2016

The Effect of Dietary Fruits & Vegetable Consumption and Physical Activity on Obesity in African American Adolescent Females.

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This is to certify that the doctoral dissertation by

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2017

Abstract

Fruits and Vegetables, Physical Activity, and Obesity in Black Adolescent Females

by

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BS, Bowie State University, 2009

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

January 2017

Abstract

Obesity is epidemic among Black adolescent females, and adolescent obesity often leads to adult obesity. Previous research suggests that there may be an interaction between physical activity and dietary fruit and vegetable intake on body mass index (BMI) in obese adolescent females in general, but it was unclear whether the same pattern is evident in Black adolescent females, who, on average, tend to have low levels of physical activity and fruit and vegetable intake. Bandura's social learning theory implies the possibility that adolescent females might model their behaviors on the behavior of others in their high school years, including physical activity and dietary behaviors. The primary research question for this quantitative, retrospective, cross-sectional study asked whether there is a statistically significant interaction between dietary fruit and vegetable intake and physical activity on the BMI of Black adolescent females. In this study, data from 1,211 Black female adolescents in the Center for Disease Control Youth Risk Behavior Survey database were analyzed using multiple linear regression statistics. BMI was the dependent (outcome) variable, physical activity was the independent (predictor) variable, and fruit and vegetable intake was the moderator variable. Physical activity had a significant negative association with BMI while intake of fruits and vegetables showed no significant association with BMI. Unlike previous research that was not focused specifically on Black adolescent females, Fruit and vegetable intake did not significantly moderate the relationship between physical activity and BMI. This study has positive social change implications for practitioners designing obesity prevention programs for Black female adolescents, which should focus on increasing physical activity levels towards controlling BMI, leading to a healthier life for Black female adolescents.

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Public Health

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January 2017

Dedication

I dedicate this dissertation to my family. Without their patience and understanding, and most of all love, the completion of this work would not have been possible.

And let us not be weary in well doing: for in due season we shall reap, if we faint not. Galatians 6:9

Acknowledgments

I would like to express my sincere gratitude to my committee for their continuous support.

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Chapter 1: Introduction

Background

Obesity disproportionately affects Black adolescent females, but little is known regarding whether the dietary intake of fruits and vegetables moderates the relationship between physical inactivity and obesity. Obesity is commonly assessed as the body mass index (BMI), which combines age, sex, height, and weight data to determine whether an individual is overweight or obese (Centers for Disease Control & Prevention [CDC], 2011b; Kumanyika, 2008). Using BMI standards, obesity is an epidemic among Black adolescent females. This is important, because obese adolescents are likely to become obese adults (CDC, 2015a). Blacks have the highest rates of obesity in the United States and Black women are 60% more likely to be obese than non-Hispanic White women (Siceloff, Coulon, & Wilson, 2013; Office of Minority Health [OMH], 2008).

Obesity is associated with severe negative heath consequences, including psychosocial problems and an increased risk for chronic disease (Brownson et al., 2010; CDC, 2015b). Obesity increases risk for cardiovascular diseases and cancers (Brownson et al., 2010; CDC, 2015b). With every unit increase in BMI, type 2 diabetes significantly increases, particularly in Black females (CDC, 2015b; UNC, 2015). Obesity reduces quality of life (Kranz et al., 2012) and accounts for 21% of health care dollars (Cawley & Meyerhoefer, 2012). For these reasons, it is not surprising that obesity accounts for 1in 10adult deaths (Danaei et al., 2009). Adolescent obesity is increasing, and at the present rate of increase, half of Black female adolescents will be obese by 2050 (Wang et al., 2008).

Possible Causes of Obesity in Black Adolescent Females

The obesity epidemic in Black adolescent females has been attributed to a variety of causes, including poverty, cultural differences in body image, early pubertal maturation in Black females, and slower body metabolism that makes losing weight difficult, in addition to issues of choice, such as physical inactivity and the choice to eat or to not eat fruits and vegetables. Each of these is discussed below.

Poverty is a possible cause of the obesity epidemic in Black adolescent females, but the obesity is increasing across ethnicities and obesity increases do not occur disproportionately among the poor (Chang & Lauderdale, 2005). Further, Crawford, Story, Wang, Ritchie, and Sabry (2001) found that parental socioeconomic status (SES) is inversely associated with childhood obesity among Whites, such that poorer Whites have higher obesity rates, but also that SES was not statistically related to obesity in African-Americans. Later, Chang and Lauderdale (2005) used four waves of the National Health and Nutrition Examination Survey (NHANES) and found that higher incomes were associated with higher, not lower, obesity rates among Black. Further, the relationship between income and weight status may change with time (Chang & Lauderdale, 2005). The works of Crawford, Story, Wang, Ritchie, and Sabry (2001) and of Chang and Lauderdale (2005) suggest that poverty is unlikely to be the cause of the obesity epidemic in Black adolescent females.

Body image and the self-perception of weight are important to consider in the context of adolescent obesity in Black females because eating and weight-loss behaviors can potentially be driven by self-perceptions of body image. Self-perceived weight status, however, is not fully explained by objective weight status (Chang & Christakis, 2003).

The self-perceived appropriateness of weight status varies among population subgroups. For example, 28% of women and 30% of men misclassified their own weight status by medical standards. Of particular note, 38% of normal weight women thought they were "overweight," while 33% of overweight men thought they were "about the right weight" or "underweight." Multivariate regression analysis revealed that, when controlling for BMI, gender, age, marital status, race, income, and education, were all independently associated with the self-evaluation of weight status (Chang & Christakis, 2003). Black females have a larger image of ideal body size than other groups (Chen & Wang, 2012), but image perception does not provide a mechanism to explain adolescent obesity in Black females.

Pubertal maturation is important to consider in understanding the obesity epidemic in Black adolescent females. Black girls undergo pubertal maturation earlier on average than White girls (Caprio et al., 2008). Pubertal maturation has a known impact on obesity development, as girls who mature early have higher BMI during their teenage years than girls who mature later, and this interaction is strongest in Black girls (Caprio et al., 2008). Best to fact that Black girls undergo pubertal maturation earlier on average than White girls, can account for some racial differences in adolescent obesity (Caprio et al., 2008).

Slow metabolism is a possible cause of the high rates of obesity in Black adolescent females. Black females have a slower metabolic rate than non-Black females (Walsh, Hunter, Sirikul, & Gower, 2004; Weinsier et al., 2000). Weinsier and colleagues (2000) found that overweight and normal-weight Black females had lower energy requirements at rest and at non-rest than White females. This may help to explain why

Black females have more difficulty than others in losing weight, but importantly, Black females generally do not compensate for this difference in energy expenditure with greater physical activity, which can thereby predispose them to risk of obesity (Weinsier et al., 2000).

Physical Inactivity

Physical activity includes any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization [WHO], 2008, 2012). The U.S. Department of Health and Human Services recommends 60 minutes of exercise per day for adolescents (Lavizzo-Mourey, 2012), but few female adolescents exercised 60 minutes per day in 2012 (Fakhouri et al., 2014). Adolescents who participate in regular activities have a greater chance of being healthy in adulthood (U.S. Department of Health and Human Services, 2012). In the past, chronic diseases, such as heart disease, hypertension, or type 2 diabetes were rarely found in adolescents. But the literature indicates that inactivity among adolescents is directly correlated with the growing incidence of these chronic diseases and their risk factors (CDC, 2015b; U.S. Department of Health and Human Services, 2008; WHO, 2015). Regular physical activity decreases the risk factors for, and development of, chronic diseases and thus results in adolescents who remain healthy into adulthood. Despite the importance of regular physical activity, current evidence shows that levels of physical activity among adolescents remain low and that levels of physical activity decrease dramatically during adolescence (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2008).

Engaging in recommended levels of physical activity can reduce the risk of obesity (U.S. Department of Health and Human Services, 2008; NIDDK, 2008; Luke et al., 2011; Ogden et al., 2007; Siceloff, Coulon, & Wilson, 2014) and some evidence suggests that, the more students exercise, the lower their BMI (Eisenmann, Bartee, & Wang, 2002). Physical activity is particularly important in combatting adolescent obesity in Black adolescent females because Black females have a slower metabolic rate that others and must therefore compensate for this difference in energy expenditure with greater physical activity towards reducing the risk of obesity (Weinsier, et al., 2000).

Diet

Diet is linked to adolescent obesity. The total number of calories a person needs each day depends on a number of factors, including age, gender, height, weight, and level of physical activity (United States Department of Agriculture [USDA], 2010a, 2010b). However, the calorie intake of many adolescents exceeds their daily needs because they are not physically active. This sets them on a track to gain weight. In preventing obesity, the composition of the diet may be as important as the calories. Of particular interest are fruits and vegetables, which have been implicated in reducing the risk of obesity (Ledoux, Hingle, & Baranowski, 2011; U.S. Department of Health and Human Services, 2010).

Fruits and vegetables are abundant in America, but few American adolescents consume fruits and vegetables at the rate necessary to be healthy (Kranz et al., 2012). Vegetables and fruits are commonly the main sources of nutrients that are under-consumed in the United States, including folate, magnesium, potassium, dietary fiber, and vitamins A, C, and K, and eating two cups of vegetables and two cups of fruits is associated with reduced risk of many chronic diseases, including cardiovascular disease and cancer (CDC, 2013d). Further, fruits and vegetables contain dietary fiber, which has been associated with obesity prevention (CDC, 2014; Chandalia et al., 2000; Kranz et al., 2012; WHO, 2015). Dietary fiber makes the person feel full, thereby reducing appetite and thus caloric intake (Flood-Obbagy & Rolls, 2008). Adolescents may consume over half of their fruit intake as fruit juice (U.S. Department of Health and Human Services, 2006; USDA, 2010a), but since fruit juice does not contain high amounts dietary fiber, they remain hungry and continue to eat beyond their caloric needs (Flood-Obbagy & Rolls, 2008).

The Fresh Fruit and Vegetable Program Handbook for Schools (USDA, 2010b) and the MyPlate food guidance system "focus on fruits" and "vary your veggies" in order to reduce adolescent obesity (USDA, n.d.; ChooseMyPlate.gov, p. 1). However, compared to other adolescents, Black adolescent females have very low rates of fruit and vegetable consumption, which makes them susceptible to becoming obese (CDC, 2013b).

In summary, the obesity epidemic in Black adolescent females has been attributed to a variety of possible causes, but Black adolescent females cannot control their household income, cultural differences in body image, early pubertal maturation in Black females, or slower body metabolism that makes losing weight difficult. However, Black adolescent females can choose to be physical active and to eat fruits and vegetables.

Problem Statement

Obesity is a major health problem among Black adolescent females, but it is unclear whether dietary intake of fruits and vegetables has a significant effect on the relationship between physical inactivity and obesity. Evidence suggests that physical activity can help reduce obesity rates in adolescents (Lavizzo-Mourey, 2012). Other evidence suggests that obesity in adolescents is related to their lack of fruit and vegetable intake (Ledoux, Hingle & Baranowski, 2011). Many state-based, school-based, and community-based programs include both increased exercise and increased dietary fruit and vegetable consumption for obesity reduction (CDC, 2013a).

While Wechsler and Lepold (2003) suggested that obesity should be investigated using a multimodal approach, and while Faith, Calamaro, Meredith, and Pietrobelli (2004) suggested that a moderator framework could be useful for determining the relationships between variables related to obesity, few studies to date have explored whether the dietary intake of fruits and vegetables could moderate the relationship between physical activity and adolescent obesity. That is, dietary fruits and vegetables might interact with physical inactivity in adolescent obesity. However, the few studies that have explored whether physical activity and dietary fruits and vegetables interact in adolescent obesity yielded mixed results (Patrick, 2004). No previous studies to date were designed to determine whether physical activity interacts with dietary fruit and vegetable consumption in obesity in Black adolescent females.

Purpose of the Study

The purpose of this quantitative, retrospective, cross-sectional study was to determine whether fruit and vegetable intake moderates the relationship between physical inactivity and BMI in Black adolescent females. That is, this study evaluated whether physical activity interacts with dietary fruit and vegetable consumption in obesity in Black adolescent females. This study fills an important gap in the literature by quantitatively evaluating the interaction of physical activity and dietary fruit and vegetable consumption on BMI among Black adolescent females to do that, a national database was used. The Youth Risk Behavior Surveillance Survey (YRBS), is a quantitative national survey conducted by local education and health agencies health-risk behaviors that contribute to the leading causes of death and disability among youth and adults. The YRBS is representative of teens across the nation because it used a stratified random sampling strategy to acquire a representative sample of high school students across the United States. The YRBS includes the height and weight data necessary for calculating BMIs, in addition to the race, sex, and dietary behaviors of fruit and vegetable intake that were necessary to test the hypotheses of this study. There is some evidence to suggest that higher intake of fruits and vegetables are associated with a decreased risk for some types of cancer, cardiovascular disease, and stroke. [It is not clear how the following two sentences are related to the previous sentences; please add a transition] In 2009, 22% of high school students nationwide had eaten fruits and vegetables five or more times per day during the 7 days before the survey. The percentage of students who ate fruits and vegetables five or more times per day decreased during 1999–2005 (24%–20%) and then did not change significantly (20%–22%) during 2005–2009 (CDC, 2011).

A quantitative methodology was appropriate because the purpose of this study involved a quantitative question.

Research Questions and Hypothesis

This research was designed to determine whether dietary fruit and vegetable consumption moderates the relationship between physical activity and BMI in Black adolescent females. This research question has the underpinnings of two foundational research questions on whether obesity is related to physical activity and whether BMI is related to the dietary intake of fruits and vegetables in Black adolescent females, and the third research question regarding whether dietary consumption of fruits and vegetables moderated the relationship between physical activity and BMI.

Research Question 1: Is physical activity significantly related to obesity in Black adolescent females?

$H1_0$: There is no significant relationship between physical activity and obesity in Black adolescent females.

$H1_a$: There is a significant relationship between physical activity and obesity in Black adolescent females.

Research Question 2: Is the dietary consumption of fruits and vegetables significantly related to obesity in Black adolescent females?

$H2_0$: There is no significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

$H2_a$: There is a significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

Research Question 3: Does the dietary consumption of fruits and vegetables significantly interact with physical activity in obesity in Black adolescent females?

$H3_0$: There is no significant interaction between the dietary consumption of fruits and vegetables and physical activity in obesity in Black adolescent females.

$H3_a$: The dietary consumption of fruits and vegetables interacts with physical activity in obesity in Black adolescent females.

For Hypothesis 1, the dependent variable was body mass index (BMI) and the independent variable was physical activity, measured as the number of days in the past week that the participant was physically active for a total of at least 60 minutes per day.

For Hypothesis 2, the dependent variable was BMI and the independent variable was dietary consumption of fruits and vegetables, measured as how many times a participant ate fruit, green salad, potatoes, carrots, or other vegetables the past 7 days.

For Hypothesis 3, the dependent variable was BMI, the independent variable was physical activity, and the moderator variable was dietary consumption of fruits and vegetables, measured as how many times a participant ate fruit, green salad, potatoes, carrots, or other vegetables the past 7 days.

Simple regression was the appropriate statistic for testing Hypothesis 1 because both BMI and physical activity are continuous scales and because the purpose of the analysis was to determine the relationship between physical activity and BMI. Similarly, simple regression was the appropriate statistic for testing Hypothesis 2 because both BMI and dietary intake of fruits and vegetables are continuous scales and because the purpose of the analysis was to determine the relationship between BMI and the dietary intake of fruits and vegetables.

Multiple regression was appropriate to test Hypothesis 3 because BMI, physical activity, and dietary intake of fruits and vegetables are continuous scaled variables and because the purpose of this analysis was to determine whether physical activity (independent variable) interacts with dietary intake of fruits and vegetables (moderator variable) towards predicting BMI (dependent variable).

Theoretical Framework

Bandura's (1977, 1982, 1997) theory of self-efficacy, as part of Bandura's social learning theory, provides the theoretical framework for this study. Bandura's theory was appropriate for consideration because it suggests that we model our behaviors on the behaviors of others, and adolescent females model behaviors for each other during the high school years. Within social learning theory, Bandura's theory of self-efficacy is appropriate for this study because it provides a mechanism for behavioral change, and behavioral change which is necessary to combat the obesity epidemic in Black adolescent females. According to Bandura's theory of self-efficacy, self-perception of personal competence mediates behavioral change and goal achievement (Bandura, Adams, & Beyer, 1977). This theory has been used in previous studies of nutrition and activity behaviors (Berkman, 2000; Berman, 2013; Eisenmann, Bartee, & Wang, 2002; Kwawchi & Berkman,2000).

Kwawchi and Berkman (2000) found that self-efficacy and modeling are evident in a number of nutrition-related studies, and that they provide the driving forces behind students' long-term changes in dietary behaviors and increasing physical activity. According to Kwawchi and Berkman (2000), this is achieved by having students set small goals then rewarding themselves. Further the National Institute of Health (NIH) used self-efficacy theory as the theoretical framework to evaluate the relationship between consumption of water, fruits, and vegetables in the context of adolescent obesity (Eisenmann et al., 2002).

