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Fruit and Vegetable Consumption, Physical Activity, and Colorectal Cancer Among African Americans

Stella Francoise Nanga Ndzana
Walden University

Walden University

College of Health Sciences

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Stella Francoise Nanga Ndzana

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Review Committee
Dr. Hebatullah Tawfik, Committee Chairperson, Public Health Faculty
Dr. Loretta Cain, Committee Member, Public Health Faculty
Dr. JaMuir Robinson, University Reviewer, Public Health Faculty

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Sue Subocz, Ph.D.

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Colorectal cancer (CRC) is a deadly and costly cancer, especially among African Americans. The purpose of this quantitative, retrospective, cross-sectional study was to examine African Americans' health behaviors that may have an association with CRC. The Health Belief Model was used to guide this study. The study addressed whether there is a statistical association between fruit intake, vegetable intake, and physical activity, and the occurrence of CRC while controlling for confounders, such as body mass index, smoking status, and income level. After conducting an overall analysis, the final research question examined if the association varied by race. In this study, data from 14,451 people in the Health Information National Trends Survey database were analyzed using binary logistic regression analysis. There was no association between the intake of fruits and vegetables and the occurrence of CRC in this population. Physical activity had a statistically significant association with CRC, with physical activity being protective against the occurrence of CRC among the whole sample population (adjusted OR = .671, 95% CI = [.458-983], p = .040). When stratified by race the association between Physical activity and CRC was only significant among Whites. The findings of this study have positive social change implications for practitioners designing CRC prevention programs, who should focus on increasing physical activity levels yielding healthier living in general. Future research should focus on addressing other possible risk factors in the African American population including genetic predispositions and gene-environment interactions.

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Dedication

I dedicate this dissertation to God; my husband, Dr. Eric Christian Nemzou; my children, Irene Maika Ndzana-Nanga, Eric Mendel Ndzana-Nemzou, and Laurent Christian Ndzana-Nemzou; and my family, including all Etoudi, Mvog Effa, Beyimbanga Eton Beti, and Etenga relatives. I also dedicate this study to not only colorectal cancer patients but all cancer patients, cancer survivors, and those who fought and lost the battle against this devastating disease. To my parents, my late father, Ndzana Ahanda Laurent and my mother, Ongola Bougou Anastasie Elisabeth, who instilled the love of learning to me. My parents worked tirelessly and provided me the tools to be academically successful. My father and my mother always emphasized the importance of education since I was a child in my home country Cameroon.

To my wonderful, lovely husband, Dr. Eric Christian Nemzou, who has been with me since the beginning of this journey and provided me with his moral, spiritual, emotional, and financial support. Thank you for putting up with me through the last couple of years. You are the one who conveyed me to embark on my Ph.D. candidature, and your support, encouragement, and constant love have sustained me throughout this journey. You are my backbone; you gave me hope when I thought I would not make it.

I dedicate my dissertation to my children, Irene Maika Ndzana-Nanga, Eric Mendel Ndzana-Nemzou, and Laurent Christian Ndzana-Nemzou. Maika, Mendel, and Laurent have supported me throughout the process in different ways. They sacrificed several hours of “mommy and me” time and gave me constant encouragement along the journey as they understood the importance of concluding this adventure. They kept me on track with their efforts to minimize distractions. Thank you for your patience during those long hours when I was focusing on my laptop and failed to acknowledge your presence. I love you so much.

I am dedicating this dissertation to three beloved people who have meant and continue to mean so much to me. Although they are no longer in this world to give me strength and support, their memories continue to regulate my life. I always feel their presence that used to urge me to strive to reach out to my goals in life.

First and foremost, to the memory of my first love, the hero of my childhood and later years as well, my late father, Ndzana Ahanda Laurent, whose love for me knew no bounds. My father taught me the value of hard work, his tenacity and perseverance nurtured me. I still want to be like you when I grow up. You provided me with the light to guide me along dark and lonely roads. You prepared me to face the challenges with faith and humility. You built confidence in me; you taught me to believe in myself and showed me that God never fails. Papa, you will always be my inspiration. Thank you so much, "Monsieur Ndzana," for everything! You left a void in my life that will never be filled. I will make sure your memory lives on as long as I shall live.

Next, I dedicate this dissertation to the memory of my late paternal grandmother, Nanga Ahanda Francoise, who raised my father and his siblings as a single mother. She loved me as I was named after her and taught me determination and courage against adversity. Mami Nanga was a constant source of inspiration to my life. Her belief in me has made this journey possible.

Finally, I also dedicate my work to the memory of my late godmother and sweet aunt, Lambertine Hildegarde Noah. She was an amazing and adorable woman who always believed in my ability to be successful in the academic arena. Mama Sita Hilde, you always had confidence in me and offered me encouragement and support in all my endeavors.

May you all find peace and happiness in Paradise! I love you all and miss you all beyond words.

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I want to thank my cousin and friend, Krystel Henriette Bikie Tchoungui Koffi, for her unstoppable support through this journey and always. She is my best cheerleader since I entered the States in 2002. I will also extend acknowledgments to my cousins, Guy Daniel Abouna Zoa and Hilaire Abouna Ndzana, who have been academic role models to me since my tender childhood. Guy and Hilaire always encourage, mentor, and support me whenever I needed them. Last but not least, I would like to thank my entire family: my parents, my siblings, my paternal (Etoudi and Beyimbanga Eton Beti) and maternal (Mvog Effa and Etenga) relatives. They all contributed in one way or another to make me the person I am today as they say it takes a village to raise a child. Thank you for all you do!

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Chapter 1: Introduction to the Study

Introduction

In this study, I aimed to assess the association between fruit and vegetable consumption, physical activity, and colorectal cancer (CRC) among African Americans. Also, I compared the African Americans with the whole population and the White population. In this chapter, I discuss the background, the problem statement, the purpose of the study, the different research questions and hypotheses, the theoretical framework of the study, the nature of the study, the definitions, the assumptions, the scope and delimitations, the limitations, the significance, and the summary of the chapter.

Background

CRC is a deadly and costly cancer, especially among African Americans. Grimmett et al. (2015) demonstrated that lifestyle factors, like diet and physical activity, are associated with better outcomes in CRC. Ashktorab et al. (2013) noted that in the United States, African Americans exhibited higher incidence and death rates of CRC. Lifestyle factors, such as high-fat diet or poor diet, physical activity, and alcohol consumption, have been suggested to be risk factors (Grimmett et al., 2015). It is recommended to consume fruits and vegetables to prevent CRC, but according to the Centers for Disease Control and Prevention (CDC) (2017), there are many adults who are still not meeting this recommendation. Men, young adults, and people in poverty have the lowest fruit and vegetable intake (CDC, 2017).

While some studies have shown the possible association between fruit and/or vegetable intake and CRC (Bradbury et al. 2014; Koushik et al. 2007; Lee et al., 2017;

Luo et al. 2015; Nagle et al. 2015; Qiwen et al., 2015; Tayyem et al., 2014), other researchers have not concurred because their findings were different (Aoyama et al., 2014); Nomura et al., 2016). Most of the studies in the literature did not represent the African American population, and the studies that did had low numbers of African American participants. Lee et al. (2017) assessed the association between the colors of vegetables and fruits and the risk of CRC in Korea and found that vegetable and fruit intake from various color groups may protect against CRC. Luo et al. (2015) provided information about the association between consumption of vegetable and fruit color groups and the risk of CRC in a Chinese population, while Mahfouz et al. (2014) identified the relationship between dietary and lifestyle factors and the development of CRC in patients attending a Minia, Egypt oncology center, comparing them with their controls.On the other hand, Akinyemiju, Wiener, and Pisu (2017) conducted an analysis of cancer-related risk factors and incidence of significant cancers by race, gender, and region in a prospective cohort of 566,398 adults aged 50–71 years. Among this population, there were only 19,677 African Americans and 450,623 Whites (Akinyemiju et al., 2017).

I found no studies that previously examined whether fruit and vegetable consumption and physical activity have an impact on preventing CRC in African Americans while taking into consideration race as an effect modifier variable. Therefore, conducting this study allowed for the filling of this crucial gap. This study was needed because it is essential to develop preventive measures against CRC among African Americans that will take into consideration socio-economic aspects.

Problem Statement

The problem addressed in this study was the association between fruit and vegetable consumption, physical activity, and CRC among African Americans in comparison to the whole population and the White population. According to the CDC (2017a), in the United States, among all cancers seen in both males and females, CRC is the second leading cause of death due to cancer and the third most commonly seen cancer in adults. Furthermore, the African American population demonstrates a higher incidence of CRC and mortality caused by CRC (Zaharek-Girgasky, Wolf, Zybert, Basch, & Basch, 2015). In 2014, the incidence of CRC was higher in African Americans within both genders; around 50 Black men and 39 Black women out of 100,000 got CRC versus 42 White men and 32 White women out of 100,000 (CDC, 2017a). In 2014, the mortality rate of CRC was higher in African Americans versus White people within both genders (CDC, 2017a). There were around 23 Black men and 15 Black women out of 100,000 who died of CRC versus 16 White men and 12 White women out of 100,000 (CDC, 2017a). As previously mentioned, Ashktorab et al. (2013) posited that in the United States, African Americans exhibited higher incidence and death rates of CRC. Furthermore, lifestyle factors, like diet, physical activity, and alcohol consumption, have been suggested to be risk factors (Grimmet et al., 2015). There is a gap in the literature concerning how the African American population might benefit from the consumption of fruits and vegetables and increased physical activity to prevent CRC while taking into consideration income level.

There is increasing epidemiologic evidence associating diet-induced obesity, excess body fat, and abdominal fat with increased risk of colon cancer (O'Neill et al., 2016). Data from the CDC (2017b) showed that the pattern of death from CRC has changed from 1999 to 2014 by race and ethnicity. In the United States, African Americans now have the highest risk of CRC (CDC, 2017b). Moreover, Akinyemiju et al. (2017) found that African Americans, in comparison to Whites, adhere less to changes in lifestyle like smoking, alcohol, physical activity, and diet.

Purpose of the Study

The primary purpose of this quantitative, retrospective, cross-sectional study was to identify whether race is an effect modifier in the association between fruit and vegetable consumption, physical activity, and CRC while focusing on African Americans. The high rate of CRC in developed countries has been linked to the adoption of a Western lifestyle, including elevated consumption of saturated and hydrogenated fats as well as high-energy food (O'Neill et al., 2016). Black men and women were more likely to die of CRC than their counterparts in other races (CDC, 2017b). Understanding the association between fruit and vegetable consumption and physical activity could reveal trends that may potentially help public health practitioners design CRC prevention strategies for the African American population.

Research Questions and Hypotheses

I designed this study to identify whether race is an effect modifier in the association between fruit and vegetable consumption, physical activity, and CRC. The following research questions and corresponding hypotheses guided this study:

Research Question 1: Is there an association between fruit consumption the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0$1: There is no association between fruit consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

H_a1: There is an association between fruit consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 2: Is there an association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0$2: There is no association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

H_a2: There is an association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 3: Is there an association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0$3: There is no association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

H_a3: There is an association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 4: Is there an association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0$4: There is no association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

H_a4: There is an association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 5: Is there an association between fruit and vegetable consumption, physical activity, and the occurrence of colorectal cancer when stratified by race?

$H_0$5: There is no association between fruit and vegetable consumption, physical activity, and the occurrence of colorectal cancer when stratified by race.

H_a5: There is an association between fruit and vegetable consumption, physical activity, and the occurrence of colorectal cancer when stratified by race.

In Hypotheses 1, 2, and 3, the dependent variable was CRC, and the independent variables were fruit intake, vegetable intake, and physical activity, respectively. In Hypothesis 4, the dependent variable was CRC, and the independent variables were fruit intake, vegetable intake, and physical activity, respectively. In Hypothesis 5, the dependent variable was CRC, and the independent variables were fruit intake, vegetable intake, and physical activity. Race was the effect modifier variable.

Theoretical Framework of the Study

I used the health belief model (HBM) as the theoretical foundation for this study. In the early 1950s, social scientists at the U.S. Public Health Service developed the HBM to better comprehend the reasons why people fail to practice disease prevention methods or screening tests for the early detection of disease (LaMorte, 2016). The HBM is based on psychological and behavioral theory (LaMorte, 2016). The desire for wellness, the avoidance of illness, and an individual's belief that their actions will contribute to wellness by treating, preventing, or curing disease are the main components of HBM (LaMorte, 2016). Per LaMorte (2016), HBM is a framework beneficial in the studies of cancer preventive behaviors because it is based on psychological and behavioral theory.

Consuming fruits and vegetables can diminish the incidence of CRC. ChooseMyPlate (2018) stated that individuals who eat a lot of fruits and vegetables have higher chances to lessen the risk of some chronic diseases because they provide nutrients that are vital for the health and maintenance of the body. CRC incidence among Blacks, including those younger than 50 years old, has historically been higher than that among Whites (Wolf et al., 2018). Depending on the eating pattern, the diet may ameliorate or even increase CRC risk (Donovan, Selmin, Doetschman, & Romagnolo, 2017). According to National Colorectal Cancer Roundtable recommendations, a higher burden of cancer risk factors include high rate of tobacco use, high rate of alcohol use, a diet high in animal fats as well as low in whole foods and fresh fruits and vegetables, inactivity, obesity, and prevalence of diabetes (Donovan et al., 2017). Both fruits and vegetables have low fat, low calories, and no cholesterol; fruits have low sodium (ChooseMyPlate, 2018). Potassium, dietary fiber, vitamin C, and folate (i.e., folic acid) are some nutrients found in fruits (ChooseMyPlate, 2018). In addition to the nutrients found in fruits, vegetables have vitamins (ChooseMyPlate, 2018).

Grimmett et al. (2015) demonstrated that there is evidence that lifestyle factors, like diet and physical activity, are associated with better outcomes in CRC. Moreover, moderate to vigorous physical activities are recommended for health benefits (ChooseMyPlate, 2018). The risk of CRC in individuals that are physically active is 27% less than the those who are not physically active (Gafarih, Mohammadian, Valipour, & Mohammadian-Hafshejani, 2016). Therefore, physical activity decreases the incidence of CRC.

