervention without losing weight (*P*=0.001).

A study by Ekelund et al. (2011) reported a correlation between physical activity such as VRA/MRA and lower BMI among individuals younger than 50 years as well as reduced risk of obesity by 7% in women and 10% in men (*P*<0.001). Several studies indicated that increasing exercise over time may not reduce weight but can induce changes in body fat distribution and body composition. Those studies have shown that increasing exercise over time tends to reduce in waist circumference (*P*<0.001) (Church et al., 2007; Eriksson et al., 2009; Ross et al., 2004; Ross & Bradshaw, 2009). Studies found that habitual exercise over time tends to have a positive effect on lean mass, bone mass, and bone strength in young children (Janz et al., 2007; Sardinha et al., 2008; Sayers et al., 2011). A study by Ross et al. (2000) indicated that cardiovascular fitness improved by 16% in physical activity groups ($P<0.01$). Total fat decreased in both weight loss groups by an average of 1.3 kg ($P<0.001$), and abdominal subcutaneous, visceral fat ratio decreased in the weight loss group ($P<0.001$). Abdominal and visceral fat decreased in the physical activity group without weight loss ($P=0.001$). Based on evidence, exercise can lead to decreases in percentage of body fat, BMI, and WC. Therefore, health benefits of regular physical activity, such as walking or biking and vigorous/moderate recreational activities may reduce the risk for obesity and obesity-related disease over time.

Literature Review on Sociodemographic Factors

Evidence suggested that prevalence of obesity differs by educational level and income, although patterns might vary between low-income and high-income countries (Dinsa et al., 2012; Freedman, 2011; May et al., 2013). The analysis of data from NHANES 2011–2014 by Ogden et al. (2017) indicated that frequency of obesity by income differs by sex and race. There was no relationship between level of income and obesity among men compared to women. The prevalence of obesity is associated with level of income among women, and the risk of obesity declined from 45.2% to 29.7% with enhanced income in women. Additionally, the prevalence of obesity was lower among adults with a college degree compared with less education for non-Hispanic Black women, Hispanic women, and non-Hispanic White men and women, but not for non-Hispanic Black or Hispanic men, or non-Hispanic Asian men and women (no *P* value was reported). This study also suggested that the association between obesity, level of educational, and income is complex and differs by race and sex.

Literature Review on Sex Differences in Obesity

Adipose tissues have an active role in the production of fatty acids in response to a meal and regulate the release of fatty acids for use by tissue and organs between meals and during activity (Zore et al., 2018). There are key variances in adipose tissue distribution in males and females; males have a higher quantity of visceral adipose tissues, whereas females have greater fat in gluteal or subcutaneous tissues (Zore et al., 2018). In terms of sex differences, diet and hormonal factors have an influence in the distribution of fat. One sex difference is in adipose tissue and the degree of fatty acids that absorb from lipoprotein lipase. Lipase is the enzyme accountable for the release of fatty acids from lipoproteins. The proportion of fatty acid is higher in the abdominal area in men and in the glute-femoral fat storage in women (Mundi et al., 2014). Researchers indicated that both visceral fat and fat mass are related to the development of type 2 diabetes, hypertension, cardiovascular disease, insulin resistance, and stroke (Link & Reue 2017; Pulit et al., 2017; Zore et al., 2018). Some studies reported that heritability of fat distribution differs across ethnic groups and is greater in women than in men (Demerath et al., 2007; Lear et al., 2007; Pulit et al., 2017). African American women, with an obesity prevalence of 54.8%, are the most at risk for obesity compared to African American men, with an obesity prevalence of 36.9%. Hispanic women have a 50.6% prevalence of obesity and Hispanic men have a prevalence of 43.1%, but non-Hispanic White and Asian women and men have a lower risk of obesity at 38%, 14%, 37.9%, and 10.2%, respectively (Halls et al., 2017; Byrd et al.,

2018) (statistical significant was not reported). Men have a lower prevalence of obesity at 6.9% compared to women, who had a higher prevalence of severe obesity at 11.5% (Hales et al., 2020). Understanding obesity disparities across sex differences and ethnic groups is important in implementing effective interventions that allow health professionals to improve the health among those in need of medical services. Additionally, it will be important for providers and health professionals to understand the obesity risks that are unique to Hispanic and African Americans as well as their sex differences when developing intervention and prevention programs.

Literature Review on Racial Disparities in Obesity

Racial disparities regarding obesity are the result of any factors that directly influence an individual's health, such as attitudes, behaviors, values, and knowledge, or that indirectly influence an individual's health, such as families, neighborhoods, and social status (Notterman & Mitchell, 2015). Racial disparities are impacted by the conditions of daily life paired together with the inequalities of power, money, resources, employment opportunities, education, and environmental pathogens, which may predispose disadvantaged populations or ethnic minorities to chronic diseases and obesity, lowering their quality of life (Marmot, 2018; Singh et al., 2017). Evidence has shown that the demographic characteristics of individuals, groups, communities, and societies have a great impact on the health and welfare of individuals. Racial inequalities in education, employment opportunities, environmental exposure to pollution, and resources create barriers to good health among disadvantaged populations (Marmot, 2018). Despite improvements in health care access, racial disparities in the U.S. continue to affect disadvantaged and minority groups, leading to large inequalities in morbidity and mortality (Obama, 2016; Vick and Burris 2017). Obesity disparities reflect health inequalities as well as the advantages and disadvantages of social groups, and these disparities can provide insight that allows health professionals to improve the health among those in need of social and medical services. Racial disparities are serious to consider when addressing the problem of obesity and its many adverse results on health outcomes. Consequently, factors including physical activity, diet, stress, discrimination, and level of income result in higher rates of obesity among African Americans and Hispanics (Byrd et al., 2018; Peterson et al., 2019) ($P<0.05$). These factors may influence the development of obesity and quality of life across racial groups.

Diet behavior is a key factor that contributes to the development of obesity among racial groups. Other factors that influence the occurrence of obesity include breastfeeding infants, the age at which solid foods are introduced, intake of the content of family meals, fast food consumption, and sweetened beverages (Byrd et al., 2018). Studies also suggest that Hispanic and African American children are more likely to eat foods of lower quality, such as fast foods and sweetened beverages, by the age of 2 years compared to non-Hispanic Whites or non-Hispanic Asians (Byrd et al., 2018; Taveras et al., 2006). Researchers investigated how lower socioeconomic status of racial and minority groups tends to influence the eating of calorically solid foods with less nutritious value, such as hydrogenated oils and meals in high saturated fats, while wealthier individuals are more likely to consume fresh fruits, vegetables, and lean proteins (Byrd et al., 2018; ; Parks et al., 2012; Schmidt et al., 2005; Taveras et al., 2010). Preferences of less nutritious foods among African American and Hispanic adults with low socioeconomic status are not a consequence of the lack of knowledge about nutritious foods, but rather are a result of the cost of healthy foods (Acheampong & Haldeman, 2013) ($P<0.001$).

Literature Review on Body Mass Index

BMI is one of the most common screening tools to assess obesity and people who are overweight (Cornier et al., 2011). It has become one of the significant tools for differentiating individuals at higher risk of obesity and health outcomes related to obesity (Klein et al., 2007). BMI is calculated as weight in kilograms divided by height squared in meters. A drawback of using BMI is that it does not discriminate between fat and lean. Individuals with normal weight who have extra fat might not be detected as obese or overweight. However, individuals who are active might be detected as overweight with a high weight or BMI because of increased lean muscle mass compared with fat (CDC, 2011). Evidence has shown a significant relationship between percentage of body fat and BMI that differs by age, sex, and race (CDC, 2013; Gallagher et al., 1996; Prentice & Jebb, 2001). Women have more body fat than men with an equal BMI, and older people have more fat than younger people (CDC, 2013). Additionally, the association between percentage of body fat and BMI varies among diverse ethnic groups. The differences found in the BMI and body fat and relationship in diverse ethnic groups might be due to differences in energy balance (Deurenberg et al., 1998; no significant value was reported [CDC, 2013]).

Literature Review on the Percentage of Body Fat

Obesity is a result of regulation of an elevated level of adiposity, which diet can influence over long time intervals. Energy expenditure is adjusted to maintain body adiposity within its regulated range in lean and obese individuals (Schwartz & Brunzell, 1997). Researchers reported that gonadal hormones have their main effects on percentage of body fat and diseases by comparing postmenopausal and premenopausal women. Evidence from studies have shown a reduction in other gonadal hormones and in the levels of estrogen after menopause and, subsequently, women experience increased fat storage in the abdomen and an enhanced risk of obesity and obesity-related diseases such as cardiovascular diseases, insulin resistance, hyperlipidemia, and hypertension (Zore et al., 2018). A short-term, 4-week reduction of testosterone levels in men led to increased storage of fatty acids in the gluteal fat compared to reduction of estrogen in women (Zore et al., 2018). Therefore, the effects of gonadal hormones on fat distribution and metabolism are likely to be influenced by numerous variables, including hormone levels such as androgen and estrogen levels.

Additionally, a study by Kanter and Caballero (2012) suggested that sociocultural factors related to dietary behaviors and physical activity appear to have a greater impact on reducing body fat in those who are overweight or obese. The association between percentage of body fat and BMI differs by age, sex, and race ($P<0.001$). The study reported that the healthy percentage of body fat for women is typically defined as 21-33%. while the healthy percentage for men is 8-19%. So, having a higher percentage of body fat can have adverse effects on a person's health outcome (Mundi et al., 2014). The association between percentage of body fat and BMI is different among diverse populations (Deurenberg et al., 1998). More research is needed to explain associations between obesity and percentage of body fat among various racial/ethnic groups.

Literature Review on Waist Circumference

WC is often used as a marker of abdominal fat mass because it is associated with abdominal fat mass and metabolic syndromes (Després, 2012; Klein et al., 2007). BMI and WC are the measurements that are most frequently used together (Cornier et al., 2011). Several studies reported that WC is a suitable tool for measuring abdominal fat mass (Pouliot et al., 1994) and that it also associates fairly with the percentage of total body fat ($P<0.0001$) (Flegal et al., 2009). Other studies demonstrated that WC is a better predictor of an accumulation of abdominal fat than the waist-to-hip ratio (Balkau et al., 2007; Pouliot et al., 1994; Wang & Hoy, 2004).

Summary/ Precision Health

Obesity is a multifaceted behavior, and a variety of factors impact its progression in every population. These factors include an individual's beliefs, a sedentary lifestyle, genetic risk, and an increase in eating outside of the home among families. Thus, obesity remains one of the major public health problems because of its correlation to chronic diseases, influence on health outcomes, and increase in healthcare expense (Flegal et al., 2012). Many studies have conducted a lifestyle intervention for patients with obesity, including behavioral interventions that increase adherence to recommendations for a healthy foods plan and increased physical activity (Power et al., 2008; Sanderson et al., 2013). Therefore, precision health considers individual risk factors and various lifestyle interventions and is considered to become the most effective treatment for obesity in the future. Individualized treatment or precision health may include a personalized type of physical activity interventions and diet (Rohde et al., 2019). A conceptual model based on existing literature about factors that contribute to the development of obesity according to racial disparity was created (see Figure 2).

There is a paucity of research focused on racial differences in obesity. In response to the lack of research on racial differences, researchers developed a theoretical definition that considered advantages and disadvantages that come from racial and ethnic groups and settings. There is a lack of research regarding the changes in percentage of body fat and WC following behavioral intervention in diverse groups. Additional research is needed to further explain the genetic and epigenetic factors that lead to differential development of obesity based on racial and minority groups.

CHAPTER THREE

INTRODUCTION

This chapter describes the hypotheses, research design, sample, setting, study procedure and measures, and statistical analysis. This chapter also includes a description used to protect human subjects. This secondary analysis is outlined in the study design in figure 1.

Hypotheses

The hypotheses are:

1) Younger adults are more likely to eat foods prepared outside of the home and to have higher BMI, percentage of body fat, and WC compared with middle-aged and older adults.

2) Men are more likely to eat foods prepared outside of the home and to have higher BMI, percentage of body fat, and WC compared to women who eat foods prepared outside of the home.

3) Men who perform physical activity (walking or biking or VRA or MRA) are more likely to have lower BMI, percentage of body fat, and WC compared to women who perform physical activity (walking or biking or VRA or MRA).

4) Non-Hispanic Black and Hispanic men are more likely to eat foods prepared outside of the home compared to Non-Hispanic Black and Hispanic women.

5) Hispanic and non-Hispanic Blacks are more likely to eat foods prepared

outside of the home and to have lower physical activity and higher BMI, percentage of body fat, and WC compared to non-Hispanic Whites.

6) Hispanic and non-Hispanic Blacks have lower annual family income and less education and higher BMI, percent of body fat, and WC compared to non-Hispanic Whites.

Method

Research Design

NHANES is a cross-sectional survey conducted in the U.S. and designed to examine the health and nutritional status of the U.S. population. Each year, approximately 5,000 individuals are interviewed at their homes and undergo a physical assessment.

Sample

The 2017-2018 NHANES cycle collected data from 3942 people of ages 20 to 80 years old among males (n=1887) and females (n=2055) between January 2017 and December 2018. This secondary analysis used adults aged 20 years and older. This study includes adults aged 20 years and over with no missing data on BMI, percentage of body fat, and WC. This study uses SPSS version 22 for visualization, interpretation, and statistical analyses. A *P* value less than 0.05 will consider with power of 0.80 significant.

Setting

The mode of data collection and health examination was conducted in a mobile examination center that provided the data with higher quality. The interviewer from NHANES contacted the chosen family in person and asked questions regarding the participant's health at home and scheduled time for a medical exam at a mobile facility.

Study Procedures and Measures

In this study, the variables were selected from the NHANES 2017-2018 cycle. The variables are age, sex, race, level of education, family income, foods prepared outside of home, walking or biking, VRA/MRA, body mass index, percentage of body fat, and waist circumference. Each of these are independent variables except BMI, percentage of body fat and WC, which are dependent variables. The variable age is 20 years or older and is measured as a continuous variable, the variables of gender (male = 0, female = 1) (nominal), race/ethnicity (Hispanic, non-Hispanic White, Non-Hispanic Black), foods prepared outside of the home, and walking or biking or VRT/MRT are all measured as categorical variables.

Measures

Dependent variables:

BMI was calculated as weight/height^2 and is data with a ratio level of measurement. BMI percentile was based on age, sex, height, and weight. A BMI of 18.5-24.9 was considered normal weight, a BMI of 25-29.9 was considered overweight, and a BMI >30 was considered obese.

Percentage of Body Fat

Body fat distribution was measured using dual-energy x-ray absorptiometry and has one component: percentage of body fat. These are at ratio level of measurement.

Waist Circumference

WC was determined to the nearest centimeter and was measured as ratio-level data. WC is determined by placing a tape measure around the abdomen at the level of the iliac crest. The tape measure should be snug but not compress the skin.

Abnormally high waist circumference was considered >102 cm in men and >88 cm in women, which increased risk of obesity-related diseases (CDC, 2020).

Independent variables:

We included demographic factors, diet behaviors, physical activity, and sociodemographic factors as covariates in our analysis.

- Demographic factors: age at screening is reported in years and was measured in ratio. Sex was measured nominally with men being the reference category. Race/ethnicity was coded into three categories: Hispanic, non-Hispanic White, non-Hispanic Black, and was measured nominally.
- Dietary behavior factors: meals prepared outside of the home during the past 7 days was measured ratio. This study transformed it in different name with two categories.
- Physical activity factors: walking or biking (nominal), VRA, and MRA (nominal). They are all coded into two categories: 1) Yes, 2)

No.

- Sociodemographic factors: Level of education is coded in adults over 20 years old as level 1 with less than 9th-11th grade, level 2, high school grade, and level 3 college degree. Level of family income is coded as level 1 with less than $25000, level 2 with $25000-$65000, and level 3 with higher than $65000.

Protection of Human Subjects

The interviewer from NHANES contacted the chosen family in person and ask questions regarding the participant's health at home and scheduled a time for medical exam by mobile facility. The interviewer assured the participant about keeping his/her information secure by NHANES and that the data from the survey would help researchers to understand health issues such as obesity, high blood pressure, and diabetes in the U.S. population. Participants received exam results at no cost and were compensated for their time. Informed consent was obtained from all participants.

Statistical Analysis

The NHANES 2017-2018 data will screen for cofounding factors and outliers for further analysis. The outliers can change the output of the regression analyses and reduce the accuracy of the outcome as well as the statistical significance. SPSS can detect outliers through explore analysis.

Descriptive Statistics

Descriptive statistics provides mean, frequencies, and standard deviation

(SD) for all study variables including age, sex, race/ethnicity, level of education, level of family income, foods prepared outside of the home, walking or biking, BMI, percentage of body fat, and WC by using SPSS version 22.

Independent t-test

Using an independent sample t-test, mean differences in eating foods outside of the home were determined between non-Hispanic Black women and men and Hispanic women and men.

General Linear Model

Multivariate Analysis

Multivariate analysis of variance (MANOVA) extends the capabilities of ANOVA by assessing multiple dependent variables simultaneously. ANOVA tests the differences between three or more group means but assesses only one dependent variable at a time. MANOVA is used when there are at least two dependent variables that are of interval/ratio measurement scale and one or more independent variables. It allows researchers to look for relationships among multiple dependent variables and independent variables simultaneously. MANOVA can also detect patterns between dependent variables through graphs, which makes it easier to understand. The combination of the dependent variables is referred as the joint distribution (Kellar & Kelvin, 2013). Wilk's lambda was used for the main effect of independent variables on the combined dependent variables.

The assumption of MANOVA includes random sample, normal distribution, equal variances across the groups on the dependent variables, no outliers because

MANOVA is sensitive to outliers, moderately correlated dependent variables, and homogeneity of the variance, which is tested using Box's M test, and homogeneity of variance among the independent groups for each dependent variable, which is tested with Leven's test. A *P* value threshold of <0.05 with power of 80 is generally used to identify significant association between independent variables and outcome.

CHAPTER FOUR

INTRODUCTION

This chapter presents the findings of the study. Included here are a description of the overall variables; how missing data were handled; data analysis; results; and summary of results. The specific findings related to each hypothesis are also presented.