According to Bandura's (1977, 1982, 1997) theory of self-efficacy and social learning theory, the perceptions of self and others drive people to change their behavior

(Bandura,1997; Bandura, Adams, & Beyer, 1977). People can choose to make changes by having the confidence they can complete their goal, especially if they see the target behavior in others. This theoretical framework is important to understanding the present study, because self-efficacy is needed to overcome the deficit of physical activity and consumption of fruits and vegetables needed to reduce the epidemic of obesity in Black adolescent females.

Nature of the Study

This study used quantitative methodology to evaluate the relationship between physical inactivity, dietary fruits and vegetables, and BMI. The dependent variable for this study was BMI, a calculation of body fat based on an adolescent's weight and height (CDC, 2012b). For Hypothesis 1, the independent variable was physical activity. For Hypothesis 2, the independent variable was dietary intake of fruits and vegetables. For Hypothesis 3, the independent variable is physical activity and the moderator variable was dietary intake of fruits and vegetables.

Archival quantitative data from the 2011Youth Risk Behavior Surveillance Survey (YRBS) was used to determine whether dietary intake of fruits and vegetables by Black adolescent females interacted with physical inactivity as revealed by the BMI of. The YRBS data were collected on Black adolescents from Grades 9-12 in 2011. The research methodology (research design, population sample and setting, instrumentation and materials, variables, data collection, and analysis) is detailed in Chapter 3.

Definition of Key Terms

BMI: Body Mass Index (BMI) is a body fat estimation based on weight and height, using the formula of (weight (lbs) / [height (in)^2] x 703) (CDC, 2010a).

Demographics: Social statistic of a human population that affects studies including; age, race, sex, economic status, educational attainment, and income level (Porta & International Epidemiological Association, 2008).

Dietary Behaviors: A particular group's eating habits (Porta & International Epidemiological Association, 2008).

Energy dense foods: High calorie foods (U.S. Department of Health and Human Services, 2010)

Family based intervention: strategy to change in health behavior by using the family unit for support (Porta, M. S. & International Epidemiological Association, 2008).

Obese: BMI at or above the 95th percentile for adolescents of the same age and sex (CDC, 2011d).

Overweight: BMI between the 85^{th} percentile to the 95th percentile (CDC, 2010a).

Prevalence: is the total number of cases infected within a population at a specific time (Porta, M. S., & International Epidemiological Association, 2008).

Socioeconomic Status: The social class of an individual or group (Porta & International Epidemiological Association, 2008).

Youth Risk Behavior Survey: Commonly abbreviated "YRBS", an annual questionnaire administered to public high school students to observe adolescent health risk behaviors, evaluate state and federal efforts, and plan new programs and strategies (CDC, 2004).

Assumptions

In this study, it was assumed that the YRBS database was representative of national patterns regarding adolescent BMI, physical activity, and eating patterns of fruit and vegetable consumption. The YRBS was designed to be representative by use of stratified sampling. YRBS was constructed from self-report data and self-report tools remain the most widely used method for assessing behavior in adolescents (Affuso et al., 2011), so it was therefore assumed that the self-report of YRBS participants reflects honest and accurate information.

Scope and Delimitations

This study was limited to Black adolescent females enrolled in high schools in different states at the time of YRBS survey. The results of this study might not generalize to other samples or other years. It will therefore be important to generalize the findings of this study only with appropriate caution.

Significance

This line of investigation could reduce adolescent obesity among Black females. Understanding the relationship between dietary behaviors and physical activity could reveal trends that may potentially help health researchers and practitioners design obesity prevention strategies. This study can add empirical evidence to the knowledge base of governmental agencies about the relationship between physical activity and dietary fruits and vegetables on adolescent obesity in Black females so that future programs could be based on empirical evidence. This study fosters positive social change by contributing valuable knowledge that can potentially be used to decrease the prevalence of obesity among Black adolescent females.

Summary and Transition

This chapter provided an overview of adolescent obesity among Black adolescent females, the health risks associated with obesity, and possible causes of the obesity epidemic in Black adolescent females. Physical activity and the possible relationship between obesity and fruit and vegetable consumption was provided, along with the statement of the problem, statement of purpose, the research question, and the hypotheses for this study. The theoretical framework and nature of the study were delineated. Key terms were defined, assumptions were provided, and the scope and delimitations of the study were detailed, along with the significance of the study. The following chapter provides a review of the published literature regarding obesity, physical activity, and dietary fruits and vegetables in anticipation of the methods chapter that details the methodology used to tests the research hypotheses for this study. This study fosters positive social change by identifying the relationship between factors that contribute to the obesity epidemic in Black adolescent females, which can potentially improve their quality of life.

The following chapter provides a review of the literature relevant to obesity, physical activity, and the consumption of fruits and vegetables to provide a foundation for the methodology employed in the present study. Following the results, the final chapter includes a summary, recommendations, and conclusions of the present study.

Chapter 2: Literature Review

Introduction

In this chapter, research studies are reviewed—those that contribute to the body of knowledge on obesity in Black adolescent females, with emphasis on physical activity and dietary intake of fruits and vegetables. The following topics are covered: the problem of obesity, the prevalence of adolescent obesity, adolescent obesity in Black females, the impact of physical activity on obesity, the impact of fruits and vegetable intake on obesity, and the possible impact on obesity of physical activity and the intake of fruits and vegetables.

The literature reviewed here was gathered using electronic databases, books, and Internet sources. The following databases and vendors were searched: PubMed, Market Data Retrieval, Google Scholar, ProQuest Dissertation, EBSCO, and SAGE, limited to the years 1990-2015. This literature review pinpoints the gaps in the literature that show the need for research to assess the possible interaction of physical activity and the intake of fruits and vegetables on adolescent obesity.

The theoretical framework for this research was Bandura's self-efficacy theory. It is used to explain how perception influences an ability to reach a goal. Research shows that a learned behavior can be altered by observing others and being confident that a behavior can be changed. Without self-efficacy, the rate of adolescent obesity will continue to increase among Black females. This review begins with the literature on obesity and its effects.

What is Obesity?

Obesity generally refers to being overweight due to having excessive body fat. Obesity is commonly assessed by body mass index (BMI) standards of based on height and weight (CDC, 2015b; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). BMI standards are calculated for each year of age across the lifespan (U.S. Department of Health and Human Services, 2010). Opinions vary (Ogden & Flegal, 2010), but in general, a person with a BMI between 25 and 29, which corresponds to the 85th and 94th percentiles, is considered to be "overweight" and at risk for obesity. Person with a BMI at or above 30, the 95th percentile, is categorized as obese (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). However, some of the published literature uses the term obesity and other reports use the term overweight, so these terms can be considered interchangeable in this literature review.

What is Fat?

Body fat is largely adipose tissue, connective tissue that functions as the major storage site for fat (in the form of triglycerides) in humans. The average size of an adipocyte ranges from 0.2 to 1.4 microgram of lipid per cell, (Mayo Clinic, 2014, 2015). On a molecular level, adipocytes play a role in exercise, food intake, and are subject to genetic variation (Greenberg & Obin, 2006). There are two types of adipocytes, White adipose tissue (WAT) and brown adipose tissue (BAT); they differ in function, origin, and structure (Church, Horowitz, & Rodeheffer, 2012). The majority of adipose tissue is White (WAT). White adipose tissue serves three functions: heat insulation, mechanical cushion, and a source of energy storage. WAT is an efficient way to store excess energy because it is stored with very little water. Brown adipose tissue (BAT) provides a vital source of heat to maintain body temperature in small mammals and infants and is activated when the body temperature drops. Most of BAT disappears in adult humans.

Why is Excess Fat a Problem?

Obesity is the excessive accumulation of White adipose tissue (WAT). Subcutaneous fat is found beneath the outermost layer of skin (epidermis) and is the protective wrap over the body's surface. The body surface is made up of stratified squamous epithelium with an underlying basal lamina. Fat accumulated in the lower body is subcutaneous, while fat in the abdominal area is largely visceral (Harvard, 2014).

Visceral fat (also called abdominal fat or organ fat) is located inside the peritoneal cavity. High body fat around the abdomen and waist carries a greater risk for developing cardiovascular disease, diabetes and high cholesterol than lower body fat. In obese people, secretions from abdominal fat cells can lead to plaque buildup in arteries and heart disease (Coffman, n.d.). Visceral fat also known as organ fat is located inside the peritoneal cavity and contributes to belly fat. Visceral fat is directly linked with higher total cholesterol and lowering the good cholesterol HDL and raising the bad cholesterol LDL. Visceral fat contributes to insulin resistance, glucose intolerance, hypertension, and coronary artery disease (Harvard, 2014).

It is now apparent that adipocytes are not simply a storage reservoir of fat but are active endocrine organs that play multiple roles in the body (Greenberg & Obin, 2006). In this context, obesity is problematic, because pro-inflammatory factors are produced in adipose tissue with increasing obesity. For example, compared with that of lean individuals, adipose tissue in an obese person shows higher expression of pro-inflammatory transmembrane adapter protein SIT (Greenberg & Obin, 2006).

Obesity is Deadly and Costly

Obesity is the second leading cause of preventable death in the America, accounting for one in ten adult deaths (Danaei et al., 2009). Obesity is associated with an increased risk of negative health outcomes, including psychosocial, morbidity, mortality, and high risk factors for chronic disease (Brownson et al., 2010). Being overweight makes the individual susceptible to cardiovascular disease, cancers, diabetes, broken hips in the elderly and Blount's disease in adolescents (Brownson et al., 2010; CDC, 2015b). Obesity reduces quality of life (Kranz et al., 2012). With every unit increase in BMI, type 2 diabetes significantly increases, particularly in Black females (West, DiLillo, Bursac, Gore, & Greene, 2007)

Finkelstein, Trogdon, Cohen, and Dietz (2009) estimate that obesity cost 147 billion dollars per year in 2008, up from 117 billion dollars in 2000 (U.S. Department of Health and Human Services, 2002). A Cornel study estimates that obesity accounts for 21% of health care dollars (Cawley & Meyerhoefer, 2012). Total health care costs toward obesity could double every decade to anywhere from $860–956 billion by 2030 (Wang et al., 2008). This is perhaps not surprising, given that 34% of adults are obese (Brownson et al., 2010).

Socioeconomic Status (SES)

In adults, there is a well-established negative relationship between socioeconomic status and being overweight, but the relationship with children is inconsistent. Bishop, Middendorf, Babin, and Tilson (2005) found that SES is negatively associated with children being overweight or obese. The relationship between SES and obesity varies by race/ethnicity. The negative relationship is only apparent in Whites and is not consistent among Black or Latino adolescents. Black and Latino children from families with higher socioeconomic status are no less likely to be overweight or obese than those in families with lower socioeconomic status. The relationship among race/ethnicity, SES, and childhood obesity may result from unhealthy eating patterns, decreased physical activity, more sedentary behavior, and cultural attitudes about body weight (Bishop, Middendorf, Babin, & Tilson,2005).

Parental Influences

The home environment has a strong influence on the availability and accessibility of healthy and unhealthy foods (Assari, Lankarani, Caldwell, & Zimmerman, 2015; Berry et al., 2004). Adults have a basic understanding and are often confused regarding healthy eating and understanding that high-fat foods in the home have been associated with fat intake and fruit and vegetable availability has been linked with fruit and vegetable intake and lower fat intake (Kegler et al., 2014; Jones et al., 2014). Numerous parental influences shape the eating habits of children including; the choice of an infant feeding method, the foods they introduce in the home, the amount of time children are left unsupervised, their eating behaviors, and how different sectors of the society influences their dietary behaviors (Bishop, Middendorf, Babin, & Tilson, 2005; Blom-Hoffman, 2004; CDC, 2015b). Even in the changes of family structure women still have primary responsibility for feeding children in most households; and are left with little time to devote to feeding their family (Birch & Fisher, 1998; Savage, Fisher, & Birch, 2007). Parents who ate diets rich in saturated fats also had children that ate diets high in saturated fats. It is suspected that this observation is not merely due to the foods parents feed their children, but rather due to the preferences children develop through exposure to foods that their parents prefer early in their lives (Vantage Professional Education, 2011). This was proven with the Feeding Infants and Toddlers Study evaluated the dietary patterns of 3,022 infants and toddlers between ages of 4 to 24 months of age, and raised concerns with the quality of young children's diets finding children consumed significant amounts of energy-dense but nutrient poor foods (Fox, Pac, Devaney, & Jankowski, 2004).

Genetics

Research studies support the theory of genetic susceptibility as a risk factor for obesity. Family studies suggest that hereditary contributes between 5-40% among biological relatives risk for obesity. Genetic susceptibility to obesity in most cases is due to multiple genes that interact with environmental and behavioral factors (Karnik & Kanekar, 2012; O'Rahilly & Faroogi, 2006). The use of quantitative obesity sub-phenotypes that can be accurately measured has resulted in significant measures of heritability for skinfold thickness, waist circumference and total and regional fat distribution (Walley, Blakemore, & Froguel, 2006). Genes define the propensity to become overweight, while diet and physical activity can determine to what extent that propensity becomes a reality, within the context that behaviors are influenced by the environment (EUFIC Food Today, 2012; Karnik & Kanekar, 2012; O'Rahilly & Faroogi, 2006)

Mother and Baby

Obesogenic behaviors, is the maternal behaviors that predict or protect the child's health. Health behaviors are learned within families and parents play a powerful role in the development of children's dietary behaviors throughout childhood. Mothers, in particular have always had a strong influence in shaping the health behaviors of children, because the mother spends more time with children than fathers, the child will mirror the health behaviors that are practiced in the home. If the mother eats unhealthy there is a strong likelihood the child will eat unhealthy due to access of the food kept in home and by establishing health-related household rules (Sonneville et al., 2012). A longstanding theory is that exposure to complex sugars and fats contained in bottle formula influence “obesogenic factors” in infants, predispose them to weight gain later on in life. A recent study argue that breastfed infants are healthier and eat until satisfied, whereas bottle fed babies may be encouraged to eat until they have consumed all of the formula. Breast feeding provides a variety of nutrition. Formula fed infants experience a single flavor, whereas breastfed infants are exposed to a variety of flavors from the maternal diet that are transmitted through the milk. Research indicates that the perception of flavors in mother’s milk is one of the human infant’s earliest sensory experiences, and support the idea that early exposure to a variety of flavor influence the acceptance of a variety of foods (Bishop et al., 2005).

There is a trend between maternal obesity in the first trimester of pregnancy and obesity in child (Sonneville et al., 2012). The Barker Hypothesis proffers that size at birth is related to risk of developing diseases in life, including both a low birth weight baby and a high birth weight baby (Leddy, Power, & Schulkin, 2008). Women are increasingly beginning pregnancy at greater weights and gaining excessive weight during pregnancy is another proven strategy in reducing childhood obesity. Gestational diabetes leads to fetal hyperinsulinemia and increased fetal growth, may cause obesity and impaired glucose tolerance as the child becomes an adult (Kumanyika, 2008).

Researchers have evaluated the associations between childhood appetitive traits and parental obesity on weight gain from 0 to 24 months and body mass index (BMI) where examined and concluded that having two obese parents is related to greater weight gain from birth to 24 months independent of childhood appetitive traits (Fuemmeler, Lovelady, Zucker, & Østbye, 2013). Sonneville et al. (2012) explored longitudinal studies showing that parental modeling of healthful behaviors can positively influence child diet over time. Sonneville and colleagues (2012) examined the cross-sectional association between obesogenic behaviors, specifically TV/video viewing, sugar-sweetened beverage intake, and fast food intake, of mothers and their overweight or obese pre-school aged children study subjects are children participating in the High Five for Kids Study, a cluster-randomized controlled trial to reduce obesity among youth taking place in 10 primary care offices. Of the 479 youth initially enrolled in the study, 428 had baseline interviews completed by mothers. The results found that there is a strong, positive association between the obesogenic behaviors of mothers and their overweight or obese pre-school aged children. The overweight or obese children in our study were far more likely to meet behavioral recommendations for TV/video viewing, sugar-sweetened beverage intake, and fast food intake if their mothers had lower levels of these behaviors. The associations we observed in obesogenic behaviors among mothers, who are overweight or obese help to explain the broader environmental commonalities in obese families which efforts to prevent and reduce childhood obesity must consider (Sonneville et al., 2012).

National Epidemic

Teen obesity is an epidemic in the U.S., with more than 18% of adolescents categorized as obese (CDC, 2015a). This rate is triple the adolescent obesity rate of 1980 (Brownson et al., 2010; CDC, 2015a, Godson, 2012; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Reducing adolescent obesity is an important priority for society, because overweight adolescents are at high risk for becoming obese adults (CDC, 2015a). Cossrow and Falkner (2004) illustrated very high rates of overweight trends in the youth that is projected to follow them into adulthood. Bishop et al. (2005) estimated that being overweight during adolescent years is associated with a 70% likelihood of becoming an overweight adult. Similarly, Patrick and colleagues (2004) estimated that 70% of obese 10 to 13-year-old children become obese adults.