According to the CDC (2018a), 7% of adults who are below the poverty level can meet the daily vegetable recommendation. Financial barriers can substantially delay medical care (Thomson & Siminoff, 2014). Lower income can promote financial strain, which can also have impacts on lifestyle and overall health. Advani et al. (2014) posited that financial strain is associated with high unmet health needs, which leads to increased mortality among older African Americans. The HBM is related to this study because fruit and vegetable consumption and physical activity routines of the African American population fall within people's behaviors.

Nature of the Study

In this study, I used a quantitative, cross-sectional, retrospective study to identify if appropriate fruit consumption, proper vegetable consumption, and the recommended level of physical activity are independently related to CRC and if race modifies the relationships among the dependent variable and the independent variables. In this study, the independent variables were fruit and vegetable consumption and physical activity, and the dependent variable was CRC. Race was the effect modifier. I used a logistic regression model as the statistical analysis to identify if there was an independent effect of each of the three independent variables in the occurrence of CRC. A secondary data analysis was conducted using the Health Information National Trends Survey (HINTS) 2011–2014 data set.

Definitions

Fruit and vegetable consumption: The daily intake of fruits and vegetables measured in number of cups (HINTS, 2018a).

Health Information National Trends Survey (HINTS): A part of the National Cancer Institute's Division of Cancer Control and Population Sciences. HINTS (2018a) collects data about the use of cancer-related information by the U.S. public.

Income level: Total, pretax, combined annual income from all sources earned within the previous year (HINTS, 2018a).

Physical activity: Number of days in a week of any physical activity or exercise of at least moderate intensity, such as brisk walking, bicycling at a regular pace, swimming at a consistent pace, and heavy gardening (HINTS, 2018a).

Assumptions

I assumed that many factors may not be measured and would have an impact on the incidence of CRC in the African American population. The impact of genetics on CRC among African Americans is one of those factors that was not measured in this study. People who have a single, affected, first-degree family member, like a parent, sibling, or child, with CRC have elevated risk around two folds over the general population (Macrae, 2016). Many other environmental factors play a role in CRC in African Americans. According to the CDC (2018c), unhealthy lifestyle choices, like alcohol consumption and tobacco usage, have been assumed to increase the risk of CRC in general. I used tobacco usage among the confounders in this study.

Scope and Delimitations

The scope of the study incorporated African Americans, Whites, and the whole population with CRC. The population size was an envisaged limitation in this study. Data on the participants were collected from the HINTS database.

Limitations

The main limitation of this study was that the participants in the HINTS data set provided the information on their fruit and vegetable consumption and level of physical activity. Therefore, the reported fruit and vegetable intake and level of physical activity may not represent the real participants' lifestyle because these data were self-reported. Moreover, cross-sectional studies such as this one implicate recall bias due to the self-reported data. The HINTS is used to collect nationally representative data about the U.S. public's knowledge of, attitudes toward, and use of cancer- and health-related information (HINTS, 2018a). The mail questionnaire instrument used by HINTS was assessed for internal and external validity through different rounds of questions (HINTS, 2018a). Several questions had been used in previous HINTS years and had been demonstrated to be valid and reliable (HINTS, 2018a). In the same sense, from the fact that HINTS questions came from a large, well-known study that has been validated over the course of 5 years and extensive research, it can be concluded that the instrument is reliable in representing the constructs it is intended to serve.

Significance

The findings of this study fill a gap in the literature by quantitatively determining the interaction that dietary fruit and vegetable consumption and physical activity may have on CRC among African Americans. The results of the study can contribute to the epidemiology field in the creation of an awareness of the risk factors among this specific target population. This knowledge can be used to create programs that may help decrease the incidence of CRC in the African American population. The findings of this study could also add evidence to the knowledge about the association between dietary fruits and vegetables and physical activity on CRC in African Americans that future programs could be based on. In the same sense, the long-term purpose of this study was to aid public health providers in creating interventions that will take into consideration race to fight against CRC among African Americans.

Summary and Transition

In Chapter 1, I provided an overview of fruit and vegetable consumption, physical activity, and their implications in CRC among African Americans. The background, the problem statement, the purpose of the study, the different research questions and hypotheses, the theoretical framework of the study, the nature of the study, the definitions, the assumptions, the scope and delimitations, the limitations, the significance, and the summary of the chapter were clearly stated. In Chapter 2, I will discuss the different risk factors associated with CRC, namely fruit and vegetable consumption and physical activity among African Americans. In the literature review, I will highlight the relationship between these variables and CRC among the African American population.

Chapter 2: Literature Review

Introduction

The problem I addressed in this study was the association between fruit and vegetable consumption, physical activity, and CRC among African Americans in comparison with the whole population and the White population. The primary purpose of this study was to identify if there is an association between fruit and vegetable consumption, physical activity, and CRC. Moreover, I evaluated whether race interacts with dietary fruit and vegetable consumption and physical activity in incidences of CRC.

This chapter includes an overview of the seminal studies addressing CRC among different populations, focusing on African Americans. In the chapter, I emphasize the impact of risk factors for the occurrence of CRC among African Americans based on evidence-based findings from previous studies. The following topics are covered: CRC epidemiology, high risk groups for CRC, CRC and fruit and vegetable intake, CRC and physical activity, CRC and income level, and CRC and social-ecological theory.

Literature Search Strategy

I retrieved the literature reviewed using electronic databases and internet sources. I searched for peer-reviewed, mostly English-language articles in the EBSCO, PubMed, Google Scholar, ProQuest Dissertation, and CDC databases, focusing on sources published between 2013–2018. The following terms were used to search for relevant articles relating to CRC: *colorectal cancer, African Americans, blacks, fruits and vegetables, diet, physical activity,* and *income level*. My review of the literature review allowed me to find the gaps in the literature and justified the importance of this study.

The aim was to examine the possible association between fruit and vegetable intake, physical activity, and CRC and see whether this association is modified by race.

Theoretical Framework

I used the HBM as the theoretical foundation for this study. In the early 1950s, social scientists at the U.S. Public Health Service developed the HBM to better comprehend the reasons why people fail to practice disease prevention methods or screening tests for the early detection of disease (Huang et al., 2016; LaMorte, 2016). The HBM is based on psychological and behavioral theory (LaMorte, 2016). The desire for wellness, the avoidance of illness, and an individual's belief that their actions will contribute to wellness by treating, preventing, or curing disease are the main components of HBM (LaMorte, 2016). Per LaMorte (2016), HBM was a framework beneficial in the studies of cancer preventive behaviors because it is based on psychological and behavioral theory.

The six constructs of the HBM that can be used to predict health behavior are risk susceptibility, risk severity, benefits to action, barriers to action, self-efficacy, and cues to action (Jones et al., 2015). The benefits and barriers are the two constructs that usually define the course of action taken by people (Jones et al., 2015). HBM is one of the most used theoretical frameworks to identify and explain behaviors associated with health, which is the reason why several researchers and scholars have used it (Poortaghi et al., 2015).

The HBM construct of barriers to action was the sole focus of this study. Perceived barriers are physical and/or psychological difficulties or obstacles to execute a behavior (Jones et al., 2015). In other words, perceived barriers pinpoint the eventual negatives outcomes of practicing a health action. Examples of barriers could be cost, inconvenience, and/or accessibility.

Several reseacrhers used HBM as a framewwork previously to explain health behaviors association with CRC . Almadi et al. (2015) used the HBM as a framework to examine the different barriers that participants were encountering to undergo CRC screening. Some of the barriers to participation in screening were the lack of knowledge about the impact of CRC, the risk factors of CRC, and the importance that they could gain through screening (Almadi et al., 2015). Omenukor (2018) used the HBM as a framework to identify the obstacles that patients (mostly African Americans) found in the path to prevent the morbidity and mortality of CRC. Screening is one of the best options to avoid the morbidity and mortality associated with CRC (Omenukor, 2018). Omenukor found that the examples of system barriers for CRC screening were financial issues, lack of insurance, and the inability to access care. In this study, preventive health behaviors were fruit and vegetable consumption and physical activity. The aim was to find out if income level plays a barrier role in the prevention of CRC in the African American population.

What is Colorectal Cancer?

CRC is cancer that begins in the colon or the rectum and is also known as colon cancer or rectal cancer (American Cancer Society, 2018b). Colon cancer and rectal cancer are usually put together because they show several common characteristics (American Cancer Society, 2018b). Growths on the inner lining of colon or rectum, named polyps, are signs of the beginning of most CRC (American Cancer Society, 2018; CDC, 2016). It usually takes many years for many types of polyps to become cancer; moreover, all polyps do not end up as a cancer (American Cancer Society, 2018b). The main two types of polyps that have high chances of becoming cancer are: adenomatous polyps, called adenomas, and hyperplastic and inflammatory polyps (American Cancer Society, 2018b). Adenomas usually become cancer, which gives it the name of the precancerous condition (American Cancer Society, 2018b). The other type is mostly seen but is not considered precancerous (American Cancer Society, 2018b). It is important to note that adenocarcinomas represent 96% of CRCs (American Cancer Society, 2018b).

Colorectal Cancer Epidemiology

CRC incidence and mortality rates profoundly differ from one area to another one around the world. According to Vos et al. (2016), worldwide, CRC is the third most commonly seen cancer in men and the second in females. In 2015, 1.65 million new people were diagnosed with CRC, and roughly 835 000 lost their life (Vos et al., 2016). In the United States, there are 97,220 new cases of colon cancer, and 43,030 new cases of rectal cancer and around 50,630 people were supposed to die from CRC in 2018 (American Cancer Society, 2018a).

Colorectal Cancer Incidence

Worldwide, the incidence of CRC changes over tenfold with the most significant incidence rates seen in Australia and New Zealand, Europe, and North America and the lowest rates seen in Africa and South-Central Asia (Macrae, 2016). In addition to the genetic background, the different types of diet and the environment within these geographic locations may explain the variations in incidences (Macrae, 2016). Jemal et al. (2017) stated that there had been a reduced percentage of CRC incidence in the United States, around 2.5% to 4% each year within the previous 15 years. In the United States, CRC incidence is roughly 25% greater in males than in females and is around 20% greater in African Americans compared to Whites (Jemal, Siegel, Xu, & Ward, 2010).

Colorectal Cancer Mortality

In the United States and several other Western countries, since the mid-1980s, death rates due to CRC have gone down (Jemal et al., 2017; Siegel, Miller, & Jemal, 2018). The detection and removal of colonic polyps, the identification of CRC at earlier stages, and the effectiveness of primary and adjuvant treatments have been known to be the leading causes of the improvement in CRC outcomes (Macrae, 2016). Several tests are available to detect polyps or CRC (CDC, 2018f). For instance, stool tests (i.e., guaiac-based fecal occult blood test, the fecal immunochemical test, and fecal immunochemical-DNA test); flexible sigmoidoscopy; colonoscopy; and computed tomography colonography (i.e., virtual colonoscopy) are the CRC screening tests that are recommended (CDC, 2018f).

On the other hand, in the United States, reduced mortality is masking trends in younger adults (Macrae, 2016). According to Surveillance, Epidemiology, and End Results Program (SEER) database of the National Cancer Institute, CRC rates per 100,000 populations within people between 20 to 54 years old went down from 6.3 in 1970 to 3.9 in 2004 with an elevated 1% to 4.3% in 2014 (Siegel, Miller, & Jemal, 2017). Per the American Cancer Society (2018a), early screening reduces CRC mortality.

Colorectal Cancer High Risks Groups

According to the CDC (2018b), the risk of having CRC increases as people get older, but there are other risks factors, such as inflammatory bowel disease (i.e., Crohn's disease or ulcerative colitis); history of CRC or colorectal polyps in the family; and genetic syndrome, like familial adenomatous polyposis or hereditary, nonpolyposis CRC called Lynch syndrome. Moreover, lifestyle factors that have been found to have an impact on the high risk of CRC are a sedentary lifestyle, low fruit and vegetable consumption, a diet low in fiber and high in fat, overweight and obesity, alcohol intake, and usage of tobacco (CDC, 2018b). I discuss the association between CRC and age, race, gender, BMI, and socioeconomic status (SES) in the following subsections.

Colorectal Cancer and Age

The risk of CRC increases as people age (American Cancer Society, 2018; CDC, 2018). According to the CDC (2018), 90% of cases of CRC happen in individuals who are at least 50 years old. The cancer of the large bowel is not commonly seen in individuals before 40 years of age (CDC, 2018). The incidence significantly increases between 40 and 50 years old and continues to rise after each decade (Macrae, 2016).

On the other hand, the SEER Program (2016) reported that in the United States, the incidence of CRC in both sexes on individuals less than 50 years old increased at the rate of 2% each year from 1992 through 2013. Data from the U.S. SEER database and some Western cancer registries mention that CRC incidence is increasing in individuals who are less than 50 while it is decreasing in older people (Siegel et al., 2018). Moreover, Siegel et al. (2017b) posited that certain cancer registries find an elevated incidence of

CRC in young adults 20–39 years old even though this incidence is still far lower compare to the people aged 50 years old or more. Steele et al. (2014) conducted a study to identify age-based CRC outcomes in an identical healthcare system and found that out of the 7,948 patients who participated in the study, patients who were < 40 years old and between 40–49 years old demonstrated more advanced disease (Stage III: 35% and 35%, respectively and Stage IV: 24% and 21%, respectively) in comparison to the patients who were 50–79 years old and > 80 years old (Stage III: 28% and 26%, respectively and Stage IV: 18% and 15%, respectively). Steele et al. concluded that in an equal-access system, there is a statistically significant association between younger people's presentation (< 50 years old) and advanced stage and higher recurrence of CRC. This can be explained by the fact that screening for CRC is not highly recommended for younger people even though they may be exposed to lifestyle factors that could trigger this cancer (Macrae, 2016) Macrae (2016) also posited that CRC is mostly seen at a younger age, and there is a higher frequency of CRC under age 50 in African Americans.