Descriptive Statistics of Overall Variables

The overall sample consisted of a total of 3942 participants that ranged in age from 20 to 80 years with a mean age of 51.52 years (SD = 17.71). Fifty-two percent were women (52.1%), and 47% were men (47.9%). Participants were non-Hispanic White (43%), Hispanic (29.3%), and Non-Hispanic Black (27.7%). The mean frequency of foods prepared outside of the home was 3.22 times per week (SD = 3.87). The mean frequency for walking or biking was 1.73 times per week (SD = 0.45), the mean frequency for moderate recreational activities was 1.6 times per week (SD = 0.49), and the mean frequency for vigorous activities was 1.73 times per week (SD =0.45). Most participants had some college (55.7%), some had a high school diploma (23.9%), and some had less than 9th-11th grade education (20.4%). The mean BMI was 25.05 (SD = 6.52). The minimum BMI was 14.70 kg/m^2 indicating lower weight. The maximum BMI was 44.40 kg/m^2, indicating class III obesity or serious obesity. Most of the participants (32.7%) had normal weight with BMI <24.9 kg/m^2; 25.7% of participants had overweight BMI 25-29.9 kg/m^2; and 23.9% of participants were obese with a BMI >30 kg/m^2. The mean of total percent of body fat was 32.17 (SD = 8.62). The minimum percent of body fat was 12.90% and the maximum was 54.20%. The mean WC was 86.02 (SD = 19.89). The minimum WC was 40 cm and the maximum was 122.20 cm. Demographics and descriptive statistics are presented for the entire variables (see Table 1).

Cleaning Data

This decision for cleaning data was based on box plot and stem and leaf plot analysis. The total sample of 8704, all the sample for age less than 20 years, and samples with missing data entry were deleted. This study removed all data of refused to answer, do not know, and missing cases in all three dependent variables and independent variables. Therefore, the final sample size consisted of a total of 3942 participants for analyses.

Results

Hypothesis 1: Younger adults are more likely to eat foods prepared outside of the home and to have higher BMI, percentage of body fat, and WC compared with middle-aged and older adults. This hypothesis was not supported.

A general linear model (two-way MANOVA) was conducted. The continuous variables of age and eating foods outside of the home were transformed into three and two categorical groups: age 1) 20-40 years, 2) 41-60 years, and 3) 61-80 years; and 1) eating foods outside of the home ≤5 times during past 7 days, and 2) eating foods outside of the home >5 times during past 7 days. Age groups and foods prepared outside of the home were the independent variables and the outcomes were BMI, percent of body fat, and WC (see Figure 3).

The mean of BMI (m= 30.71, SD = 4.40) was slightly higher among younger adults (20-40 years) who had higher frequency of eating foods outside of the home than BMI in middle-aged (41-60 years) (m = 29.90, SD = 4.67) and older adults (61-80 years) (m = 29.58, SD = 3.89). The mean percent of body fat was slightly higher among middle-aged (61-80 years) (m = 32.59, SD = 8.76) than younger adults (20-40 years) (m = 32.42, SD = 7.49) and older adults (41-60 years) (m = 32, SD = 9.59). The mean of WC (m = 102.42, SD = 11.69) was higher among younger adults (20-40 years) who had higher frequency of eating foods outside of the home than WC in middle-aged (41-60 years) (m = 100.35, SD = 12.18) and older adults (m = 100.38, SD = 12.33) (see Figure 3).

There was no statistically significant main effect of age [F (6, 3918) = 1.378, P=0.2; Wilks' Λ = 0.996] or eating foods outside of the home [F (3, 1958) = 0.434, P= 0.7; Wilks' Λ = 0.999] on the combined dependent variables. There was no significant interaction effect between age and eating foods outside of the home [F (6, 3916) = 0.590, P= 0.7; Wilks' Λ = 0.998] on the combined dependent variables.

There was no statistically significant interaction effect between age and eating foods outside of the home on BMI [F (2, 1960) = 1.579, P=0.2], percent of body fat [F (2, 1960) = 0.435, P=0.6], or WC [F (2, 1960) = 1.284, P=0.2]. The mean BMI and WC were higher among younger adults (age 20-40 years) than middle-aged and older adults. The mean percent of body fat was higher among middle-aged adults than younger and older adults. However, the mean was not statistically significant. The graph of mean differences of BMI, percent of body fat, and WC according to age and eating foods outside of the home category is presented in Figure 3.

Hypothesis 2: Men who eat foods prepared outside of the home have higher BMI, percentage of body fat, and WC compared to women who eat foods prepared outside of the home. This hypothesis was not supported.

To assess whether men eat more foods prepared outside of the home and have higher BMI, percent of body fat, and WC compared to women, a general linear model (two-way multivariate) was conducted. Sex and eating foods prepared outside of the home were the independent variables, and the outcomes were BMI, percent of body fat, and WC (see Figure 4).

The mean of BMI (m = 30.39, SD = 4.81) was higher among women who had higher frequency of eating foods outside of the home than men BMI (m = 30.07, SD = 4.08). The mean of percent of body fat (m = 32.72, SD = 8.57) was higher among women who had higher frequency of eating foods outside of the home than men (m = 31.99, SD = 8.41). The mean of WC (m = 101.35, SD = 12.39) was slightly higher among men who had higher frequency of eating foods outside of the home than women (m = 101.27, SD = 12.79) (see Figure 4).

There was no statistically significant main effect of sex [*F* (3, 1960) = 0.782, *P*=0.5; Wilks' Λ = 0.999] or eating foods outside of the home [*F* (3, 1960) = 0.12, *P*=0.9; Wilks' Λ = 1] on the combined dependent variables. There was no significant interaction effect between sex and eating foods outside of the home [*F* (3,[1960) = 0.71, *P*=0.5; Wilks' Λ = 0.999] on the combined dependent variables.

There was no statistically significant interaction effect between sex and eating foods outside of the home and BMI [*F* (1, 1962) = 0.045, *P*=0.8], percent of body fat [*F* (1, 1962) = 0.545, *P*=0.4], and WC [*F* (1, 1962) = 0.264, *P*=0.6]. The mean of BMI and percent of body fat were lower among men than women. The mean of WC was lower among women than men. However, the mean was not statistically significant. The graph of mean differences of BMI, percent of body fat, and WC, according to sex and eating foods outside of the home category, is presented in Figure 4.

Hypothesis 3: Men who perform physical activity (walking or biking or VRA or MRA) have lower BMI, percentage of body fat, and WC compared to women who perform physical activity (waslking or biking or VRA or MRA). This hypothesis was not supported regarding the sex difference.

To assess whether men walked or biked or performed VRA or MRA have lower BMI, percent of body fat, and WC compared to women, a general linear model (two-way multivariate) was conducted. Three separate two-way MANOVA were conducted that included sex and walking or biking as independent variables (see Figure 5), sex and VRA as independent variables (see Figure 6), and sex and MRA as independent variables (see Figure 7) as they relate to the three dependent variables. Means are displayed in the figures.

The mean of BMI (m = 30.42, SD = 4.75), percent of body fat (m = 32.42, SD = 9.23), and WC (m = 101.91, SD = 12.58) was lower among men who walked or biked than women's BMI (m = 30.82, SD = 4.75), percent of body fat (33.27, SD = 9.27), and WC (m = 103.00, SD = 12.19) (see Figure 5).

There was no statistically significant main effect of sex [*F* (3, 1965) = 0.574, *P*=0.6; Wilks' Λ = 0.999] on the combined dependent variable. There was a significant main effect of walking or biking [*F* (3, 1965) = 4.043, *P*=0.007; Wilks' Λ = 0.999] on the combined dependent variable. There was no significant interaction effect between sex and walking or biking [*F* (3, 1965) = 0.608, *P*=0.6; Wilks' Λ = 0.999] on the combined dependent variables.

There was a significant association between walking or biking and BMI [*F* (1, 1967) = 6.770, *P*=0.009], percent of body fat [*F* (1, 1967) = 5.415, *P*=0.02], and WC [*F* (1, 1967) =10.554, *P*=0.001]. There was no significant interaction effect between sex and walking or biking on BMI [*F* (1, 1967) = 0.382, *P*=0.54], percent of body fat [*F* (1, 1967) = 1.410, *P*=0.2], or WC [*F* (1, 1967) = 0.941, *P*=0.3]. The graph of mean differences of BMI, percent of body fat, and WC according to sex and walking or biking category is presented in Figure 5.

The mean of BMI (m = 31.09, SD = 4.38), percent of body fat (m = 33.58, SD = 8.34), and WC (m = 103.39, SD = 10.93) was lower among men who had VRA than women's BMI (m = 31.24, SD = 4.73), percent of body fat (34.39, SD = 8.84), and WC (m = 103.41, SD = 11.53) (see Figure 6).

There was no statistically significant main effect of sex [*F* (3,1955) = 0.456, *P*=0.7; Wilks' Λ = 0.999] on the combined dependent variables. There was a statistically significant main effect of VRA [*F* (3, 1955) = 20.059, *P*=0.0001; Wilks' Λ = 0.970] on the combined dependent variables. There was no significant interaction effect between sex and VRA [*F* (3,1955) = 0.773, *P*=0.5; Wilks' Λ = 0.999] on the combined dependent variables.

There was a statistically significant association between VRA and BMI [*F* (1, 1957) = 40.409, *P*=0.0001], percent of body fat [*F* (1, 1957) = 37.206, *P*=0.0001], and WC [*F* (1, 1957) = 33.704, *P*=0.0001]. There was no statistically significant interaction between sex and VRA on BMI [*F* (1, 1957) = 0.09, *P*=0.7], percent of body fat [*F* (1, 1957) = 1.423, *P*=0.2], and WC [*F* (1, 1957) = 0.22, *P*=0.6]. The graph of mean differences of BMI, percent of body fat, and WC according to sex and VRA category is presented in Figure 6.

The mean of BMI (m = 29.96, SD = 4.52), percent of body fat (m = 33.24, SD = 9.27), and WC (m = 100.79, SD = 11.85) was lower among men who had MRA than women's BMI (m = 30.25, SD = 4.53), percent of body fat (m = 33.73, SD = 9.11), and WC (m = 101.05, SD = 11.69) (see Figure 7).

There was no statistically significant main effect of sex [*F* (3,1954) = 0.603, *P*=0.6; Wilks' Λ = 0.999] on the combined dependent variables. There was a statistically significant main effect of MRA [*F* (3, 1954) = 12.224, *P*=0.0001; Wilks' Λ = 0.982] and no significant interaction effect between sex and MRA [*F* (3, 1954) = 0.454, *P*=0.7; Wilks' Λ = 0.999] on the combined dependent variables.

There was a statistically significant association between MRA and percent of body fat [*F* (1, 1956) = 28.615, *P*=0.0001] and no significant association on BMI [*F* (1,

1956) = 0.589, *P*=0.4] or WC [*F* (1, 1956) = 0.357, *P*=0.5]. The interaction effect between sex and moderate recreational activity was not statistically significant on BMI [*F* (1, 1956) = 0.015, *P*=0.9], percent of body fat [*F* (1, 1956) = 0.692, *P*=0.4], and WC [*F* (1, 1956) = 0.083, *P*=0.7]. The graph of mean differences of BMI, percent of body fat and WC according to sex and MRA category is presented in Figure 7.

Hypothesis 4: Non-Hispanic Black and Hispanic men are more likely to eat foods prepared outside of the home compared to Non-Hispanic Black and Hispanic women. This hypothesis was supported; the difference was statistically significant, but the difference was small and not clinically significant.

To assess whether non-Hispanic Black and Hispanic men are more likely to eat foods prepared outside of the home than non-Hispanic Black and Hispanic women, an independent t-test was conducted. The continuous variable of eating foods prepared outside of the home was selected data for non-Hispanic Black and Hispanic and sex differences (see Figure 8).

Hispanic and non-Hispanic Black men had a significantly higher frequency of eating foods outside of the home compared to Hispanic and non-Hispanic Black women (t = 5.252, df = 1812, P<0.0001); the difference was statistically significant but the difference was small and not clinically significant.

Hispanic and Non-Hispanic Black men are significantly different from Hispanic and Non-Hispanic Black women regarding frequency of eating foods outside of the home. Inspection of the two group means indicate that the average for eating outside of the home for Hispanic and Non-Hispanic Black men (m = 1.28, SD = 0.45) is significantly higher than for Hispanic and Non-Hispanic Black women (m = 1.18, SD = 0.38). The difference between the mean was small (0.1). The mean differences between frequency of eating foods outside of the home among Hispanic and non-Hispanic Black men and women is presented in Figure 8.

Hypothesis 5: Hispanic and non-Hispanic Blacks are more likely to eat foods prepared outside of the home and to have lower physical activity and higher BMI, percentage of body fat, and WC compared to non-Hispanic Whites. This hypothesis was not supported.

A general linear model (two-way multivariate) was conducted. Four separate two-way MANOVA were conducted include race and eating foods outside of the home as independent variables (see Figure 9), race and walking or biking as independent variables (see Figure 10), race and VRA as independent variables (see Figure 11), and race and MRA as independent variables (see Figure 12) on three dependent variables.

The mean of BMI (m = 30.22, SD = 3.98) and percent of body fat (m = 32.27, SD = 8.27) was higher among Hispanic people who eat foods outside of the home more than 5 times during the past 7 days compared to non-Hispanic Whites on BMI (m = 30.25, SD = 4.38), percent of body fat (m = 32.14, SD = 8.92), and non-Hispanic Blacks on BMI (m = 30.1, SD = 4.65) and percent of body fat (m = 31.98, SD = 8.7). The mean of WC was higher among non-Hispanic Whites (m = 101.73, SD = 10.56) who eat foods outside of the home more than 5 times during the past 7 days compared to Hispanic WC (m = 101.59, SD = 11.51) and non-Hispanic Blacks (m = 100.52, SD = 13.8). The mean differences of BMI, percent of body fat, and WC were lower among non-Hispanic Blacks than Hispanic and non-Hispanic Whites (see Figure 9).

There was no statistically significant main effect of race [F (6, 3180) = 0.333, P=0.9; Wilks' Λ = 0.999] or eating foods outside of the home [F (3, 1590) = 0.309, P=0.8; Wilks' Λ = 0.999], and no significant interaction effect between race and eating foods outside of the home [F (6, 3182) = 0.239, P=0.9; Wilks' Λ = 0.999] on the combined dependent variables.

There was no significant association of race and eating foods outside of the home on each dependent variable. There was no statistically significant interaction effect between race and eating foods outside of the home on BMI [F (2, 1592) = 0.052, P=0.9] and on percent of body fat [F (2, 1592) = 0.071, P=0.9] and on WC [F (2, 1592) = 0.095, P= 0.9]. The mean differences of BMI, percent of body fat, and WC according to race and eating outside of the home is presented in Figure 9.

The mean of BMI (m = 30.11, SD = 4.68) was lower among non-Hispanic Blacks who walk or bike than non-Hispanic Whites (m = 30.84, SD = 4.54) and Hispanic people (m = 31.18, SD = 5.03). The mean of percent of body fat (m = 32.49, SD = 8.95) was lower among non-Hispanic Blacks who walk or bike than non-Hispanic Whites (m = 33.32, SD = 9.46) and Hispanic people (m = 32.66, SD = 9.66). The mean of WC (m = 100.98, SD = 13.94) was lower among non-Hispanic Blacks who walk or bike than non-Hispanic Whites (m = 103.18, SD = 11.38) and Hispanic people (m = 103.2, SD = 11.76) (see Figure 10).

There was no statistically significant main effect of race [F (6, 3186) = 0.740, *P*=0.6; Wilks' Λ = 0.997] on the combined dependent variables. There was a statistically significant main effect of walking or biking [*F* (3, 1593) = 3.857, *P*=0.009; Wilks' Λ = 0.993] on the combined dependent variables. There was no significant interaction effect between race and walking or biking [*F* (6, 3186) = 0.778, *P*=0.5; Wilks' Λ = 0.997] on the combined dependent variables.

There was no significant association between race and each dependent variable. There was a statistically significant association between walking or biking and BMI [*F* (1, 1595) = 8.788, *P*=0.003], percent of body fat [*F* (1, 1595) = 4.352, *P*=0.03], and WC [*F* (1, 1595) = 10.019, *P*=0.002]. There was no statistically significant interaction effect between race and walking or biking on BMI [*F* (2, 1595) = 1.695, *P*=0.1], percent of body fat [*F* (2, 1595) = 0.656, *P*=0.5], and WC [*F* (2, 1595) = 1.282, *P*=0.2]. The mean differences of BMI, percent of body fat, and WC according to race and walking or biking are presented in Figure 10.

The mean of BMI (31.29, SD = 4.86) was lower among Hispanic people who did VRA than non-Hispanic Whites (m = 31.18, SD = 4.4) and non-Hispanic Blacks (m = 31.36, SD = 4.59). The mean of percent of body fat (m = 33.22, SD = 8.8) was lower among Hispanic people who did VRA than non-Hispanic Whites (m = 33.89, SD = 9,08) and non-Hispanic Blacks (m = 35.14, SD = 8.38). The mean of WC (m = 102.86, SD = 11.38) was lower among Hispanic people who did VRA than non-Hispanic Whites (m = 103.28, SD = 10.66) and non-Hispanic Blacks (m = 104.59, SD = 12.19) (see Figure 11).

There was no statistically significant main effect of race [*F* (6, 3166) = 0.392, *P*=0.8; Wilks' Λ = 0.999] on the combined dependent variables. There was a statistically significant main effect of vigorous recreational activity [*F* (3, 1583) = 19.779, *P*=0.0001; Wilks' Λ = 0.964] and no statistically significant interaction effect between race and vigorous recreational activity [*F* (6, 3166) = 1.484, *P*=0.1; Wilks' Λ = 0.994] on the combined dependent variables.

There was no statistically significant association between race and each dependent variable. There was a statistically significant association between vigorous recreational activity and BMI [*F* (1, 1585) = 42.953, *P*=0.0001], percent of body fat [*F* (1, 1585) = 33.653, *P*=0.0001], and WC [*F* (1, 1585) = 34.935, *P*=0.0001]. There was no statistically significant interaction effect between race and VRA on BMI [*F* (2, 1585) = 0.374, *P*=0.6], percent of body fat [*F* (2, 1585) = 2.273, *P*=0.1], and WC [*F* (2, 1585) = 2.165, *P*= 0.1]. The mean differences of BMI, percent of body fat, and WC according to race and VRA are presented in Figure 11.