Adolescent Obesity Among Black Females

The High School Youth Risk Behavior Survey (YRBS) of 2011 found that the obesity rate in Black high school girls was 18.6%, more than twice as high as the 7.7% obesity rate of White high school girls (Eaton, 2012, Table 101, p. 149). Cossrow and Falkner (2004) examined obesity among race and ethnic groups using data from the National Health and Nutrition Examination Survey and also found that obesity is significantly more common in Black than in White. The National Health and Nutrition Examination Survey found that Black adolescents have a 12% greater chance of being overweight than White adolescents (CDC, 2015a). Fryar, Carroll, and Ogden (2012) conducted an analysis of obesity prevalence among adolescents age 12 to 19 years showed that 25% of black females were obese, compared to 15% of White females. The U.S. Department of Health & Human Services Office of Minority Health reported that, in

2007-2008, Black adolescents were 30% as likely to be overweight than Non-Hispanic Whites (OMH, 2008). Wang, Beydoun, Liang, Caballero, and Kumanyika (2008) estimated that half of U. S. Black adolescents will be obese by 2050 based on BMI trends from the National Health and Nutrition Examination Study. This rapid increase in obesity prevalence is associated with serious health consequences, morbidity, and mortality (Eaton, 2012; Cawley & Meyerhoefer, 2012)

The proposed causes of the high rate of obesity in Black adolescent females are numerous. A review by Caprio et al. (2008) indicated that race, ethnicity, and culture affect obesity in adolescents. Pubertal maturation is known to impact on obesity development. Girls who mature early have higher BMI and more skinfolds during their teenage years than girls who mature later, and this interaction is strongest in black girls (Caprio et al., 2008). Because black girls undergo pubertal maturation earlier on average than White girls, differences in pubertal maturation stage can account for some racial differences in adolescent obesity (Caprio et al., 2008). Some scholars point to excessive dietary fat (CDC, 2014; Levi, Segal, St. Laurent, Lang, & Rayburn, 2012), sugar consumption (CDC, 2014; Johnson et al., 2009), slower metabolic rates (Pan & Prat, 2008; Walsh, Hunter, Sirikul, & Gower, 2004; Weinsier et al., 2000), or excessive beverage intake (Bleich, Wolfson, Vine, & Wang, 2014), while other scholars point to socioeconomic status as an indicator of obesity in Black females (Johnston, Delva, & O'Malley, 2007; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010).

Two additional potential causes of obesity in Black females are physical activity (Lavizzo-Mourey, 2012) and diet (Ledoux, Hingle & Baranowski, 2011; Mama et al., 2016). The next section provides an overview of published literature demonstrating the relationship between physical activity and obesity.

Physical Activity and Obesity

Physical activity is linked to obesity and obesity prevention (CDC, 2014; Karnik & Kanekar, 2012; Luke et al., 2011; Ogden et al., 2007). In this context, physical activity refers to body movement that requires energy expenditure (WHO, 2012). Reduced energy expenditure is a significant contributing factor to the high prevalence of obesity (Ogden et al., 2007). Eisenmann, Bartee, and Wang (2002) studied a sample of 15,143 U. S. high school students between 14 and 18 years old who participated in Youth Risk Behavior Survey sponsored by the Centers for Disease Control and Prevention (CDC)and found a correlation between physical activity and BMI. The more students exercised, the lower their BMI (Eisenmann et al., 2002).

Adolescents who participate in regular activities have a greater chance of being healthy in adulthood. In the past, chronic diseases, such as cardiovascular disease, hypertension, or type-2 diabetes where rarely found in adolescents. Teens who engage in at least moderate levels of physical activity have better levels of cardiorespiratory fitness and lower overall mortality rates than inactive teens (CDC, 2015a; WHO, 2015). The inactivity in adolescents has a direct correlation with the growing incidence of these chronic diseases and their risk factors (U.S. Department of Health and Human Services, 2008). Regular physical activity decreases the risk factors and development of chronic diseases resulting in adolescents that remain healthy as adults (WHO, 2015).

The U.S. Department of Health and Human Services recommends 60 minutes of exercise per day for adolescents (Lavizzo-Mourey, 2012). However, the Physical Activity in U.S. Youth Aged 12–15 Years study of Tala, et al. (2014) indicated that less than 23% of female adolescents' exercise 60 minutes per day in 2012. Health surveys conducted by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) discovered that only 35% of the high school students report that they participate in at least 60 minutes of physical activity on 5 or more days a week, and only 39% of students report that they attend physical education class daily. As their age increases, participation in regular physical activity decreases dramatically (NIDDK, 2008).

Body Mass Index (BMI) is a tool used to measure body fat. The correlation between the BMI number and body fatness is fairly strong; however, the correlation varies by sex, race, and age. At the same BMI, women tend to have more body fat than men do. At the same BMI, older people, on average, tend to have more body fat than younger adults. Highly trained athletes may have a high BMI because of increased muscularity rather than increased. The standard weight status categories associated with BMI ranges for adults are shown in Table 1.

Table 1

BMI and Weight Status

BMI	Weight status
Below 18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 and above	Obese

Note. Adopted from CDC. (2015) *Overweight and Obesity: Data and Statistics*. Retrieved from http://www.cdc.gov/obesity/data/childhood.html

BMI can be lowered by reducing fat mass. To achieve negative fat balance, one must alter intake or expenditure such that fat oxidation exceeds fat intake. Since fat oxidation is increased during exercise, and since endurance exercise training increases the capacity to oxidize fat.

BMI is calculated using the metric system of weight in kilograms divided by height in meters squared (weight (kg) / [height $(m)^2$]). The metric system uses kilograms and meters. The Imperial system uses pounds and inches. BMI is calculated in the study using the Imperial system of Weight in pounds (lbs) divided by height in inches (in) squared and multiplied by a conversion factor of 703 (weight (lbs) / [height $(in)^2$] x 703).

A systematic review and meta-analysis by Atlantis et al. (2006) evaluated the efficacy of exercise alone for treating overweight in adolescents in randomized trials. Studies of isolated or adjunctive exercise/physical activity treatment in overweight/obese children or adolescents which reported any overweight outcome were included. From the 14 studies evaluated by Atlantis et al. (2006), 481 12-year-old overweight boys and girls were pooled, with large effects on body weight evident with large amounts of exercise but nonsignificant and smaller effects seen from studies with lower levels of exercise. Based on the small number of short-term randomized trials currently available, Atlantis et al. (2006) recommended an aerobic exercise prescription of 155–180 min/weeks at moderate-to-high intensity is effective for reducing body fat in overweight children/adolescents.

Stafford et al. (2013) conducted a systematic review of the literature to examine the association between changes in physical fitness and chronic disease risk factors in overweight and obese youth. A review of the literature was conducted to identify the relationship between physical fitness and health in youth (ages 5-18 years). A total of 78 experimental studies on overweight/obese youth published from 2000–2010 were identified and evaluated. Of these, 33 studies met the inclusion criteria of an exercise or physical activity intervention for overweight and/or obese participants randomized into intervention and control groups. The largest effects in BMI and percent body fat reduction were associated with a single study of a diet plus exercise intervention compared to an exercise intervention with no dietary component, but overall, Stafford et al (2013) concluded that physical fitness was the major contributor to improved health and fat reduction in obese youth.

Physical Activity and Obesity in Black Females

Despite the importance of regular exercise, the lack of physical activity contributes to obesity in Black adolescent females (Kimm, Glynn, Kriska, Barton, Kronsberg, Daniels & Liu, 2002; Lavizzo-Mourey, 2012). In general, Black females are less physically active than White females (Walsh, Hunter, Sirikul, & Gower, 2004). Further, Black adolescent females are less likely than White American White American females to meet the HHS guidelines of 60 minutes of exercise per day (Patrick, Norman, Calfas, Sallis, Zabinisky, Rupp, & Cella, 2004).

The level of physical activity decreases dramatically during adolescence, with physical activity in Black girls declining at twice the rate of White American girls (Kimm, Glynn, Kriska, Barton, Kronsberg, Daniels & Liu, 2002). Additionally, Black adolescent females are less likely to exercise and are less likely to participate is sports and physical activity outside of school (Lavizzo-Mourey, 2012). This is important, because Thompson and colleagues (2004) found that the higher the physical activity, the lower the body fat in African-American girls.

Low levels of energy expenditure can contribute to obesity (Luke et al., 2011). Sharp et al. (2002) found lower metabolic rate in Black females than in White American females. The lack of physical activity in Black adolescent females is compounded by slower metabolic rates in Black females (CDC, 2014). Weinsier and colleagues (2000) found that overweight and normal-weight Black females had lower energy requirements at rest and at non-rest than White females. Further, in general, Black females do not compensate for this difference in energy expenditure with greater physical activity, which can thereby predispose them to risk of obesity (Weinsier, et al., 2000).

Fruits, Vegetables, and Dietary Fiber

Fruits and vegetables contain dietary fiber. This section begins by addressing what dietary fiber is, followed by the literature regarding obesity and dietary fiber from fruits and vegetables.

What is Dietary Fiber?

Dietary fiber refers to non-digestible carbohydrates intact in plants, such as fruits and vegetables (Kranz et al., 2012). Fiber is a complex carbohydrate that pushes through our digestive system, absorbing water along the way and easing bowel movements. The recommended fiber dose is 30 to 38 grams for men and 21 to 25 grams for women. Some of the benefit of fiber include soluble fiber travels through your intestines, it picks up extra cholesterol and helps it pass out of the body through fecal waste. Soluble fiber balances your blood sugar levels by delaying the absorption of sugar (Coffman, n.d.). Some dietary fiber is soluble, dissolvable in water, while insoluble fiber does not dissolve in water (Baird et al., 2009; Wanders et al., 2011).

Both soluble fiber and insoluble fiber are implicated in obesity prevention (Kranz et al., 2012). Table 2 displays the soluble fiber and insoluble fiber content in some common fruits and vegetables. A more extensive list of soluble fiber and insoluble fiber content in some common fruits and vegetables is provided in Appendix B.

Table 2

Fiber content of common fruits and vegetables

Fruits/Vegetables	Portion Size	Grams of Fiber	Insoluble Fiber	Soluble Fiber
Apples	1 Medium	2.7	1.0	2.7
Bananas	1 Medium	2.8	2.1	0.7
Oranges	1 Medium	3.1	1.3	1.8
Pear	1 Medium	4.0	1.8	2.2
Strawberries	1 cup	3.3	2.4	0.9
Green salad	1 cup	0.9	0.6	0.3
Potatoes with skin	1 cup	2.9	1.7	1.2
Carrots raw	1 cup	3.3	1.7	1.6
Broccoli raw	1 cup	2.6	1.7	0.9
Green beans canned	1 cup	2.6	1.6	1.0

Note: adopted from *Fiber Content of Foods* by Prebiotin (2015), retrieved from: https://www.prebiotin.com/resources/fiber-content-of-foods/ and from *Fiber Food Chart* by the National Fiber Council (2015), retrieved from: http://www.nationalfibercouncil.org/food_chart.shtml

Why is Dietary Fiber Important?

High fiber intake has health benefits in reducing the risk for developing coronary heart disease, ischemic stroke, hypertension, and diabetes, as well as reducing risk for gastrointestinal disorders, including gastro esophageal reflux disease, duodenal ulcer, diverticulitis, constipation, and hemorrhoids (Anderson et al., 2009; National Heart, Lung, and Blood Institute (NHLBI], 2012, 2015b). Many fruits and vegetables that are high in fiber are also rich in anticargogenic compounds that promote dental health and reduce tooth decay (Patrick, Norman, Calfas, Sallis, Zabinisky, Rupp, & Cella, 2004).

The American Heart Association recommendation is 25–30 grams of dietary fiber per day, but the average dietary fiber intake in the United States may be as low as 15 g/day, half of the AHA recommended levels (Howarth, Saltzman & Roberts, 2001; Kranz et al., 2012). The rates may be even lower for adolescents (Kranz et al., 2012). As many as 9 out of 10 adolescents fail to achieve the recommendations for fiber intake. (Kranz et al., 2012). For these reasons, dietary guidelines for patients with diabetes should emphasize on overall increase in dietary fiber through the consumption of unfortified foods, rather than the use of fiber supplements (Chandalia, et al., 2000).

Dietary fiber from fruits, as part of an overall healthy diet, helps reduce blood cholesterol levels and may lower risk of heart disease. Fiber is important for proper bowel function. It helps reduce constipation and diverticulosis. Fiber rich fruits and vegetables increase feelings fullness without adding a lot of calories. Whole fruits are sources of dietary fiber; fruit juices contain little or no fiber. (Choosemyplate, 2015) Water and fiber in foods increase volume and thereby reduce energy density. Fat increases the energy density of foods, while water and fiber decrease energy density. Water has a positive effect on energy density because it adds weight to food without increasing calories, thus decreasing energy density (Rolls, Drewnowski, & Ledikwe, 2005). In their natural state, fruits and vegetables have high water and fiber content and are low in calories and energy density (CDC, 2014). Whole fruit is lower in energy density and more satiating than fruit juices. Pulp-free fruit juices lose their fiber content in the process of juicing. For eight control purposes, the whole fruit contains added fiber that helps make one feel full. Vegetables tend to be lower in calories than fruit; thus, substituting more vegetables than fruit for foods of higher energy density can be helpful in a weight management plan low fat content (CDC, 2015b).

Obesity and Dietary Fiber from Fruits and Vegetables

Evidence suggests that dietary fiber from fruits and vegetables can play a significant role in obesity and weight control (Ledoux, Hingle, & Baranowski, 2011). That is, the lack of dietary fiber from fruits and vegetables increases the risk of obesity (Ebbeling et al., 2002). Conversely, consuming at least 25 grams of dietary fiber per day can decrease obesity risk (Howarth, Saltzman, & Roberts, 2001). Based on published reports and expert testimony, the 2010 Surgeon General's Vision for a Healthy and Fit Nation concluded that replacing high calorie food with fruits and vegetables can reduce obesity (U.S. Department of Health and Human Services, 2010). There is evidence for a link between energy intake and obesity, but fruit and vegetable fiber intake has been insufficiently studied (Bray & Popkin, 1998; Burton-Freeman, 2000; Patrick, 2004). However, studies show that for every 10 grams of soluble fiber a person consumes in his or her daily diet, 3.7% less belly fat was gained over time proving that dietary fruits and vegetables are effective reducing body fat (Brownstein, 2011). A limited number of research studies specifically evaluate consumption of dietary fruits and vegetables and weight management. Clinical evidence shows that combining advice to increase fruit and vegetable consumption with caloric restriction is an effective strategy for weight management. Epidemiologic support that dietary fiber intake prevents obesity is strong. Dietary fiber generally decreases food intake and, hence, body weight (Tohill, Seymour, Serdula, Kettle-Khan, & Rolls, 2004; Slavin, 2005).

Slavin (2005) found that the consumption level of dietary fiber is inversely related to body fat and BMI. A high fiber diet reduces caloric intake, reduces the absorption of macronutrients, and changes the secretion of intestinal hormones. Dietary fiber helps to control blood sugars and increased intake of soluble fiber improves glycemic control (Anderson et al., 2009; Howarth et al., 2001).

Dietary fiber from fruits and vegetables promotes satiety, which means that the person feels full sooner, and experiences a reduced subjective appetite. Alinia, Hels, and Tetens (2009) demonstrated that satiety plays a role in the relationship between obesity and the intake of fruits and vegetables. That is, if someone eats fruits and vegetables, they feel full earlier, and therefore quit eating sooner. Anderson and colleagues (2009) point out that people have known for millennia that high-fiber foods are more filling than low-fiber foods and that fiber supplements to reduce caloric intake have been used by dieticians for decades. Alinia, Hels, and Tetens (2009) concluded that removal of the dietary fiber from fruit, and also the physical disruption of the dietary fibers, resulted in faster and easier ingestion and in decreased satiety. Flood-Obbagy and Rolls (2008) study show that a solid apple brings more satiety than applesauce, which brings more satiety than apple juice, and that eating an apple before a meal can significantly reduce food intake at the meal.

Dietary fiber can reduce subjective appetite, energy intake and body weight, but it is important to note that different types of dietary fiber may affect these outcomes differently (Wanders et al., 2011). Insoluble fiber provides bulk and reduces the feelings of hunger, while soluble fiber may send signals from the intestine to reduce fat absorption. Burton-Freeman (2000) points to the dietary fiber sending signals from the intestine to increase satiety and reduce fat absorption, but the mechanism of this signaling has not been fully characterized. Early signals of satiation may be induced by the bulking effects of insoluble fiber on energy density, while soluble fibers may enhance satiety by modifying gastrointestinal function, which can delay fat absorption (Burton-Freeman, 2000).