Colorectal Cancer and Race and Gender

Among all the ethnic groups in the United States, African Americans have the highest CRC rates (American Cancer Society, 2018; Macrae, 2016). African Americans demonstrate a higher incidence of CRC and mortality caused by CRC (Zaharek-Girgasky et al., 2015). In 2014, around 50 Black men and 39 Black women out of 100,000 got CRC versus 42 White men and 32 White women out of 100,000 (CDC, 2017a). African Americans also have a 20% higher CRC mortality compared to Whites (Jemal et al., 2010). African Americans mostly have the proximal distribution of CRCs and adenomas

(Macrae, 2016). Macrae (2016) stated that it is still not clear if these racial differences are due to the genetic or low frequency of access to screening and polypectomy within the African Americans population in the United States. In 2015, 51.1 Black men and 37.5 Black women out of 100,000 had CRC versus 42.5 White men and 32.7 White women out of 100,000 (CDC, 2018c; see Table 1). The CRC mortality rate is almost 25% greater in men than in women, but colonic adenomas and CRCs seem to be mostly seen more in the proximal distribution in females, especially in postmenopausal women (Macrae, 2016). Kim et al. (2015) stated that women demonstrate a higher risk of having proximal (i.e., right-sided) colon cancer compared to men, which is related with a more aggressive type of neoplasia. Moreover, the male gender and an age of 65 years old or more were still significant predictors of adenoma detection rate (ADR) (Pietrak, Kang, Patel, Colangelo, & Ahmad, 2017).

Table 1

Colorectal Rectal Cancer rate per 100,000 people in 2015

Sex	Black	White
Men	51.1	42.5
Women	37.5	32.7

Note. adapted from CDC, 2018b, https://gis.cdc.gov/Cancer/USCS/DataViz.html

Colorectal Cancer and BMI

There is an association between a higher BMI and elevated risks of both colon and rectal cancers in both genders, but the increases are higher in males than in females (National Cancer Institute, 2017). Individuals who are obese are about 30% more likely to have CRC than normal-weight group (National Cancer Institute, 2017). Ma et al. (2013) also found that general and central obesity had a positive association with the risk of CRC in their meta-analysis. Doleman, Mills, Lim, Zelhart, and Gagliardi (2016) ran a systematic review and meta-analysis of observational researches to identify the relationship between BMI and CRC outcomes. According to Doleman et al., obese and underweight patients demonstrated a higher risk of all-cause mortality and cancer-specific mortality compared to regular weight patients. Ashktorab et al. (2014) posited that men and overweight African Americans have almost twofold more chance to develop colorectal polyp and adenoma. The colon adenoma seen in men was on the right side (Ashktorab et al., 2014).

On the other side, Pietrak et al. (2017) conducted an extensive study examining for ADR in predominantly African Americans living in the inner city with extensive morbidity obese subpopulation. ADR is defined as the percentage of individuals 50 years of age at least who had a colonoscopy done for the first time and had at least one adenoma found and removed (Marcondes et al., 2015). Pietrak et al. concurred that gender and age represent a significant risk factor for greater ADR, but obesity failed to have an impact on ADR. In their study, Pietrak et al. concluded that BMI was not related to ADR or right-sided ADR after controlling for age, race, and gender. It is important to note that Murphy, Martin, and Sandler (2015) focused on three obesity measures which are body mass index (BMI), waist circumference , and waist-hip-ratio , and they found that BMI was not associated with colorectal cancer adenomas among African Americans but only among whites. Murphy et al. mentioned that African Americans demonstrated a high WHR or WC, which means that they could have few abdominal fats and more fat around the hips, which explain why there is no association between BMI and CRC adenomas among African Americans.

Colorectal Cancer and Socioeconomic Status

As mentioned in the introduction, in the United States, African Americans have the highest incidence of CRC and death rate due to CRC. DeSantis et al. (2016) stated that these inequalities could be due to social and economic disparities more than biological differences. For example, in 2014, African Americans were living more under the federal poverty level in comparison to non-Hispanic Whites (26% versus 10%), and the percentage of African Americans who completed 4 years of college was lower to the one of the non-Hispanic Whites (22% versus 36%; DeSantis et al., 2016). Furthermore, people with lower Socioeconomic Status (SES) are more likely to indulge in behaviors that elevate the risk of cancer (DeSantis et al., 2016).

The association of the education and the neighborhood SES with the risk of CRC is explained by the combination of healthy behaviors and BMI, especially for the right colon cancers (Doubeni, Major, et al., 2012). Low SES has been associated with an elevated risk for developing CRC (Doubeni, Laiyemo, et al., 2012; Macrae, 2016). Most studies were done in a predominately non-Hispanic White population. The socioeconomic disparity risk of newly diagnosed CRC patients is 33% to 50% due to potentially modifiable behaviors like physical activity, unhealthy diet, smoking, and obesity (Doubeni, Major, et al., 2012; Willet, 2005). The income level could play a role in some of those modifiable behaviors such as physical activity, diet, and smoking

(DeSantis et al., 2016). Jandova et al. (2016) stated that patients with high education levels and high incomes had a lower incidence of CRC.

People who do not have health insurance and the ones covered by Medicaid demonstrated a more advanced CRC than the privately insured patients (Tawk, Abner, Ashford, & Brown, 2015). Many African Americans fall into the category of uninsured, and advanced stages of disease; moreover, high risk of death from CRC was mostly seen in this population (Tawk et al., 2015). Furthermore, Fitzgerald, Lea, Brinkley, and Zervos (2014) pointed out that social/economic barriers like the access to care and the different systems of healthcare services could be the reason why patients in rural and large metropolitan counties have a higher incidence of advanced CRC even though this etiology is not clear enough. Therefore, the SES of the African Americans may explain their behaviors such as fruit and vegetable intake, and physical activity toward their colorectal cancer status.

Fruits and Vegetables

Consuming fruits and vegetables have health benefits (ChooseMyPlate, 2018). Individuals who eat a lot of fruits and vegetables have higher chances to diminish the risk of some chronic diseases because they provide nutrients that are vital for the health and maintenance of the body (ChooseMyPlate, 2018). Both fruits and vegetables have low fat, low calories, and no cholesterol; fruits have low sodium (ChooseMyPlate, 2018). Potassium, dietary fiber, vitamin C, and folate (folic acid) are some of the nutrients in fruits (ChooseMyPlate, 2018). In addition to the nutrients found in fruits, there is a vitamin in vegetables (ChooseMyPlate, 2018). The fiber in fruits and vegetables gives a feeling of fullness while providing fewer calories (ChooseMyPlate, 2018). According to the CDC (2018c) and ChooseMyPlate, a diet rich in some fruits and vegetables helps to avoid the development of certain types of cancers.

Table 2

Cup of Fruits and Vegetables Table

Fruit	Amounts that represent 1 cup	Other amounts that represent ½ cup of fruit/vegetable unless mentioned
Apple	½ large 1small 1 cup sliced or chopped, raw or cooked	½ cup, sliced or chopped, raw or cooked
Banana	1 cup sliced 1 large	1 small
Grapes	1 cup, whole or cut-up 32 seedless grapes	16 seedless grapes
Orange	1 large 1 cup ,sections	1 small
Strawberries	About 8 large berries 1 cup, whole, halved, or sliced, fresh or frozen	½ cup whole, halved or sliced
Spinach	1 cup cooked 2 cups raw	1 cup raw
Carrots	1 cup, strips, slices, or chopped, raw or cooked 2 medium 1 cup baby carrot (about 12)	1 medium carrot About 6 baby carrots
Sweet potato	1 large baked (2 ¼" or more diameter) 1 cup, sliced or mashed, cooked	
Cucumbers	1 cup, raw, sliced or chopped	
Lettuce, iceberg or head	2 cups, raw, shredded or chopped	1 cup, raw, shredded or chopped

Note. adapted from *ChooseMyPlate* , by U.S. Department of Agriculture, 2018 https://www.choosemyplate.gov/

The 2015–2020 Dietary Guidelines for Americans advises that adults eat 1.5–2 cups of fruits and 2–3 cups of vegetables every day (CDC, 2018c). Recent data demonstrated that few people consume the recommended amount of fruits and vegetables (Lee-Kwan, Moore, Blanck, Harris, & Galuska, 2017; Moore, Thompson, & Demissie, 2017). Lee-Kwan et al. (2017) stated that only one-tenth of U.S. adults consume the recommended quantity of fruits and vegetables daily. Generally, a cup of fruit or 100% fruit juice, or a half cup of dried fruit is the equivalent of a cup from the fruit group. Table 2 displays the exact amounts that represent a cup of fruits and vegetables in a daily recommended consumption from common fruits. Appendix A is an extensive list of fruits and vegetables from ChooseMyPlate (2018).

Colorectal Cancer - Fruits and Vegetables

Studies are still underway to identify if changing diet can diminish the CRC risk, and the experts in the medical field are not concurring on the impact of diet in the prevention of CRC (CDC, 2018d). On the other hand, several epidemiologic studies have demonstrated that there is an association between the consumption of a diet high in fruits and vegetables and the prevention from CRC which is the reason why medical experts recommend a diet low in animal fats and high in fruits, vegetables and whole grains which may reduce the risk of CRC (CDC, 2018d; Macrae, 2016). The relative risk of CRC is around 0.5 when a comparison is made between the highest fruits and vegetables intake groups and the lowest (Macrae, 2016). Tayyem et al. (2014) investigated the possible association between the number of servings and frequency of fruits and vegetables commonly consumed by Jordanians and the risk of developing CRC. Tayyem et al. found that total vegetable consumption was associated with the risk of developing

CRC. On the other hand, the authors found that consuming various types of fruits showed no association with risk of CRC (Tayyem et al., 2014).

Furthermore, Koushik et al. (2007) did a pooled analysis of 14 cohort studies to assess the association between fruits and vegetables and colon cancer. The conclusion was that consuming more than 800 g of fruit and vegetable every day in comparison to fewer than 200 g reduce the risk for distal colon cancer (Risk Ratio 0.74) but it is not the case for proximal colon cancer (Koushik et al., 2007). On the other side, after a meta-analysis of 19 cohort studies, Lee and Chan (2011) found that there was the weak protective impact of fruit and vegetable consumption for highest versus lowest consumption of fruits and vegetables (*RR* 0.92, 95% *CI* 0.86-0.99) which seemed to be limited to distal colon cancers only. In this case, the risk reduction was given to elevating consumption higher of 100g/day, with few benefits related to higher levels of consumption (Lee & Chan, 2011).

Lee et al. (2017) conducted a case-control study with 923 CRC patients and 1,846 controls from the National Cancer Center in Korea to identify the association between the colors of vegetables and fruits and the risk of CRC in Korea. Lee et al. found that high total consumption of fruits and vegetables was highly related to a reduced risk of CRC in females (*OR* = 0.32, 95% *CI*: 0.21-0.48 for highest *versus* lowest tertile) and similarly with men (*OR* = 0.60, 95% *CI*: 0.45-0.79). There was an inverse association between green and white vegetables and fruits and the risks of CRC in males and an inverse association between the green, red/purple, and white fruits and vegetables in females (Lee et al., 2017). On the other hand, orange/yellow fruit and vegetable consumption were associated with an elevated risk of CRC (*OR* = 1.61, 95% *CI*: 1.22-2.12) in men (Lee et al., 2017). In this study, Lee et al. concluded that fruits and vegetables consumption from different color groups might prevent CRC.

Another study had different findings. Luo et al. (2015) conducted a case-control study to investigate the association between the consumption of fruit and vegetable color groups and the risk of CRC in a Chinese population. Luo et al. found that the intake of orange/yellow, red/purple, and white vegetables and fruit was inversely related to the risk of CRC. Luo et al. also found that there was an inverse association between the intake of total fruit and vegetable and CRC risk. Furthermore, the consumption of green fruit and vegetable was not associated with the risk of CRC (Luo et al., 2015).

Bradbury, Appleby, and Key (2014) summarized findings published from the European Prospective Investigation into Cancer and Nutrition , which is a prospective cohort with more than 500,000 participants from 10 European countries. The study was on the association between fruit, vegetable, or fiber intake and the risk of 14 different cancer sites (Bradbury et al., 2014). Bradbury et al. concluded that the risk of CRC was inversely related to the consumption of whole fruits, vegetables, and total fiber. Also, Turati et al. (2017) evaluated the association between the application to the World Cancer Research Fund (WCRF) and the American Institute for Cancer Research (AICR), eight recommendations for cancer prevention on body fatness, diet and physical activity that were released in 2007. Turati et al. (2017) identified that there was an inverse association between the adherence to the WCRF/AICR and the CRC risk in two Italian case-control studies.

Nagle et al. (2015) stated that some cancers occurred due to insufficient intake of fruit and non-starchy vegetables, and 18% of CRC were due to insufficient fiber consumption. According to Nagle et al., if Australians consume fiber from fruits and vegetables daily, an estimated 8.8% of CRC is preventable. Aoyama et al. (2014) conducted a cohort study using data of 45, 516 and 14, 549 people (40-79 years) from the Japan Collaborative Cohort Study for Evaluation of Cancer Risk to identify any association between low consumption of fruits and vegetables and increased CRC since this evidence has been inconclusive. Aoyama et al. suggested that low consumption and continued low consumption of fruits and vegetables were not strongly associated with CRC risk.

The contradictory findings between the association of fruit and vegetable consumption with colorectal adenoma (CRA) risk continue with the study conducted by Qiwen et al. (2015). After a thorough meta-analysis of 22 studies that implicated 11,696 CRA participants, Qiwen et al. concluded that fruits intake has a significant protective impact on CRA, but the vegetables do not. It is important to note that findings in these studies varied from one population to another one; therefore, the plausible association between fruit and vegetable intake and CRC could be genetic or due to a combination of risk factors.

Colorectal Cancer - Fruits and Vegetables in African Americans

Busch, Galanko, Sandler, Goel, and Keku (2018) stated that race could modify associations between lifestyle factors and colorectal tumor methylation. Busch et al. posited that higher fruit intake was related to higher odds of high CRC tumor methylation among European Americans but not among African Americans. Satia-Abouta, Galanko, Martin, Ammerman, and Sandler (2004) examined the associations between different food groups and colon cancer in African Americans and whites in a case-control study. The finding of this study was that high refined carbohydrate and red meat intake was statistically significantly associated with a twofold elevated risk of colon cancer in non-energy adjusted models (Satia-Abouta et al., 2004). In the African Americans population, constant consumption of dairy foods was linked with twice the risk of colon cancer in non-energy-adjusted models, while constant fruit intake was associated with a non-significant 30% lower risk of colon cancer (Satia-Abouta et al., 2004). Nomura et al. (2016) examined whether the WCRF/AICR cancer prevention recommendations were related to CRC incidence in Black Women's Health Study. Nomura et al. found that there was no association between the adherence to cancer prevention recommendations and CRC risk within females in the Black Women's Health Study , which was not the case with the study done by Turati et al. (2017). These contradictory results indicate that it is crucial to assess these recommendations in this specific population.