The mean of BMI (m = 29.82, SD = 4.78) was lower among non-Hispanic Blacks who did MRA than non-Hispanic Whites (m = 30.09, SD = 4.21) and Hispanic people (m = 30.36, SD = 4.83). The mean of percent of body fat (m = 33.34, SD = 9.45) was slightly lower among non-Hispanic Whites who did MRA than Hispanic (m = 33.46, SD = 9.76) and non-Hispanic Blacks (m = 33.77, SD = 8.62). The mean of WC (m = 99.71, SD = 13.27) was lower among non-Hispanic Blacks who did MRA than non-Hispanic Whites (m = 101.25, SD = 11.31) and Hispanic people (m = 100.90, SD = 11.66) (see Figure 12).

There was no statistically significant main effect of race [*F* (6, 3164) = 0.475, *P*=0.8; Wilks' Λ = 0.998] on the combined dependent variables. There was a statistically significant main effect of moderate recreational activity [*F* (3, 1582) = 11.707, *P*=0.0001; Wilks' Λ = 0.978] on the combined dependent variables. There was no statistically significant interaction effect between race and moderate recreational activity [*F* (6, 3164) = 0.612, *P*=0.7; Wilks' Λ = 0.998] on the combined dependent variables.

There was no statistically significant association between race and each dependent variable. There was a statistically significant association between moderate recreational activity and percent of body fat [*F* (1, 1584) = 25.357, *P*=0.0001 but no significant on BMI [*F* (1, 1584) = 0.369, *P*=0.5] or WC [*F* (1, 1584) =1.018, *P*=0.3]. There was no significant interaction effect between race and moderate recreational activity on BMI [*F* (2, 1584) = 0.366, *P*=0.6], percent of body fat [*F* (2, 1584) = 0.215, *P* = 0.8], and WC [*F* (2, 1584) = 0.523, *P*=0.5]. The mean differences of BMI, percent of body fat, and WC according to race and MRA are presented in Figure 12.

Hypothesis 6: Hispanic and non-Hispanic Blacks have lower annual family income and less education and higher BMI, percent of body fat, and WC compared to non-Hispanic Whites. This hypothesis was partially supported.

This study conducted two separate two-way MANOVA, first between race and level of education as independent variables (see Figure 13) on three dependent variables (BMI, percent of body fat, and WC), the second two-way MANOVA between race and level of annual family income as independent variables (see Figure 14) on three dependent variables.

First two-way MANOVA: the mean of BMI (m = 29.9, SD = 3.89) was lower among non-Hispanic Blacks who had less than 9th to 11th grade education than Hispanic (m = 29.99, SD = 4.29) and non-Hispanic Whites (m = 30.63, SD = 4.15). The mean of percent of body fat (m = 31.55, SD = 8.72) was lower among non-Hispanic Blacks who had less than 9th to 11th grade education than Hispanic (m = 31.99, SD = 8.76) and non-Hispanic Whites (m = 33.15, SD = 8.66). The mean of WC (m = 100.22, SD = 10.73) was lower among non-Hispanic Blacks who had less than 9th to 11th grade education than Hispanic (m = 101.13, SD = 11.31) and non-Hispanic Whites (m = 102.02, SD = 10.73) (see Figure 13).

The mean of BMI (m = 29.81, SD = 4.17) was lower among non-Hispanic Blacks who had high school degree than non-Hispanic Whites (m = 30.29, SD = 4.26) and Hispanic people (m = 30.70, SD = 4.73). The mean of percent of body fat (m = 32.55, SD = 8.15) was lower among non-Hispanic Blacks who had a high school degree than non-Hispanic Whites (m = 32.32, SD = 9.37) and Hispanic people (m = 33.09, SD = 9.61). The mean of WC (m = 100.7, SD = 11.39) was lower among non-Hispanic Blacks who had a high school degree than non-Hispanic Whites (m = 101.82, SD = 11.12) and Hispanic people (m = 102.11, SD = 10.68) (see Figure13). The mean of BMI (m = 30.06, SD = 4.36) was lower among non-Hispanic Whites who had some college than Non-Hispanic Blacks (m = 30.19, SD = 4.65) and Hispanic people (m = 30.25, SD = 4.66). The mean of percent of body fat was lower among non-Hispanic Whites (m = 31.68, SD = 8.57) and Hispanic people (m = 31.69, SD = 8.43) than non-Hispanic Blacks (m = 32.21, SD = 8.24). The mean of WC (m = 100.72, SD = 12.96) was lower among non-

Hispanic Blacks who had some college than Non-Hispanic Whites (m = 100.91, SD = 11.21) and Hispanic people (m = 100.76, SD = 11.59) (see Figure 13).

There was no statistically significant main effect of race [*F* (6,3176) = 0.354, *P*=0.9; Wilks' Λ = 0.999] or level of education [*F* (6,3176) = 0.545, *P*=0.7; Wilks' Λ = 0.998] on the combined dependent variables. There was no statistically significant interaction effect between race and level of education [*F* (12, 4201) = 0.549, *P*=0.8; Wilk's Λ= 0.996] on the combined dependent variables.

There were no statistically significant associations of race and level of education on each dependent variable. There was no significant interaction effect between race and level of education on BMI [*F* (4, 1590) = 0.852, *P*=0.4], percent of body fat [*F* (4, 1590) = 0.290, *P*=0.8], and WC *[F* (4, 1590) = 0.781, *P*=0.5]. The mean differences of BMI, percent of body fat, and WC according to race and level of education are presented in Figure 13.

Second two-way MANOVA: the mean of BMI (m = 29.97, SD = 4.65) was lower among Hispanic people with family income less than $25000 than non-Hispanic Whites (m = 30.44, SD = 4.45) and non-Hispanic Blacks (m = 30.52, SD = 5.08).

The mean of percent of body fat (m = 32.16, SD = 8.92) was lower among Hispanic people with family income less than $25000 than non-Hispanic Whites (m = 32.69, SD = 8.83) and non-Hispanic Blacks (m = 32.57, SD = 8.15). The mean of WC (m = 100.77, SD = 10.97) was lower among Hispanic people with family income less than $25000 than non-Hispanic Whites (m = 102.47, SD = 11.09) and non-Hispanic Blacks (m = 101.19, SD = 12.92). The mean of BMI (m = 29.82, SD = 4.49) was lower among Hispanic people with family income of $25000-$65000 than non-Hispanic Whites (m = 30.55, SD = 4.19) and non-Hispanic Blacks (m = 29.87, SD = 4.01). The mean of percent of fat (m = 31.55, SD = 8.81) was lower among non-Hispanic Whites than Hispanic (m = 32.02, SD = 8.81) and non-Hispanic Blacks (m = 33.01, SD = 8.29). The mean of WC (m = 100.11, SD = 11.37) was lower among Hispanic people with family income of $25000-$65000 than non-Hispanic Whites (m = 101.91, SD = 10.94) and non-Hispanic Blacks (m = 101.20, SD = 11.42) (see Figure 14). The mean of BMI (m = 29.98, SD = 4.39) was lower among non-Hispanic Blacks with family income higher than $65000 than non-Hispanic Whites (m = 29.81, SD = 4.32) and Hispanic people (m = 30.98, SD = 4.64). The mean of percent of body fat (m = 31.03, SD = 8.32) was lower among non-Hispanic Blacks with family income higher than $65000 than non-Hispanic Whites (m = 32.42, SD = 8.79) and Hispanic people (m = 32.14, SD = 8.46). The mean of WC (m = 99.67, SD = 12.58) was lower among non-Hispanic Blacks with family income higher than $65000 compared to non-Hispanic Whites (m = 100.27, SD = 11.2) and Hispanic people (m = 102.44, SD = 11.32) (see Figure 14).

There was no statistically significant main effect of race [*F* (3, 3178) = 0.380, *P*=0.8; Wilks' Λ = 0.999] or level of annual family income [*F* (6, 3178) = 0.716, *P*=0.6; Wilks' Λ = 0.999] on the combined dependent variables. There was a statistically significant interaction effect between race and level of family income [*F* (12, 4204) = 2.131, *P*=0.01; Wilk's Λ= 0.984] on the combined dependent variables. This means that the effect of level of annual family income on the dependent variables is not the same for Hispanic, non-Hispanic Blacks, and non-Hispanic Whites.

There was no statistically significant association between race or level of family income and each dependent variable. There was a statistically significant interaction effect between race and level of family income on BMI [F (4, 1591) = 3.126, P=0.01] and no significant interaction on percent of body fat [F (4, 1591) = 1.539, P=0.1] and WC [F (4, 1591) = 2.27, P=0.06]. This means that level of annual family income on the BMI is not the same for Hispanic, Non-Hispanic Whites, and non-Hispanic Blacks. Therefore, non-Hispanic Blacks and non-Hispanic Whites who had lower annual family income had higher BMI than Hispanic people. The mean differences of BMI, percent of body fat, and WC according to race and level of family income is presented in Figure 14.

Summary of the Results

- Walking or biking or VRA was significantly associated with BMI, percentage of body fat, and WC.
- MRA was significantly associated with percent of body fat.
- Hispanic and non-Hispanic Black men had a significantly higher frequency of eating foods outside of the home compared to Hispanic and non-Hispanic Black women, but the difference was small and not clinically significant.

CHAPTER FIVE

INTRODUCTION

In this chapter, the summary of the study, results, limitation, implication for the results, recommendation for future research, and conclusion are presented. This chapter contains discussion of the findings.

Summary of the Study

This secondary study explored the association between eating foods prepared outside of the home, walking or biking, VRA or MRA, level of education, and level of family income on the dependent variables: BMI, percent of body fat, and WC.

Results

Demographic and Descriptive Variables

The overall sample consisted of a total of 3942 participants that ranged in age from 20 to 80 years with a mean age of 51.52 years. Fifty-two percent were women (52.1%), and 47% were men (47.9%). Most of the participants were non-Hispanic Whites (43%), Hispanic (29.3%), and Non-Hispanic Blacks (27.7%), underscoring the importance of including non-Hispanic Blacks and Hispanics in further research on the combined BMI, percent of body fat, and WC. Past studies have included predominantly non-Hispanic Whites (Ekelund et al., 2008; Flegal et al., 2009; Kant & Graubard, 2004; Seguine et al., 2016; Wang et al., 2017).

Age and Eating Foods Prepared Outside of the Home

The current secondary study did not show that younger adults are more likely to eat foods prepared outside of the home and to have higher BMI, percentage of body fat, and WC compared with middle-aged and older adults. However, the mean of BMI and WC was higher among younger adults with higher frequency of eating foods outside of the home than middle aged and older adults. Further research needs to investigate aging and foods groups on BMI and WC to provide effective intervention.

The study by Van der Horst et al. (2011) demonstrated that significant inverse correlation between age and eating foods away from home ($B=-1.28$, $P<0.0001$) in which younger individuals eats more foods away from home than older individuals. Take-away food intake was also associated with age (40-59 years) (OR = 0.58, $P<0.01$) and age ≥ 60 years (OR= 0.28, $P<0.0001$).

The current study showed that the mean of percent of body fat was higher among older adults than middle-aged and younger adults and was not significant. A cross sectional study by Boneva-Asiova & Boyanov (2011) indicated that mean for percent of fat for age 35 to 39 years was 32.7%, for age 40 to 49 years was 37.9%, for age 50 to 59 years was 38.4%, and for age 60 to 65 years was 38.9%. This study also demonstrated that there was a significant association between aging and increasing percent of body fat in normal weight group ($R^2 = 0.50$, $F = 7.06$, $P= 0.03$) and in overweight group ($R^2 = 0.14$, $F = 6.31$, $P=0.02$).

Sex Differences and Eat Foods Prepared Outside of the Home

The current secondary study did not show that men who eat foods prepared outside of the home had higher BMI, percentage of body fat, and WC compared to women who eat foods prepared outside of the home. These results are supported by previous research. A cross sectional study indicated no association between eating foods away from home and BMI or a negative association among women and men (Bezerra et al., 2012). The author of this review suggested that a lack of a common definition of eating foods away from home concepts, foods consumption methods, frequency of foods from restaurant or fast foods may contribute to lack of association (Bezerra et al., 2012). However, a survey study by Seguin et al. (2016), among a sample of 2001 adult women and men aged 18 years to over 54 years, reported that higher frequency of foods prepared outside of the home was significantly related to with higher BMI (P<.0001). Frequency of eating foods outside of the home was significantly higher among males (54%) compared to females (43.1%) (P<0.001). Females have higher frequency of eating fruits and vegetables than males (P<0.001). This study has also found that individuals eat more when they are served larger servings (P<0.0001) compared to regular portions. Portion sizes in meals prepared outside from the home may contribute to excess energy intake and may lead to weight gain over time without reducing caloric intake (Seguin et al., 2016). Another study by Bezerra & Sichieri (2009) revealed that that the frequency of the consumption of certain food groups (soft drinks, deep-fried snacks, fast foods, sweets, and sit-down meals) was positively associated with overweight and obesity. Being overweight and being obese is positively associated with sit-down meals and soft drinks

($P<0.05$). Eating away from home was increased among men compared to women (46.8% v. 34.5%, $P<0.0001$). Both sit-down meals and soft drinks were significantly associated with overweight and obesity among men and women ($P<0.05$).

Sex Differences and Physical Activity

The current secondary study did not show that men who perform physical activity (walking or biking or VRA or MRA) have lower BMI, percentage of body fat, and WC compared to women who perform physical activity (walking or bikng or VRA or MRA). However, there was a significant association between walking or biking or VRA and BMI, percent of body fat, and WC. These findings were supported by previous evidence (Bullo et al., 2011; Ekelund et al., 201). Evidence suggested that there was significant correlation between physical activity and energy expenditure ($P<0.0001$) and no association between physical activity (walking or biking) and BMI in men and women (P=0.1). However, physical activity was associated with lower WC among men and women (P=0.001). Physical activity was positively and inversely associated with a change in WC in men ($P<0.001$) and women (P=0.01) and was associated with reduced BMI by 7% in women and 10% in men ($P=0.001$) (Bullo et al., 2011; Ekelund et al., 2011). Ekelund et al. (2008) revealed that sedentary time was significantly associated with higher BMI (P<0.0001), WC (P= 0.003), and percent of fat mass (P<0.0001). In the study by Ekelund et al. (2011), physical activity was significantly associated with WC in men and women ($P<0.001$). Physical activity significantly was associated with a change in WC in men (B = –0.044, $P<0.001$) and women (B = –0.02, $P=0.01$). A significant decrease was shown in BMI by 7% and 10% among men and women, respectively

(P=0.001). VRA was associated with changes in distribution of body fat among both men and women (Bowen et al., 2015; Zanovec et al., 2009).

The current study showed that MRA was significantly associated with percent of body fat. This finding is like a previous study in which physical activity was negatively associated with percent of body fat (P<0.0001) and not associated with BMI (P=0.4) (Zanovec et al., 2009). Evidence shows that physical activity varies in intensity, and different intensities may have different associations with body fat and distribution (Slentz et al., 2009). One possible reason for this is that different intensities of activity have different effects on metabolic processes that, in turn, influence an individual's propensity to put on weight (Wells, 2013).) In addition, moderate recreational activities may not lead to weight loss overall, may be associated with increase in lean mass instead of fat mass, and may lead to changes in body fat distribution (Ekelund et al., 2011). Further longitudinal study needs to explore the effect of regular physical activity over time among men and women on the outcomes (BMI, percent of body fat, and WC).

Non-Hispanic Black/Hispanic Men/Women and Eat Foods Prepared Outside of the Home

Hispanic and Non-Hispanic Black men had a significantly higher frequency of eating foods outside of the home than Hispanic and Non-Hispanic Black women, but not clinically significant. The results are supported by previous research (Acheampong & Haldeman,2013; Kant & Graubard, 2004; Wang et al., 2017). The study by Kant & Graubard (2004) demonstrated that African American (m = 2.4) and Hispanic men (m = 2.9) who had higher mean on frequency of prepared foods consumption than African

American (m = 1.8) and Hispanic women (m = 1.7) ($P<0.005$).

Hispanic/Non-Hispanic Black/Non-Hispanic White and Eat Foods Prepared Outside of the Home

The current secondary study did not show that Hispanic and non-Hispanic Blacks are more likely to eat foods prepared outside of the home and have higher BMI, percentage of body fat, and WC compared to non-Hispanic Whites. The results are not supported by previous research (Acheampong & Haldeman, 2013; Flegal et al., 2009). The study by Acheampong and Haldeman showed that African Americans had good knowledge of healthy foods compared to Hispanics. Attitudes toward eating healthy foods were significantly related to low-fat consumption among Hispanics and high fiber intake among African Americans ($P=0.016$, $R^2=0.007$). However, attitudes and beliefs about healthy foods related to BMI among Hispanics ($P=0.016$) showed that African Americans had significantly more knowledge than Hispanics ($P=0.013$). Hispanic participants had a significant positive attitude toward healthy foods compared with African Americans ($P < 0.001$). In addition, Hispanic populations significantly believed that eating higher quality, healthy, and nutritious foods kept them healthy than did African American populations ($P=0.008$) (Acheampong & Haldeman, 2013).

Studies also suggest that Hispanic and African American children are more likely to eat foods of lower quality, such as fast foods and sweetened beverages, by the age of 2 years as compared to non-Hispanic Whites or non-Hispanic Asians (Byrd et al., 2018; Taveras et al., 2006). Further study needs to investigate the influence of food groups over time among Hispanic and non-Hispanic Blacks on the outcomes (BMI, percent of body fat, and WC).

Hispanic/Non-Hispanic Black/Non-Hispanic White and Physical Activity

The current secondary study did not show that Hispanic and non-Hispanic Blacks were more likely to have lower physical activity (walking or biking, VRA, and MRA) and higher BMI, percentage of body fat, and WC compared to non-Hispanic Whites. However, there was a significant association between walking or biking or VRA and BMI, percent of body fat, and WC. These finding is like the previous evidence (Bullo et al., 2011; Ekelund et al., 2011). Previous research has shown that there was a significant association between physical activity (walking or biking, VRA) and BMI and WC among Whites and African American people (Wang et al., 2017).A study by Bullo et al. (2011) has shown that there is a negative association between regular physical activity (walking or MRA) and general and abdominal obesity across elderly at high risk of heart disease. There was a significant association between regular physical activity and WC and BMI (P<0.001). The current study showed that MRA was significantly associated with percent of body fat.