Recently, De Vadder and colleagues (2014) showed that soluble dietary fiber produces signals from the intestine wall to the portal vein that triggers the brain to regulate blood glucose in mice. This mechanism reduces eating behavior by producing satiety and reduces the glucose production of the liver. While this study has not been replicated in humans, the results of De Vadder and colleagues (2014) provide a promising signaling mechanism that may explain the relationship between soluble dietary fiber and weight control. The combination of the bulking effect of insoluble fiber and the intestinal signaling mechanism of soluble fiber may combine to explain why dietary fiber from fruits and vegetables can reduce the risk of obesity. Insoluble fiber sweeps through your intestinal tract, speeding up digestion (Coffman, M. (n.d.); George Mateljan Foundation, 2015b; Brownstein, 2011)

While the epidemiologic support that dietary fiber intake reduces obesity, risk is strong, not all studies support this idea. For example, Field, Gillman, Rosner, Rockett, and Colditz (2003) surveyed 8203 girls ages 9 to 14 in 1996 and again in 1999 and found that fruits, vegetables, and fruit juice intake was not predictive of reductions in BMI. Because fruit juice was considered to be similar to fruits and therefore not controlled-for in the study, it is possible that the sugars in fruit juice may have counteracted the positive effects of fruits and vegetables in the Field, Gillman, Rosner, Rockett, and Colditz (2003) study. Further, Ledoux, Hingle and Baranowski, (2011) reviewed the published literature and found that increased fruit and vegetable intake was associated with adipose reduction in adults, but that this relationship was apparent in only half of childhood studies. These authors concluded the relationship between obesity, physical activity, and the intake of fruits and vegetables was unclear (Ledoux, Hingle, & Baranowski, 2011). It is therefore important to review the literature that combines the study of physical activity levels with the study of intake of fruits and vegetables towards understanding obesity.

The Produce for Better Health Foundation (2014) study evaluated over a period of one year the weight changes of parent-focused behavioral weight fluctuations in families. One set of families increased fruit intake to 2 fruits per day and vegetables to 3 per day; while the other group reduced fat and sugar servings to less than 10 per week. The families that increased fruit and vegetable intake had the greatest reduction in percentage of overweight adults. Furthermore, families who increased fruit and vegetable intake also lowered their fat and sugar intake whereas the group that reduced fat and sugar intake did not increase intake of fruits and vegetables. These data support the positive benefits of including fruits and vegetables in weight loss diets and suggest that an effective approach to weight loss might focus on increasing intake of healthy foods rather than emphasizing dietary restriction.

The recommended daily amount of fiber can be consumed by eating a diet high in fiber-rich fruits, vegetables, and whole grains. Green salad and lettuce is a great way to build your fiber intake. The words lettuce and salad are practically interchangeable since most salads are made predominantly with the green crispy leaves. Green leaves insoluble fiber, one of the most popular types grown in home gardens, contains 0.9 grams of fiber per serving (George Mateljan Foundation, 2015a; Tohill, Seymour, Serdula, Kettle-Khan & Rolls, 2004).

Fruits and vegetables are naturally low in fat and calories, and proven to be very filling providing essential vitamins and minerals, fiber, and other substances that are important for reducing risk of cancer and a number of ailments. Inclusion of fruits and vegetables perpetuates the theory suggesting energy density, fiber content, palatability, and dietary variety are important determinants of energy consumption (CDC, 2013d).

There are several ways to ensure one consumes enough fiber is first important to read food labels. Although they do not distinguish between the two types of fiber, the labels of almost all foods will provide the amount of dietary fiber in each serving. Raw or slightly cooked vegetables will also provide an excellent source of fiber. However, overcooking vegetables may reduce the fiber content. Whole-grain cereals, whole-wheat bread, fresh or dried fruit, beans, rice, and salad are all good sources of fiber. The table in Appendix B presents the fiber content of various foods.

Obesity, Physical Activity, and Dietary Fiber from Fruits and Vegetables

While the relationship between obesity and either diet or physical activity has been studied extensively, less is known about how diet and exercise might interact in adolescent obesity among Black females. Many obesity reduction programs combine physical activity and diet without assessing the interaction of physical activity and dietary considerations. Combating the adolescent obesity epidemic is so important that state-based (Agrawal, 2012; Welsh & Perveen, 2013), school-based, (Budd & Volpe, 2006; Hoelscher et al., 2004; Neumark-Sztainer, Story, Hannan & Rex, 2003) and community-based (King, Gill, Allender, & Swinburn, 2011) programs that combine diet and exercise have emerged to reduce adolescent obesity (CDC, 2013).

Further, in 2010, First Lady Michelle Obama launched the Let's Move program (www.letsmove.gov) that focuses on exercise and a diet rich in fruits and vegetables towards the goal of reducing adolescent obesity. This program was made in conjunction with the Fresh Fruit and Vegetable Program Handbook for Schools (USDA, 2010b) and the MyPlate food guidance system that emphasizes the need to "focus on fruits" and "vary your veggies" as fundamental to reducing adolescent obesity (USDA, 2010a; ChooseMyPlate.gov, p.1). Combined with the U.S. Department of Health and Human Services recommendation of 60 minutes of exercise per day for adolescents (Lavizzo-Mourey, 2012), it is clear that the federal government believes that both exercise and a diet rich in fruits and vegetables are fundamental to reducing adolescent obesity. However, the relationship between exercise and dietary fruits and vegetables in reducing obesity remains unclear.

Janssen and colleagues (2005) compared the rates of overweight and obesity in school-aged youth from 34 countries and concluded that physical activity is important to reducing overweight and obesity in youth, but found that the intake of fruits and vegetables was not associated with lower rates of overweight and obesity. However, this study assessed physical activity and the intake of fruits and vegetables as isolated variables and did not assess the possible interaction between physical activity and the intake of fruits and vegetables.

In a classic study, Peña et al. (1989) studied the interaction between exercise and dietary fiber on obesity and found a significant interaction between fiber and exercise in girls, but not in boys. Peña (1989) did not differentiate analyses by race, so the potential interactive effects of exercise and dietary fiber on obesity in Black adolescent females was beyond the scope of the Peña (1989) study. This study is old but important, because, unlike more recent studies, Peña et al. (1989) is the only study that directly assessed the statistical interaction between exercise and dietary fiber on obesity, but not assess outcomes by race.

In contrast, Patrick (2004) conducted a randomized controlled trial of 878 adolescents, evaluating diet and physical activity, and sedentary behaviors in relation to obesity, under the justification that "the evidence linking specific eating and physical activity behaviors with overweight is inconclusive. Most previous studies have examined nutrition or physical activity factors, but few have examined both" (p. 388). Patrick (2004) found that physical activity was inversely related to obesity, but found no evidence of an interaction between diet and activity on weight status. While 42% of participants were from minority backgrounds, Patrick (2004) did not separately analyze Black females to assess the possible interaction between diet and physical activity on weight status in Black adolescent females, an at-risk group for obesity (Johnston, Delva, & O'Malley, 2007; Ogden, Carroll, Kit, & Flegal, 2010). Patrick (2004) concluded that more studies are needed to clarify the relationship between diet and physical activity in overweight adolescents.

Ho et al. (2013) conducted a systematic review of school-based programs to reduce childhood obesity and found a lack of consistency about effectiveness of such programs, with some including multiple strategies in their intervention beyond exercise, some including informative components, some including behavioral components; some including environmental components, some including cognitive components, and some including parental support. Overall, these studies showed that school-based prevention interventions are at least mildly effective in reducing BMI, particularly when the studies were longer in duration. In particular, programs that included a diet component along with an exercise component yielded larger reductions in obesity than programs that included only a dietary component. Ho et al. (2013) concluded that development of comprehensive interventions in the form of school-based obesity prevention programs directed at improving nutrition and increasing physical activity may help to reduce childhood obesity and associated health problems. However, none of the studies reviewed by Ho et al. (2013) directly measured the interaction between physical activity and dietary intake of fruit and vegetables on obesity, body fat, or BMI.

Little is known regarding the interaction between diet and exercise in adolescent Black female obesity. The published literature shows that many programs emphasize both physical activity and the intake of fruits and vegetables towards obesity prevention and reduction in adolescents. Further, the federal government fosters physical exercise to reduce adolescent obesity and also fosters a diet rich in fruits and vegetables to reduce adolescent obesity. However, the few published studies to date that have explored whether physical activity interacts with dietary fruits and vegetables have yielded mixed results. Importantly, no published reports to date have studied the interaction of physical activity and dietary intake of fruits and vegetables on obesity in Black adolescent females.

Summary of Reviewed Literature

Obesity is an epidemic among Black adolescent females and adolescent obesity is strongly predictive of adult obesity. This is important, because obesity is deadly and costly. Physical activity is recommended for obesity reduction and prevention, but Black adolescent females are confronted with a slower metabolic rate than other female adolescents, in addition to a general resistance to vigorous physical activity (Brownson et al., 2010). Fruits and vegetables provide dietary fiber, which may assist in obesity reduction, but Black adolescent females have very low rates of fruit and vegetable intake (CDC, 2012a). While some published research demonstrates the potential efficacy of physical activity in reducing obesity (CDC, 2014; NHLBI, 2012; Eisenmann, Bartee, & Wang, 2002; WHO, 2015 and other studies show the potential value of fruits and vegetables in reducing obesity (NHLBI, 2012; Field, Gillman, Rosner, Rockett, & Colditz, 2003), the few studies that have explored the interaction of physical activity and the intake of fruits and vegetables on obesity have yielded mixed results.

No previous studies have explored whether physical activity and the consumption of fruits and vegetables interact in reducing obesity in Black adolescent females. This presents an open empirical question and the purpose of the present study. What was needed is a study that focuses on the interaction of physical activity and fruit and vegetable intake on BMI in Black adolescent females. The present study was designed to fill this important gap in the literature. The following chapter details the methodology used in the present study.

Chapter 3: Methods

Research Design and Rationale

This quantitative, retrospective, cross-sectional study was designed to examine whether the dietary consumption of fruits and vegetables moderates the relationship between physical activity and BMI in Black adolescent females. The dependent variable for this study is BMI, a calculation of body fat based on an adolescent's weight and height (CDC, 2011b; NHLBI, 2015a). For Hypothesis 1, the independent variable is physical activity. For Hypothesis 2, the independent variable is dietary intake of fruits and vegetables. For Hypothesis 3, the independent variable is physical activity and the moderator variable is dietary intake of fruits and vegetables. If dietary fruit and vegetable intake moderates the relationship between physical inactivity and BMI in this sample of Black adolescent females, then the statistical interaction of physical activity and fruit and vegetable intake will be statistically significant.

Because the research questions and hypotheses are quantitative in nature, quantitative data were required to address the research questions and hypotheses. A retrospective, cross-sectional design was appropriate to address the research questions and hypotheses because the purpose of the study is to determine whether the dietary consumption of fruits and vegetables moderated the relationship between physical activity in the BMI of Black adolescent females in 2011. Further, YRBS data are valid, reliable, and stratified towards being representative of high school students nationwide, providing a retrospective data resource that would be difficult to improve upon with a prospective study design (CDC, 2010e).

This chapter details the setting and sample (including inclusion and exclusion criteria), instrumentation, procedures for recruitment and permissions, data acquisition and data management, analysis (an overview of the study design and the plan for hypothesis testing), and the steps taken to comply with ethical guidelines to protect the participants**.**

Setting and Sample

The Centers for Disease Control & Prevention (CDC) developed a national school based survey to follow and assess the high-risk health behaviors in six different categories of students in grades 9-12 as a representative of U.S. high school students of all races called the Youth Risk Behavior Surveillance System (YRBS) (CDC, 2010e). The questions administered to the students are based off chronic diseases and illness with high morbidity and mortality among youth and adults. The YRBS is a tool has been used for over 10 years with reliable results as the nation's trusted surveying tool and cited in well over 50 articles to evaluate health behaviors in high school aged adolescents establishing trends of health behavior. The YRBS sample was collected from the CDC using the Market Data Retrieval database, Pubmed, and EBSCOhost. A three-stage cluster sample design produced a nationally representative sample of students in grades 9-12 who attend public and private schools in United States of America (CDC, 2010e). The YRBS data collection strategy included stratification to ensure that the YRBS data would be representative of high school students nationwide, including Black adolescent females from 352 high schools. Importantly, the YRBS database includes the demographic and behavioral variables necessary to test the hypotheses of this study.

Inclusion and Exclusion Criteria

Inclusion Criteria

The inclusion criteria required that YRBS participants identify themselves as female Black, grades 9-12, enrolled in public high school, and with complete data regarding physical activity, height and weight data for calculation BMI, as well as fruit and vegetable intake data.

Exclusion Criteria

Participants were excluded from the study if YRBS questionnaires data were not complete regarding key variables, or if potential participants identified themselves as anything other than Black female grades 9-12, enrolled in public high school.

Instrumentation and Materials

The CDC's Youth Risk Behavioral Survey (YRBS) was the instrument of choice because the YRBS is reliable, includes a large sample, was designed specifically for high school students, and includes all of the important variables for this study. The survey questions are obtained from the CDC Youth Risk Behavior Survey (YRBS) website. YRBS data are in the public domain and therefore require not permissions to access.

Body Mass Index (BMI)

The YRBS includes the height and weight data necessary for calculating BMI. BMI is calculated as weight in pounds divided by height in inches squared, multiplied by 703 (CDC, 2010a, 2010b; NHLBI, 2015a). This information is not to be used to give a diagnosis for individual students but to provide estimates of obesity levels within a population (CDC, 2010c, 2010d, 2010e). According to the CDC (2010c, 2012b), obesity is defined as BMI of 30 or higher.

Physical Activity

Physical activity was operationally defined as the YRBS self-report of how many days' participants were physically active for a total of at least 60 minutes per day during the past 7 days. Physical inactivity scores will range from 0 days to 7 days (Appendix A).

Dietary Fruits and Vegetables

Dietary fruits and vegetables intake was operationally defined as the sum of YRBS items 73-77, which ask the participants to indicate how many times they ate fruit, green salad, potatoes, carrots, or other vegetables the past 7 days (Appendix B).

Race

To be included in this study of Black female adolescents, race / ethnicity was operationally defined as self-report of being "Black or Black" on the YRBS.

Adolescents

This study includes only adolescents, defined as anyone enrolled in high school from grades 9-12 and between the ages of 14 and 18 according to the YRBS survey. Potential data from participants who indicate that they are not in grades 9-12 were excluded, as were those who self-identified as under 14 or older than 18 years of age.

Procedures

Permissions and Approval

This study received approval from the Walden University Institutional Review Board (Approval No. 08-05-15-0226135) prior to data collection. The YRBS questionnaire is in the public domain, so no additional permission was required (CDC, 2013).

Data Collection

The data for this archival study were collected from the CDC's Youth Behavior Risk Survey 2011. YRBS survey data were acquired via internet download from the YRBS database.

Data Management

Data downloaded from the YRBS database were checked for errors and exclusion criteria using Excel software (Microsoft Corp., Redmond Washington) in preparation for hypothesis testing using SPSS software (version 23.0, Armonk, NY: IBM Corp.). Descriptive statistics of participant characteristics are provided in the following chapter.

Research Question and Hypothesis

Three research questions are addressed in this study. For each research question, the null and alternative hypotheses are expressed below.

Research Question 1: Is physical activity significantly related to obesity in Black adolescent females?

$H1_0$: There is no significant relationship between physical activity and obesity in Black adolescent females.

$H1_a$: There is a significant relationship between physical activity and obesity in Black adolescent females.

Research Question 2: Is the dietary consumption of fruits and vegetables significantly related to obesity in Black adolescent females?

$H2_0$: There is no significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

$H2_a$: There is a significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

Research Question 3: Does the dietary consumption of fruits and vegetables significantly interact with physical activity in obesity in Black adolescent females?

$H3_0$: There is no significant interaction between the dietary consumption of fruits and vegetables and physical activity in obesity in Black adolescent females.

$H3_a$: The dietary consumption of fruits and vegetables interacts with physical activity in obesity in Black adolescent females.

Dependent Variable

The dependent variable for this study was body mass index (BMI), calculated as weight in pounds divided by height inches squared, multiplied by 703 (CDC, 2010a, 2010b; NHLBI, 2015a).

Independent Variables

The independent variable for testing Hypothesis 1 was physical activity. The independent variable for testing Hypothesis 2 was dietary fruits and vegetables. For Hypothesis 3, physical activity was the independent variable and dietary fruits and vegetables was the moderator variable, so that the interaction of physical activity and dietary fruits and vegetables on BMI could be assessed.