After examining the associations of dietary patterns which included fruit and vegetable intake with colon cancer risk in African Americans and Whites from a case-control study in North Carolina, Satia, Tseng, Galanko, Martin, and Sandler (2009) concluded the findings explained that the presence of racial differences in colon incidence highlighted the importance of studying diet-cancer associations in various population subgroups. In the same sense, Satia-Abouta et al., 2004 mentioned that even though plant foods may have a protective effect against colon cancer, this impact changes by ethnic group.

Physical Activity

Physical activity is defined as the movement of the body that consumes energy (ChooseMyPlate, 2018). ChooseMyPlate.gov is a United States Department of Agriculture website that has the main objectives to focus on nutrition policy and promotion. According to Healthy People 2020 (2018), structural environments like the availability of sidewalks, bike lanes, trails, and parks have a positive impact on physical activity. Moderate to vigorous physical activities are recommended for health benefits (ChooseMyPlate, 2018; CDC, 2018e). Walking briskly, bicycling, general gardening, dancing, water aerobics, and doubles tennis are examples of moderate physical activities (ChooseMyPlate, 2018). Running/jogging, walking very fast, heavy yard work, swimming, aerobics, basketball, and singles tennis are examples of vigorous physical activities (ChooseMyPlate, 2018).

Colorectal Cancer and Physical Activity

The association between physical activity and colon cancer is not the same as the association between physical activity and rectal cancer (Physical Activities Guidelines Advisory Committee, 2018). An inverse association between physical activity and colon cancer has been found in several studies. On the other hand, the results have been contradictory with rectal cancer (Physical Activities Guidelines Advisory Committee, 2018).

Physically active people have a lower risk of colon cancer compared to the ones who are not active (CDC, 2018e). Kyu et al. (2013) stated that several observational studies noted that constant physical activity (occupational or leisure) is associated with colorectal cancer protection. Li et al. (2016) did a meta-analysis of 126 studies to assess the association between leisure-time physical activity and the risk of all cancer based on the World Health Organization (WHO) recommendation. Li et al. found that the present WHO recommendation of physical activity may impact the cancer risk by reducing it (7%), which is mainly given to its protective role against breast and CRC. There was an association between higher physical activity and reduced colon cancer risk (Morris, Bradbury, Cross, Gunter, and Murphy, 2018). High metabolic equivalents (METs) hours, which is around 60 MET-hours per week versus low, which is less than 10 MET-hours per week total physical activity, was related to reducing colon cancer risk, but not the rectal cancer (Morris et al., 2018). In the same sense, people who are practicing aerobic physical activity at a moderate pace or higher for 3-4 hours weekly have around 30% reduction in colon cancer (Physical Activities Guidelines Advisory Committee, 2018). This explains that there could be an increased genetic susceptibility in the association between CRC and physical activity or a combination of risk factors.

Income Level

According to the CDC (2018c), 7% of adults who are below the poverty level can meet the daily vegetable recommendation, while 11.4% of people with the highest income level are doing it. Lower-income can promote financial strain, which can have some impacts on lifestyle and overall health. Advani et al. (2014) posited that financial strain is associated with elevated unmet health needs, which implicate increased mortality among older African Americans. Many modifiable cancer risk factors like higher smoking rates, lower cessation rates, at-risk use of alcohol, obesity, and unhealthy dietary habits have been associated with the financial strain (Advani et al., 2014). Financial barriers can substantially have a negative impact on colorectal cancer medical care (Thomson and Siminoff, 2014). Liu, Zhang, and Xianglin (2016) found that in Texas, higher income was associated with a reduced risk of colorectal cancer. However, few studies pinpointed these relationships, especially within the African American population (Advani et al., 2014). The CDC (2019) stated that a family history of CRC, overweight and obesity, alcohol consumption, and tobacco use are among the factors that may elevate the risk of CRC. Macrae (2016) mentioned that age, gender, family history of CRC, obesity, tobacco, alcohol are among CRC risk factors. Confounders are defined as variables that influence both the dependent variable and independent variable yielding a spurious association. Therefore, age, gender, smoking status, and BMI were confounders in this study while income level was effect modifier.

Summary of Reviewed Literature and Transition

The topic of CRC within the African Americans population is crucial because this cancer is deadly and costly. Fruit and vegetable consumption are recommended for colorectal cancer prevention, but as mentioned by the CDC (2017b), not enough adults are meeting the recommendation. Furthermore, men, young people, and individuals living in poverty get the fewest amount of fruits and vegetables (CDC, 2017b). In the United States, 14.3% of African Americans are meeting federal fruit intake recommendations compared to 11.2% for Whites and 15.7% for Hispanic, and only 5.5% of African Americans are meeting the federal vegetable intake recommendations compared to 9.5% for Whites and 10.5% for Hispanic (Lee-Kwan et al., 2017). This finding represented one of the controversies on this topic. More White adults, around 28%, met the 2008 Physical Activity Guidelines for aerobic and muscle-strengthening in comparison to 18% of African Americans and 16% of Hispanic adults only (CDC, 2014). Also, 54% of males versus 46% of females were more likely to meet those guidelines (CDC, 2014). People with higher education and income level were also more likely to meet those guidelines (CDC, 2014).

While some studies showed the possible association between fruit and/or vegetable intake and CRC (Bradbury et al. 2014; Koushik et al. 2007; Lee et al., 2017; Luo et al. 2015; Nagle et al. 2015; Qiwen et al., 2015; Tayyem et al., 2014), other researches did not concur with these (Aoyama et al., 2014 & Nomura et al., 2016). Studies conducted by Kyu et al. (2013) and Li et al. (2016) found an association between fruit and vegetable intake and colorectal cancer. On the other hand, some studies like Lee and Chan (2011) and Morris et al. (2018) found an association only with colon cancer only and not rectal cancer and fruit and vegetable consumption and physical activity, respectively. It is important to note that most studies were done on other ethnic/races, and none focused on African Americans.

In this study, I examined the associations between each independent variable, fruit and vegetable consumption, physical activity, respectively, with CRC among African Americans in comparison to the whole population and the Whites. Furthermore, the interaction between all three risk factors, fruit and vegetable consumption, and physical activity and the occurrence of CRC among African Americans was assessed. Then, the association between the three independent variables and the occurrence of CRC and whether the association varies by race was examined. No studies previously examined whether fruits and vegetables consumption and physical activity have an impact on preventing CRC in African Americans while taking into consideration the income level as a confounder variable. Therefore, it allows this study to fill in this crucial gap. Moreover, the contradictory findings in the literature that exists regarding gender differences, fruits, and vegetables, colon and rectal cancer, will also be taken into consideration in this study. In the next chapter, I discussed the methodology used in the present study.

Chapter 3: Research Method

Introduction

The main purpose of this quantitative, retrospective, cross-sectional study was to identify if there is an association between fruit and vegetable consumption, physical activity, and CRC among African Americans. I used a secondary analysis of the HINTS, a large public data set. I also evaluated whether race interacts with dietary fruit and vegetable consumption and physical activity in the determination of association of CRC among African Americans. The high rate of CRC in developed countries has been linked to the adoption of a Western lifestyle, including elevated consumption of saturated and hydrogenated fats as well as high energy food (O’Neill et al., 2016). African American men and women are more likely to die of CRC than their counterparts in other races (CDC, 2017b). Understanding the association between fruit and vegetable consumption and physical activity could reveal trends that may help public health practitioners design CRC prevention strategies for African Americans while taking into consideration confounders, such as income level. The findings of this study could have an impact on the planning of preventive strategies and policies to combat the burden of CRC in the African American population. In this chapter, I present the research design and rationale; methodology (i.e., setting and sample, instrumentation and materials, data collection and analysis, protection of participants’ rights); threats to validity; and ethical procedures.

Research Design and Rationale

I designed this study as a secondary analysis of the HINTS 2011–2014 national data collection program. A quantitative, cross-sectional design was employed to analyze the association between the consumption of fruit and vegetable, physical activity, and CRC according to race. The independent variables were fruit consumption, vegetable consumption, and physical activity, and the dependent variable was CRC. The effect modifier variable was race. I used the following potential confounders: age, gender, smoking status, BMI, and income level. These confounders have been associated with CRC risk and outcomes in many studies. For the analysis, I only used questions from the 2011 to 2014 HINTSs that fell into the HBM constructs of behaviors regarding the consumption of fruits and vegetables, physical activity, and the diagnostic status of CRC in African Americans. The questions were easily identified because the type of survey question categorizes the HINTS data.

Population

HINTS (2018b) is a nationally representative survey that has been conducted every few years by the National Cancer Institute since 2003. The target population of the HINTSs performed from 2011 to 2014 was adults over the age of 18 years old in the civilian, noninstitutionalized population of the United States (HINTS, 2018b). The HINTS 4, which was the version of HINTS used in this study, included four, mail-mode data collection cycles in the 3 years. In this study, I used all four cycles of HINTS 4. They had to complete a total of 3,500 interviews for each mode (HINTS, 2018b). According to HINTS:

HINTS 4 Cycle 1: October 2011 – February 2012

HINTS 4 Cycle 2: October 2012 – January 2013

HINTS 4 Cycle 3: September 2013 – December 2013

HINTS 4 Cycle 4: August 19, 2014 – November 17, 2014

Sampling and Sampling Procedures

The sample design for the HINTS 4 survey had two stages (HINTS, 2018b). First, a stratified sample of addresses was chosen from a file of residential addresses (HINTS, 2018b). Next, in the second stage, a sample of people older than 18 years of age within sampled households was selected (HINTS, 2018b).

The sampling frame of all four cycles of HINTS 4 consisted of a database of addresses used by the Marketing Systems Group (MSG) to give random samples of addresses (HINTS, 2018b). The addresses that were part of the sampling were: every nonvacant residential address in the United States present on the MSG databases, which included post office (PO) boxes; throwbacks, such as street addresses for which the U.S. Postal Service redirects mail to a specified PO box; and seasonal addresses (HINTS, 2018b). According to HINTS (2018b), the stratification was done by grouping the sampling frame into three explicit sampling strata:

- Addresses in areas with high concentrations of an ethnic minority population.
- Addresses in areas with a low concentration of ethnic minority population.
- Addresses located in counties comprising Central Appalachia, regardless of ethnic minority population.

HINTS (2018b) created high and low ethnic minority strata, then oversampled the high minority stratum to increase the precision of estimates for minority subpopulations. In each cycle of HINTS 4, an equal-probability sample of addresses was chosen from within each explicit stratum (HINTS, 2018b). The total number of addresses selected for

HINTS 4 Cycle 1, Cycle 2, Cycle 3, and Cycle 4 were, respectively: 12,385; 12,055; 12,010; and 14,000 for each cycle (HINTS, 2018b). In HINTS 4 Cycle 1, Cycle 2, Cycle 3, and Cycle 4, respectively, there were 6,730; 7,490; 7,790; and 8,855 from the high minority stratum; 5,047; 4,350; 4,123; and 5, 025 from the low minority stratum; and 180; 215; 97; 120 from the Central Appalachia stratum (HINTS, 2018b). The high-minority strata's proportion of the sampling frame was 23.4 %; 24.6%; 24.6%; and 25%, respectively, and oversampled so that their proportions of the sample were 54.3%; 62.1%; 64.9%; and 63.3%, respectively, for each cycle (HINTS, 2018b). Per HINTS:

- In Cycle 1, complete data collected from 3,959 respondents.
- In Cycle 2, complete data collected from 3,630 respondents.
- In Cycle 3, complete data collected from 3,185 respondents.
- In Cycle 4, complete data collected from 3,677 respondents.

Inclusion and Exclusion Criteria

The inclusion criteria required that HINTS participants in this study had completed data information regarding fruit and vegetable consumption, physical activity, income level, age, gender, smoking status, and BMI as well as colorectal or colon and rectal cancer status data. On the other side, exclusion criteria focused on the questionnaires. Participants were excluded from the study if they failed to complete the HINTS questionnaires regarding the main variables.

Power Analysis

I conducted statistical power analyses using G*Power 3.1.9.2 tests for logistic regression analyses. G*Power 3.1.9.2 is a free, downloadable, statistical analysis program usually used in social, behavioral, and biomedical studies, and it works on most computers. G*Power 3.1.9.2 covers a large variety of statistical tests, power analysis, effect size calculations, and graphic options (Cohen, 2013). Since this study was a quantitative epidemiological study, G* Power 3.1.9.2 was well suited for determining the appropriate sample size. The application specific to logistic regression was also well suited for this study.

I completed a power analysis to identify the minimum sample size for this study. The test family used was *z* tests, and the statistical test used was logistic regression. I conducted an a priori power analysis to compute sample size, assuming:

1. One tail or two tail.
2. The statistical power level at 0.8. The power level value should be higher than or equal to 0.80 by convention.
3. Probability level: 0.05. Also called *p* value, alpha level, or Type I error rate. The *p* value should be less than or equal to 0.05 to claim statistical significance by convention (Cohen, 1969).

Based on the results of this analysis, I concluded that the total sample size should be a minimum of 568 (one tail) or 721 (two tails) participants, and the number of samples supplied by the HINTS data set met this criterion.

Recruitment, Participation, and Data Collection in the Main Study

It is important to note that a total of four mailings were sent out to participants during Cycles 2, 3, and 4 (HINTS, 2018b). All households received the first mailing and the reminder postcard (HINTS, 2018b). The nonresponding families received the last two survey mailings. On the other hand, five mailings went out during Cycle 1 (HINTS, 2018b). During this cycle, all participants received the first mailing, and only nonresponding families got the remaining four mailings (HINTS, 2018b).

Procedure for Accessing the Data Set

HINTS is a data set that is open to the public, and it is easily accessible through the HINTS website: https://hints.cancer.gov. On the main page, there is a column titled, "Data," between the columns of "About HINTS" and "View Questions/Topics." In this column, there are the following subpages to guide the users in accessing the database:

- Download Data
- Summary Findings by Items
- Survey Instrument
- Methodology Reports
- How-to HINTS Webinar

The first subpage, "Download Data," leads to "Public Use Dataset." HINTS provided three ways to access each cycle (i.e., Statistical Analysis System , STATA, and Statistical Package for the Social Sciences (SPSS)).