Hispanic/Non-Hispanic Black/Non-Hispanic White and Annual Family Income and Level of Education

The current secondary study did not show that Hispanic and non-Hispanic Blacks have less education and higher BMI, percent of body fat, and WC compared to non-Hispanic Whites**.** Previous research found significant effects (Acheampong & Haldeman, 2013; Astbury et al., 2019; Flegal et al., 2012; Hales et al., 2017; Ogden et al., 2017;

Seguin et al., 2016). Researchers investigated how lower socioeconomic status (level of education and level of income) of racial and minority groups tends to influence the eating of calorically solid foods with less nutritious value, such as hydrogenated oils and meals in high saturated fats, while wealthier individuals are more likely to consume fresh fruits, vegetables, and lean proteins (Byrd et al., 2018; Parks et al., 2012; Schmidt et al., 2005; Taveras et al., 2010). Preferences of less nutritious foods among African American and Hispanic adults with low socioeconomic status are not a consequence of the lack of knowledge about nutritious foods, but rather are a result of the cost of healthy foods (Acheampong & Haldeman, 2013) ($P<0.001$).

Limitation of This Study

This secondary study had several limitations. First, because this study was a secondary analysis, findings must be viewed with caution. Second, definite conclusions cannot be made about race because race was a category set up by others who established the database. For example, it is not suggested that all Hispanics in the U.S. might demonstrate the same patterns found in the data. Third, the foods prepared outside of the home variable was not well defined as to what kinds of foods they choose or what kind of restaurants they went to during the past 7 days. Fourth, physical activity included walking or biking, vigorous recreational activities, and moderate recreational activities, and they were all based on yes and no questions; 70% of participants said no on those activities. Fifth, BMI and percent of body fat are highly correlated by DXA, which may have interfere with the findings (Flegal et al., 2012). Finally, some statistically significant differences were small in magnitude and the clinical relevance of these specific findings needs further review.

Implication for the Results

The current study produced new knowledge related to walking or biking for at least 10 minutes continuously to get and from places was correlated with BMI, percent of body fat, and WC (see Figure 5). Additionally, vigorous recreational activities for at least 10 minutes such as jogging, running, or walking fast that increase in breathing or heart rate was associated with BMI, percent of body fat, and WC (see Figure 6). Further investigation is warranted on the effect of walking or biking and VRA over time on BMI, percent of body fat, and WC among Hispanic and non-Hispanic Black/White populations and sex.

Moderate recreational activities such as brisk walking, biking, or swimming for at least 10 minutes that cause small increases in breathing or heart rate were associated with percent of body fat (see Figure 7). Further research needs to investigate the effect of MRA in BMI, percent of body fat, and WC among Hispanic and non-Hispanic Black/White populations and sex.

This current study added new knowledge that frequency of eating foods prepared outside of the home was higher among Hispanic and non-Hispanic Black men than Hispanic and non-Hispanic Black women. Future study should investigate the quality and quantity of food groups prepared outside of the home among Hispanic and African American men and women.

The current study produced new knowledge that non-Hispanic Blacks who had annal family income higher than $65000 had lower BMI, percent of body fat, and WC than non-Hispanic Whites and Hispanic people. Furthermore. Hispanic and non-Hispanic Blacks who had lower than $25000 annual family income had higher BMI, percent of body fat and WC than non-Hispanic Whites.

An interaction effect between race and level of annual family income and BMI means that level of annual family income is not the same among Hispanic, Non-Hispanic Blacks, and non-Hispanic Whites.

Recommendation for Future Research

Future studies should consider more non-Hispanic Blacks and Hispanics on the combining of BMI, percent of body fat, and WC to better understand the behavior patterns that relate to obesity disparity in these minority groups. Future research should focus more on foods prepared away from home with categorizing based on what kind of restaurant, foods, calories, different salads, and nuts to improve individualized healthy foods intervention for each minority group.

Further research needs explore or test using walking or biking, vigorous/moderate recreational activities for at least 10-15 minutes each day on the effect on reducing the combination of BMI, percent of body fat, and WC among minority groups. Additional studies with longitudinal analyses such as multiple or repeated measure are needed to further explore eating foods away from home and physical activity, which are more likely to address the issue of obesity disparity among minority groups.

Future research should explore the impact of eating foods away from home and physical activity on epigenetic changes over time with focus on DNA methylation patterns to address the development of obesity among diverse populations.

Conclusion

This secondary study has presented the mean differences and significant results regarding eating foods prepared outside of the home, walking or biking, and vigorous/moderate recreational activities on dependent variables: BMI, percent of body fat, and WC.

Significant Findings (*P*<0.05) From the Current Study:

- Walking or biking and VRA were significantly associated with BMI, percentage of body fat, and WC.
- MRA was significantly associated with percent of body fat.
- Hispanic and non-Hispanic Black men had significantly higher frequency of eating foods outside of the home compared to Hispanic and non-Hispanic Black women, but the difference was small and not clinically significant.

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Appendix A. List of Table

Table 1. *Study Characteristics/Findings/ Evidence Table*

Author/ Year/ Country	Methods/ Design	Sample/ Setting	Measurement	Intervention	Findings
Wang et al., 2017 United States	Secondary analysis of California Health Interview Survey (CHIS) 2011-2012	N= 42935 Whites: 26376 Latinos: 6453 Asians: 4253 African Americans: 2079 Other: 3774 Age:18-44 45-64 & 65> Male: 17848 Female: 25087	Self-reported weight & height, BMI PA, smoking as (never, current, past), alcohol intake	Serious psychological distress (SPD) using Kessler psychology distress scale (6 items). Diabetes medication, PA, &smoking status.	Prevalence of obesity: White 22%, Latinos 33.6%, AAs 36.1%, & Asians 9.8%, male 25.8%, female 23.9%, age 18-44 21.8%, 45-64 years 30.1%, & 65> 23.1%, all with *P*<0.0001. Females were obese among African Americans (OR = 1.43, 95% CI = 1.05–1.94) compared to whites (OR = 0.80, 95% CI = 0.74–0.87). Male 45–64 years, unemployment, lack of physical activity, past

					smoking, arthritis, and diabetes medicine intake (all *P* < 0.001) risk factors for obesity in Whites (gender, age, physical activity, smoking, arthritis, & diabetes medicine intake), Latinos (age, arthritis, & diabetes medicine intake), Asians (age, binge drinking, arthritis, & diabetes medicine intake), and African Americans (gender, physical activity, smoking, binge drinking, & diabetes medicine intake).
Seguine et al., 2016	Cross sectional	N=1570 Age 39-	Frequency of Foods away	Self-reported data on	Higher frequency of

United States	survey, phone survey	70 Male=634 Female=936 Setting: Seattle WA	from home (0-1, 2-4, +5 times), fruits & vegetables Socio-demographic & lifestyle factors, weight, height	frequency of foods away from home, frequency of eating fruits, green salad, or other vegetables	FAFH associated with ↑BMI (women; *P*=0.001, men; *P*=0.003) Negative association between FAFH and FV. Frequency of FAFH higher among men than women (*P*<0.001) (54% versus 43.3%), Women eat more FV than men (*P*<0.001)
Bowen et al., 2015 UK	Cross sectional study: Hyderabad DXA Study: Indian Migration Study (IMS) or the Andhra Pradesh Children &Parents' Study (APCAPS)	N=2208 Age 18-79 IMS: 829 Male: 447 Female: 392 APCAPS: 1379 Male:964 Female: 415 Setting: ST George's University, London, UK	Total & abdominal body fat using DXA scan Diet & PA, total energy intake, Dietary intake: proteins, carbohydrates, & fat. Sedentary time	BMI, Diet behavior & PA questionnaires. interviewer-administered clinical questionnaire: demographic, family structure, educational, health and lifestyle, & using a subset of 14 questions from the Standard of	Total energy intake was positively associated with total body fat. There was an interaction effect between sex and PA (*P*=0.03). no association between energy intake and body fat (*P*=0.1), significant association between

	Living Index (SLI)	dietary intake & body fat (*P*=0.001). In the APCAPS population, each 100 kcal higher daily energy intake was associated with 0.02% higher proportion of fat distributed abdominally (*P*<0.001). In the IMS population there was no association with total energy intake (*P*=0.3). no association between sedentary time and body fat in both populations (P>0.5), but significant between sedentary time and BMI in IMS (*P*=0.003). Significant association between MVPA and body fat, BMI in IMS

					(*P*<0.001) but not in APCAPS (*P*=0.2).
Acheampong & Haldeman, 2013 United States	Secondary analysis Data from three previous studies conducted in Guilford and Chatham counties	N= 364 women Age African American = 92 Hispanic = 272 Setting: North Carolina	BMI, weight, height, nutrition knowledge, attitude & belief score, food security, diet intake Diet quality. food security status, diet quality, nutrition knowledge, attitudes, behaviors, beliefs (KAB), and self-efficacy.	In home interview: Nutrition knowledge: 20 items questionnaire <5 poor knowledge >16 excellent knowledge >6 but>10 fair >11 but <15 good knowledge. KAB <5 poor 6-12 fair 13-19 good >20 excellent. Foods security (18 items) by USDA Frequency diet intake (food items, serving size)	In terms of self-efficacy, African Americans versus Hispanics were significantly confident in choosing (97.8% versus 69.5%), preparing (96.7% versus 76.5%), and selecting (98.9% versus 77.2%) healthy foods (*P*<0.05). More Hispanics (29.4%), than African Americans (18.5%), described their diet as healthy (*P*=0.008). diet significantly related to ethnicity (*P*= 0.016).

					AA eat ↑ fruits than Hispanic (*P*=0.02), ↓food security ↑ met dietary intake (*P*=0.003). Hispanics have a better diet quality (*P*= 0.001). significant relationship between nutritional knowledge and attitude among Hispanic (*P* < 0.001) & significantly associated with a better diet quality 96.7% Hispanic healthy compared to 90.2% AA (*P*= 0.008).
Ekelund et al., 2011 UK	prospective cohort study of EPIC	N=288498 Age 25-79 Men: 84511 Women: 203987	Weight, height, WC, BMI at baseline & follow up BMI<25 kg/m^2 Normal weight 25-29.99 overweight >30 obese	Self-report PA questionnaire (inactive, moderately inactive, moderately active, active). Dietary intake using foods frequency questionnaire. sociodemographic	Significant correlation between PA and PAEE (*P*<0.0001). No association between PA & body weight in men & women (*P*=0.1).

				characteristics & lifestyle variables such as smoking, alcohol consumption, & educational level. Total energy intake	PA significantly associated with WC in men & women (*P*<0.001). physical activity significantly & inversely associated with a change in waist circumference in men ((B = -0.044, *P*<0.001) &women (-0.02, *P*=0.01). significant ↓ BMI by 7% and 10% among men & women (*P*=0.001).
Boneva-Asiova & Boyanov, 2011 Bulgaria	Cross sectional study 1) overweight or obese group: 100 BMI 25.0 & 34.9 kg/m^2 (50 men & 50 women), (2) a normal weight	N=130 Age 35-65 BMI<25 kg/m^2: Women; 18 Men:12 BMI>25-34.9 kg/m^2: Women:50 Men:50 Setting:	Weight, height, BMI, abdominal fat by CT scan & DXA	Food frequency questionnaire, fasting plasma glucose (FPG) & insulinemia (IRI), glycated hemoglobin A1c, and lipid profile. The Homeostatic Model Assessment (HOMA)	Normal weight group: VAT (cm2) age in years (*P*=0.033, F = 7.06, R^2 = 0.502). Overweight group: VAT (cm2) age in years (*P*= 0.016, F = 6.31, R^2 = 0.136). The

	group: 30 BMI< 25.0 kg/m^2 (12 men &18 women).	Medical University of Sofia, Bulgaria		index was calculated as FPG (mmol/l) ×IRI (UI/l)/22.5. Blood pressure, Foot-to-foot bioelectrical impedance analysis (BIA) early morning after fasting for 12 h.	subcutaneous adipose tissue (cm^2) associated with age in the normal weight group (P=0.040, F = 6.33, R^2 =0.475). Age influenced FM, FFM, SAT, and VAT differently in both sexes for normal weight and overweight/obese individuals. In men, FM and FFM on age whereas SAT and VAT were not significantly influenced by age (R2 < 0.200, P > 0.05) FM men (R2 = 0.278, P= 0.01), FFM men (R^2 = 0.223, p = 0.029), FM women (R^2 = 0.299, P=0.049), FFM women (R^2 = 0.218,

					P=0.09). significant link between aging and the body composition changes. ↑age associated ↑ percent body fat & ↓ fat-free mass.
Goedecke et al., 2011 Newlands & United States	Cross sectional study or Quasi-experimental	N= 54 women Age 18-45 years Black: 14 BMI<25 kg/m^2 Black: 14 BMI>30 kg/m^2 White: 13 BMI<25 kg/m^2 White: 13 BMI>30 kg/m^2 Setting: University of Cape town, South Africa & UW Seattle	BMI, body composition, insulin sensitivity (S_1), & adipose tissue biopsies (DXA)	Adipose tissue gene expression (SREBP1, FASN, PEPCK, PPARY) mRNA level in both gluteal & SAT, abdominal fat	Black women had ↑BMI with less visceral fat (*P*=0.03), more abdominal fat (*P*=0.01), & SAT lower (*P*<0.01) than white women. Interaction between ethnicity and BMI for SREBP1 (*P*=0.04), FASN (*P*=0.01) in the SAT & for PPARY (*P*=0.004), PEPCK (*P*=0.01), & FABP (*P*=0.01) in gluteal fat. mRNA expression decreased with obesity

					in black compared with white women (*P*=0.05). in Black women the expression of those genes associated with S_1 (*P*<0.05).
Bullo et al., 2011 Spain	Cross sectional study or quasi-experimental study Experimental: two traditional Mediterranean with nuts or virgin olive Control: low fat diet	N=7200 Age 55-80 Women: 4111 Age 60-80 Men: 3089 Age 55-80 Obese BMI≥30 kg/m^2 Abdominal obesity WC≥102 cm in men and ≥88 cm in women. Setting: Reus, Spain	food consumption, physical activity, smoking status, anthropometrical measures, educational level, occupation status, and medication use. Weight, height, BMI, WC	Adherence to Mediterranean Diets (MedD)with 14 items questionnaire. moderate alcohol intake for men consumption of 1–30 g/day & for women 1–15 g/day. Physical activity using the validated Spanish version of the Minnesota Leisure-Time Physical Activity (LTPA) Questionnaire.	↑ adherence to the MedD (≥9 points) had a ↓ BMI (−0.4 kg/m2) & a ↓ WC (−1.9 cm) than those with ↓ adherence (*P*<0.001). No significant differences in BMI or WC associated with alcohol intake. Subjects who expended 200kcal/day on LTPA had a ↓ BMI & ↓WC (*P*<0.001). Former & never smokers had ↑ BMI & WC than current smokers

					(P<0.05). Significant interaction effect between sex and alcohol, as well as sex and smoking on abdominal obesity among women (P<0.01).
Flegal et al., 2009 United States	Secondary analysis of NHANES 1999-2004	N=12556 Age 20-80> Age 20-39 40-59 60-79 & >80 Mexican American White Black Setting:	BMI, percentage body fat (from DXA), WC, WSR	Whole-body percentage body fat was calculated as total body fat mass divided by total mass (from DXA) × 100	percentage fat significantly more correlated with WC or with WSR than with BMI (P < 0.0001) in youngest men compared to women correlated with BMI than with WC (P < 0.00001), & percentage fat correlated with BMI than with WSR (P < 0.05), significant only for women aged 40–59 y (P < 0.0001). The differences statistically

					significant only in the youngest age group for both men (*P* < 0.0001) & women (*P* < 0.0001). For both men & women and within each age group, WC and BMI significantly more correlated with each other than either was with percentage fat (*P* < 0.0001) WSR and BMI significantly more correlated with each other than either was with percentage fat (*P* < 0.0001 for all sex-age groups)
Bezerra & Sichieri, 2009 Brazil	Data were based on the 2002–2003 Household Budget Survey	N=56178 Age 25-65 Men: 26225 Women: 29953 Setting: Urban	BMI: Normal weight BMI<25 kg/m^2 Overweight BMI >25-29.9 kg/m^2 Obese BMI>30	Food groups: soft drinks, deep-fried snacks, fast foods, sweets and sit-down meals. Foods & drinks	Frequently food groups. Both were positively associated with overweight (OR=51.34 for meals;

		areas in Brazil	kg/m^2 Out of home eating	purchased for OH eating during a one-week .	OR=51.17 for soft drinks, $P<0.05$) and obesity (OR=51.51 for meals; OR=51.39 for soft drinks, $P<0.05$). OH eating (40.3%) ↑among men compared to women (46.8% v. 34.5%, $P<0.0001$). Both Sit-down meals and soft drinks positively associated with overweight (OR=51.34 for meals; OR=51.17, &for soft drinks, $P<0.05$) & obesity (OR=51.51 for meals; OR=51.39 for soft drinks, $P<0.05$) among men, but negatively associated with overweight &

					obesity among women. overweight and obesity associated with age & income (*P*<0.0001).
Ayala et al., 2008 United States	Secondary data analysis used baseline (data from A venturas para Ninos)	N=708 latino Parents of children in grades K-2 age 4-7 Parent's age 30-40 Setting: 13 elementary schools in Southern California	Weight, height, BMI parents and their children. Frequency eating away from home, family's primary restaurant, & children's dietary intake. Sociodemographic variables.	Parents completed a self-administered survey in the language of Spanish or English. The survey included frequency of eating foods away from home, type of restaurant frequented, & a 49-item food frequency screener assessing children's dietary intake.	Consuming at least once a week away from home associated with children's dietary intake & risk of obesity. Families reported preferring to eat at fast foods restaurant than buffet restaurant (*P*<0.05). 45.9% of parents reported consuming foods away from home weekly at any type of restaurant compared to 37.5% from relatives, or neighbors, or friends' home.