Statistical Analysis

Hypothesis 1 was tested using simple regression (simple correlation) (Table 1). For this analysis, the dependent variable was BMI and the independent variable was physical activity. Simple regression (akin to simple correlation) was the appropriate statistic for testing Hypothesis 1 because the independent (physical activity) and dependent (BMI) variables are continuous scaled variables, and because the purpose of the analysis was to determine whether these variables are significantly associated with each other Campbell & Stanley, 1963). This hypothesis was tested at the $p < .05$ threshold for statistical significance. Table 3 displays the analysis plan for this study.

Table 3

Analysis Plan

Hypothesis	Independent Variable	Dependent Variable	Moderator	Statistic
H1	Physical Activity	Obesity		Simple Regression
H2	Dietary Fruits and Vegetables	Obesity		Simple Regression
H3	Physical Activity	Obesity	Dietary Fruits and vegetables	Multiple Regression

Hypothesis 2 was tested using simple regression (simple correlation) (Table 3). For this analysis, the dependent variable was BMI and the independent variable is dietary fruits and vegetables. Simple regression (akin to simple correlation) was the appropriate statistic for testing Hypothesis 1 because the independent (dietary fruits and vegetables) and dependent (BMI) variables are continuous scaled variables, and because the purpose of the analysis was to determine whether these variables are significantly associated with each other. This hypothesis was tested at the $p < .05$ threshold for statistical significance.

Hypothesis 3 was tested using multiple linear regression analysis (Table 3). For this analysis, the dependent variable was BMI, the independent variable was physical activity, and the moderator variable was dietary fruits and vegetables. This moderator hypothesis was tested using the moderator model of Baron and Kenny (1986). When testing the moderator hypothesis, the independent, moderator, and control variables were entered into the multiple regression equation, along with the independent x moderator interaction. If the interaction is statistically significant in the direction of prediction, the moderator hypothesis is supported (Baron & Kenny, 1986). Equation 1 describes the multiple linear regression components of the moderator model that is used to test Hypothesis 3.

Equation 1: Ypred = a + b1X1 + b2X2 + b3(X1xX2)

Where...Ypred = the predicted value of the dependent variable

a = the intercept

X1 = the Predictor variable (physical activity)

X2 = the Moderator variable (dietary fruits and vegetables)

X1xX2 = the Predictor by Moderator interaction (physical activity x dietary fruits and vegetables)

The moderator model of Baron and Kenny is displayed in Figure 1.

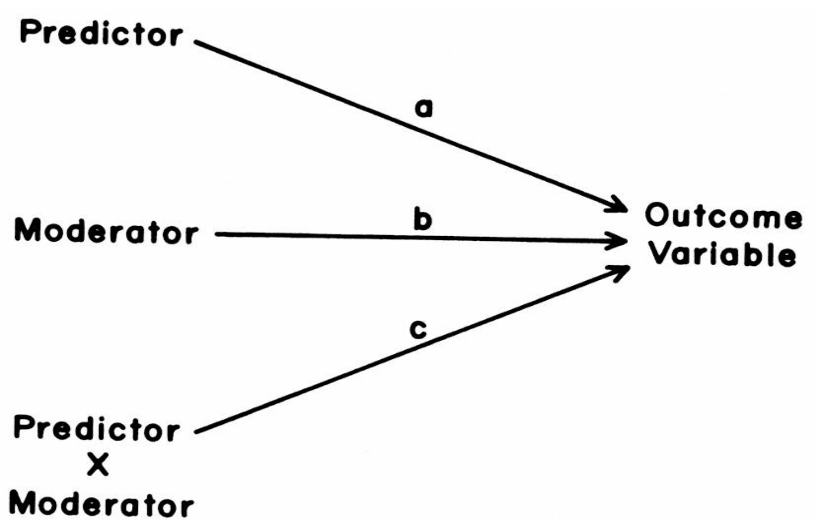


Figure 1, Moderator model of Baron and Kenny (1986).
From: Baron, R. M. and Kenny, D.A. (1988) The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations, *Journal of Personality and Social Psychology51*, 6, 1173-1182.

As stated by Baron and Kenny (1986),"The moderator hypothesis is supported if the interaction is significant (Baron& Kenny, 1986). Therefore, dietary behaviors are considered a significant moderator variable only if the physical activity x dietary fruits and vegetables (path "c" in figure 1; b3 in Equation 1) is statistically significant ($p < .05$). The analysis plan for this study is summarized in Table 3.

Multiple linear regression was the appropriate statistic for determining the moderating effects of dietary fruits and vegetables on the relationship between physical activity and obesity because the outcome variable is a scaled (linear) variable (BMI). While all variable results are reported, the emphasis for hypothesis testing is on the interaction between physical activity and dietary fruits and vegetables. If the interaction was statistically significant, this would be interpreted as empirical evidence rejecting the null hypothesis of no moderating effect of dietary fruits and vegetables on the relationship between and physical activity and obesity. This hypothesis was tested at a statistical significance threshold of p < .05.

Instrumentation and Operationalization of Constructs

The data for this study came from the Youth Risk Behavior Survey (YRBS). The YRBS was designed in 1989 by the Center for Disease Control and Prevention (CDC) to be a valid and reliable measuring instrument to "monitor health risk behaviors that contribute to the leading causes of mortality, morbidity, and social problems among youth" (Brener, Kann, Mcmanus, Kinchen, Sundberg, & Ross, 2002, p. 336). The YRBS was an appropriate database for the present study because the YRBS was stratified to be representative of American high school youth and includes reliable assessment data for testing the study hypotheses, including BMI components, fruit and vegetable intake, and physical activity (Baheiraei, et al., 2012).

The reliability of the YRBS was established through test-retest methodology by Brener and colleagues (1995; 2002, 2003). Brener et al. (2003) applied test-retest methodology by measuring the YRBS twice, two weeks apart, on 4619 high school students from 61 schools across 20 states and the District of Columbia and found that YRBS responses to most items were generally consistent from pretest to posttest, that White, Black, Hispanic, and other racial/ethnic groups were similar in consistency from pretest to posttest, and concluded that "Overall, students appeared to report health risk behaviors reliably over time" (p. 281).

Brener and colleagues (2003) found that test-retest measures of height and weight correlated at .90, and that the correlation between self-reported and measured height and weight correlated at .93. While high school students tended to somewhat overestimate their height and underestimate their weight, which implies that a correction factor may be of value to adjust towards more accurate BMI estimation, Brener et al. (2003) concluded that "Even without such conversion factors, surveillance systems, such as the YRBSS, can still yield valuable results by using self-reported height and weight" (p. 287).

Using the Intraclass Correlation Coefficient (ICC) statistics of Shrout and Fleiss (1979) to assess test-retest reliability, Baheiraei, Hamzehgardeshi, Mohammadi, Nedjat, and Mohammadi (2012) found that the ICC was .85 for the YRBS body weight and dietary measures, .82 for the YRBS physical activities, and the ICC for the YRBS exercise or physical activity of 60 minutes or more was .89. According to the criteria of

Fleiss (1986) and Cicchetti (1994), these observed ICCs are each >.75 and are therefore are considered to show excellent reliability.

As testament to the accepted reliability of YRBS data in the scientific and governmental communities, the YRBS has been used in over one-hundred published studies and YRBS data are used by 47 states and the District of Columbia to make policy and to provide the foundation of official government reports designed to monitor changes in health risk behaviors in high school students (CDC, 2010e). Because the present study focused on Black females, it is important to note that Black participants showed similar test-retest reliability as other racial/ethnic groups, and females showed similar test-retest reliabilities as males on the YRBS (Brener, Collins, Kann, Warren, & Williams, 1995).

For these reasons, the YRBS data were considered to be of sufficient reliability to test the study hypotheses' data are in the public domain, so no permissions are necessary to acquire the data for the present study.

Operationalization of Constructs

Race

Race / ethnicity is operationally defined as self-report of being "Black or Black" on the YRBS. On YRBS question Q5, participants were asked, "What is your race?" Response options were American Indian or Alaska Native, Asian, black or Black, Native Hawaiian or other Pacific Islander, and White. All YRBS cases that failed to self-identify as "Black or Black" is excluded for failing to meet this inclusion criterion.

Adolescents

Adolescence was defined as anyone enrolled in high school from grades 9-12 according to the YRBS survey Potential participant who indicate that they are not in grades 9-12 is excluded. On YRBS question Q3, participants were asked, “In what grade are you?” Available responses were

A. 9th grade

B. 10th grade

C. 11th grade

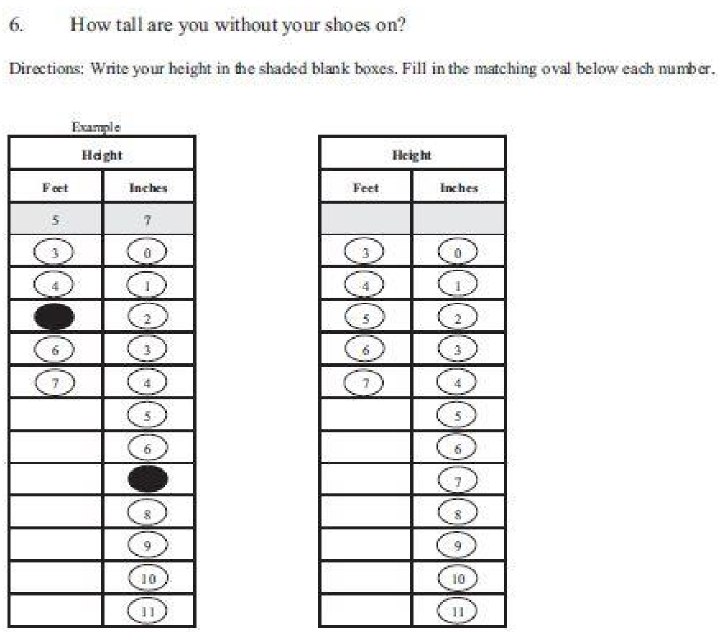
D. 12th grade

E. Ungraded or other grade.

Participants who responded “E” is excluded from this study for failing to meet the inclusion criterion of being a high school student in grade 9-12.

Body Mass Index(BMI)

BMI was calculated from height (Figure 2) and weight (Figure 3) data provided in YRBS.


6. How tall are you without your shoes on?

Directions: Write your height in the shaded blank boxes. Fill in the matching oval below each number.

Example

Height	
Feet	Inches
5	7
3	0
4	1
●	2
6	3
7	4
	5
	6
	●
	8
	9
	10
	11

Height	
Feet	Inches
3	0
4	1
5	2
6	3
7	4
	5
	6
	7
	8
	9
	10
	11

Figure 2. YRBS height measure.

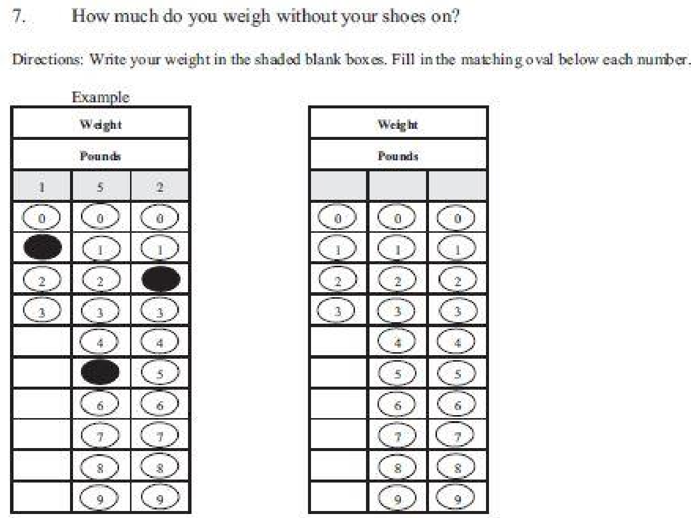


Figure 3. YRBS weight measure.

BMI is calculated as weight in pounds divided by height inches squared, multiplied by 703 (CDC, 2012b), as shown in Equation 1. BMI for YRBS data requires the conversion factor of 703 to convert pounds and inches from the kilograms and meters used in the original BMI from Belgian Adolphe Quetelet in the mid-1800s (CDC, 2010a, 2010b; NHLBI, 2015a; Eknoyan, 2007). Note that the CDC recommends that BMI data should not be used to diagnose individual students as obese, but is appropriate to provide estimates of obesity levels within a population (CDC, 2010c, 2010d, 2010e).

Equation 1: $BMI = pounds/inches^2 * 703$

BMI Example:

An adolescent is 5 foot 2 inches tall (62”) and weighs 120 pounds.

BMI = [120 / (62*62)] * 703

BMI = [120 / (3844)] * 703

BMI = [.0312]*703

BMI = 22

Physical Inactivity

Physical Inactivity was operationally defined as the YRBS self-report of how many days' participants were physically active for a total of at least 60 minutes per day during the past 7 days. Physical inactivity scores ranged from 0 days to 7 days (Appendix A).

YRBS Physical Activity Question:

79. During the past 7 days, on how many days were you physically active for a total at least 60 minutes per day? Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)

A. 0 days

B. 1 day

C. 2 days

D. 3 days

E. 4 days

F. 5 days

G. 6 days

H. 7 days

YRBS Physical Activity Score Key

This Physical Activity scoring key is scaled from 0 to 7.

A=0 No days of physical Activity in a week

B= 1 days of physical activity in a week

C= 2 days of physical activity in a week

D=3 days of physical activity in a week

E= 4 days of physical activity in a week

F= 5 days of physical activity in a week

G= 6 days of physical activity in a week

H= 7 days of physical activity in a week

YRBS Physical Activity Example:

During the past 7 days, on how many days were you physically active for a total at least 60 minutes per day?

A. 0 days

B. 1 day

C. 2 days

D. 3 days

E. 4 days

F. 5 days ✓

G. 6 days

H. 7 days

YRBS Physical Activity Example Answer: F; This respondent participated in physical activity for 5 days in a week.

Dietary Fruits and Vegetables

Dietary fruits and vegetables intake was operationally defined as the sum of YRBS items 73-77, which ask the participants to indicate how many times they ate fruit, green salad, potatoes, carrots, or other vegetables the past 7 days (Appendix A).

YRBS Dietary Fruits and Vegetables Items:

73. During the past 7 days how many times did you eat fruit?

74. During the past 7 days how many times did you eat green salad?

75. During the past 7 days how many times did you eat potatoes?

76. During the past 7 days how many times did you eat carrots?

77. During the past 7 days how many times did you eat other vegetables?

YRBS Dietary Fruits and Vegetables Response Interface

A. I did not eat (this food) during the past 7 days

B. 1 to 3 times during the past 7 days

C. 4 to 6 times during the past 7 days

D. 1 time per day

E. 2 times per day

F. 3 times per day

G. 4 times or more per day

YRBS Dietary Fruits and Vegetables Score Key

Items are scored using the midpoint of the response then summed, so that that the score reflects the number of times fruits and vegetables were consumed in a 7-day week.

A=0 (Did not eat during the past 7 days; 0 per 7 days)

B= .29 (The midpoint of 1-3 is 2; 2/7=.29 per 7 days)

C=.58 (The midpoint of 4-6 is 5; 5/7 = .71 per 7 days)

D=1 (1 time per day in 7 days)

E= 2 (2 times per day in 7 days)

F= 3 (3 times per day in 7 days)

YRBS Dietary Fruits and Vegetables Example:

During the past 7 days, how many times did you eat fruit?

Response: D

During the past 7 days, how many times did you eat green salad?

Response: F

During the past 7 days, how many times did you eat potatoes?

Response: E

During the past 7 days, how many times did you eat carrots?

Response: A

During the past 7 days, how many times did you eat other vegetables?

Response: C

YRBS Dietary Fruits and Vegetables Scored Example:

D = 1

+F = 3

+E = 2

+A = 0

+C = .71

= 6.71 times this participant consumed dietary fruits and vegetables in 7 days.

Threats to Validity

It is important to assess potential threats to the internal validity and external validity of a study (Creswell, 2009). Internal validity is important to determining whether the results are not due to some confounders within the study design or the responses from the participants or procedures that might bias results, while external validity is important to determining whether study findings are generalizable to other populations that were not included in the study (Creswell, 2009).

Threats to internal validity include history, maturation, experimental mortality, subject selection, and testing (Creswell, 2009). History can be a threat to internal validity of a study if an unanticipated event that can affect participant responses occurs during a study that includes measures taken over time (Creswell, 2009). History was not a threat to internal validity because the present study was cross-sectional does not included measures over time (Creswell, 2009).

Maturation can be a threat to internal validity if a developmental change in the participants can alter study scores over time (Creswell, 2009). However, the present study utilized cross-sectional data of Black female adolescents from the YRBS historical database. Maturation was not a threat to internal validity because each participant is measured only once in this cross-sectional study.

Experimental mortality is a threat to the internal validity of a study if participants drop-out of a study over time (Creswell, 2009). Experimental mortality was not a threat to the validity of this study because the YRBS data were collected at one point in time, precluding dropout over time that can occur in longitudinal study designs.

Instrumentation can be a threat to internal validity if the measuring instruments change over the course of the study (Creswell, 2009). However, the YRBS measuring instrument was identical for all participants in the study (Creswell, 2009), so instrumentation was not a threat to internal validity.