Permissions to Gain Access to the Data

The results of HINTS are public data that are accessible online. Therefore, no permission was needed before data collection. I received approval from the Walden University Institutional Review Board (Approval No 04-09-19-0585538) before data were collected.

Instrumentation and Materials

The HINTS 4 was the instrument of choice because the HINTS is reliable, incorporates a large sample, was explicitly designed for cancers, and includes all the crucial variables for this study. The survey questions were retrieved from the HINTS website. Moreover, HINTS data information is in the public domain and, therefore, does not require permission to access it. Several questions had been used in the previous HINTSs and had been demonstrated to be valid and reliable. Nelson et al. (2004) stated that there was an internal HINTS advisory committee who got together to put up the principles and framework for the selection of topics and questions for the survey instrument. This committee created criteria for the inclusion of measures on the survey instrument, covering scientific validity, utility, and implementation (Nelson et al., 2004). Examples of criteria for the inclusion of measures in the HINTS interview instrument were:

- Scientific validity criteria: Well-established questions for assessing information or knowledge on cancer; participants are at least 18 years old to ensure that the self-reported data can yield valid estimates for the adult population; and the adequacy of the sample size.
- Utility criteria: Data will help guide the National Cancer Institute's program efforts in health communication and health promotion as well as monitor Healthy People 2010 health communication objectives.
- Implementation criteria: There was an equitable distribution of questions among different subjects, and the instrument would have the capacity to be

used to do experimental studies to identify the effects of question-wording (Nelson, 2004).

HINTS 4, Cycle 1 (2011), Cycle 2 (201, Cycle 3 (2013), and Cycle 4 (2014) consisted of a single-mode mail survey, using the next Birthday Method for respondent selection (HINTS, 2018). There were an English and a Spanish version of the questionnaires. English speakers received just the English version, and Spanish speakers received both English and Spanish versions of the questionnaire (HINTS, 2018b). The instruments used for HINTS 4 Cycle 1, Cycle 2, Cycle 3, and Cycle 4 were survey questionnaires consisting of two stages (HINTS, 2018b). First, a stratified sample of addresses was chosen from a file of residential addresses (HINTS, 2018b). Next, in the second stage, a sample of people older than 18 years of age within sampled households was selected (HINTS, 2018b).

To provide random samples of addresses, the Marketing Systems Group (MSG) was used. Also, two toll-free 800 numbers were given to participants. One toll-free 800 number was used for English calls, and the other one was used for Spanish calls (HINTS, 2018b). These numbers were both given in each mailing (HINTS, 2018b). Respondents were told that they could call the number if they had comments, concerns, or if they needed to request anything special (such as additional questionnaires or a questionnaire in Spanish (HINTS, 2018b).

Operationalization of Constructs

In this current study, I used just a part of the questionnaire. This research was a secondary data analysis of a larger database. The different questions from the HINTS survey picked for analysis of this study will be operationalized in this section.

Race / Ethnicity

Race/ethnicity was operationally defined as self-report of being "Non-Hispanic Black or African American" on the HINTS. On HINTS 4, the participants had to answer questions [RaceEthn] for Cycles 1 and 2, the question [011] on Cycle 3, and question [Race_Cat2] on Cycle 4. All HINTS participants who failed to self-identify themselves as "Non-Hispanic Black or African American" were excluded for failing to meet this inclusion criterion. Table 1 shows the response options.

Colorectal Cancer

HINTS provided a questionnaire for colorectal cancer status and colon and rectal cancers separately in Cycle 4. CRC was operationally defined in the HINTS self-report as a known diagnosis of the disease. The participants were asked if they were ever diagnosed as having cancer, and the participants who answer "yes" on this question were asked which type of cancer they had. Have you ever been diagnosed as having cancer? " Was the question [H1], [M1], [L1], [L1], for HINTS 4 Cycle 1, Cycle 2, Cycle 3, and Cycle 4 respectively. Table 3 shows the response options. People with a history of cancer were asked: "What type of cancer did you have?". Table 3 shows the response options. Participants who were diagnosed with CRC selected it as their choice, and the ones who were not diagnosed with CRC did not select it.

Fruit and Vegetable intake

Fruit and vegetable consumption were operationally defined as questions that ask the participants to indicate how many cups of fruit/vegetables they ate daily. HINTS fruit and vegetable intake items are:

Fruits intake variable:

Question [D7], [G5], [H7], [G4] on HINTS 4 Cycles 1, 2, 3, and 4 respectively was “About how many cups of fruit (including 100% pure fruit juice) do you eat or drink each day?” Table 3 shows the response options.

Vegetable intake variable:

Question [D6], [G3], [H6], [G2] on HINTS 4 Cycles 1, 2, 3, and 4 respectively was “About how many cups of vegetables (including 100% pure vegetable juice) do you eat or drink each day?” Table 3 shows the response options.

In this study, new binomial variables were created for fruit and vegetable consumption to indicate their recommended intakes. Their values will be respectively

- Fruit intake: Not recommended consumption (0) = *None*, *1/2 cup or less, 1/2 to 1 cup, 1 to 2 cups*, and Recommended consumption (1) = *2 to 3 cups, 3 to 4 cups, 4 or more cups*
- Vegetable intake: Not recommended consumption (0) = *None, 1/2 cup or less, 1/2 to 1 cup, 1 to 2 cups, 2 to 3 cups*, and Recommended consumption (1)= *3 to 4 cups, 4 or more cups.*

Physical Activity

Physical activity was operationally defined as the HINTS self-report of how many days participants did any physical activity or exercise of at least moderate intensity. Examples of exercise of at least moderate intensity were brisk walking, bicycling at a regular pace, swimming at a regular pace, and heavy gardening. Another question asked the participants about the length of their physical activity.

The question was [D9], [H1], [H9], and [H1] for HINTS 4 Cycle 1, Cycle 2, Cycle 3, and Cycle 4 respectively. The question was: "In a typical week, how many days do you do any physical activity or exercise of at least moderate intensity, such as brisk walking, bicycling at a regular pace, swimming at a regular pace, and heavy gardening?" Table 3 shows the response options.

Physical activity variable was created to a binomial variable as:

- Not recommended physical activity (0) = *None, 1 day per week, 2 days per week*
- Recommended physical activity (1) = *3 days per week, 4 days per week, 5 days per week, 6 days per week, 7 days per week*

Income Level

Income level was operationally defined as the HINTS self-report of the combined annual income, meaning the total pre-tax income from all sources earned in the past year by the participants. Question [K17], [DM-7], [O18], and [N18] on HINTS 4 Cycles 1, 2, 3, and 4 respectively was "What is your combined annual income, meaning the total pre-tax income from all sources earned in the past year?". Table 3 shows the response options.

Statistical Analysis

The cross-sectional study design was used to examine the hypotheses of this dissertation. As mentioned above, public access data from HINTS was the source for the data about participants who are at least 18 years of age, their CRC status, their fruit and vegetable intake, their physical activity, their age, their gender, their smoking status, their BMI, and their income level. The research questions identified if there are associations between the dependent variable CRC and the independent variables. Data from all participants who are at least 18 years of age in HINTS sample years 2011-2012, 2012-2013, 2013, 2014, was used. The data for the study was retrieved in the HINTS web site. The information files were opened with SPSS. The combined data from the 3 years of HINTS was used within the statistical analysis described below. Two continuous variables and eight categorical variables, with two to nine levels were used. Table 3 showed the description of the variables.

Description of Variables

Table 3

Data Dictionary

Variables	Variable type	Values options for this variable
Dependent variable		
Colorectal cancer (what type of cancer)	Nominal, categorical	Colorectal cancer Selected Colorectal cancer Not Selected
Independent variables		

continues

Table 3 *Data Dictionary* (continues)

variables	Variable type	Values options for this variable
Fruit consumption	Ratio, categorical	0 = None, 1/2 cup or less, 1/2 to 1 cup, 1 to 2 cups 1 = 2 to 3 cups, 3 to 4 cups, 4 or more cups
Vegetables consumption	Ratio, categorical	0 = None, 1/2 cup or less, 1/2 to 1 cup, 1 to 2 cups, 2 to 3 cups 1= 3 to 4 cups, 4 or more cups
Physical activity	Ratio, categorical	0 = None, 1 day per week, 2 days per week 1 = 3 days per week, 4 days per week, 5 days per week, 6 days per week, 7 days per week
Effect modifier variable		
Race	Nominal, categorical	African Americans, Whites.
Confounder variables		
Age	Integral, continuous	18-99 years
Gender	Nominal , categorical	Male, Female
Smoking status	Nominal, categorical	Every day, somedays, not at all
BMI	Ratio, continuous	13%-92%
Income level	Nominal, categorical	Less than $25,000, $25,000 to <$35, 000, $35,000 to <$50, 000, $50,000 to <$75, 000, $75, 000 or More, Less than $20,000, $20,000 to < $35,000, Refused, Don’t know

Research Questions and Hypothesis

Research Question 1: Is there an association between fruit consumption the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0$1: There is no association between fruit consumption and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

H_a1: There is an association between fruit consumption and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

Research Question 2: Is there an association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level?

$H_0$2: There is no association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

H_a2: There is an association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

Research Question 3: Is there an association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level?

$H_0$3: There is no association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

H_a3: There is an association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

Research Question 4: Is there an association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level?

$H_0$4: There is no association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

H_a4: There is an association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors such as age, gender, BMI, smoking status, and income level.

Research Question 5: Is there an association between fruit and vegetable consumption, physical activity, and the occurrence of colorectal cancer when stratified by race?

$H_0$5: There is no association between fruit and vegetable consumption, physical activity, and the occurrence of colorectal cancer when stratified by race.

H_a5: There is an association between fruit and vegetable consumption, physical activity, and the occurrence of colorectal cancer when stratified by race.

The dependent variable for all five hypotheses was CRC. The independent variables for testing Hypotheses 1, 2, and 3 were fruit intake, vegetable intake, and physical activity, respectively. For Hypotheses 4 and 5, the independent variables were fruit intake, vegetable intake, and physical activity. For Hypothesis 5, the race was the effect modifier variable, so that the association between fruits and vegetable consumption, and physical activity and CRC among African Americans could be assessed.

Regression Analysis

Using SPSS 25.0, a regression coefficient was calculated to determine if there are significant associations between one and more of these variables. Hypotheses 1,2, and 3 were tested using univariate binary logistic regression (Table 2). The dependent variable here was colorectal cancer, and their independent variables were fruit intake, vegetable intake, and physical activity, respectively. Binary logistic regression was the right statistic for testing these hypotheses because the dependent variable (CRC) is dichotomous (yes/no), and their respective independent variables are continuous scaled variables. Moreover, the aim of the analysis here was to identify whether these independent variables are significantly related to colorectal. These hypotheses were tested at the $p < .05$ threshold for statistical significance. Table 2 showed the analysis plan for this study.

Hypothesis 4 was tested using multiple binary logistic regression (Table 2). The dependent variable here was CRC, and the independent variables were fruit intake, vegetable intake, and physical activity. Multiple binary logistic regression was the appropriate statistic for testing this hypothesis because the dependent variable (CRC) is dichotomous (yes/no), and there is more than one independent variable, which is all continuous scaled variables. This hypothesis was tested at the $p < .05$ threshold for statistical significance. Table 1 shows the analysis plan for this study.

Equation 1: Y = a + b1X1 + b2X2 + b3X3

Where Y = the predicted value of the dependent variable

a = the intercept

X1 = the Predictor variable (fruit intake)

X2 = the Predictor variable (vegetable intake)

X3 = the Predictor variable (physical activity)

Hypothesis 5 will be tested using multiple binary logistic regression (Table 2). The dependent variable here was CRC, and the independent variables were fruit intake, vegetable intake, and physical activity, and the effect modifier variable was the race. Multiple logistic regression was the appropriate statistic for testing this hypothesis because the dependent variable (CRC) is dichotomous (yes/no), and there is more than one independent variable, which are all continuous scaled variables. This hypothesis was tested at the $p < .05$ threshold for statistical significance. Table 4 shows the analysis plan for this study.

Effect modification occurs when the effect measure depends according to the level of another factor. In other words, the effect modification separates exposure effects based on another variable. An effect modifier variable is the one that modifies positively or negatively the observed effect of a risk factor on a disease status, which will be colorectal cancer in this study.

Equation 2: Y = a + b1X1 + b2X2 + b3(X1xX2)

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

a = the intercept

X1 = the Predictor variable (fruit intake or vegetable intake or physical activity)

X2 = the Effect Modifier variable (income level)

X1xX2 = the Predictor by Moderator interaction (fruit intake or vegetable intake or physical activity X income level)

Also, the confounder variables will be included in the research question 5.

Table 4

Summary of Analyses and Variables

Research question	Independent variables (IV)	IV level of measurement	Dependent variable (DV)	DV level of measurement	Effect Modifier (EM)	EM level of measurement	Statistical Analysis
RQ1	Fruit intake	Continuous scaled	Colorectal cancer	Binary			Binary Logistic regression
RQ2	Vegetable intake	Continuous scaled	Colorectal cancer	Binary			Binary Logistic regression
RQ3	Physical activity	Continuous scaled	Colorectal cancer	Binary			Binary Logistic regression
RQ4	1-fruit intake 2-vegetable intake 3-physical activity	Continuous scaled	Colorectal cancer	Binary			Binary Multiple logistic regression
RQ5	1-fruit intake 2-vegetable intake 3-physical activity	Continuous scaled	Colorectal cancer	Binary	Race	Continuous scaled	Binary Multiple logistic regression

Threats to Validity

According to Creswell (2009), it is crucial to identify potential threats to the internal validity and external validity of a study. Eventual confounders within the study design, participants' answers, or procedures that could bias results are determined within internal validity (Creswell, 2009). History, maturation, experimental mortality, subject selection, and testing are threats to internal validity (Creswell, 2009).On the other hand, when looking at external validity, it is crucial to assess if study findings are generalized to other populations other than the one in the actual study (Creswell, 2009).