Schroder et al., 2007 Spain	Cross sectional survey	N=3054 Age 25-74 Male: 1491 Female: 1563 Setting: Northeast Spain Girona	Weight, height, BMI Foods & fast foods consumption, Diet quality and energy. Medical history, diet, lifestyle factors include smoking, alcohol consumption, PA	Assess 4 typical fast foods items: hamburger, cheeseburger, BigMac, & French fries (less than once to 6 or more times)	10% reported eating fast foods once per month. ↓eating fast foods by ↑age (P<0.001). Direct association between obesity and fast foods consumption (P=0.04). Consumption of fast foods ↓quality of diet (P<0.001).
Wang & Hoy, 2004 Australia	Cohort study	N= 836 Age 20-74 Males: 422 Females: 414 Setting: School of health research, Darwin	WC, BMI, waist to hip ratio, hip circumference, CVD risk factors,	Testing cardiovascular risk factors (total cholesterol, HDL, triglyceride, BMI, diabetes, BP, drinking) at baseline between 1992, 1995, & follow up in 2002	BMI, WC, & hip circumference associated to cardiovascular outcome (P<0.05). WC was a better predictor for CVD than BMI, HC.
Ross et al., 2000 United States	RCT 4 Groups: 1)Diet-induced weight loss 2)Exercise induced	N=52 men Age 20>	BMI, WC Change in total, subcutaneous, & visceral fat; skeletal muscle mass	Cardiovascular fitness, glucose tolerance & insulin sensitivity.	Cardiovascular fitness in the exercise groups improved b 16% (P < 0.01).

	weight loss 3) exercise induced without weight loss 4)Control		Total fat ↓ in both weight loss groups (*P* < 0.001), the average ↓ 1.3 kg (95% CI, 0.3 to 2.3 kg) ↑ in the exercise-induced weight loss group than in the diet-induced weight loss group (*P*= 0.03). ↓ in abdominal subcutaneous, visceral, and visceral fat–to–subcutaneous fat ratios in the weight loss groups (*P* < 0.001). Abdominal and visceral fat also ↓ in the exercise without weight loss group (*P*= 0.001). Weight loss induced by ↑ daily physical activity ↓ obesity & insulin resistance (*P*= 0.001).

RCT: randomized controlled trial, BMI: body mass index, FAFH: foods away from home, FV: fruits and vegetables,
DXA: dual x-ray energy absorptiometry, WC: waist circumference, CVD: cardiovascular diseases, MVPA: moderate/vigorous physical activity, AA: African American, PAEE: physical activity energy expenditure, VAT: visceral adipose tissue, SAT: subcutaneous adipose tissue, FM: free mass, FFM: free fat mass, LTPA: leisure time physical activity, OR: odds ratio, OH: out of home, HC: hip circumference.

Table 2. *Demographics and Descriptive Statistics*

Variables	**Total**	**Mean**	**SD**	**Frequency**
Age (years)	N= 3942 20-40 years=1240			31.5%
	41-60 years=1299			33%
	61-80 years=1403			35.6%
Sex	Male= 1887			47.9%
	Female= 2055			52.1%
Race	Hispanic=935			29.3%
	Non-Hispanic white=1373			43%
	Non-Hispanic black=884			27.7%
	N= 3942			
Level of education	Less than 9-11th grade=802			20.3%
	High school= 942			23.9%
	college degree=2193			55.6%
Level of Family Income	Less than $25000=818			20.8%
	$25000-65000=1542			39.1%
	>$65000=1497			38%
	N= 3942			
Foods from outside of the home	Less than 5 times =3015			76.5%
	Higher than 5 times=920			23.3%
	N= 3942			
Walking or biking	Yes= 1063			27%
	No= 2879			73%
Vigorous recreational activities	Yes=1079			27.4%
	No=2853			72.4%
Moderate Recreational activities	Yes=1572			39.9%
	No=2359			59.8%
BMI (kg/m^2)	N= 3942	25.05	6.52	
Percent of Total Body Fat (%)	N= 3942	32.17	8.62	
WC (cm)	N= 3942	86.02	19.9	

Appendix B, List of Figures

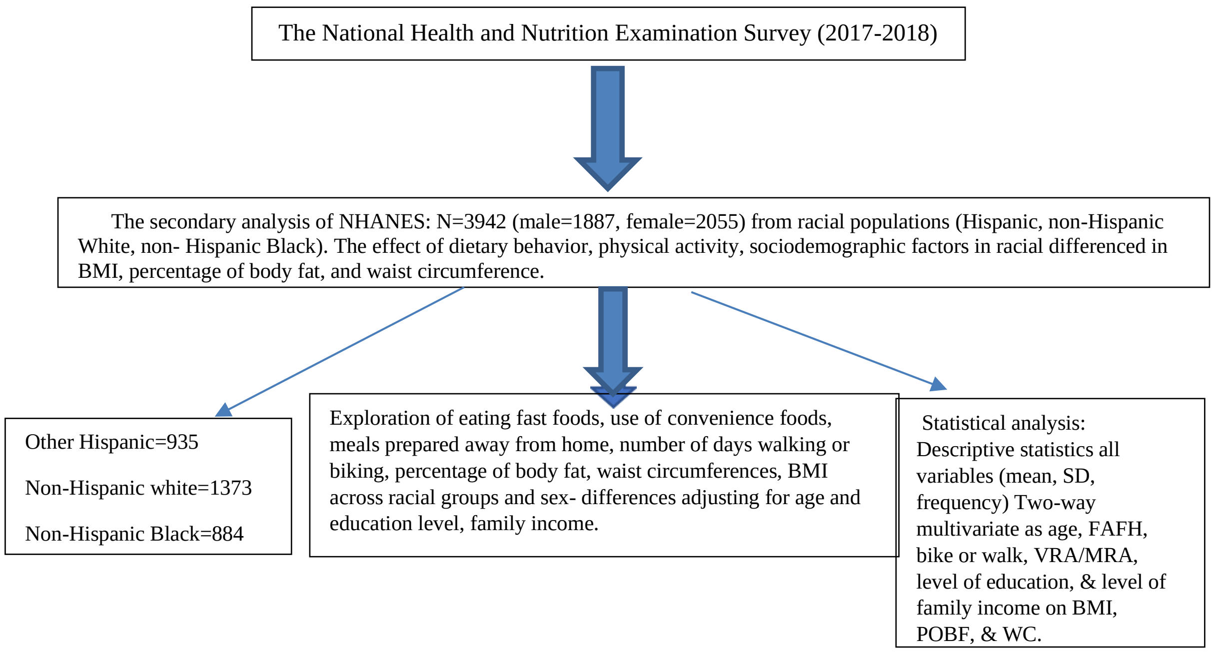


Figure 1. *The schematic of the secondary analysis, which focused on dietary behavior, physical activity, and sociodemographic factors in a sample of diverse groups.*

Conceptual Model

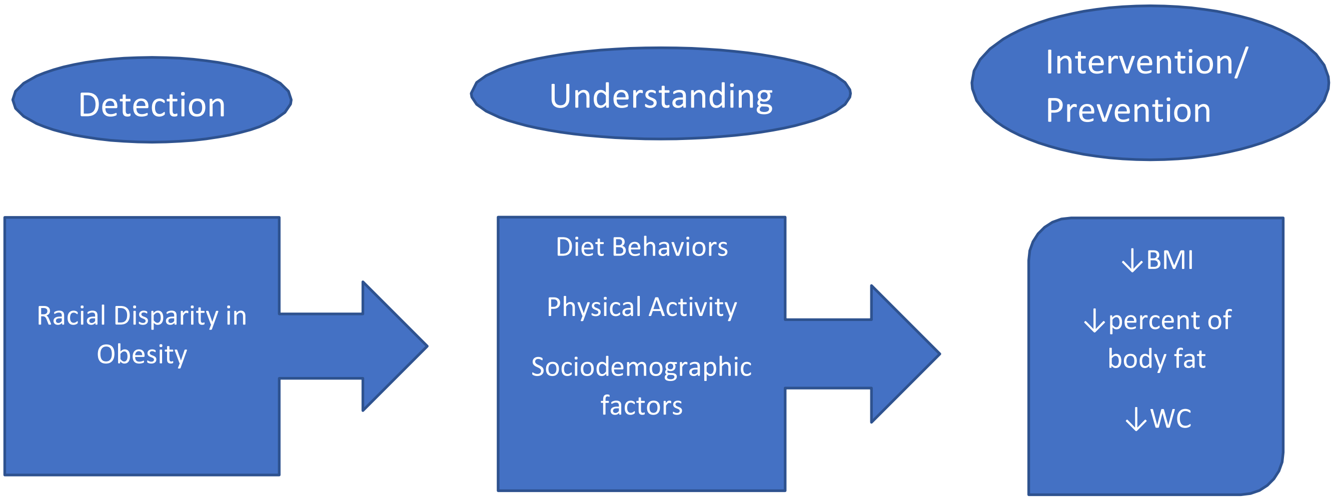
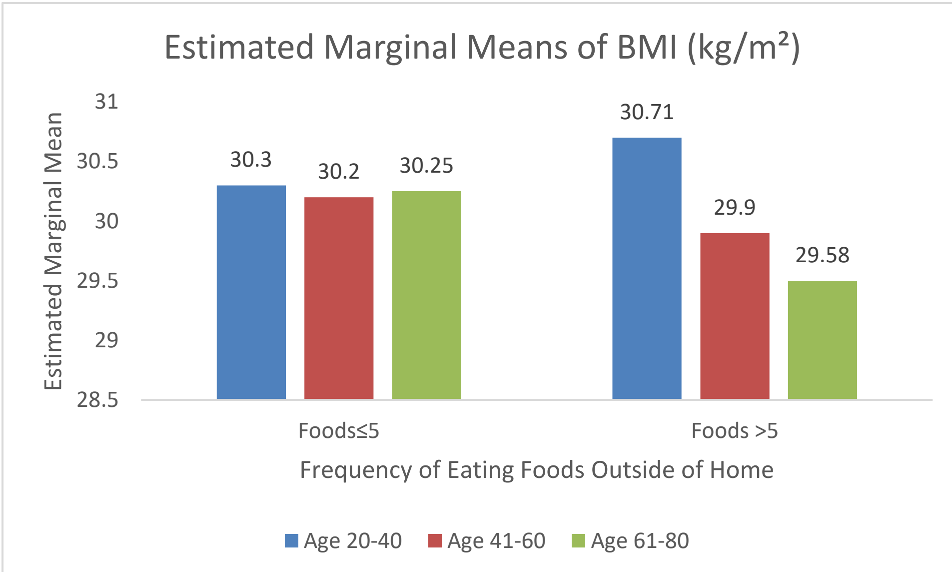
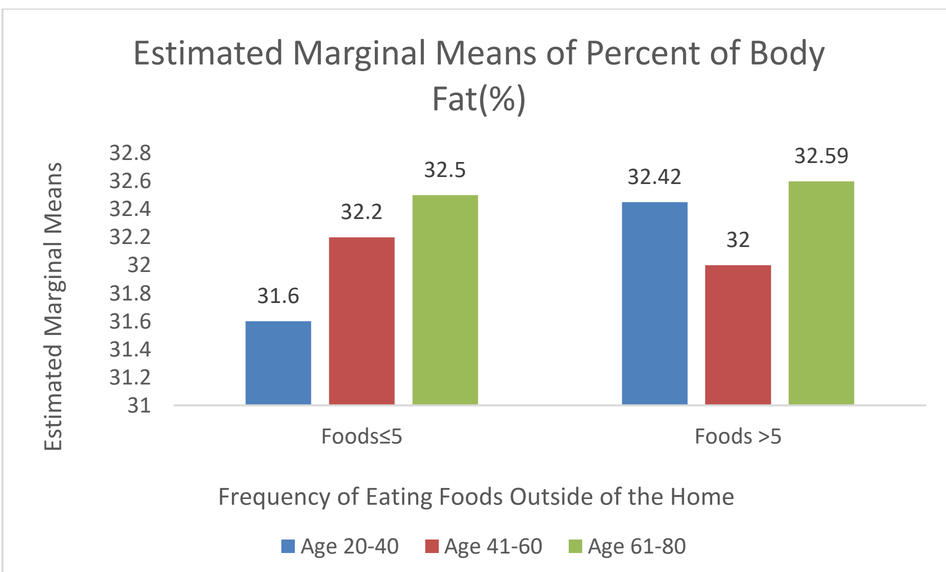


Figure 2. A conceptual framework on factors that contribute to the development of obesity based on racial disparity. Understanding factors such as diet behaviors, physical activity, and sociodemographic factors that lead to inequality in obesity helps create an effective intervention to reduce obesity among racial groups.

Figure 3. *The Mean Differences of BMI, PBF, and WC According to Age Group and Eating Outside of the Home*





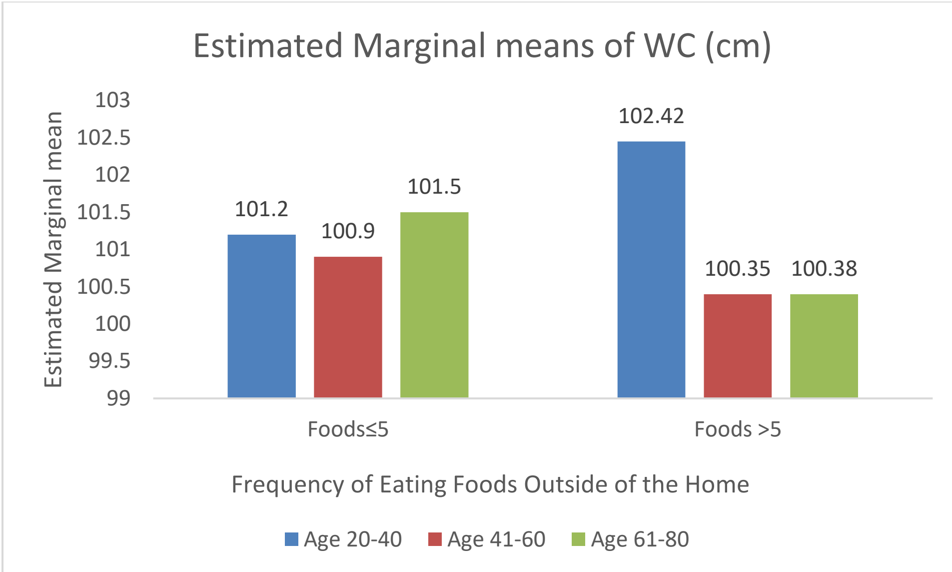
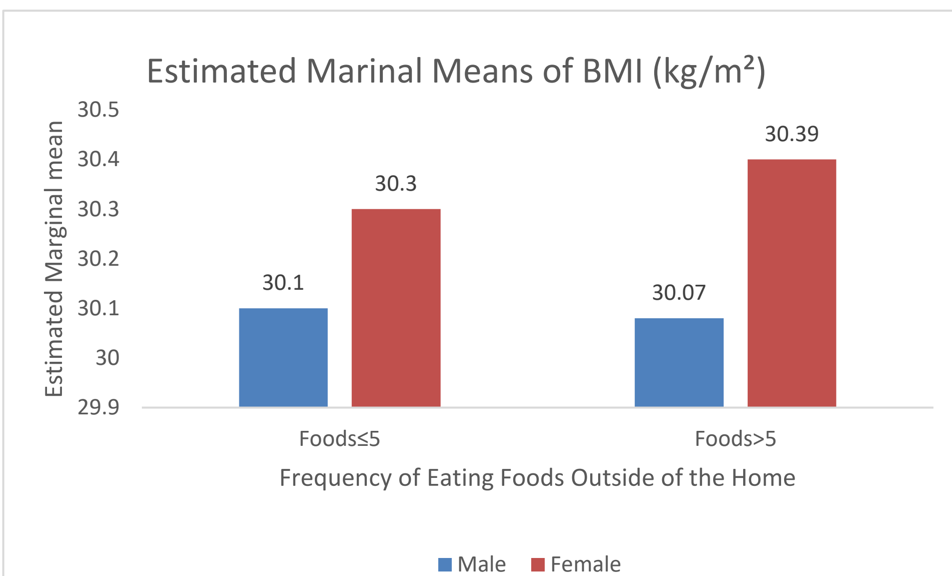
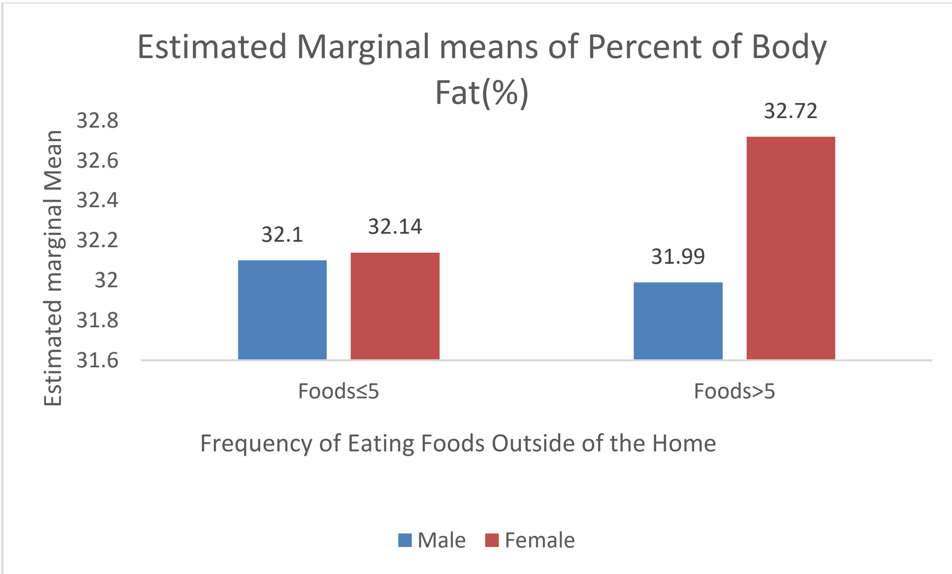


Figure 4. *The Mean Differences of BMI, PBF, and WC According to Sex and Eating Outside of the Home*




Estimated Marginal means of Percent of Body Fat(%)
Estimated marginal Mean
32.8
32.6
32.4
32.2
32
31.8
31.6
32.1
32.14
31.99
32.72
Foods≤5
Foods>5
Frequency of Eating Foods Outside of the Home
Male
Female