Selection of subjects can be a threat to internal validity if there are differences between groups in a study (Creswell, 2009). The present study employed a one-group design, so selection of subjects was not a threat to the internal validity of this study, particularly given that the YRBS data are nationally stratified to foster representativeness and that all participants that met the inclusion criteria is included in the analysis.

Testing can be a threat to internal validity if previous exposure to a measuring instrument affects later scores, as can occur in pretest-posttest designs (Creswell, 2009). Because this study was cross-sectional in design, testing is not a threat to internal validity.

Threats to external validity include population validity, ecological validity, Interaction effects of testing and multiple treatment inference (Creswell, 2009). Population validity is a threat to external validity when a derived sample is not representative of the population being studied (Creswell, 2009; Sapsford, 2006). Population validity was not a threat to the external validity of this study because YRBS data are stratified with the goal of being representative of high school students nationwide.

Ecological validity can be a threat to external validity if the results from data that were collected in a setting or set of experimental conditions do not generalize to other settings or experimental conditions (Creswell, 2009). While the ecological validity of YRBS data was fostered by having students complete a pencil and paper survey in a format that is similar to standard classroom tests and assignments to foster ecological validity, it is unclear what results would be realized if the YRBS data were collected in a non-scholastic environment. Given that the goal of the present study was to use YRBS data to assess the relationship between BMI, physical activity, and the intake of fruits and vegetables among Black adolescent females using a common multiple-choice and fill-in interface, ecological validity was not a threat to the external validity of this study.

Interaction effects of testing and multiple treatment inference can be threats to external validity in studies that include pre-and post testing or include multiple treatments (Creswell, 2009). This study was cross-sectional in design, so interaction effects are not possible, and this study includes no treatments, so multiple treatment inference was not a threat to the external validity of this study.

Presentation of Findings

Descriptive data results are presented as means, standard deviations, counts, and frequencies, as appropriate, in tables and in text. For Hypothesis 1 and for Hypothesis 2, the results of simple regression include a scatterplot with line of best fit and the p-value for hypothesis testing. For Hypothesis 3, the results from multiple linear regression will include the overall model fit along with the coefficients table that includes each variable, with special focus on the physical activity x dietary fruits and vegetables interaction that is crucial for testing this hypothesis.

Compliance with Ethical Guidelines and Protection of Participants

This study complied with the ethical guidelines of Walden University and the American Psychological Association, including privacy, confidentiality, and anonymity. Data were collected from the Center of Disease Control YRBS 2011 archival database only after permission is granted by Walden University IRB. This study used archival data, so participants did not provide informed consent beyond the informed consent they provided when agreeing to participate in YRBS. The CDC's internal Institutional Review Board approved the research for the national survey. The CDC is considered to be in the public domain, so no additional permission was required to conduct this study. Participant privacy was protected in that codes is used throughout the analysis and no names or other individuating information are included in the YRBS data. Data were kept confidential and will be deleted five years after completion of this research.

Summary

This quantitative, retrospective, cross-sectional study was designed to examine whether the dietary consumption of fruits and vegetables moderates the relationship between physical activity and body mass index (BMI) in Black adolescent females. Quantitative data from the YRBS database were obtained to answer three research questions: (1) is physical activity significantly related to obesity in Black adolescent females? (2) is the dietary consumption of fruits and vegetables significantly related to obesity in Black adolescent females? and (3) Does the dietary consumption of fruits and vegetables significantly interact with physical activity in obesity in Black adolescent females? YRBS data were downloaded from the YRBS website, then analyzed using SPSS statistical software. Hypothesis 1 and Hypothesis 2 were tested using simple regression to determine whether physical activity is significantly related to BMI (H1) and whether dietary consumption of fruits and vegetables is significantly related to BMI. Hypothesis 3 was tested using multiple regression to determine whether the dietary consumption of fruits and vegetables interacts with physical activity in the BMI of Black adolescent females. This chapter highlighted the methods, instrumentation, procedures, analysis plan, threats to validity, and compliance with ethical guidelines for protection of participants. Chapter 4 highlights the results of this study.

Chapter 4: Results

Introduction

This purpose of this cross-sectional quantitative study was to investigate whether dietary intake of fruits and vegetables might moderate the relationship between and physical activity and obesity in Black adolescent females using the 2011 Youth Risk Behavior Surveillance (YRBS). The following research questions and hypotheses were addressed:

Research Question 1: Is physical activity significantly related to obesity in Black adolescent females?

$H1_0$: There is no significant relationship between physical activity and obesity in Black adolescent females.

$H1_a$: There is a significant relationship between physical activity and obesity in Black adolescent females.

Research Question 2: Is the dietary consumption of fruits and vegetables significantly related to obesity in Black adolescent females?

$H2_0$: There is no significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

$H2_a$: There is a significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

Research Question 3: Does the dietary consumption of fruits and vegetables significantly interact with physical activity in obesity in Black adolescent females?

$H3_0$: There is no significant interaction between the dietary consumption of fruits and vegetables and physical activity in obesity in Black adolescent females.

$H3_a$: The dietary consumption of fruits and vegetables interacts with physical activity in obesity in Black adolescent females.

This chapter begins with a review of the data collection process. Next, participant demographics descriptives are detailed. Study results to address the research questions are then provided. This chapter ends with a summary of findings.

Data Collection

Data were obtained from the 2011 YRBS database, which was chosen because YRBS is nationally stratified to be representative of public high school students nationwide. Of the 15,425 total cases, 1211 cases with complete data met the criteria of being female Black adolescents between the ages of 14 and 18 and within grade 9 through grade 12. Therefore, the sample size for this study was $N = 1211$.

Data Analysis

Data were downloaded from the CDC website into Microsoft Excel for scoring and then entered into SPSS for Windows (version 23) for analysis. Descriptive analysis for demographic data included frequencies and percentages or means and standard deviations for grade level, age, BMI, intake of fruits and vegetables, and physical activity. Hypothesis testing included simple linear regression for Hypothesis 1 and

Hypothesis 2, while multiple linear regression was used to test Hypothesis 3. Exploratory analyses included multiple linear regression and logistic regression.

Results Introduction

Results include demographic descriptors (grade level, age, fruit and vegetable intake, physical activity, and BMI) and results from hypothesis testing to answer the three research questions. This section ends with a summary of results.

Demographic Characteristic Descriptives

All participants were Black females. The 1211 study participants were well divided across 9th graders (n = 255, 21%), 10th graders (n = 295, 24%), 11th graders (n = 343, 28%), and 12th graders (n = 318, 26%). Most participants were 15 (n = 263, 22%), 16 (n = 303, 25%), or 17 (n = 349, 29%) years of age. The remaining were 18 (n = 183, 15%) or 14 (n = 113, 9%) years of age.

Table 4 displays the mean, sample size (N), and standard deviation (SD), minimum score, maximum score, and the standard error of the mean (SEM) for BMI, fruits and vegetables intake, and physical activity. Participants averaged 2.4 portions of fruits and vegetables per week (SD = 2.6; Range = 0-20; SEM = 0.1). Participants averaged 3.0 days of physical activity per week (SD = 2.6; Range = 0-7; SEM = 0.1). BMI levels averaged 24.6 (SD = 5.4; Range = 14.8-48.5; SEM = 0.2).

Table 4

Participant Descriptives

Statistic	BMI	Fruits & Vegetables	Physical Activity
Mean	24.6	2.4	3.0
N	1211	1211	1211
SD	5.4	2.6	2.6
Minimum	14.8	0	0
Maximum	48.5	20	7
SEM	0.2	0.1	0.1

Note. SD = standard deviation; SEM = standard error of the mean. Fruits & Vegetables = servings per week; Physical Activity = number of days per week engaging in physical activity for at least 60 minutes.

Summary of Participant Characteristics

This sample of 1211 Black female adolescents was well distributed across grades 9 through 12, across ages 14 to 18, and included a wide range of fruits and vegetables intake levels, physical activity, and BMI. This sample was therefore considered to be appropriate to test the research questions of this study, which are detailed below.

Results from Hypothesis Testing

Three research questions were addressed using simple linear regression (Hypothesis 1 and Hypothesis 2) or multiple linear regression (Hypothesis 3).

Research Question 1

Research Question 1 asked, "Is physical activity significantly related to obesity in Black adolescent females?"

Null Hypothesis 1: There is no significant relationship between physical activity and obesity in Black adolescent females.

Research Question 1 was tested using simple linear regression. Simple linear regression was the appropriate statistic to test Research Question 1 because both the independent variable (physical activity, defined as the number of days per week with a total of 60 minutes of physical activity) and the dependent variable (BMI, body mass index) and are continuous variables and because the goal was to determine whether there was a statistically significant relationship between physical activity and BMI.

Physical activity was significantly associated with BMI ($r = -.07$, $p < .02$). While statistically significant, the relationship was weak, with physical activity accounting for 0.5% of the variance in BMI ($r^2 = .005$). This relationship was negative in direction, indicating that the greater the physical activity, the lower the BMI. The unstandardized beta (β) of -.15 in Table 5 indicates that each additional day of physical activity per week was associated with a decrease of .15 BMI units. This relationship is visually displayed in Figure 4.

Table 5

Linear Regression Coefficients for Research Question 1

Variable	β	$SE_β$	Standardized Beta	T	p-value
Physical Activity	-.15	.06	-.07	-2.39	.02

Because there was a significant relationship between physical activity and BMI, this finding rejected Null Hypothesis 1.

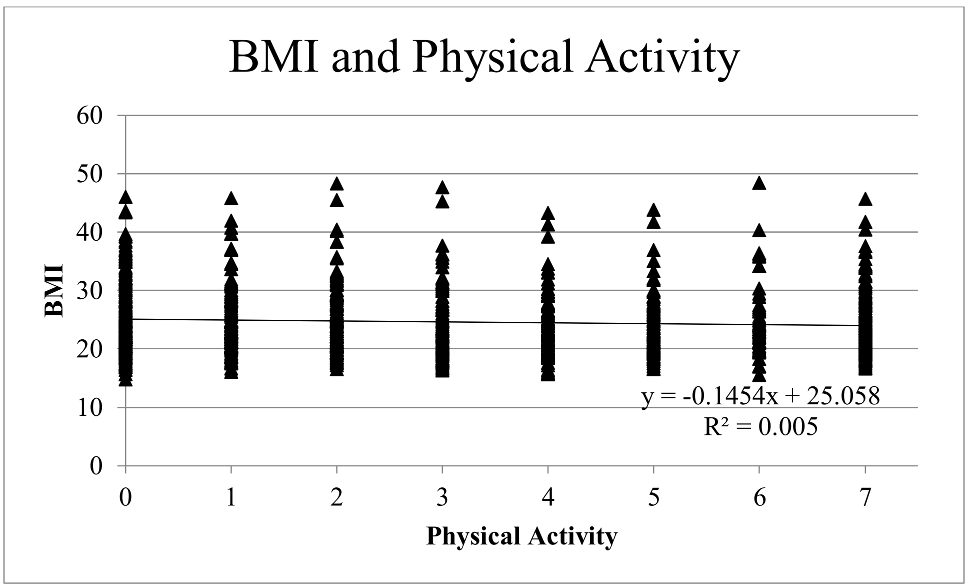


Figure 4. Scatterplot of days of physical activity and BMI.

Research Question 2

Research Question 2 asked, "Is the dietary consumption of fruits and vegetables significantly related to obesity in Black adolescent females?"

Null Hypothesis 2: There is no significant relationship between the dietary consumption of fruits and vegetables and obesity in Black adolescent females.

Research Question 2 was tested using simple linear regression. Simple linear regression was the appropriate statistic to test Research Question 2 because both the independent variable (dietary consumption of fruits and vegetables) and the dependent variable (BMI, body mass index) and are continuous variables and because the goal of the analysis was to determine whether there was a statistically significant relationship between dietary consumption of fruits and vegetables and BMI.

Dietary consumption of fruits and vegetables was not significantly associated with BMI ($r = -.02$, $p = .56$). Dietary consumption of fruits and vegetables accounted for three-one hundredths of 1% of the variance in BMI ($r^2 = .0003$). The unstandardized beta (β) of -.04 in Table 6 indicates that each unit of additional unit of fruits and vegetables consumption per week was associated with a decrease of .04 BMI units. This relationship is visually displayed in Figure 5.

Table 6

Linear Regression Coefficients for Research Question 2

Variable	β	SE_{β}	Standardized Beta	t-score	p-value
Fruits and Vegetables	-.04	.06	-.02	-.59	.56

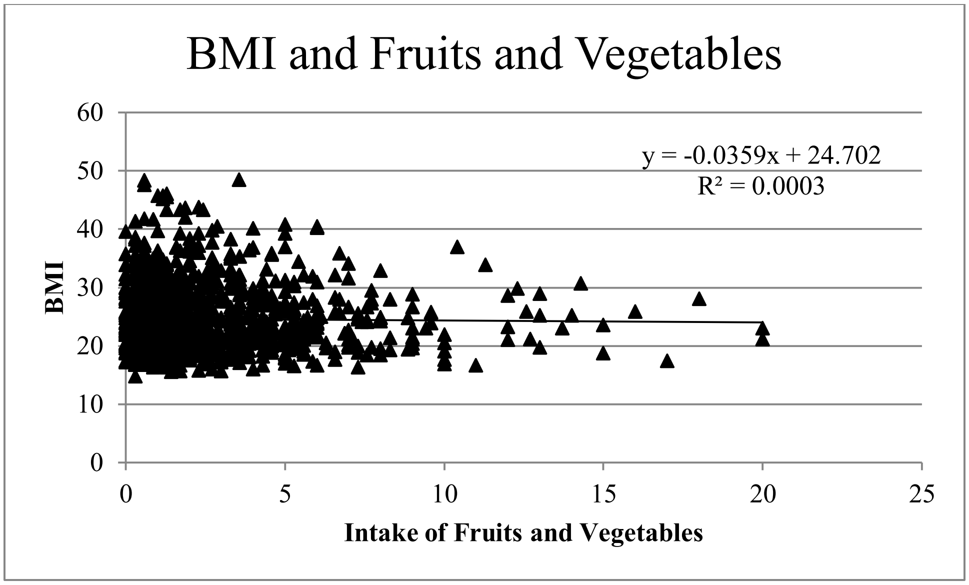


Figure 5. *Scatterplot of intake of fruits and vegetables and BMI.*

Because there was no significant relationship between dietary consumption of fruits and vegetables and BMI, this finding failed to reject Null Hypothesis 2.

Research Question 3

Research Question 3 asked, "Does the dietary consumption of fruits and vegetables significantly interact with physical activity in obesity in Black adolescent females?"

Null Hypothesis 3: There is no significant interaction between the dietary consumption of fruits and vegetables and physical activity in obesity in Black adolescent females.

Research Question 3 was tested using multiple linear regression. Multiple linear regression was the appropriate statistic to test Research Question 3 because the independent variable (physical activity), the moderator variable (dietary consumption of fruits and vegetables), and the dependent variable (BMI, body mass index) and are continuous variables and because the goal of the analysis was to determine whether there was a statistically significant interaction between physical activity and dietary consumption of fruits and vegetables on BMI. According to the moderator model of Baron and Kenny (1986), the moderator hypothesis is only supported if the independent x moderator (physical activity x dietary consumption of fruits and vegetables) interaction is statistical significant.

Table 7 shows that the physical activity x dietary consumption of fruits and vegetables interaction was not statistical significant ($p = .80$). This non-significant interaction is visually displayed in Figure 6. This finding failed to reject null hypothesis 3.