History and maturation were not threats to internal validity because the current study is a cross-sectional design that did not include measures over time (Creswell, 2009). Since this study was not experimental, the threats to validity that were covered were those that focus on subject selection and measurement bias. The questions asked in the HINTS surveys were valid and reliable because, throughout the extended process, several steps provided validity and reliability. These steps were:

1. First, experts met in advance to discuss operational problems and gave advice on the content of the surveys, and an internal advisory committee developed the questionnaire that included inclusion and exclusion criteria
2. The measurement of population-based constructs in reliable manners that were supported by external evidence was demonstrated by scientific validity according to inclusion items.
3. A well-known company administrated the surveys
4. Several steps were taken in each cycle to maximize the response rate.

The unique inclusion criteria for participants in this study was that they responded to the HINTS cycles surveys. HINTS survey questions come from a large reputable study that has been validated over the past 15 years, and after the substantial amount of research is done, it can be concluded that it is reliable within the constructs it is meant to be used. In 2005, Finney Rutten, Wanke, and Augustson (2005) researched the systems and individual factors associated with smoking status using HINTS data. In 2008, Coups, Hay, and Ford (2008) did a study on the awareness of the role of physical activity in colon cancer prevention using HINTS data. In 2013, Jun (2013) also used HINTS data to research Asian and Hispanic Americans’ cancer fatalism and colon cancer screening. Another example of research that was done using HINTS data is the one Nawaz et al. (2014) did to find out if the inpatient hospital setting is a golden opportunity to improve colon cancer screening rates in the United States.

Ethical Procedures

Treatment of Human Subject

In this study, I accessed data previously collected and did not require interaction with human participants directly. The National Cancer Institute kept the data anonymous; therefore, this study did not have access to identifying information that may cause any breach of ethical standards. Upon the approval by the Institutional Review Board at Walden University (Approval No 04-09-19-0585538), the data were accessed only for analysis.

Ethical Concerns

To protect the identity of the participants, HINTS gave each of them a random identification number. Information such as name, social security number, date of birth, phone number, or address was not included in the data information sources provided by HINTS. Also, this study was a cross-sectional one that used secondary data recruitment materials; therefore, processes were not concerned. Moreover, no intervention activities were done because the HINTS data was based on the survey questionnaire.

Summary and Transition

This quantitative, retrospective, cross-sectional study was designed to identify if there is an association between the dietary consumption of fruits and vegetables, physical activity, and colorectal cancer. Also, this study determined if the association between these variables varies according to the race of the participants. Quantitative data from HINTS, which is a large national database available to the public, was obtained to answer five research questions.

HINTS data were downloaded from the HINTS website, then analyzed using SPSS statistical software. All hypotheses were tested using binary regression. In this chapter, I; highlighted the research design and rationale; methodology (setting and sample, instrumentation and materials, data collection and analysis, protection of participants' rights); threats to validity; and ethical procedures. In Chapter 4, I focused on the data collection and the results of this study.

Chapter 4: Results

Introduction

I designed this study to identify the association between fruit and vegetable consumption, physical activity, and CRC in African Americans in comparison to the whole population and Whites, specifically. Data from the 2011–2014 HINTS database were used for this study. The data collection process was described in Chapter 3. The following five research questions and their corresponding hypotheses were tested to determine this association:

Research Question 1: Is there an association between fruit consumption the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0$1: There is no association between fruit consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

H_a1: There is an association between fruit consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 2: Is there an association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0 2$: There is no association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

$H_a 2$: There is an association between vegetable consumption and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 3: Is there an association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0 3$: There is no association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

$H_a 3$: There is an association between physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 4: Is there an association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level?

$H_0 4$: There is no association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

H_a4: There is an association between fruit and vegetable consumption and physical activity and the occurrence of colorectal cancer after controlling for confounding factors, such as age, gender, BMI, smoking status, and income level.

Research Question 5: Is there an association between fruit and vegetable consumption, physical activity and the occurrence of colorectal cancer when stratified by race?

H_05: There is no association between fruit and vegetable consumption, physical activity and the occurrence of colorectal cancer when stratified by race.

H_a5: There is an association between fruit and vegetable consumption, physical activity and the occurrence of colorectal cancer when stratified by race.

In Chapter 4, I present the data collection and results of the study as well as provide a summary. In this chapter, the results of this study are organized by sections with relevant tables addressing the research question components. I also discuss the hypothesis testing used to determine the association between the incidence of CRC and the various variables of interest.

Data Collection

I used data from HINTS Cycles 1, 2, 3, and 4. Participants were aged 18 years and older and resided in the United States. The HINTS 2011–2014 data had 14,451 total participants with 3,959; 3,630; 3,185; and 3,677 participants, respectively, for Cycle 1: Years 2011–2012, Cycle 2: Years 2012–2013, Cycle 3: Year 2013, and Cycle 4: Year 2014 (HINTS, 2018). The sample size for this study was 14,451. HINTS data are available to the public in many formats, including the SPSS data set for I used for analysis in this study. In Chapter 3, I described the study design, data collection, variables, and the method of analysis.

I downloaded data from HINTS 4 Cycles 1, 2, 3, and 4 after receiving Walden University IRB approval (Approval No. 04-09-19-0585538) and merged them into a data file in SPSS Version 25.0 for statistical analysis. The variables were examined and recoded to ensure inclusion criteria were met. Table 5 summarizes the dependent and independent variables, including their recoded values.

Table 5

Summary of Analyses and Variables

	Variable from HINTS	Code from HINTS	New Code
Colorectal cancer	Colon cancer and rectal cancer	Selected Non-selected	Yes No

continues

Table 5 *Summary of Analyses and Variables* (continues)

	Variable from HINTS	Code from HINTS	New Code
Recommended fruit intake	Fruit (About how many cups of fruit (including 100% pure fruit juice) do you eat or drink each day?)	0 = None 1= 1/2 cup or less 2= 1/2 to 1 cup 3= 1 to 2 cups 4 = 2 to 3 cups 5 = 3 to 4 cups 6= 4 or more cups	0 = none, ½ cup or less, ½ to 1 cup, 1 to 2 cups = Not recommended fruit 1= 2 to 3 cups, 3 to 4 cups, 4 or more cups = Recommended fruit
Recommended vegetable intake	Vegetables (About how many cups of vegetables (including 100% pure vegetable juice) do you eat or drink each day?)	0 = None 1= 1/2 cup or less 2= 1/2 to 1 cup 3= 1 to 2 cups 4 = 2 to 3 cups 5 = 3 to 4 cups 6= 4 or more cups	0 = none, ½ cup or less, ½ to 1 cup, 1 to 2 cups, 2 to 3 cups = Not recommended vegetable 1= 3 to 4 cups, 4 or more cups = Recommended vegetable
Recommended physical activity	Times Moderate Exercise (In a typical week, how many days do you do any physical activity of at least moderate intensity?)	0 = None 1= 1 day per week 2= 2 days per week 3 = 3 days per week 4= 4 days per week 5= 5 days per week 6= 6 days per week 7= 7 days per week	0 = none, 1 day per week, 2 days per week = Not recommended physical activity 1= 3 days per week, 4 days per week, 5 days per week, 6 days per week, 7 days per week = Recommended physical activity
Age	Age (What is your age?)	18-99 years old	1 = 18-34 years old 2= 35-49 years old 3= 50-64 years old 4= 65-74 years old 5= 75 years old and more
Gender	Gender (Are you male or female?)	Male Female	Male Female
Smoking status	Smoke Now (How often do you now smoke cigarettes?)	1= Every day 2= somedays 3= not at all	1= Every day 2= somedays 3= not at all
BMI	BMI. Body Mass Index (Weight*703)/(Height in inches**2)	13-92	Underweight = <19% Healthy = 19-24 Overweight = 25-29 Obese = > 29

Continues

Table 5 *Summary of Analyses and Variables* (continues)

	Variable from HINTS	Code from HINTS	New Code
Income levels	Income Ranges (What is the total household pre-tax income from all sources earned in the past year?)	1 =$0 - $9, 999 2= $10, 000 - $14, 999 3= $15, 000 - $19, 999 4= $20, 000 - $34, 999 5= $35, 000 - $49, 999 6= $50, 000 - $74, 999 7= $75, 000 - $99, 999 8= $100, 000 - $199, 999 9= $200, 000 or more	1 =$0 - $9, 999 2= $10, 000 - $14, 999 3= $15, 000 - $19, 999 4= $20, 000 - $34, 999 5= $35, 000 - $49, 999 6= $50, 000 - $74, 999 7= $75, 000 - $99, 999 8= $100, 000 - $199, 999 9= $200, 000 or more
Race/ethnicity	Race/Ethnicity. (Hispanic, American Indian, Asian, Black, Pacific Islander, and White)	1= Hispanic 2= Non-Hispanic White 3= Non-Hispanic Black or African American 4= Non-Hispanic American Indian or Alaska Native 5= Non-Hispanic Asian 6= Non-Hispanic Native Hawaiian or other Pacific Islander 7= Non-Hispanic Multiple Races Mentioned	1= Hispanic 2= Non-Hispanic White 3= Non-Hispanic Black or African American 4= Non-Hispanic American Indian or Alaska Native 5= Non-Hispanic Asian 6= Non-Hispanic Native Hawaiian or other Pacific Islander 7= Non-Hispanic Multiple Races Mentioned

Colorectal Cancer

The CRC variable was the combination of colon cancer and rectal cancer. Every participant who selected “colon cancer” and/or “rectal cancer” to the question, “What type of cancer did you have?” was classified as having CRC. On the other hand, people who did not have CRC and those who had other cancers types were classified as not having CRC.

Recommended Fruits Intake

I recoded fruit consumption from ‘Fruit” to “Recommended Fruit Intake.” In the original HINTS data set, participants were asked “About how many cups of fruit (including 100% pure fruit juice) do you eat or drink each day?”The answer choices were coded as 0 = *None*, 1 = *1/2 cup or less*, 2 = *1/2 to 1 cup*, 3 = *1 to 2 cups*, 4 = *2 to 3 cups*, 5 = *3 to 4 cups*, and 6 = *4 or more cups* (HINTS, 2018). In this study, the recommended fruit intake variable was a nominal variable with only two answer choices, as Table 5 indicated.

According to the CDC (2018), the 2015–2020 Dietary Guidelines for Americans advises that adults eat 1.5–2 cups of fruits every day. Therefore, I recoded people who answered Codes 0, 1, 2, and 3 in the original HINTS data set as 0, which is not recommended fruit intake. The people who responded to Codes 4, 5, and 6 in the initial HINTS data set were recoded as 1, which is recommended fruit intake. The missing data and multiple answers were not included in the analysis.

Recommended Vegetable Intake

I recoded vegetable consumption from ‘Vegetable” to “Recommended Vegetable Intake.” In the original HINTS data set, participants were asked, “About how many cups of vegetable (including 100% pure vegetable juice) do you eat or drink each day?” The answer choices were coded as 0 = *None,* 1 = *1/2 cup or less*, 2 = *1/2 to 1 cup*, 3 = *1 to 2 cups*, 4 = *2 to 3 cups*, 5 = *3 to 4 cups*, and 6 = *4 or more cups* (HINTS, 2018). In this study, the recommended vegetable intake variable was a nominal variable with only two answer choices, as Table 5 indicated.

According to the CDC (2018), the 2015–2020 Dietary Guidelines for Americans advises that adults eat 2–3 cups of vegetables every day. Therefore, people who answered Codes 0, 1, 2, 3, and 4 in the original HINTS data set were recoded as 0, which is not recommended vegetable intake. I recoded the people who responded to Codes 5 and 6 in the original HINTS data set as 1, which is recommended vegetable intake. The missing data and multiple answers were not included in the analysis.

Recommended Physical Activity

I recoded recommended physical activity was recoded from "Times Moderate Exercise" to "Recommended Physical Activity." In the original HINTS data set, participants were asked, "In a typical week, how many days do you do any physical activity of at least moderate intensity?" The answer choices were coded as 0 = *None*, 1 = *1 day per week*, 2 = *2 days per week*, 3 = *3 days per week*, 4 = *4 days per week*, 5 = *5 days per week*, 6 = *6 days per week*, and 7 = *7 days per week* (HINTS, 2018). In this study, the recommended physical activity was a nominal variable with only two answer choices, as indicated in Table 5. People who answered Codes 0, 1, and 2 in the original HINTS data set were recoded as 0, which is not recommended physical activity. I recoded the people who responded to Codes 3–7 in the initial HINTS data set as 1, which is recommended physical activity. The missing data and multiple answers were not included in the analysis.

Age

In the original HINTS data set, participants were asked the question, "What is your age?" The answers ranged from 18 to 99 years old. Age was already recoded into five levels from people aged 18–99 years old to 18–34, 35–49, 50–64, 65–74,and 75 or older as indicated in Table 1. The missing data and multiple answers were not included in the analysis.

Gender

In the original HINTS data set, participants were asked the question, "Are you male or female?" They had only two options to answer with. This variable was not recoded, but the missing data and multiple answers were not included in the analysis.

Smoking Status

In the original HINTS data set, participants were asked the question, "How often do you now smoke cigarettes?" They had three answer options, which I kept in this study. These options were: 1 = *Every day*, 2 = *somedays*, and 3 = *not at all*. Some participants had never smoked before, which was coded as -1, and the one who answered in error was coded as -2 (see Table 1). The missing data and multiple answers were not included in the analysis.

BMI

In the original HINTS data set, participants were asked to provide their BMI using the formula: Body Mass Index (Weight*703)/(Height in inches**2). The answers ranged from 13 to 92 (HINTS, 2018). In this study, I recoded the BMI variable to include four answer options: underweight, healthy, overweight, and obese, which represented respectively the BMIs of < 19%, 19%–24%, 25%–29%, and > 29%, respectively, as indicated in Table 1. According to the CDC (2017), these are the standard weight status categories related to BMI ranges for adults. The missing data and multiple answers were not included in the analysis.

Income Levels

In the original HINTS data set, participants were asked the question, "What is the total household pre-tax income from all sources earned in the past year?" They had several options: 1 = *$0– $9, 999*; 2 = *$10,000–$14,999*; 3 = *$15,000–$19,999*; 4 = *$20,000–$34,999*; 5 = *$35,000–$49,999*; 6 = *$50,000–$74,999*; 7 = *$75,000–$99,999*; 8 = *$100,000–$199,999*; 9 = *$200,000 or more* (see Table 1). This variable was not recoded, but the missing data and multiple answers were not included in the analysis.