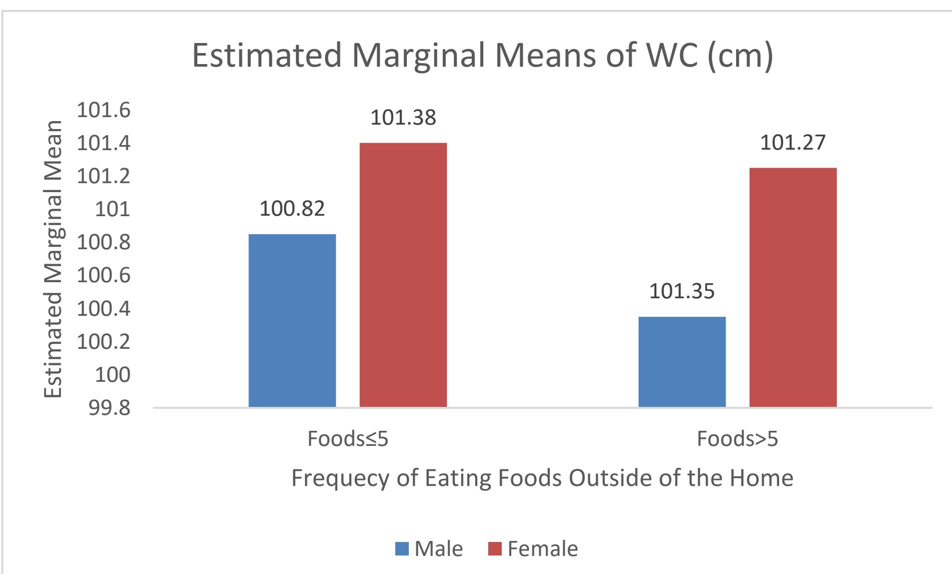
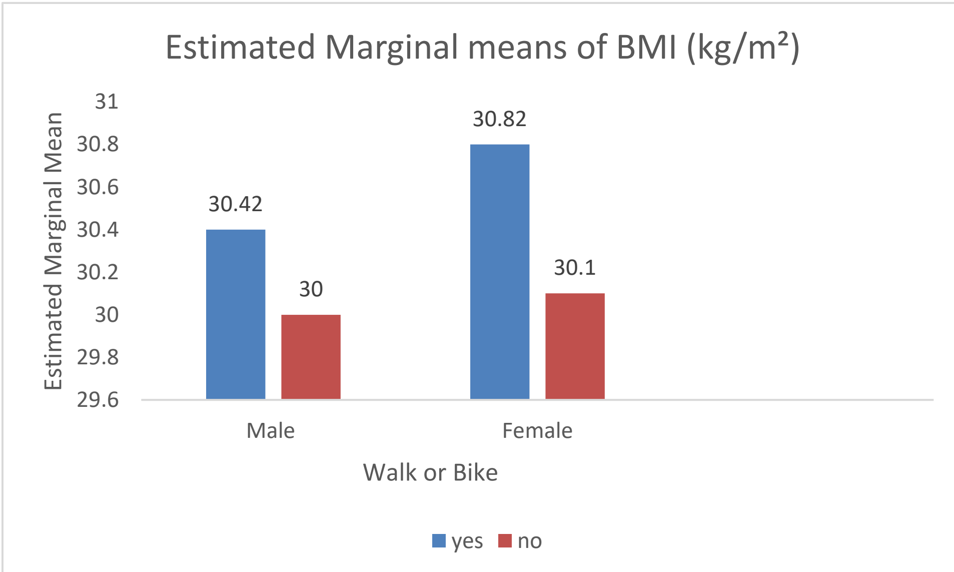
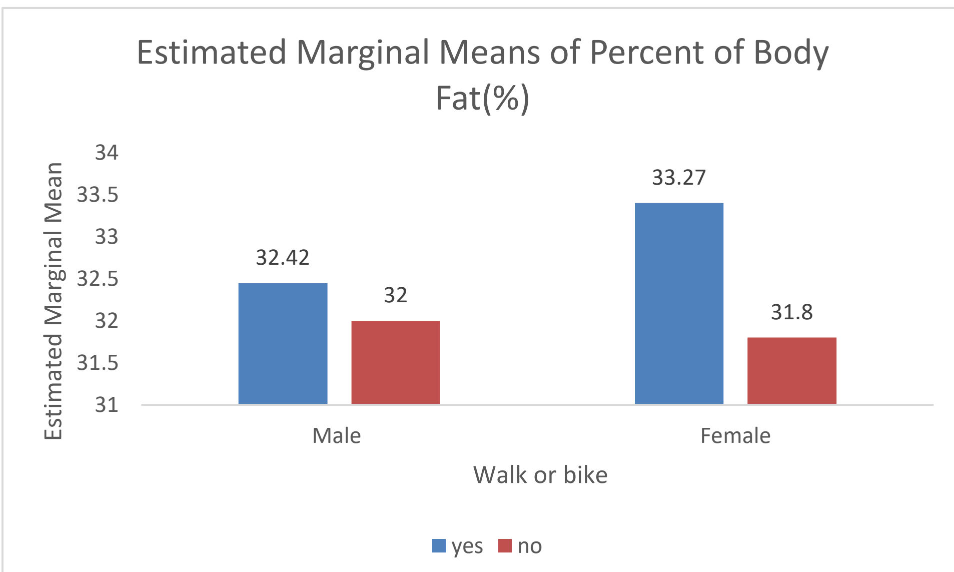

Estimated Marginal Means of WC (cm)
Estimated Marginal Mean
101.6
101.4
101.2
101
100.8
100.6
100.4
100.2
100
99.8
100.82
101.38
101.35
101.27
Foods≤5
Foods>5
Frequecy of Eating Foods Outside of the Home
Male
Female

Figure 5. *The Mean Differences of BMI, PBF, and WC According to Sex and Walk or Bike Category*





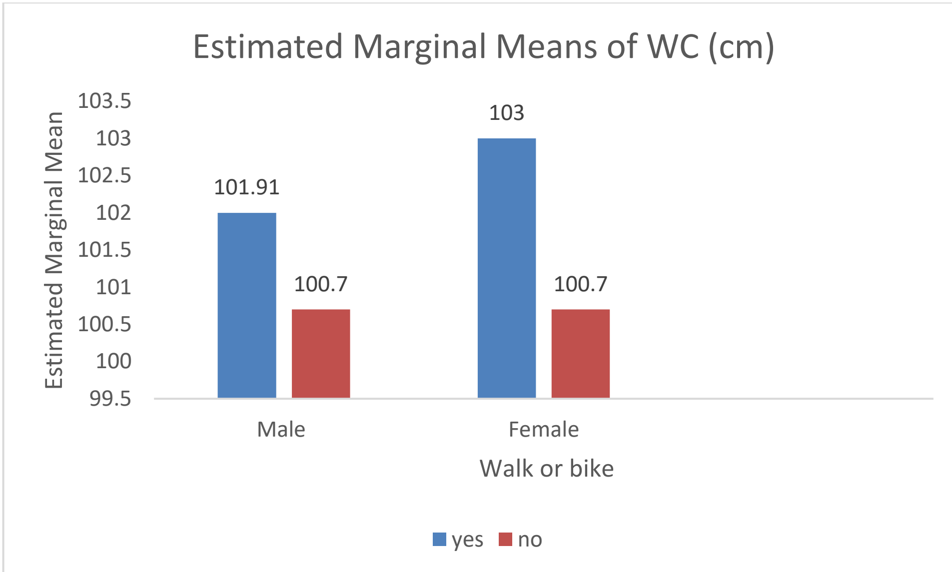
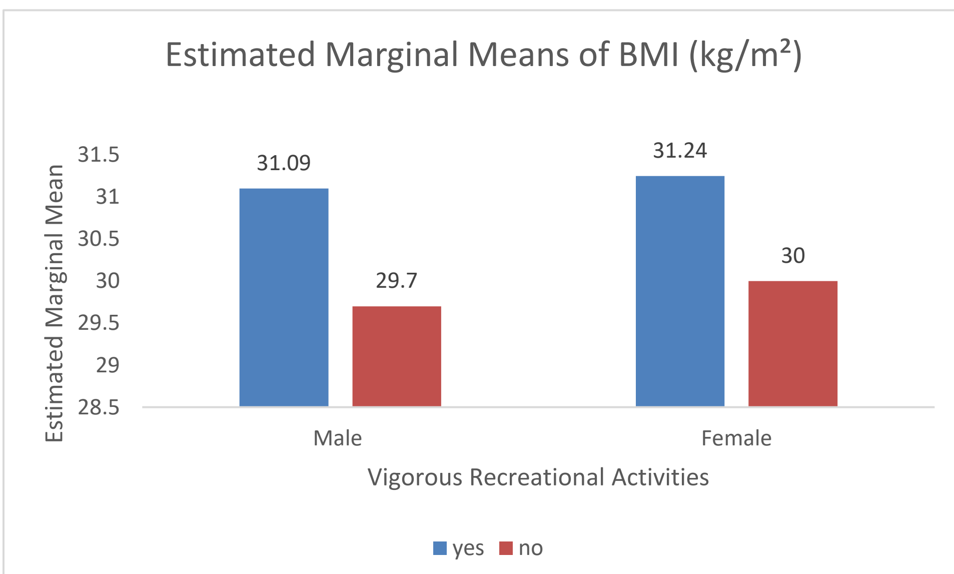
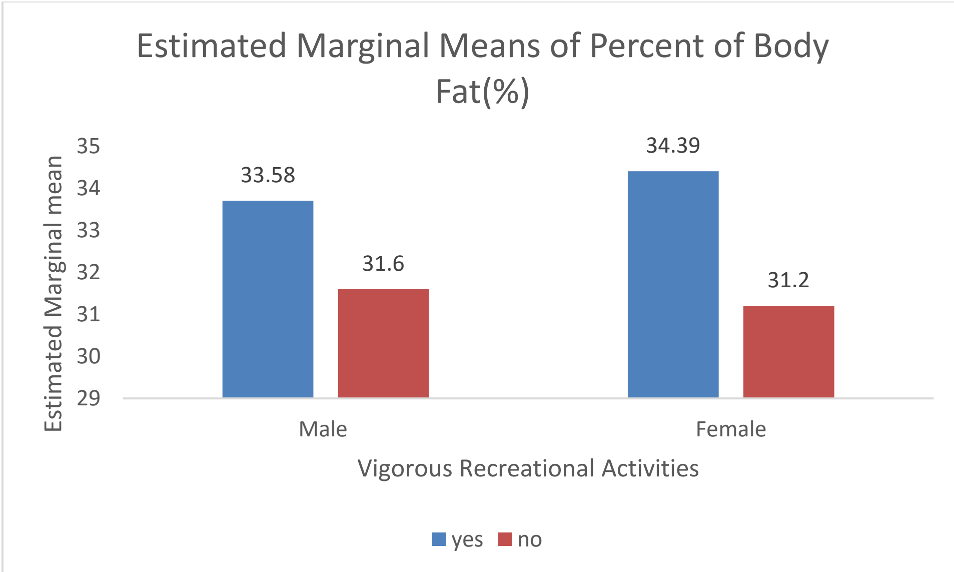


Figure 6: *The Mean Differences of BMI, PBF, and WC According to Sex and VRA*




Estimated Marginal Means of Percent of Body Fat(%)
Estimated Marginal mean
35
34
33
32
31
30
29
33.58
31.6
34.39
31.2
Male
Female
Vigorous Recreational Activities
yes
no

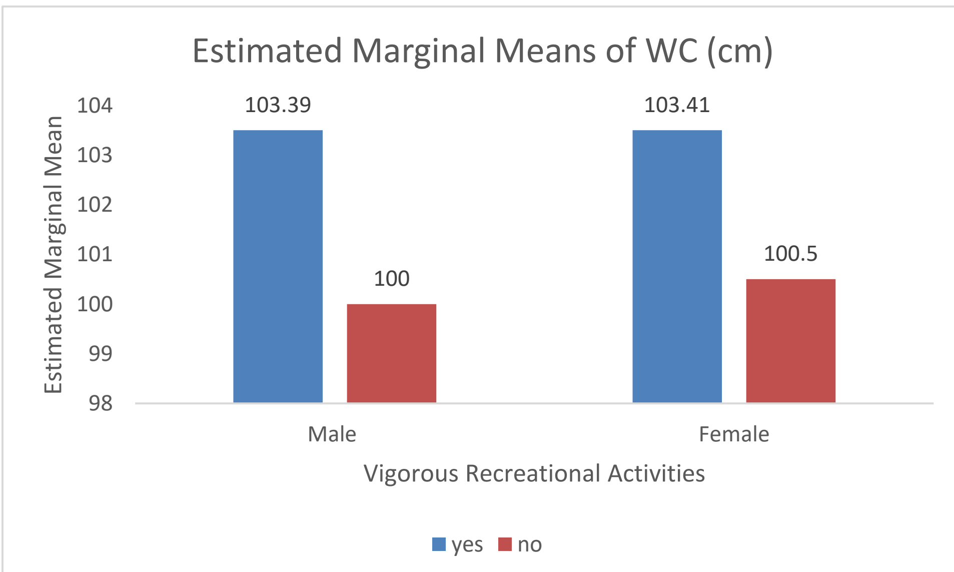
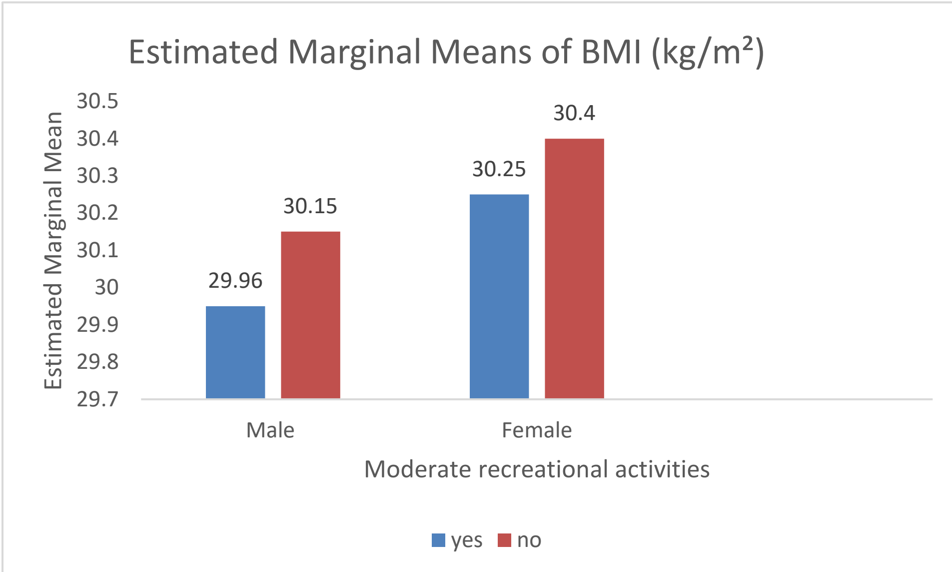
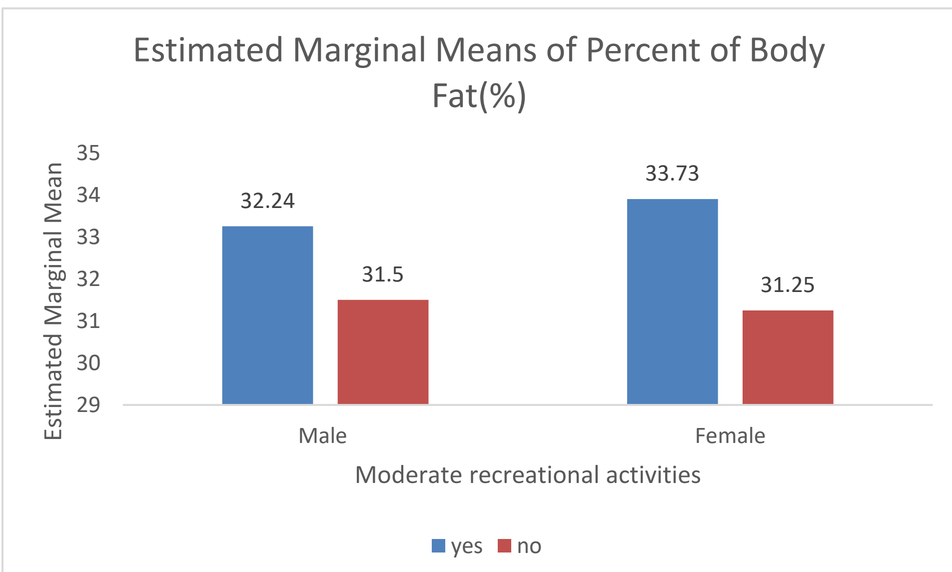

Estimated Marginal Means of WC (cm)
Estimated Marginal Mean
104
103
102
101
100
99
98
103.39
100
103.41
100.5
Male
Female
Vigorous Recreational Activities
yes
no

Figure 7: *The Mean Differences of BMI, PBF, and WC According to Sex and MRA*





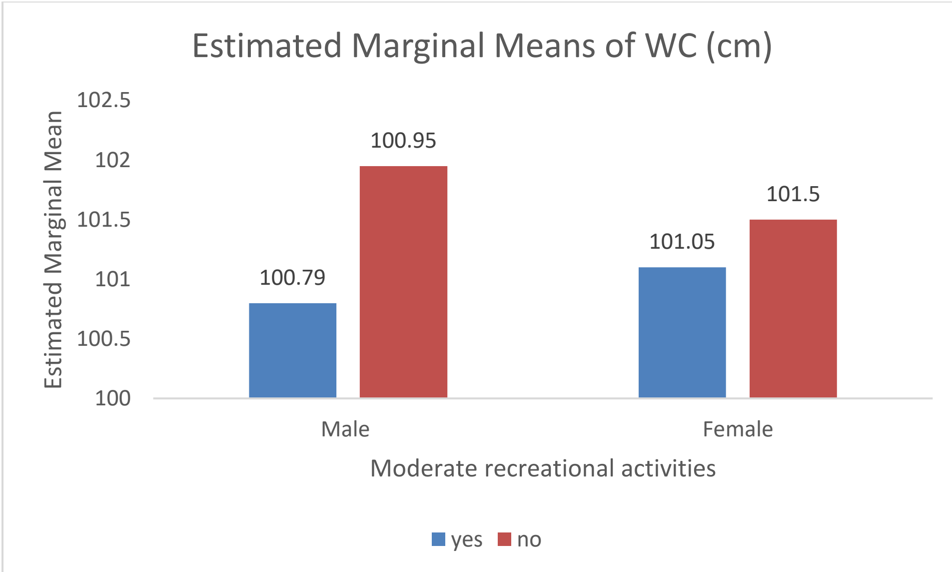


Figure 8: *The Mean Differences Between Male and Female According Frequency of Eating Foods Outside of the home*