Table 7

Linear Regression Coefficients for Research Question 3

Variable	β	SE_{β}	Standardized Beta	t-score	p-value
Physical Activity (PA)	-0.13	0.08	-0.06	-1.57	0.12
Fruits and Vegetables (FV)	0.02	0.12	0.01	0.17	0.86
PA x FV	-0.01	0.02	-0.02	-0.25	0.80

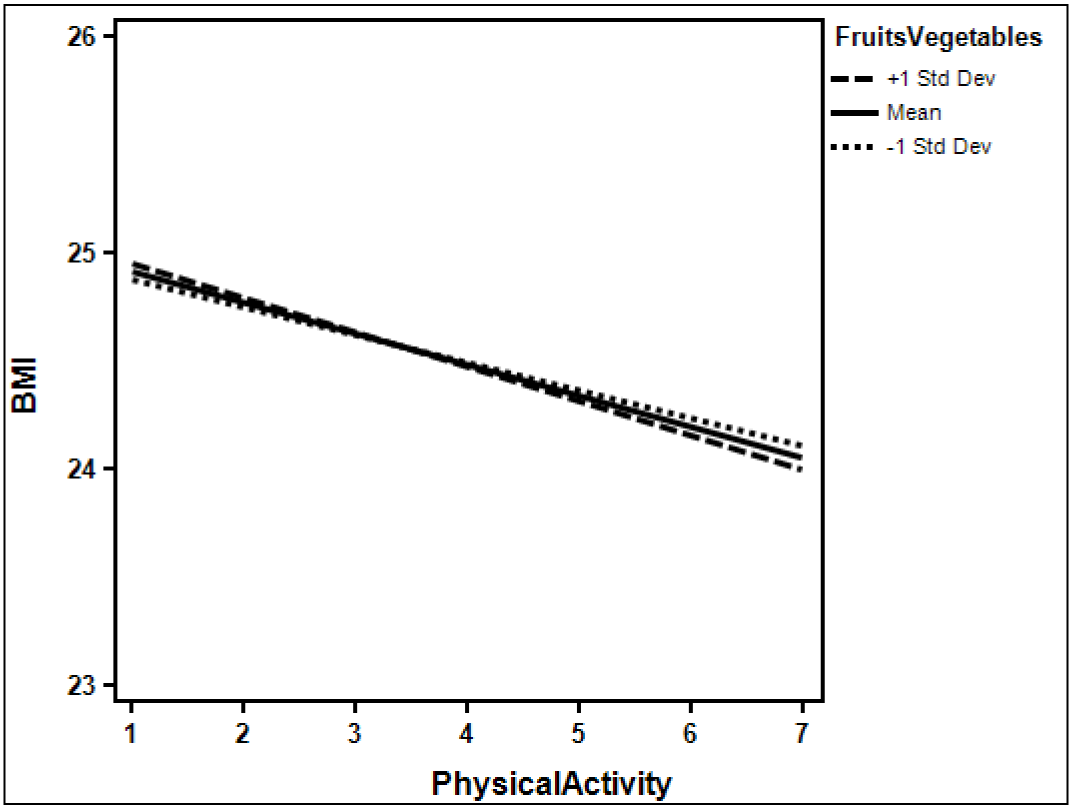


Figure 6. *Physical activity x fruits and vegetables intake interaction on BMI.*

Exploratory Analyses

Binary Logistic Regression. Because the presently proposed study was focused on obesity, Hypothesis 3 was also tested using binary logistic regression, with the outcome (dependent) variable expressed as obesity (BMI of 30+) and non-obesity (BMI less than 30) binomial categories. Note that, of 1211 participants, 1025 (85%) were non-obese (BMI scores less than 30) and 186 (15%) were obese (BMI of 30+).

Table 8 shows that the physical activity x dietary consumption of fruits and vegetables interaction was not statistical significant in the prediction of obesity ($p = .89$). This finding failed to reject Null Hypothesis 3 in an exploratory analysis using BMI as a binary variable.

Table 8

Logistic Regression Coefficients for Exploratory Analysis of Research Question 3

Variable	β	SE_{β}	Wald	p-value	Exp(B)
Physical Activity (PA)	-.09	.04	3.79	.05	.92
Fruits and Vegetables (FV)	-.01	.06	.05	.82	.99
PA x FV	-.002	.01	.02	.89	1.00

Fruits and Vegetables as a Quadratic Variable. It is possible that very low or very high intake of fruits and vegetables is associated with high BMI because low intake of fruits and vegetables may indicate a poor diet, while high intake of fruits and vegetables may indicate overeating. Therefore, to test the possibility that there is an optimal level of intake of fruits and vegetables rather than a "more is better" relationship, an exploratory analysis to test Hypothesis 3 was conducted using a quadratic ("U" shaped) expression of the fruits and vegetables variable.

Table 9 shows that the physical activity x dietary consumption of fruits and vegetables interaction was not statistical significant when the fruits and vegetables variable was expressed as a U-shaped (quadratic) variable ($p = .72$). This finding failed to reject Null Hypothesis 3 in an exploratory analysis using a quadratic expression of the fruits and vegetables variable.

Table 9

Linear Regression Coefficients for Research Question 3 using a Quadratic Expression of Fruits and Vegetables

Variable	β	$SE_β$	Standardized Beta	t-score	p-value
Physical Activity (PA)	-.15	.07	-.07	-2.25	.02
Fruits and Vegetables^2 (FV^2)	-.01	.01	-.04	-.53	.60
PA x FV	.001	.002	.03	.36	.72

Summary of Results

This chapter provided the demographic descriptives and the results of hypothesis testing. Participant data was well spread across 9th 10th 11th and 12th grade Black females. A full range of BMI data were obtained, averaging 24.6, on the border between normal and overweight, with 15% in the obese category (BMI of 30+). Physical activity was significantly, negatively correlated with BMI. This finding rejected Null Hypothesis 1. Intake of fruits and vegetables was not significantly related to BMI. This finding failed to reject Null Hypothesis 2. Intake of fruits and vegetables did not significantly moderate the relationship between physical activity and BMI, as the fruits and vegetables x physical activity interaction was not statistically significant. This null finding was consistent in multiple linear regression and in exploratory analyses expressing obesity as a binary variable in logistic regression or when the fruits and vegetables were expressed as a quadratic (U-shaped) variable. These findings failed to reject Null Hypothesis 3.

Taken together, these findings indicate that greater physical activity was associated with lower BMI in the present sample of 1211 Black adolescent females, but that the intake fruits and vegetables and the interaction between physical activity and intake of fruits and vegetables were not significantly related to BMI in the present sample of Black females.

The following chapter provides an interpretation of these findings in the context of the published literature, along with the implications of the study results for positive social change, study limitations, and recommendations for action.

Chapter 5: Summary, Recommendations, and Conclusions

Introduction

The purpose of this quantitative retrospective study was to determine whether fruit and vegetable intake moderates the relationship between physical activity and obesity in Black adolescent females. If dietary fruit and vegetable intake moderates the relationship between physical activity and obesity, then the interaction between physical activity and fruit and vegetable intake would be statistically significant in the sample of Black adolescent females. This is important, because obesity is an epidemic in Black adolescent females, and because Black adolescent females have low levels of physical activity (CDC, 2012c; Lavizzo-Mourey, 2012) and low levels of fruit and vegetable intake (CDC, 2012a, 2013).

The study found a significant negative relationship between physical activity and BMI in Black adolescent females: the higher the physical activity the lower the BMI. No statistically significant relationship was found between BMI and the intake of fruits and vegetables. No statistically significant interaction was found between physical activity, consumption of fruits and vegetables, and BMI.

This chapter begins with a review of major findings interpreted in the context of published research. The limitations of the study are then detailed, along with recommendations for future studies, implications for positive social change, and the conclusions of the study.

Interpretation of Findings

Present findings are interpreted in relation to previously published literature. This includes Research Questions 1, 2, and 3.

Research Question 1

Research Question 1 asked, “Is physical activity significantly related to obesity in Black adolescent females?”

This research question is important because of the high rate of obesity among Black female adolescents. For example, a longitudinal study of 496 females from age 12 to age 19 by Huh et al. (2012) found that 27% of Black females were overweight by the end of adolescence, twice the rate of White females. Huh et al. (2012) concluded that "adolescence is not a high-risk period for onset of obesity for White adolescent females, but is for Black...females" (p. 76). Huh et al. (2012) further stated that middle through late adolescence (corresponding to high school age), was "the period of greatest risk for the transition from overweight to obesity" (p. 76) based on the observation that 0% of Black females were obese at age 15 but 14% were obese by age 19, compared to less than 2% in White females (Huh et al., 2012). Lastly, this research question is important because adolescents who are overweight or obese are likely to remain overweight or obese as adults (CDC, 2015a).

In the present sample of Black adolescent females, a statistically significant inverse relationship was found between physical activity and BMI: higher levels of physical activity were associated with lower BMI levels. This finding was consistent with previously published literature showing that the more adolescents exercise the lower their BMI. For example, Eisenmann et al. (2002) found that female adolescents who participated in vigorous exercise 6-7 days per week had significantly lower BMI than those who participated in vigorous exercise less than 2 days per week. However, Eisenmann et al. (2002) did not assess racial subgroups, recommending that “attention should be given to adolescent girls and ethnic group minorities (Hispanics and Black), considering the lower rates of participation in physical activity" (p. 383). The present study was designed, in part, to fill this gap in the literature.

Maier and Barry (2015) used longitudinal data of 2343 adolescent females from age 13 to age 19 who were enrolled in The National Heart Lung and Blood Institute Growth and Health Study and, using a series of cross-sectional analyses, found that greater habitual activity was associated with lower BMI overall, but also found a race x habitual activity interaction, such that the relationship between habitual activity and BMI as weaker for Black females than for White females. A study of 101 Black adolescents (age 12 to 16 years) from the Birmingham, Alabama metropolitan area found that physical activity was inversely associated with obesity status (Dulin-Keita, Kaur, Thind, Affuso, & Baskin, 2013), which was consistent with the findings of Janssen and colleagues (2005), who compared the rates of overweight and obesity in 162,305 school-aged youth (age 11-15) from 34 countries and concluded that physical activity plays an important role in combatting obesity. It is important to note that Janssen et al. (2005) did not assess racial subgroups and did not include a full range of adolescent age groups, but a statistically significant relationship was found between physical activity and obesity, such that the higher the physical activity, the lower the rate of obesity. This pattern was evident in each of the 34 countries, including the United States (n = 4447).

However, the relationship between physical activity and obesity is controversial. For example, Luke et al. (2009) found no relationship between energy expenditure and weight gain in Nigerian or in Black women, consistent with a previous study of black adults in Nigeria and the United States (Luke et al., 2002). Because these findings were controversial, Luke et al. (2011) developed a protocol for evaluating 2500 Black females across five countries, including energy expenditure, dietary intake, body weight, obesity and diabetes measured at baseline. The participants were asked how many times in a typical week they consumed fruits and vegetables, how many times they exercised, and their height and weight for calculation of BMI, similar to the present study. This protocol was designed to conclude whether engaging in recommended levels of physical activity can reduce the risk of obesity. The results of the Luke et al. (2011) study, combined with previous studies by Luke et al. (2002) and Luke et al. (2009), led Luke and Cooper (2013) to conclude that it was "time to clarify the public health message" because "physical activity does not influence obesity risk" (p. 1831).

Blair, Archer, and Hand (2013) responded to the conclusions of Luke and Cooper (2013), posting that Luke and Cooper (2013) had misrepresented or ignored data, then based on previous observational cohort studies, ecological studies, and experimental studies, concluded that "there is strong, unequivocal evidence from multiple well-controlled randomized trials showing that PA has a role in weight management, especially in preserving lean mass and reducing fat mass" (p. 1837). The differences between study results and how the present study fits within this literature is explained below.

Swinburn (2013) attempted to bridge the gap between Luke and Cooper (2013) and Blair, Archer, and Hand (2013) by asserting that PA has health benefits and should therefore be promoted, but that PA is a minor player in the obesity epidemic and that PA programs contribute very little (p. 1838) to changes in obesity rates. Wareham and Brage (2013) also responded to Luke and Cooper (2013) by stating that the cross-sectional relationship between physical activity levels and obesity prevalence within populations is strong and consistent. However, the longitudinal relationship between activity and weight gain is much more complex; changes in population level physical activity on their own, even if they are achieved, are unlikely to result in a substantial reduction in the prevalence of obesity.

The differences between cross-sectional and change-over-time studies in the relationship between PA and BMI offered by Wareham and Brage (2013) may explain why the statistically significant relationship found in the present study was consistent with other cross sectional studies, such as the study of Title IX participants by Kaestner and Xin Xu (2010), which found lower BMI in physical active women. Further, a cross-sectional study using data on 12-15 year olds from the 2012 NHANES National Youth Fitness Survey found that the frequency of moderate-to-vigorous physical activity for at least 60 minutes daily was inversely related to BMI (Fakhouri et al., 2014). In contrast, a longitudinal study of the New Moves intervention (Neumark-Sztaine et al., 2010) and the Switch® what you Do, View, and Chew intervention of Gentile et al. (2009) have failed to find a relationship between increasing PA and reductions in BMI, consistent with the contention of Wareham and Brage (2013) that longitudinal studies do not provide strong evidence that increasing PA does not result in large reductions in BMI.

Body image may play a role in the relationship between physical activity and BMI. Mama and colleagues (2016) found that Black women tended to misperceive themselves as smaller than their actual weight and to perceive an obese body shape as more desirable than a normal body for health and beauty. Accelerometer-measured physical activity significantly differed by weight status, BMI and physical activity were negatively associated (consistent with the findings of the present study), and physical activity was higher in those who were more satisfied with their body size. The findings of Mama and colleagues (2016) suggest that body image may play a role in the relationship between physical activity and BMI, with greater physical activity in Black females who have a positive, non-distorted body image.

Present findings are correlational so no direct cause-and-effect relationships can be demonstrated but these results are consistent with physical activity as an important component towards reducing the epidemic of obesity in Black adolescent females. However, the strength of the relationship was weak, with the number of days per week engaging in vigorous activity accounting for less than 1% of the variance in BMI. This result was consistent with Wareham and Brage (2013), who concluded that "the evidence concerning activity and weight gain is weak" (p. 1845) but there is insufficient scientific uncertainty to change public policy that promotes physical activity (Wareham & Brage, 2013). For these reasons, future research is needed to determine the complex relationship between physical activity and BMI reduction, particularly in Black adolescent females. Meanwhile, Malhotra, Noakes, and Phinney (2015) believe that physical activity is not the major driving force in obesity reduction because "you cannot outrun a bad diet" (p. 967). Therefore, this discussion turns to the relationship between BMI and the consumption of dietary fruits and vegetables.

Research Question 2

Research Question 2 asked, "Is the dietary consumption of fruits and vegetables significantly related to obesity in Black adolescent females?"

Evidence suggests that dietary fiber from fruits and vegetables can reduce risk for obesity (Brownstein, 2011; U.S. Department of Health and Human Services, 2010) whether by reducing hunger perception (Wanders et al., 2011), speeding digestion (George Mateljan Foundation, 2015a), enhancing digestive bacteria (Dominianni et al., 2015), or regulating blood glucose (De Vadder et al., 2014).

No statistically significant relationship was found between the dietary consumption of fruits and vegetables and obesity in the present sample of Black adolescent females. The literature is inconsistent regarding the benefits of fruit and vegetable consumption, as Brogan and colleagues (2012) studied Black adolescent females and found that the consumption of high fiber fruits and vegetables was inversely associated with obesity in simple analysis, but not in multivariate analyses. Ledoux, Hingle and Baranowski (2011) reviewed the published literature and found that increased fruit and vegetable intake was associated with adipose reduction in adults, but that this relationship was apparent in only half of childhood studies and with no clear pattern identified in Black females. The present null finding was consistent with Janssen and colleagues (2005), who found that the intake of fruits and vegetables was not associated with lower rates of overweight and obesity in school-aged youth from 34 countries. The present null finding was also consistent with Field, Gillman, Rosner, Rockett, and Colditz (2003), who found that fruits, vegetables, and fruit juice intake was not predictive of reductions in BMI. However, it is important to note that Field et al. (2003) considered fruit juice as similar to fruits, even though fruit juice does not contain the dietary fiber of fruits, and therefore may not confer the benefits of fruits towards BMI reduction. That is, the sugars in fruit juice may have counteracted the positive effects of fruits and vegetables in the Field et al. (2003) study.

In contrast, the present null finding regarding the effect of dietary consumption of fruits and vegetables on BMI was not consistent with other published reports in the literature. The Produce for Better Health Foundation (2014) concluded the families that increased fruit and vegetable intake had the greatest reduction in percentage of overweight adults. The proposed mechanism for BMI reduction from dietary fruits and vegetable intake is related to the two-fold effect of dietary fiber based on two types of dietary fiber (Wanders et al., 2011). First, insoluble dietary fiber provides bulk that increases satiety and reduces hunger (Anderson et al., 2009; Flood-Obbagy & Rolls, 2008). Second, soluble dietary fiber helps to control blood sugars (De Vadder et al., 2014), which can reduce the risk for obesity. Both soluble and insoluble fiber may increase the speed of digestion, which reduces the absorption of macronutrients (Brownstein, 2011; George Mateljan Foundation, 2015a).

The null result in the present study may be because the effects of dietary fruits and vegetables are not sufficient to reduce BMI but it is also possible that that no benefit was found in the present study because the present study did not control for total caloric intake. For example, Maier and Barry (2015) found that fiber intake was negatively associated with obesity while total caloric intake was positively associated with obesity for females age 13-15, but these results did not remain consistent through later adolescent years and Maier and Barry (2015) did not seek to use caloric intake as a control variable in their assessment of the relationship between fiber intake and obesity. That is, it is possible that dietary fruits and vegetables play an important role in obesity control, but only if caloric intake is accounted for. This speculation presents an open empirical question and an important area for future research, particularly for Black female adolescents, because this group has high rates of obesity (CDC, 2015a; Eaton, 2012) and adolescents have low rates of fruit and vegetable intake (Flood-Obbagy & Rolls, 2008).