Race/Ethnicity

In the original HINTS data set, participants were asked to select their race, and they had several options: Hispanic; Non-Hispanic White; Non-Hispanic Black, or African American; Non-Hispanic American Indian, or Alaska Native; Non-Hispanic Asian; Non-Hispanic Native Hawaiian or other Pacific Islander; and Non-Hispanic Multiple Races Mentioned. This variable was not recoded, but the missing data and multiple answers were not included in the analysis.

Descriptive Statistics

The data for 14, 451 people were included in this research study. Table 6 shows the population demographics for this dissertation. It is important to note that many participants were Non-Hispanic White (55.5%). Moreover, there were 13.4% Hispanics, 17.8% African Americans, and 3.5% Asians. The other races/ethnicities did not have enough people to be represented in this study. In 2015, 38 out of 100,000 had CRC in the

United States (CDC, 2017b). In this study, 150 out of 14, 451 had CRC, as indicated in Table 6. The higher incidence of CRC seen in this study can be because HINTS data are focused on cancer. Also, this population had more females (59.3%) than males (38.5%). The descriptive statistics for each variable used in this study follows.

Table 6

Descriptive Characteristics of the Study Population

Sample Characteristic	*n*	%
Colorectal cancer		
Yes	150	1%
No	14 301	98%
Total	14 451	100%
Missing	250	1%
Race/ethnicity		
Hispanic	2023	14%
Non-Hispanic White	8018	55.5%
Non-Hispanic Black or African American	2027	14%.4%
Non-Hispanic American Indian or Alaska Native	60	3.5%
Non=Hispanic Asian	503	.1%
Non-Hispanic Native Hawaiian or other Pacific Islander	21	
Non-Hispanic Multiple Races Mentioned		2.4%
Total	343	
	12995	89.9%
Missing	1456	10.1%
Total	14 451	
Recommended fruits intake		
No	11 390	78.8%
Yes	2719	18.8%
Total	14 109	97.6%
Missing	342	2.4%
Recommended vegetable intake		
No	12 723	88%
Yes	1379	9.5%
Total	14 102	97.6%
Missing	349	2.4%
Recommended physical activity		
No	6904	47.8%
Yes	7314	50.6%
Total	14 218	98.4%
Missing	233	1.6%
Age		
18-34	2004	13.9%
35-49	3232	22.4%
50-64	4797	33.2%
65-74	2289	15.8%
75+	1657	11.5%
Total	13 979	96.7%
Missing	472	3.3%

Continues

Table 6 *Descriptive Characteristics of the Study Population* (continues)

Sample Characteristic	*n*	%
Gender		
Male	5563	38.5%
Female	8566	59.3%
Total	14 129	97.8%
Missing	322	2.2%
BMI		
Underweight	880	6.1%
Healthy	3458	23.9%
Overweight	4123	28.5%
Obese	432	29.9%
Total	12 785	88.5%
Missing	1666	11.5%
Smoking status		
Everyday	1632	11.3%%
Some days	553	3.8%
Not at all	12 037	83.3%
Total	14 222	98.4%
Missing	229	1.6%
Income levels		
$0 - $9, 999	1191	8.2%
$10, 000 - $14, 999	968	6.7%
$15, 000 - $19, 999	864	6.0%
$20, 000 - $34, 999	1992	13.8%
$35, 000 - $49, 999	1855	12.8%
$50, 000 - $74, 999	2114	14.6%
$75, 000 - $99, 999	1496	10.4%
$100, 000 - $199, 999	1677	11.6%
$200, 000 or more	564	3.9%
Total	12 721	88%
Missing	1730	12%

Table 7 shows that only physical activity ($p = .004 < .050$) had an association with CRC among the whole population. Fruit ($p = .818 > .05$) and vegetable ($p = .561 > .05$) intake failed to demonstrate a relationship with CRC (Table 7).

Table 7

Frequency of Colorectal cancer among Fruit Intake, Vegetable Intake, and Physical Activity

Fruit Intake	Yes – Colorectal Cancer	No- Colorectal Cancer	Total	Unadjusted *OR*	95%CI	*p* value
Recommended fruit intake	24	313	337	0.9478	[.601-1.494]	.818
Non-recommended fruit intake	119	1471	1590			

continues

Table 7 *Frequency of Colorectal cancer among Fruit Intake, Vegetable Intake, and Physical Activity* (continues)

Fruit Intake	Yes – Colorectal Cancer	No- Colorectal Cancer	Total	Unadjusted *OR*	95%CI	*p* value
Recommended vegetable intake	12	176	188	0.8343	[.453-1.537]	.561
Non-recommended vegetable intake	131	1603	1734			
Recommended physical activity	55	905	960	0.5964	**[.421-.844]**	**.004**
Non-recommended physical activity	91	893	984			

Note. OR=odds ratio; CI= confidence interval.

In 2014, the incidence of colorectal cancer in African Americans, Non-Hispanic White, American Indian, Asian, and Hispanic was respectively 43.2, 37.3, 30.1, 28.8, and 33.5 out of 100,000 (CDC, 2017b). In this study, among the 2571 African Americans, 29 had CRC, as seen in Table 8. Also, among the 8018 Non-Hispanic White 84 had CRC, as indicated in Table 8. In this study, the incidence rate of African Americans (11.27 per 1000) was higher than the one of the White population (10.47 per 1000). The incidence of CRC among both African Americans and Whites in this study is higher than the one mentioned by the CDC (2017b).

Table 8

Frequency of Colorectal Cancer Among Race/Ethnicity

Race	Yes -Colorectal Cancer	No- Colorectal cancer	Total	Rate of CRC per 1000
Hispanic	11	1922	1931	5.75
Non-Hispanic White	84	7934	8018	10.47
Non-Hispanic Black or African American	29	2542	2571	11.27

continues

Table 8 *Frequency of Colorectal Cancer Among Race/Ethnicity* (continues)

Race	Yes -Colorectal Cancer	No- Colorectal cancer	Total	Rate of CRC per 1000
Non-Hispanic Asian	5	498	503	9.94
Non-Hispanic American Indian or Alaska Native	2	58	60	33.3
Non-Hispanic Multiple Races	6	35	41	146.34

Note. CRC = colorectal cancer.

In 2015, 51.1 Black men and 37.5 Black women out of 100,000 had CRC versus 42.5 White men and 32.7 White women out of 100,000 (CDC, 2018c; seeTable 1). Table 9 also concurred with this incidence because the rate of CRC per 1,000 is higher in male (12.94) compared to females (8.4). According to the CDC (2018), 90% of cases of CRC happen in individuals who are at least 50 years. Table 9 also showed that the age group 50-64 had a much higher CRC incidence rate of 81.99 per 1,000 compared to the other groups. Individuals who are obese are about 30% more likely to have CRC than normal-weight group (National Cancer Institute, 2017). In the current study, the incidence rate of CRC per 1,000 for obese participants was higher than that of overweight participants but a lower rate than the underweight and the healthy (Table 9). Table 9 also shows that people who were making less than $35, 000 had a higher incidence rate of CRC per 1,000, which concurred with the literature.

Table 9

Frequency of Colorectal Cancer Among Gender, Age Group, BMI Group, Smoking Status, and Income Level

	Yes – Colorectal Cancer	No-Colorectal Cancer	Total	Rate of CRC per 1000
Gender				
Male	72	5491	5563	12.94
Female	72	8494	8566	8.40
Age group				
18-34	1	49	50	20
35-49	3	171	174	17.24
50-64	51	571	622	81.99
65-74	37	510	547	67.64
75+	54	480	534	28.83
BMI group				
Underweight	15	125	140	107.14
Healthy	36	438	474	75.94
Overweight	40	547	587	68.14
Obese	41	520	561	73.08
Smoking status group				
Everyday	16	161	177	90.39
Some days	5	50	55	90.90
Not at all	61	645	706	86.40
Income level				
$0 - $9, 999	12	122	134	89.55
$10, 000 - $4, 999	16	122	138	114.94
$15, 000 - $19, 999	11	121	132	83.33
$20, 000 - $34, 999	30	244	274	109.48
$35, 000 - $49, 999	18	245	263	68.44
$50, 000 - $74, 999	16	263	279	57.34
$75, 000 - $99, 999	15	184	199	75.37
$100, 000 - $199, 999	8	178	186	43.01
$200, 000 or more	2	84	86	23.25

Results

In Research Questions 1, 2, and 3, a binary regression was conducted to investigate if there was an association between fruits, vegetables, and physical activity, respectively and the occurrence of CRC. Afterward, the association in each of these research questions was controlled for confounding factors like age, gender, BMI, smoking status, and income level. The plausible confounders were run individually to identify which ones were confounders. According to PennState (2018), a confounder is a variable that creates a situation where the impact or relationship between an exposure and outcome is altered. Also, a variable is considered as a confounder when it is associated with both the exposure and the outcome, and this one changes the effect, specifically the odds ratio by 10% or more, as stated by PennState. Therefore, any variable that met this criterion stayed in the final model (PennState, 2018).

In research question 1, a binary regression was conducted to investigate if there is an association between fruit intake and the occurrence of CRC. There was no statistically significant association between fruit and the occurrence of CRC (p = .818 > 0.05, unadjusted odds ratio (*OR* = .948, 95% CI = .601-1.494). According to Cohen (1969), the p value should be less than or equal to 0.05 to claim statistical significance although there were associations between the group age 50-64 (p =.002<.050) and gender (p =.044<.05) and CRC on Tables 10, 11 respectively, these tables along with Table 12 showed that age, gender, and BMI were not confounders because their adjusted OR were less than 1.04 which was the limit of the 10% of the unadjusted *OR* = .948.Tables 13 and 14 showed that smoking status and income level are confounders because, in each model, the odds ratio increased to at least 10% going from *OR* = .948 to 1.1 for smoking status and 1.2 for income level. In each of these models, there was still not a statistically significant association between fruit intake and CRC. Also, the final model that include smoking status and income level as confounders did not demonstrate any association neither.

The Hosmer-Lemeshow (HL) Goodness-of-Fit test was significant ($p = .938 > 0.05$), indicating the model is correctly specified. The HL test is a goodness of fit that is mainly used for binary variables in logistic regression (Hosmer, Lemeshow, & Sturdivant, 2013). The aim of the HL shows how well the data fits the model by calculating if the observed event rates match the expected event rates within the population (Hosmer, Lemeshow, & Sturdivant, 2013). Unlike the *p*-value mentioned by Cohen (1969), the model is a good fit in the HL test when the *p*-value is equal or greater than .05 (Hosmer, Lemeshow, and Sturdivant, 2013). While the full model was not statistically significant $\chi 2$ (10, n =804) = 13.855, $p =.180 > .05$, the model was able to explain only 1.8% (Cox & Snell R Square) to 4.2% (Nagelkerke R square) of the variance in CRC status.

Table 10

Binary Regression Between Fruit Intake and the Occurrence of Colorectal Cancer Checking if Age is a Potential Confounder

	Model 1 (*n*=1927)				Model 2 (*n*=1886)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruit intake (reference=not recommended)								
Recommended	.948	.601	1.494	.818	1.017	.642	1.610	.943
Age Reference=18-34								
35 -49					5.458	.737	40.389	.097
50 - 64					6.341	1.954	20.583	**.002**
65- 74					1.305	.864	1.970	.206
75+					1.484	.956	2.305	.079

Note. * = adjusting for age; *OR* = odds ratio; CI = confidence interval.

Table 11

Binary Regression Between Fruit Intake and the Occurrence of Colorectal Cancer Checking if Gender is a Potential Confounder

	Model 1 (*n* = 1927)				Model 2 (*n* = 1886)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruit Intake (Reference=Not Recommended)								
Recommended	.948	.601	1.494	.818	1.003	.634	1.585	.990
Gender Reference=Female								
Male					.701	.496	.991	**.044**

Note. * = adjusting for gender; *OR* = odds ratio; CI = confidence interval.

Table 12

Binary Regression Between Fruit Intake and the Occurrence of Colorectal Cancer Checking if BMI is a Potential Confounder

	Model 1(*n* = 1927)				Model 2 (*n* = 1715)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruit intake (Reference= Not recommended)								
Recommended fruits	.948	.601	1.494	.818	1.002	.620	1.619	.943
BMI (reference= underweight)								
Healthy					.682	.337	1.376	.285
Overweight					.913	.570	1.463	.705
Obese					1.052	.664	1.667	.828

Note. * = adjusting for BMI; *OR* = odds ratio; CI = confidence interval

Table 13

Binary Regression Between Fruit Intake and the Occurrence of Colorectal Cancer Checking if Smoking Status is a Potential Confounder

	Model 1(*n* = 1927)				Model 2 (*n* = 922)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruit intake (Reference= Not recommended)								
Recommended fruits	.948	.601	1.494	.818	1.119	.610	2.054	.716
Smoking status (Reference=Everyday)								
Some days					.986	1.005	.556	.986
Not at all					.921	.953	.366	.921

Note. * = adjusting for smoking status; *OR* = odds ratio; CI = confidence interval

Table 14

Binary Regression Between Fruit Intake and the Occurrence of Colorectal Cancer Checking if Income Level is a Potential Confounder

	Model 1 (*n* = 1927)				Model 2 (*n* = 1662)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruit intake (reference=not recommended)								
Recommended	.948	.601	1.494	.818	1.213	.751	1.960	.429
Income level (Reference= $0 - $9, 999)								
$10, 000 - $4, 999					.127	.016	1.001	**.050**
$15, 000 - $19, 999					.094	.012	.728	**.024**
$20, 000 - $34, 999					.126	.016	.999	**.050**
$35, 000 - $49, 999					.097	.013	.726	**.023**
$50, 000 - $74, 999					.157	.021	1.198	.074
$75, 000 - $99, 999					.202	.026	1.552	.124
$100, 000 - $199, 999					.155	.020	1.198	.074
$200, 000 or more					.259	.032	2.108	.207

Note. * = adjusting for income level; *OR* = odds ratio; CI = confidence interval

Table 15

Binary Regression Between Fruit Intake and the Occurrence of Colorectal Cancer and Smoking Status and Income Level as Confounders

	Model 1 (*n* = 1927)				Model 2 (*n* = 804)			
Covariates	Unadjusted *OR*	95% *CI* Lower	95% *CI* Upper	*P* Value	Adjusted OR*	95% CI Lower	95% CI Upper	*P* Value
Fruit intake (reference=not recommended)								
Recommended	.948	.601	1.494	.818	1.522	.789	2.936	.210

Note. * = adjusting for smoking status and income level; *OR* = odds ratio; CI= confidence interval

In research question 2, a binary regression was conducted to investigate if there is an association between vegetable intake and the occurrence of colorectal cancer. There was no statistically significant association between vegetable intake and the occurrence of colorectal cancer (unadjusted *OR*=.834, 95% CI = [.453-1.537], p = .561> 0.05). As mentioned above, Cohen (1969) stated that the p value should be less than or equal to 0.05 to claim statistical significance. Tables 16, 17, and 18 show that age, gender, and income level are not confounders because in each model the adjusted odds ratio of the independent variable vegetable consumption (adjusted *OR* =886, *OR*=.894, *OR*=1.002) is within 10% of the unadjusted *OR*=.834 once age, gender, and income level are added respectively to the model. There were associations between the group age 50-64 (p =.004<.050), income level groups $15,000-$19,999(p =.027<.05) and $35,000-$49,999 (p =.026<.05) and CRC on tables 16 and 20. Tables 18 and 19 show that BMI and smoking status could be confounders in the association between vegetable intake and the occurrence of CRC. In each of these models, there was still not a statistically significant association between vegetable intake and colorectal cancer. Also the final model did not show a statistically significant associations (adjusted *OR*=.834, 95% CI = [.453-1.537], p value = .561> 0.05). The HL Goodness-of-Fit test was significant (p = .0 < 0.05), indicating the model is not correctly specified.