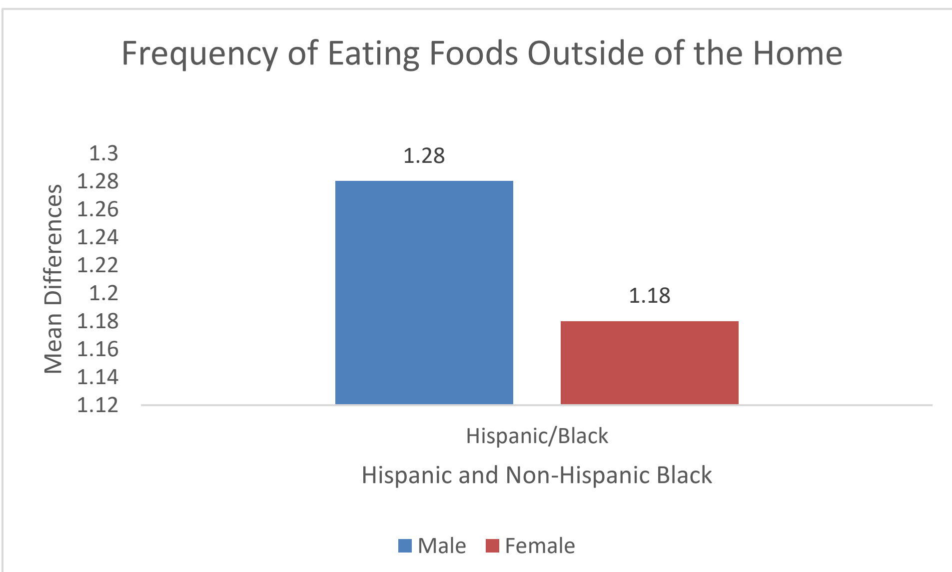
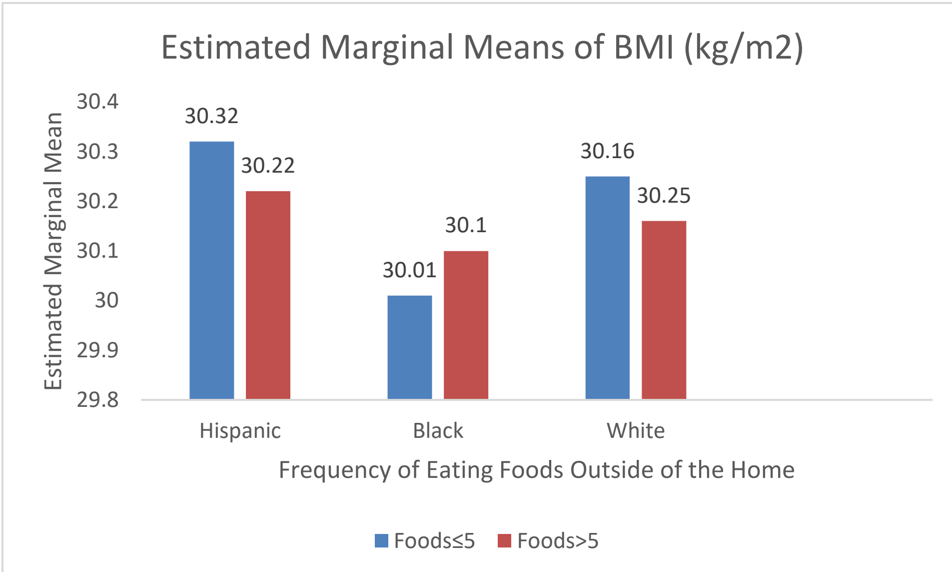
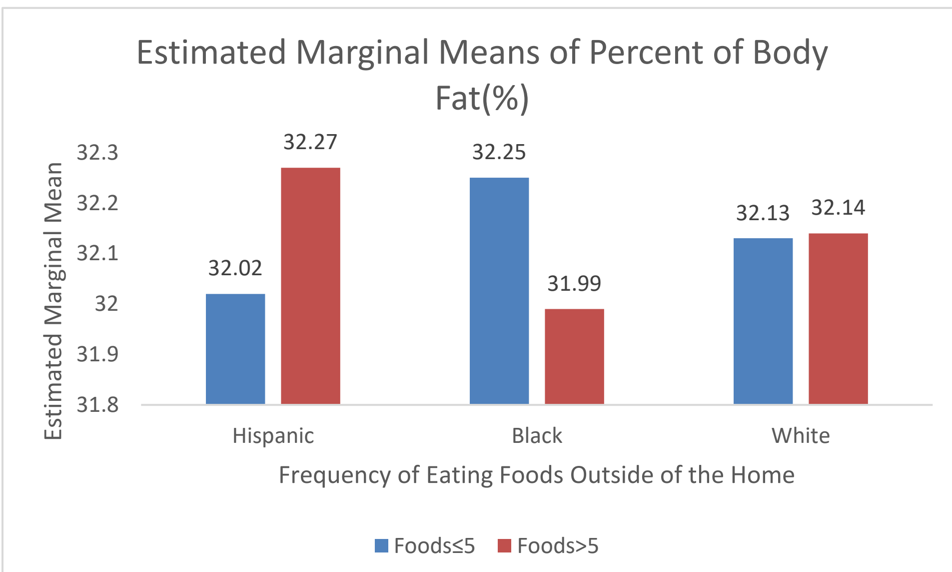


Figure 9: *The Mean Differences of BMI, PBF, and WC According to Race and Eating Foods Outside of the Home*





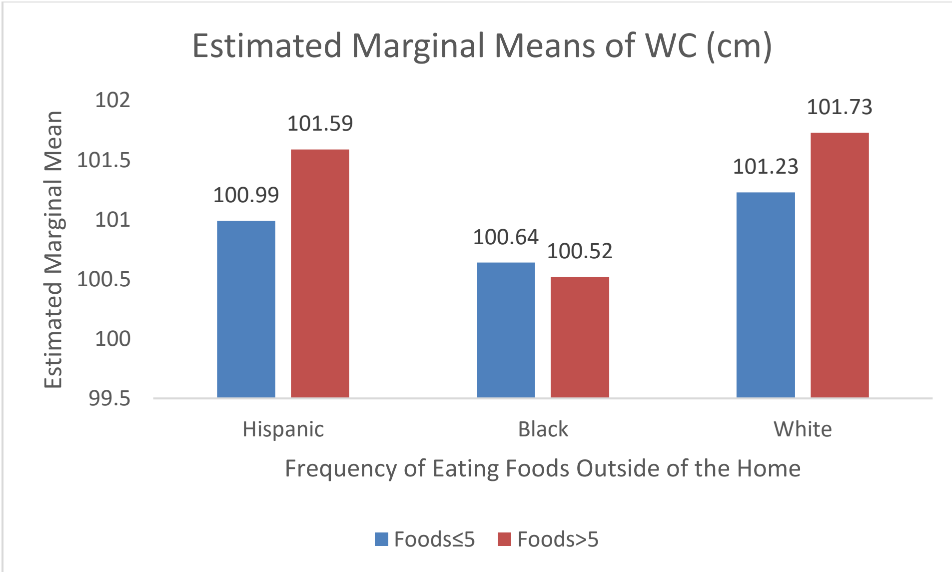
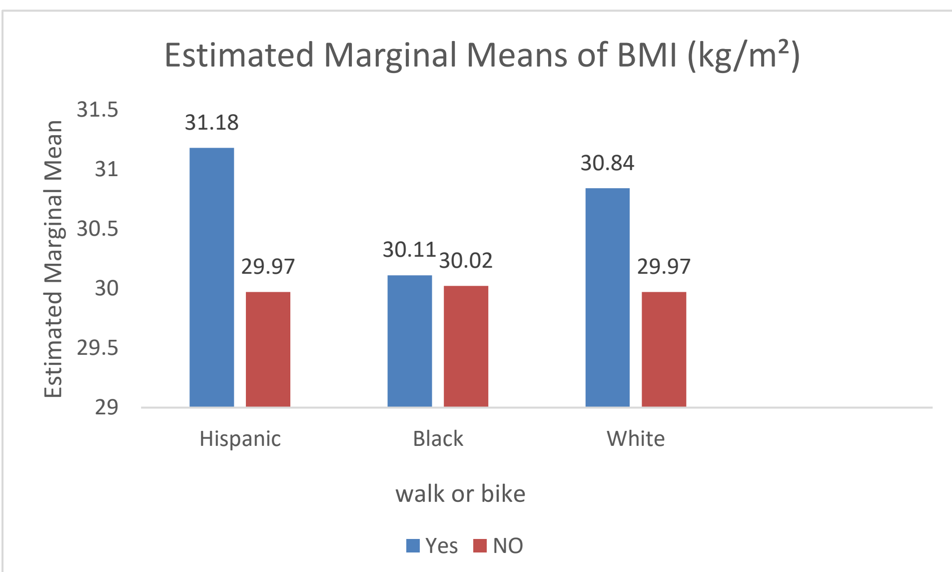
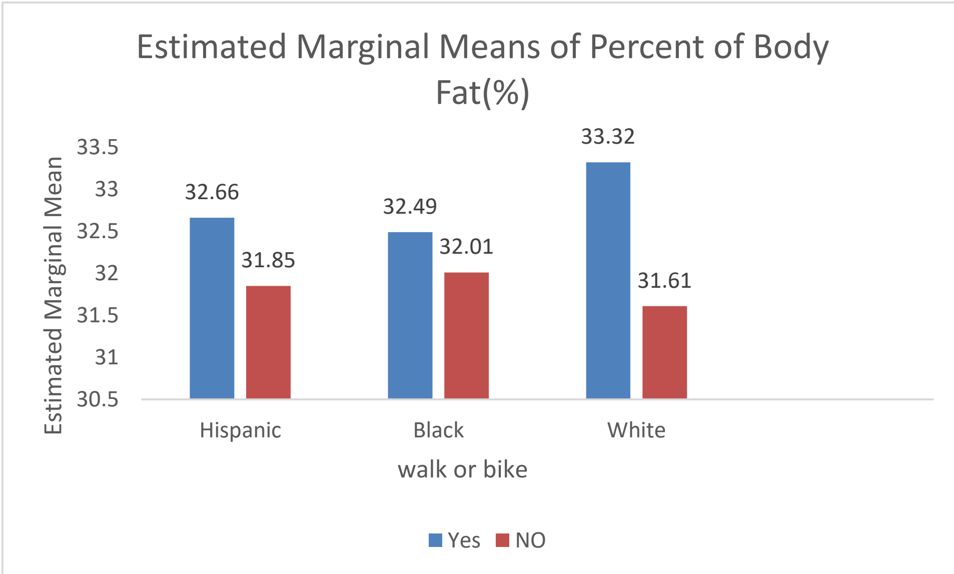


Figure 10*: The Mean Differences of BMI, PBF, and WC According to Race and Walk or Bike Category*




Estimated Marginal Means of Percent of Body Fat(%)
Estimated Marginal Mean
33.5
33
32.5
32
31.5
31
30.5
32.66
31.85
32.49
32.01
33.32
31.61
Hispanic
Black
White
walk or bike
Yes
NO

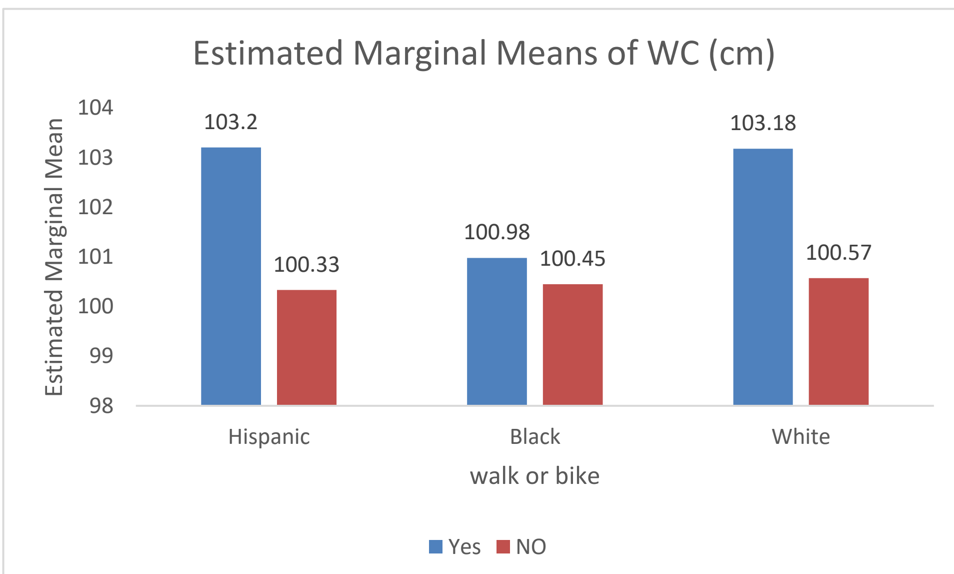
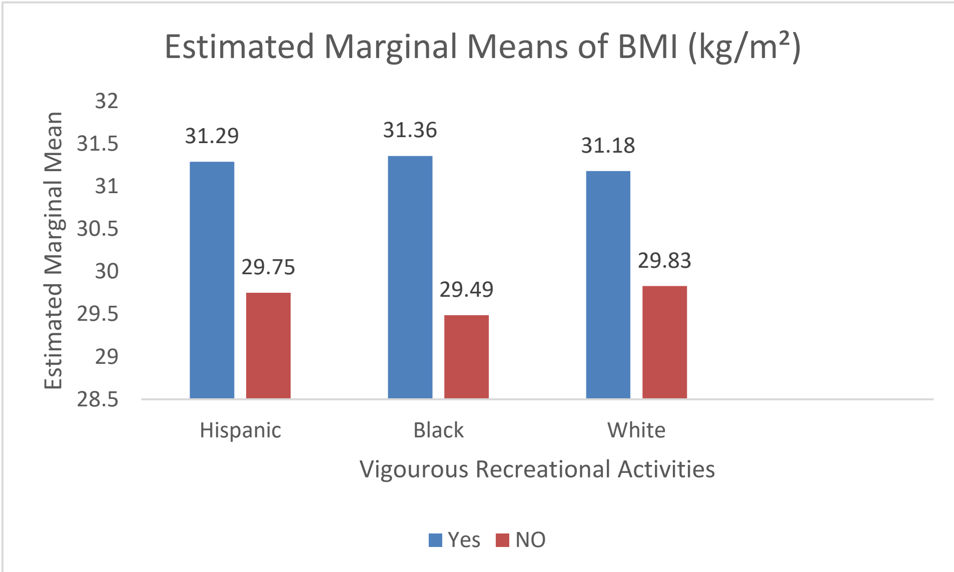
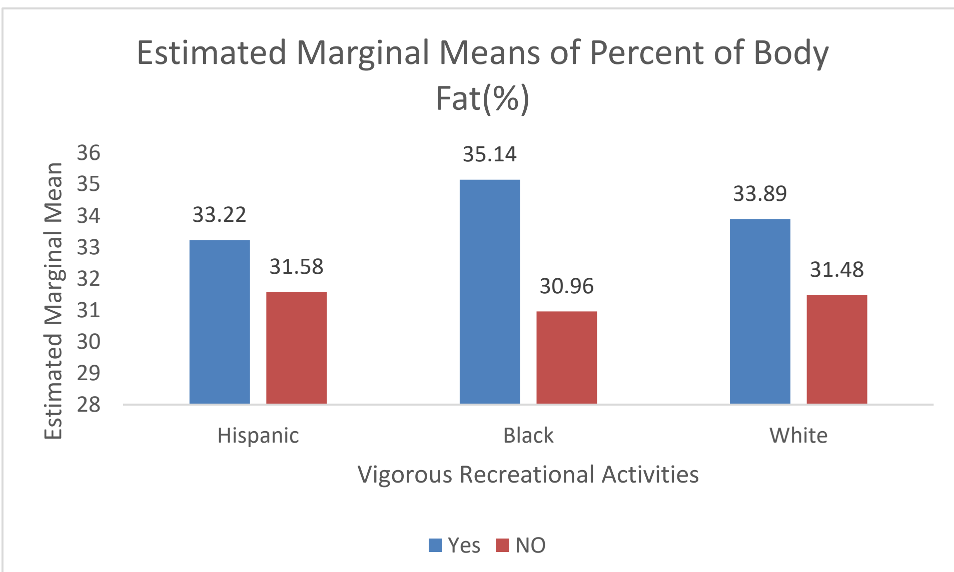

Estimated Marginal Means of WC (cm)
Estimated Marginal Mean
104
103
102
101
100
99
98
103.2
100.33
100.98
100.45
103.18
100.57
Hispanic
Black
White
walk or bike
Yes
NO