However, education may help to ameliorate the problem of low fruit and vegetable intake among adolescent females. For example, evidence from Mobasher, Tavassoli, Ramezankhani, and Mirmiran (2014) demonstrated that a 6-month education program based on the Health Belief Model (Rosenstock, Strecher, & Becker, 1988) regarding the benefits of fruit and vegetable intake towards avoiding obesity that required the adolescent (age 13-14) students to explain to parents and friends the benefits of eating five servings of fruits and vegetables is important resulted in a significant gain in perceived benefits by the experimental group (n = 77) and no change in the control group (n = 77) at the end of the program or at 2-month follow-up. More importantly, the treatment group increased vegetable consumption by 74% and fruit consumption by a 89% at 2-month follow-up compared to baseline, while the control group (n = 77) did not significantly change their intake of fruits and vegetables.

In a follow-up study, Tavassoli, Ramezankhani, Mirmiran, Mehrabi and Hafez (2015) found a negative and statistically significant relationship between BMI and knowledge regarding the benefits of fruit and vegetable intake as well as between BMI and the consumption of fruits and vegetables in a study of 308 adolescent females and concluded that education from teachers, health workers, and mass media are important towards increasing the intake of fruits and vegetables to healthy levels in adolescent females.

Further, Tavassoli and colleagues (2014) found that five 1-hour sessions that educated adolescent females on the benefits of the consumption of fruits and vegetables on reducing risk of colorectal cancer resulted in a significant increase in positive attitudes towards the intake of fruits and vegetables and a doubling of the consumption of fruits and vegetables in the treatment group (n = 65) and no significant change in the control group (n = 65) two months following the intervention.

Combined, the findings of Mobasher et al. (2014) and of Tavassoli et al. (2014) demonstrate the potential of education in improving the intake of fruits and vegetables in adolescent females. These education programs should optimally be conducted early in life, as Tavassoli et al. (2014) tabbed childhood and adolescence as "critical periods for consumption of fruits and vegetables" (p. 98).

It is also important to acknowledge the differences between type of fruits and vegetables in weight management. For example, Bertoia et al. (2015) tracked 133,468 men and women for 24 years and found that intake of fruits and vegetables was associated with weight decrease, particularly those with high fiber and low glycemic load (berries, apples, pears, cauliflower), but that starchy vegetables (corn, peas, potatoes) were significantly associated with weight gain.

Research Question 3

Research Question 3 asked, "Does the dietary consumption of fruits and vegetables significantly interact with physical activity in obesity in Black adolescent females?"

The present study found no statistically significant interaction between the dietary consumption of fruits and vegetables and physical activity on BMI in Black adolescent females. No previous studies have been specifically designed to explore whether there is an interaction between physical activity and consumption of fruits and vegetables on BMI in Black adolescent females.

Historically, Patrick et al. (2004) found that physical activity was inversely related to obesity, that lower dietary fiber was associated with higher rates of obesity, but found no evidence of an interaction between dietary calories and activity on obese weight status. It is important to note that Patrick et al. (2004) did not specifically look at the interaction between dietary fiber and activity on obesity, nor did Patrick et al. (2004) provide sub-analyses that localized effects on Black females. Also, Patrick et al. (2004) concluded that less than 20% of participating adolescents met the recommended guidelines for dietary fiber. Further, Janssen et al. (2005), assessed the rates of overweight and obesity along with physical activity and the intake of fruits and vegetables in students from 34 countries, and found that physical activity was important to reducing overweight and obesity in youth, but found no association between the intake of fruits and vegetables and lower rates of overweight and obesity. While the findings of Janssen (2005) were generally consistent with the findings of the present study, Janssen et al. (2005) did not directly assess the interaction between physical activity and consumption of fruits and vegetables on rates of overweight and obesity.

More recently, systematic review of 23 papers by Ledoux et al. (2010) concluded that it is unclear whether increases in fruit and vegetable consumption results in decreased adiposity in isolation from physical activity and caloric intake, but Ledoux et al. (2010) failed to identify any published reports investigating the interaction between of physical activity and the consumption of fruit and vegetable on obesity or BMI. Further, the New Moves intervention (Neumark-Sztaine et al., 2010) and the Switch® what you Do, View, and Chew intervention of Gentile et al. (2009) included PA and dietary consumption of fruits and vegetables and showed significant increases in targeted behaviors, but neither program assessed the interaction between physical activity and consumption of fruits and vegetables and neither program has resulted in significant reductions in BMI. It is important to note that the intervention studies of Neumark-Sztaine et al. (2010) and Gentile et al. (2009) were not specifically designed to investigate obesity of BMI in Black adolescent females.

The longitudinal study of Maier and Barry (2015) investigated race, habitual exercise, and dietary fiber on obesity in adolescent females and found significant relationships, with race, habitual exercise, and fiber intake significantly predictive of obesity, in addition to the interaction of race and habitual exercise being predictive of obesity such that Black females with low levels of habitual exercise were more likely to be obese. However, Maier and Barry (2015) did not investigate the interaction between habitual exercise and fiber or the three-way interaction between race, habitual exercise, and fiber intake on obesity. These statistical analyses would have been directly relevant to Research Question 3 of the present study.

It is important to account for cultural differences in studies of physical activity, diet, and BMI. For example, Masood and Reidpath (2016) explored the correlations between fruit and vegetable intake, physical activity, and BMI is 56 countries and found moderate correlations between BMI, physical activity (measured as metabolic equivalents), and the intake of fruits and vegetable, but stressed the marked differences between countries. While informative, the Masood and Reidpath (2016) study did not focus on adolescent females and did not include the interaction between physical activity and dietary intake of fruit and vegetables on BMI.

While combatting, obesity is important because of the negative health consequences of obesity, in investigations of the effects of physical activity and BMI, it is important to recognize that not all obese people are unhealthy. For example, Camhi, Crouter, Hayman, Must, and Lichtenstein (2015) explored the physical activity levels of metabolically healthy overweight/obese (MHO) and metabolically unhealthy overweight/obese (MUO) women, with MUO operationally defined as having high blood pressure, triglycerides, blood glucose, insulin resistance, and systemic inflammation as well as low HLD-C ("good" cholesterol). Using objective accelerometer data, Camhi et al. (2015) found that MHO women has significantly more exercise and significantly less sedentary behavior. Further, MHO women ate significantly more vegetables and had a significantly higher level of fiber intake. While the research of Camhi et al. (2015) is important towards distinguishing between metabolically healthy and metabolically unhealthy overweight/obese women and for using accelerometer data as an objective measure of physical activity, Camhi et al. (2015) did not investigate the interaction between physical activity and dietary fiber on obesity and did not include Black female adolescents in their study.

The present study results extend the findings of Peña (1989), who conducted the only previous study to date that directly assessed the statistical interaction between exercise and dietary fiber in adolescents and found that physical activity and dietary fiber interact in the prediction of obesity in girls but not in boys. However, Peña (1989) did not assess outcomes by race, so the present study adds to the literature by empirical showing no statistically significant interaction between the intake of fruits and vegetables and physical activity on BMI in Black female adolescents.

Limitations of Study

This study was limited by the sample, the measures, and by the research design. The present sample, while stratified to be representative of the nation's adolescent females, was not designed to explore regional differences. The physical activity measure assessed the number of days per week of physical activity of one hour or more, so this may have underestimated the physical activity of some who exercised for 45 minutes per day, for example. Further, the physical activity measure did not account for activity type. The dietary measure of fruit and vegetable intake did not include unhealthy eating habits, a contrast of fruits and vegetable that are low in glycemic load and higher in fiber from starchy fruits and vegetables, or a measure caloric intake, which is important in assessing BMI. Also, this study did not account for socioeconomic status and cultural preferences in food choices. Further, this study was retrospective in nature and therefore did not include random assignment to groups, experimentally controlled levels of physical activity or diet, and included no control group. A true experimental design with random assignment, experimentally controlled treatments, and control groups are necessary to determine cause and effect relationships with confidence (Creswell, 2014).

Recommendations for Future Studies

The following recommendations for future research are offered. The present study should be replicated with larger, more diverse samples, assembled by state to investigate possible regional differences. These replications should account for different measures of physical activity, fuller measures of dietary behavior, and an assessment of caloric intake.

Future researchers should account for socioeconomic status and cultural preferences in food choices.

Future scholars should strive to use prospective designs, so that Black adolescent females can be assessed at baseline, the randomly assigned to treatment groups with experimentally controlled levels of diet and exercise, then assessed after the intervention and contrasted with control groups. This will improve the level of inference when assessing whether physical activity statistically interacts with fruit and vegetable consumption towards BMI and obesity.

In the future, scholars should also strive to distinguish between fruits and vegetable that are low in glycemic load and higher in fiber from fruit juices and starchy fruits and vegetables, consistent with Bertoia et al. (2015), so that scholars and educators can focus on beneficial fruits and vegetables in interventions to reduce obesity in Black females. It is equally important to account for beverage intake, as the Fields et al. (2003) study counted fruit juice as fruit intake even though fruit juices are likely high in sugar and therefore may counteract the positive effects of fruit intake, and because a review by Muckelbauer et al. (2012) found a majority of studies found that higher water consumption was associated with lower body weight. Therefore, future studies on physical activity, diet, and BMI should consider accounting for high-sugar beverages and including water consumption as a variable

Socioeconomic status (SES) and perceived neighborhood disorder have been significantly associated with lower levels of physical activity and higher rates of obesity (Dulin-Keita, Thind, Affuso, & Baskin, 2013; Jin & Jones-Smith, 2015), so researchers should consider SES and local neighborhood dynamics in future studies of BMI and physical activity.

Because physical activity was associated with lower BMI in the present study, future research is needed to find ways to effectively promote frequent and vigorous physical activity in Black female adolescents, including measures of adherence to exercise programs. Future scholars may seek to use accelerometer data as an objective measure of physical activity, as in the research of Camhi et al. (2015), to supplement or instead of using self-report of physical activity levels. It is also important for future scholars to distinguish between metabolically healthy and metabolically unhealthy females who are overweight or obese, consistent with Camhi et al. (2015). Because self-image can influence exercise levels in Black females (Mama, et al., 2016; Ray, 2015), future scholars should seek ways to improve the body image of Black females.

Bauer and colleagues (2011) found that family support plays a key role in fostering physical activity and consumption of fruits and vegetables in adolescent females, but did not assess the effects of parental support on obesity reduction. Therefore, future research is needed to discover ways to investigate the role of family support in obesity reduction and to discover effective techniques to help families to promote healthy exercise and diet for Black adolescent females. Additionally, Brogan et al. (2012) found that caregiver BMI was associated wit obesity in Black adolescent females, so it is important for future scholars to account for parental obesity in investigating obesity in adolescents and for programs to be developed to assist parents and caregivers in their own weight management towards combatting obesity in Black adolescent females.

Implications for Positive Social Change

The results of this study foster positive social change by identifying the relationship between physical activity and BMI in Black adolescent females. Present findings imply (but do not prove, because the study was retrospective and observational rather than prospective and experimental) that increasing physical activity can potentially lower BMI in Black adolescent females. This is important because of the obesity epidemic in Black adolescent females. The implications for positive social change include implementing physical activity programs in all schools and communities aimed to reduce the number of overweight and obese children. Legislatures, educators, parents, and school administrators can use the knowledge from this study for guidance and direction in creating policies that can positively influence the health of Black female adolescents.

Study participants averaged 3.0 days per week with 60 minutes of physical activity, less than half the rate that is recommended by the U.S. Department of Health and Human Services (Lavizzo-Mourey, 2012). To foster positive social change more must be done to promote physical activity in Black adolescent females.

Weekly intake of fruits and vegetables was not significantly associated with BMI in the present study. However, it is important to note that study participants average 2.4 servings of fruits and vegetables per week. That is, participants averaged less than one serving of fruits and vegetables per day. Given the importance of a balanced diet for healthy development, more must be done to promote the consumption of fruits and vegetables in Black adolescent females.

Study participants average a BMI of 24.6, on the margin between normal and overweight status. Further, there was no significant relationship between BMI and the consumption of fruits and vegetables, and the physical activity accounted for $<1\%$ of the variance in BMI in the present sample of Black female adolescents. Combined, these findings suggest that it is important to promote positive social change at the individual level earlier than adolescence. Parents can have a strong influence in shaping their children's dietary behavior and weight status (Dalle et al., 2013). Obesogenic behaviors can play an important role, because of the correlation between the nutrient intakes of mothers and children (Sonneville et al., 2007). Fighting obesity early in life is important because the majority of overweight or obese adolescents become overweight or obese adults (Bishop et al., 2005; Patrick et al., 2004).

Strategies for promoting positive social change by combating adolescent obesity in Black females should be multifaceted. Creating a Local School Wellness Policy to foster student health may reduce childhood and adolescent obesity if the program includes encouragement to drink water in place of sugar-sweetened beverages, availability of fruits, vegetables, whole grains, and nonfat or low-fat dairy products, and the promotion of physical activity early in life.

Conclusions

This study of YRBS data based on1211 Black female adolescents found that higher levels of physical activity were associated with lower levels of BMI. Dietary consumption of fruits and vegetables was not associated with BMI and no statistically significant interaction was found between physical activity and consumption of fruits and vegetables on BMI. Combined, these findings highlight the importance of combatting obesity in Black female adolescents.

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Appendix A:Calculating Physical Activity and Dietary Fruit and Vegetable Intake

2011 State and Local Youth Risk Behavior Survey

Physical Activity

79. During the past 7 days, on how many days were you physically active for a total of **at least 60 minutes per day**? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)
  A. 0 days
  B. 1 day
  C. 2 days
  D. 3 days
  E. 4 days
  F. 5 days
  G. 6 days
  H. 7 days

Dietary Fruit and Vegetable Intake

Dietary Fruit and Vegetable Intake is calculated by summing the responses to YRBS items 73-77.

73. During the past 7 days, how many times did you eat **fruit**? (Do **not** count fruit juice.)
  A. I did not eat fruit during the past 7 days
  B. 1 to 3 times during the past 7 days
  C. 4 to 6 times during the past 7 days
  D. 1 time per day
  E. 2 times per day
  F. 3 times per day
  G. 4 or more times per day
74. During the past 7 days, how many times did you eat **green salad**?
  A. I did not eat green salad during the past 7 days
  B. 1 to 3 times during the past 7 days
  C. 4 to 6 times during the past 7 days
  D. 1 time per day
  E. 2 times per day
  F. 3 times per day
  G. 4 or more times per day

75. During the past 7 days, how many times did you eat **potatoes**? (Do **not** count french fries, fried potatoes, or potato chips.)

A. I did not eat potatoes during the past 7 days
B. 1 to 3 times during the past 7 days
C. 4 to 6 times during the past 7 days
D. 1 time per day
E. 2 times per day
F. 3 times per day
G. 4 or more times per day

76. During the past 7 days, how many times did you eat **carrots**?

A. I did not eat carrots during the past 7 days
B. 1 to 3 times during the past 7 days
C. 4 to 6 times during the past 7 days
D. 1 time per day
E. 2 times per day
F. 3 times per day
G. 4 or more times per day

77. During the past 7 days, how many times did you eat **other vegetables**? (Do **not** count green salad, potatoes, or carrots.)

A. I did not eat other vegetables during the past 7 days
B. 1 to 3 times during the past 7 days
C. 4 to 6 times during the past 7 days
D. 1 time per day
E. 2 times per day
F. 3 times per day
G. 4 or more times per day

Appendix B: National Fiber Council Fiber Food Chart:

Common Fruits and Vegetables Fiber Table

Food	**Serving Size**	**Grams of Fiber**
Fruits		
Apple (with peel)	1 medium	3
Banana	1 medium	3
Blueberries	1 cup	4
Cantaloupe	1 cup	1
Grapefruit	1 medium	3
Orange	1 medium	3
Pear (with peel)	1 medium	4
Pineapple	1 cup	2
Prunes (dried)	½ cup	6
Raspberries	1 cup	8
Vegetables and beans		
Asparagus (5 medium, cooked)	½ cup	2
Kidney beans (cooked)	½ cup	6
Pinto beans	½ cup	8
Broccoli (cooked)	½ cup	2
Carrots	½ cup	2
Cauliflower (cooked)	½ cup	2
Green Salad	1 cup	0.9
White potato, w. skin (baked)	1 medium	5
Spinach, frozen, cooked, drained	½ cup	3
Tomato	1 medium	1
Breads, cereals, grains etc.		
Rye bread	1 slice	2
White bread	1 slice	1
Whole-wheat bread	1 slice	2
Kellogg's® All-Bran (original)	½ cup	10
Kellogg's ® All-Bran Bran Buds	1/3 cup	11
Quaker® Old-Fashioned Oatmeal (cooked)	1 cup	4
Wheat germ, toasted	2 tablespoons	3
Brown rice, cooked	½ cup	2
White rice, cooked	½ cup	0.3
Spaghetti, cooked	1 cup	2
Peanuts, dry-roasted	½ cup	6