Figure 11*: The Mean Differences of BMI, PBF, and WC According to Race and VRA*





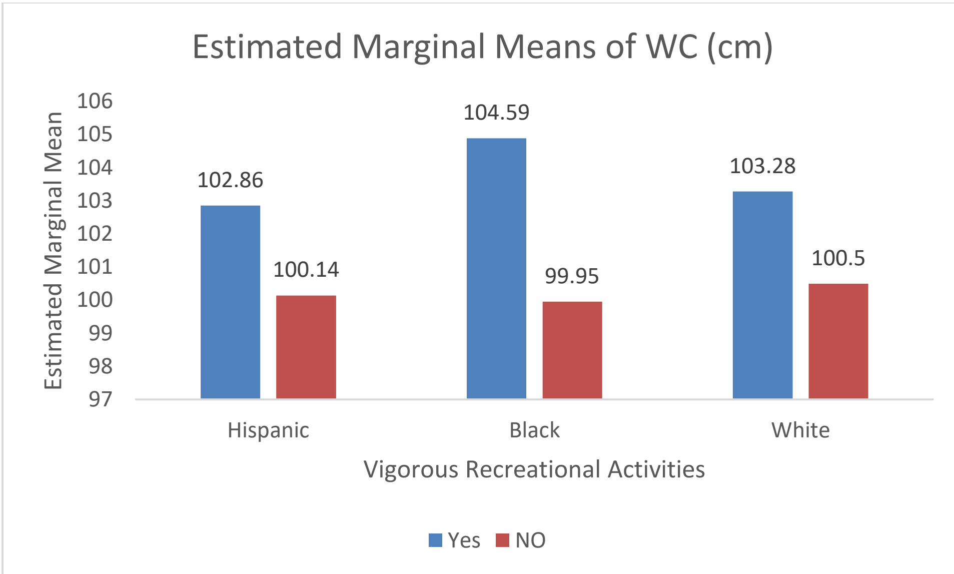
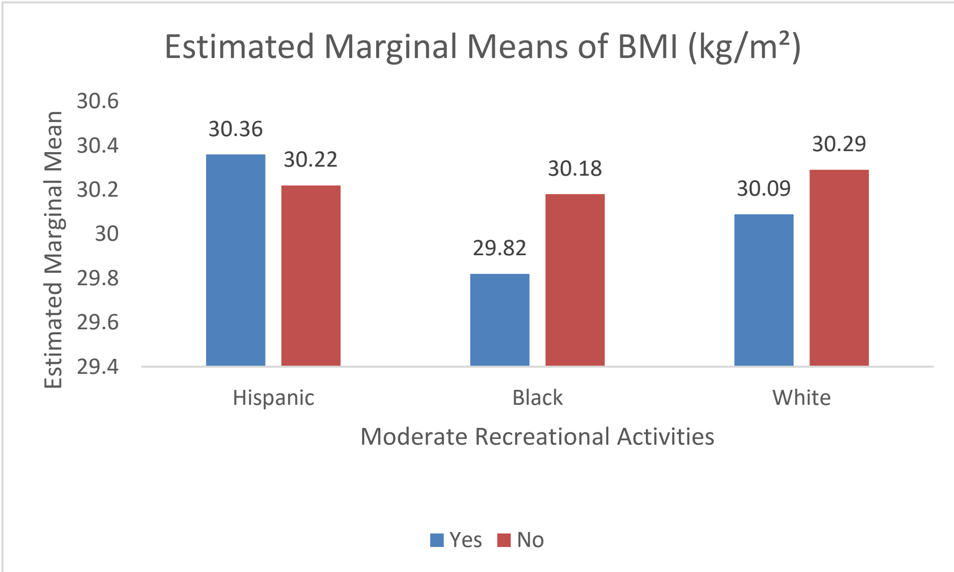
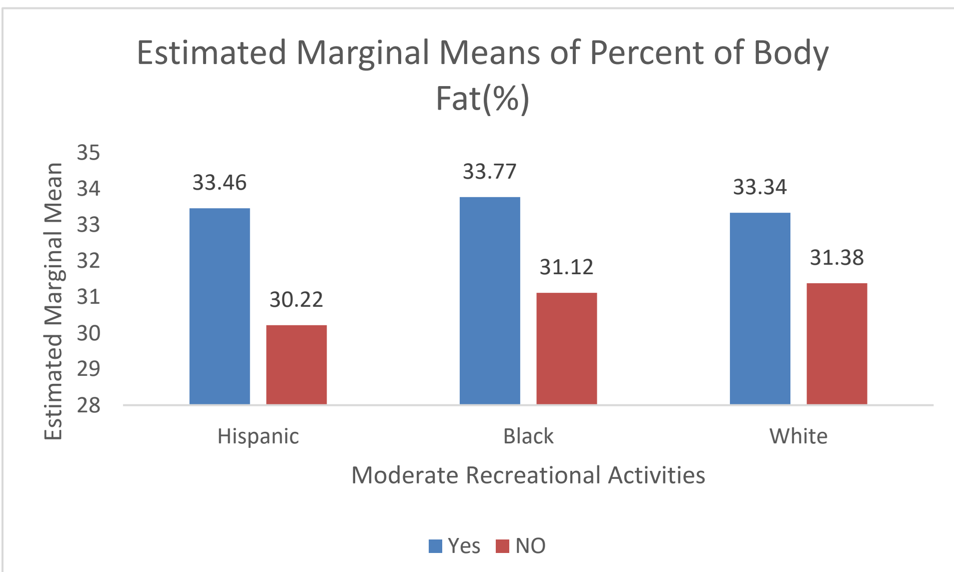

Estimated Marginal Means of WC (cm)
Estimated Marginal Mean
106
105
104
103
102
101
100
99
98
97
102.86
100.14
104.59
99.95
103.28
100.5
Hispanic
Black
White
Vigorous Recreational Activities
Yes
NO

Figure 12*: The Mean Differences of BMI, PBF, and WC According to Race and MRA*





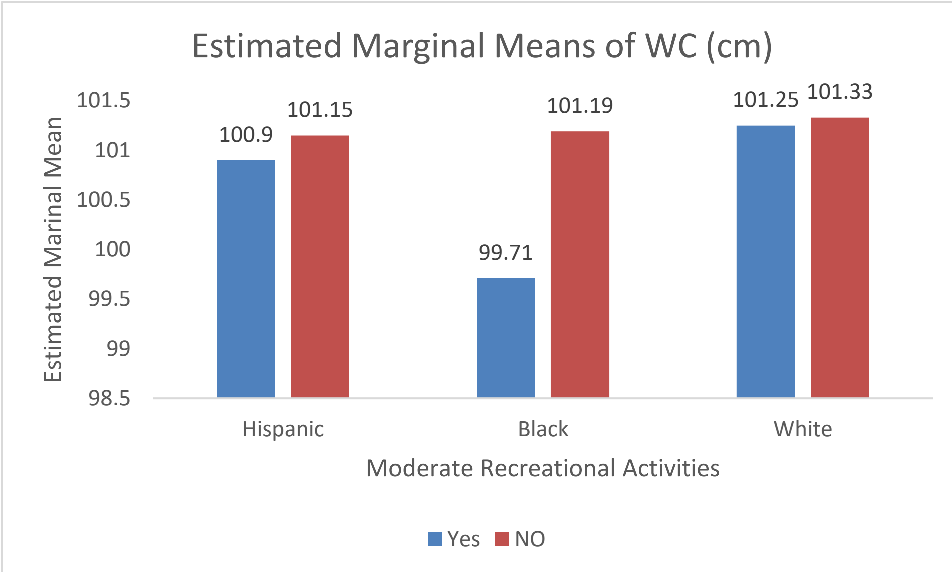
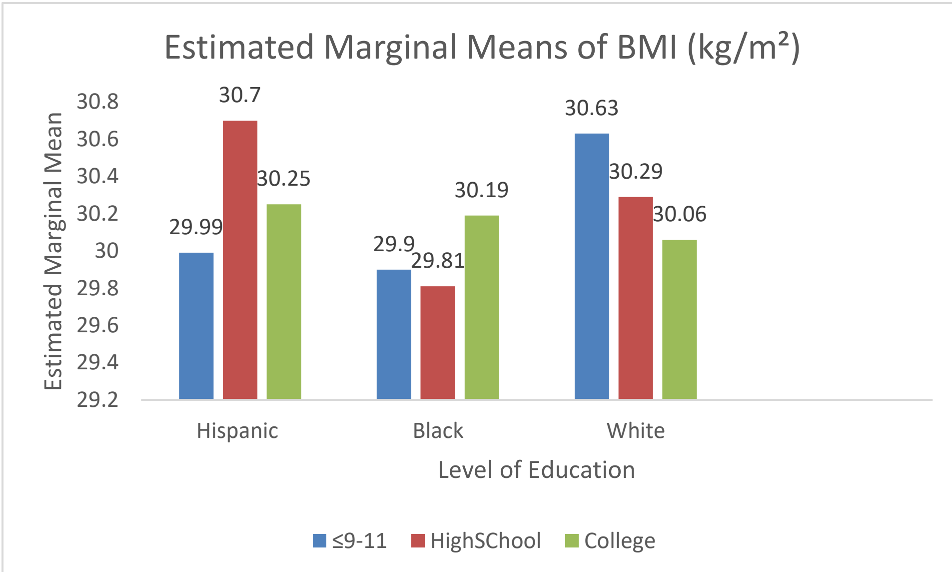
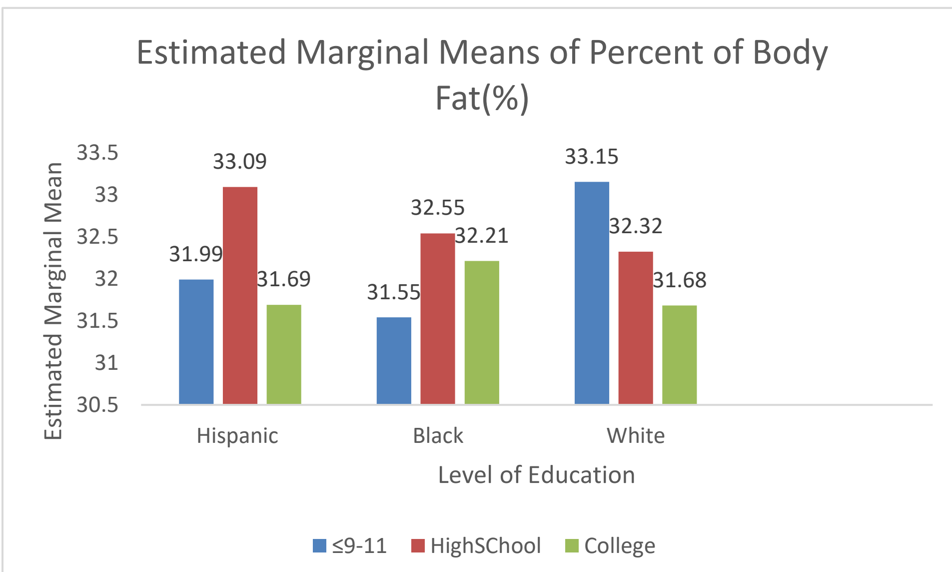

Estimated Marginal Means of WC (cm)
Estimated Marinal Mean
101.5
101
100.5
100
99.5
99
98.5
100.9
101.15
99.71
101.19
101.25
101.33
Hispanic
Black
White
Moderate Recreational Activities
Yes
NO

Figure 13*: The Mean Differences of BMI, PBF, and WC According to Race and Level of Education*





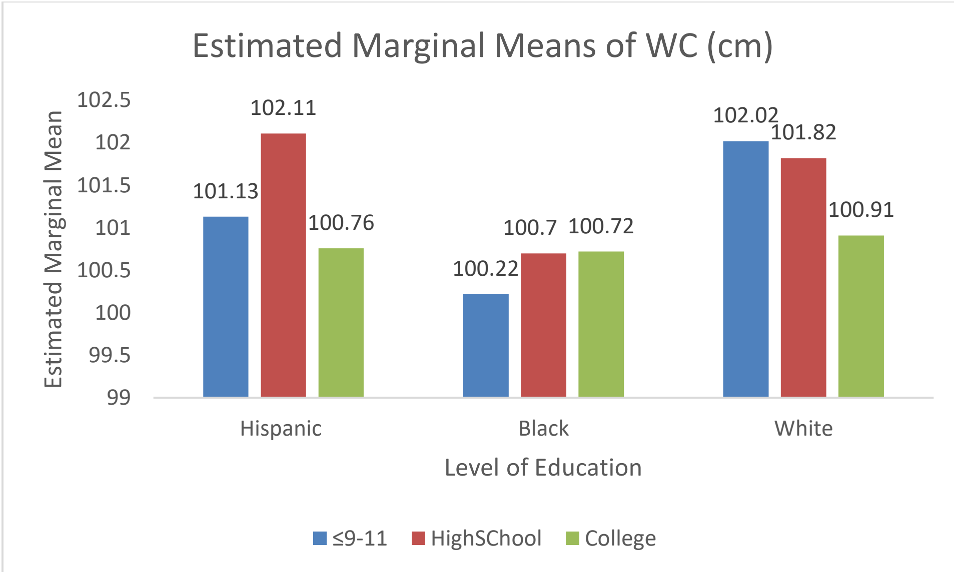
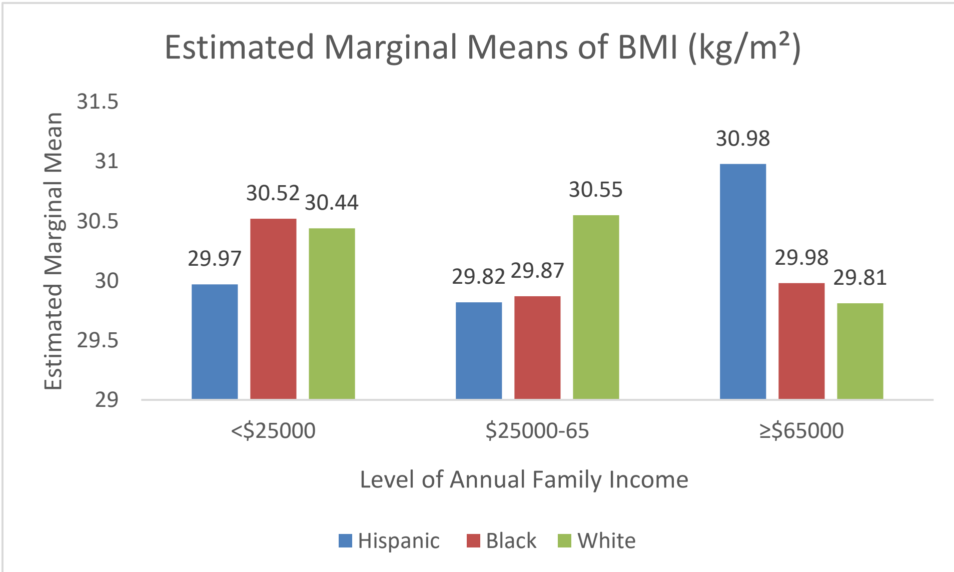
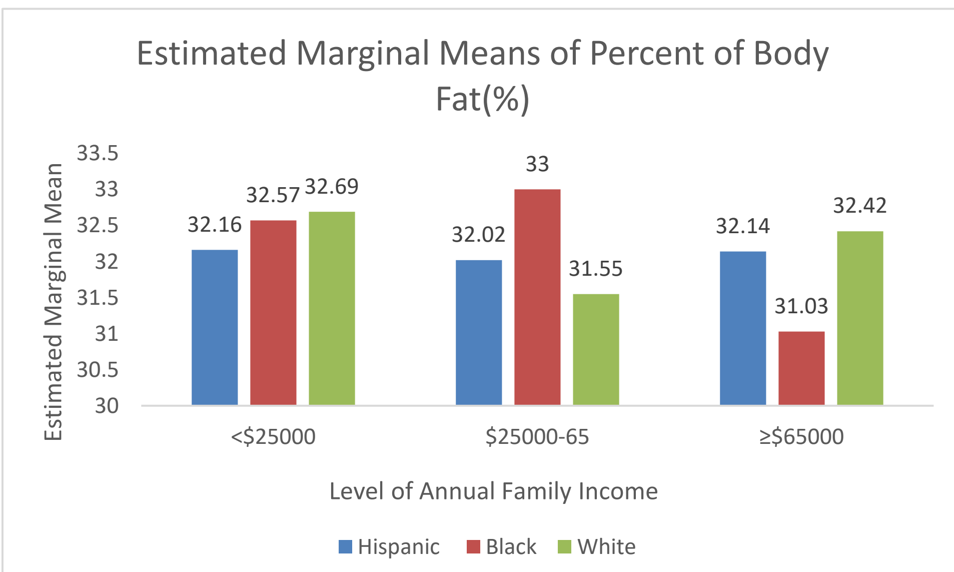
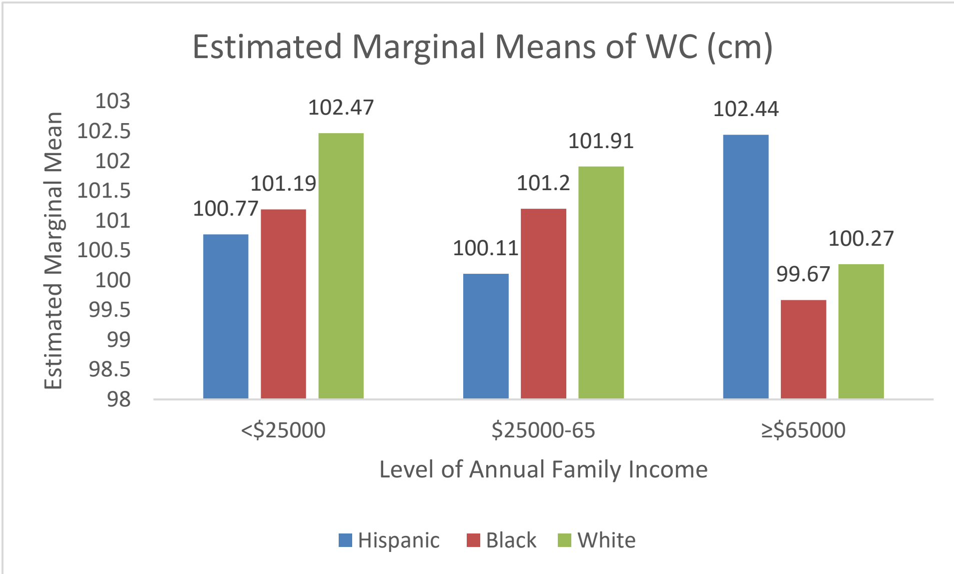

Estimated Marginal Means of WC (cm)
Estimated Marginal Mean
102.5
102
101.5
101
100.5
100
99.5
99
101.13
102.11
100.76
100.22
100.7
100.72
102.02
101.82
100.91
Hispanic
Black
White
Level of Education
≤9-11
HighSChool
College

Figure 14*: The Mean Differences of BMI, PBF, and WC According to Race and Level of Annual Family Income*






Estimated Marginal Means of WC (cm)
Estimated Marginal Mean
103
102.5
102
101.5
101
100.5
100
99.5
99
98.5
98
100.77
101.19
102.47
100.11
101.2
101.91
102.44
99.67
100.27
<$25000
$25000-65
≥$65000
Level of Annual Family Income
Hispanic
Black
White