After controlling for BMI and smoking status, there was still not a statistically significant association between the predictor's variables vegetable intake (p value=.611 >.05) and the occurrence of CRC (Table 21). HL goodness-of-fit was significant (p =

.667 > 0.05) indicating the model is correctly specified. While the full model was not statistically significant $\chi 2$ (5, n = 819) = 1.288, *p* = .936 > .05, the model was able to explain only .2% (Cox & Snell R Square) to .4% (Nagelkerke R square) of the variance in CRC status,

Table 16

Binary Regression Between Vegetable Intake and the Occurrence of Colorectal Cancer Checking if Age is a Potential Confounder

	Model 1 (*n* = 1922)				Model 2 (*n* = 1883)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Vegetable intake (reference=not recommended)								
Recommended	.834	.453	1.537	.561	.886	.479	1.639	.699
Age Reference=18-34								
35 -49					5.322	.719	39.379	.102
50 - 64					6.356	1.959	20.621	**.002**
65- 74					1.307	.866	1.972	.202
75+					1.500	.966	2.329	.071

Note. * =adjusting for age; *OR* = odds ratio; CI = confidence interval

Table 17

Binary Regression Between Vegetable Intake and the Occurrence of Colorectal Cancer Checking if Gender is a Potential Confounder

	Model 1 (*n* = 1922)				Model 2 (*n* = 1891)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Vegetable intake (reference=not recommended)								
Recommended	.834	.453	1.537	.561	.894	.484	1.653	.721
Gender Reference=Female								
Male					.710	.502	1.004	.053

*Note.**=adjusting for gender; *OR* = odds ratio; CI = confidence interval

Table 18

Binary Regression Between Vegetable Intake and the Occurrence of Colorectal Cancer Checking if BMI is a Potential Confounder

	Model 1 (*n* = 1922)				Model 2 (*n = 1711)*			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Vegetable intake (reference= not recommended)								
Recommended vegetable	.834	.453	1.537	.561	1.002	.620	1.619	.795
BMI (reference= underweight)								
Healthy					.670	.332	1.354	.265
Overweight					.911	.569	1.460	.699
Obese					1.057	.668	1.675	.812

Note.* = adjusting for BMI; *OR* = odds ratio; CI = confidence interval

Table 19

Binary Regression Between Vegetable Intake and the Occurrence of Colorectal Cancer Checking if Smoking Status is a Potential Confounder

	Model 1 (*n = 1922)*				Model 2 (*n = 920)*			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Vegetable intake (reference= not recommended)								
Recommended vegetable	.834	.453	1.537	.561	1.102	.511	2.376	.805
Smoking status (reference=everyday)								
Some days					1.003	.554	1.816	.991
Not at all					.948	.364	2.469	.913

Note.* = adjusting for smoking status; *OR* = odds ratio; CI= confidence interval

Table 20

Binary Regression Between Vegetable Intake and the Occurrence of Colorectal Cancer Checking if Income Level is a Potential Confounder

	Model 1 (*n = 1922)*				Model 2 *(n=1659)*			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Vegetable intake (reference=not recommended)								
Recommended	.834	.453	1.537	.561	.780	.386	1.577	.490
Income level (Reference= $0 - $9, 999)								
$10, 000 - $4, 999					.130	.016	1.030	.053
$15, 000 - $19, 999					.099	.013	.767	**.027**
$20, 000 - $34, 999					.129	.016	1.022	.052
$35, 000 - $49, 999					.102	.014	.760	**.026**
$50, 000 - $74, 999					.164	.022	1.248	.081
$75, 000 - $99, 999					.208	.027	1.597	.131
$100, 000 - $199, 999					.159	.021	1.234	.079
$200, 000 or more					.266	.033	2.165	.216

Note.* = adjusting for income level; *OR* = odds ratio; CI = confidence interval

Table 21

Binary Regression Between Vegetable Intake and the Occurrence of Colorectal Cancer BMI and Smoking Status as Confounders

	Model 1 (*n* = 1922)				Model 2 (*n* = 819)			
Covariates	Un adj ust ed *OR*	95% CI Lowe r	95% CI Upp er	*P* Value	Adjust ed *OR**	95% CI Lowe r	95% CI Upper	*P* Value
Fruit intake (reference=not recommended)								
Recommended	.83 4	.453	1.53 7	.561	1.226	.560	2.681	.611

*Note.**=adjusting for smoking status and income level; OR=odds ratio; CI= confidence interval

In research question 3, a binary regression was conducted to investigate if there is an association between physical activity and the occurrence of CRC. There was a statistically significant association between physical activity and the occurrence of colorectal cancer (unadjusted *OR* = .596, 95% CI = [.421-844], *p* = .004< 0.05). Tables 22, 23, 24, and 25 showed that age, gender, smoking status, and BMI are not plausible confounders because, in each model, the adjusted odds ratio for physical activity was not within the 10% of the unadjusted *OR*. Also, in each of these models, there was still a statistically significant association between physical activity, group age 50-64, gender and CRC.

As shown in Table 26, a binary regression was conducted to investigate if there is an association between physical activity and the occurrence of CRC after controlling for income level. This analysis was initially done to determine if the income level was a confounder, but it also serves as the final model for this research question because this variable is the only confounder. In this model, as seen in Table 26, there was a statistically significant association between physical activity and the occurrence of CRC (*OR* = 671, 95% C I= [.458-.983], *p* =.040<.05,).

Controlling for income level, the predictor variable, physical activity, in the logistic regression analysis was found to contribute to the model. The HL Goodness-of-Fit test was significant (*p* =.765 > 0.05), indicating the model is correctly specified. Also, the full model was statistically significant $\chi2$ (8, n = 1674) = 17.268, *p* = .027 < .05, and the model was able to explain only 1.5% (Cox & Snell R Square) to 3.6% (Nagelkerke R square) of the variance in CRC status. The estimated odds ratio favored a negative relationship (Adjusted *OR* =.671, 95% CI = [.458 - .983]) for every one unit increase of physical activity. Those who practice the recommended physical activity were less likely to develop CRC compared to those who did not practice the recommended physical activity. Also, the income groups $15,000-$19,999 (p = .027 < .50), and $35,000-$49,999(p = .027) had a statistically significant association with CRC when controlling for physical activity.

Table 22

Binary Regression between Physical Activity and the Occurrence of Colorectal Cancer Checking if Age is a Potential Confounder

	Model 1 (*n* = 1944)				Model 2 (*n* = 1902)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Physical activity (reference=not recommended)								
Recommended	.596	.421	.844	**.004**	.623	.438	.886	.009
Age reference=18-34								
35 -49					5.265	.711	39.970	.104
50 - 64					6.039	1.860	19.613	**.003**
65- 74					1.223	.813	1.839	.335
75+					1.469	.945	2.284	.088

Note.*=adjusting for age; *OR* = odds ratio; CI= confidence interval

Table 23

Binary Regression Between Physical Activity and the Occurrence of Colorectal Cancer Checking if Gender is a Potential Confounder

	Model 1 (*n* = 1944)				Model 2 (*n* = 1910)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Physical activity (reference=not recommended)								
Recommended	.596	.421	.844	.004	.574	.402	.818	.002
Gender Reference=Female								
Male					.631	.446	.891	.009

Note.*=adjusting for gender; *OR* = odds ratio; CI= confidence interval

Table 24

Binary Regression Between Physical Activity and the Occurrence of Colorectal Cancer Checking if Smoking Status is a Potential Confounder

	Model 1 (*n = 1922)*				Model 2 (*n = 920)*			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Vegetable intake (reference= not recommended)								
Recommended vegetable	.596	.421	.844	**.004**	.573	.355	.922	**.022**
Smoking status (reference=everyday)								
Some days					1.087	.599	1.973	.783
Not at all					.905	.346	2.365	.839

Note.*=adjusting for smoking status; *OR* = odds ratio; CI= confidence interval

Table 25

Binary Regression Between Physical Activity and the Occurrence of Colorectal Cancer Checking if BMI is a Potential Confounder

	Model 1 (*n* = 1944)				Model 2 (*n* = 1733)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Physical activity (reference= not recommended)								
Recommended vegetable	.596	.421	.844	**.004**	.641	.440	.933	**.020**
BMI (reference= underweight)								
Healthy					.651	.336	1.259	.202
Overweight					.830	.516	1.337	.444
Obese					.944	.595	1.499	.808

Note.*=adjusting for BMI; *OR*=odds ratio; CI= confidence interval

Table 26

Binary Regression Between Physical Activity and the Occurrence of Colorectal Cancer Checking if Income Level is a Potential Confounder

	Model 1 (*n* = 1944)				Model 2 (*n* = 1674)			
Covariates	Unadjusted *OR*	95% *CI* Lower	95% *CI* Upper	*P* Value	Adjusted *OR**	95% *CI* Lower	95% *CI* Upper	*P* Value
Physical activity (Reference=Not Recommended)								
Recommended	.596	.421	.844	**.004**	.671	.458	.983	**.040**
Income level (Reference= $0 - $9, 999)								
$10, 000 - $4, 999					.138	.017	1.090	.060
$15, 000 - $19, 999					.100	.013	.767	.027
$20, 000 - $34, 999					.144	.018	1.141	.067
$35, 000 - $49, 999					.104	.014	.774	.027
$50, 000 - $74, 999					.166	.022	1.266	.083
$75, 000 - $99, 999					.198	.026	1.513	.118
$100, 000 - $199, 999					.151	.020	1.166	.070
$200, 000 or more					.259	.032	2.108	.207

Note.*=adjusting for income level; OR=odds ratio; CI= confidence interval

In research question 4, in the first model in Table 27, a binary regression was done to investigate if there was an association between fruit and vegetable intake, physical activity and CRC. There was a statistically significant association between physical activity and CRC (unadjusted *OR* = .617, 95% CI = [.432- .880], $p = .008 < 0.05$). In the second model, a binary regression was conducted to investigate if there is an association between fruit and vegetable consumption, and physical activity and the occurrence of CRC after controlling for confounding factors such as BMI, smoking status, and income level (Table 27). In this model, there was no statistically significant association between fruit and vegetable intake, physical activity, and the occurrence of CRC. The HL Goodness-of-Fit test was significant (p value = .204 > 0.05), indicating the model is correctly specified. Also, the full model was not statistically significant $\chi 2$ (13, n = 706) = 13.712, $p = .394 > .05$, and the model was able to explain only 2.4% (Cox & Snell R Square) to 5.6% (Nagelkerke R square) of the variance in CRC status.

Table 27

Binary Regression Between Fruit Intake, Vegetable Intake, Physical Activity and the Occurrence of Colorectal Cancer and BMI, Smoking Status, and Income Level as Confounders

	Model 1 (*n*=1898)				Model 2 (*n*=706)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruits(reference= non-recommended)								
Recommended fruits	.991	.608	1.615	.971	1.671	.756	3.693	.204

continues

Table 27 *Binary Regression Between Fruit Intake, Vegetable Intake, Physical Activity and the Occurrence of Colorectal Cancer and BMI, Smoking Status, and Income Level as Confounders* (continues)

	Model 1 (n=1898)				Model 2 (n=706)			
Vegetables(reference= non-recommended)								
Recommended vegetables	.963	.504	1.838	.909	.840	.285	2.472	.751
Physical activity (reference= non-recommended)								
Recommended physical activity	.617	.432	.880	**.008**	.681	.383	1.211	.191

*Note.** = adjusting for BMI, smoking status, and income level; *OR*=odds ratio; CI= confidence interval

Whites:

First, in research question 5, a binary regression was performed to investigate if there was an association between fruit and vegetable intake, physical activity, and CRC among the White population (Table 28). There was a statistically significant association between physical activity and CRC among Whites (unadjusted *OR* = .478, 95% CI = [.296- .772], *p* = .003= 0.05). In the second model, a binary regression was conducted to investigate if there is an association between fruit and vegetable consumption, physical activity and the occurrence of CRC after controlling for confounding factors such as BMI, smoking status, and income level among the White population (Table 28).

In this model, there was no statistically significant association between fruit and vegetable intake, physical activity, and the occurrence of colorectal cancer. The HL goodness-of-fit was significant (*p* = .267> 0.05), indicating the model is correctly specified. Also, the full model was not statistically significant $\chi 2$ (13, n = 511) = 19.093, *p* = .120> .05, and the model was able to explain 4.4% (Cox & Snell R Square) to 10.1% (Nagelkerke R square) of the variance in CRC status.

Table 28

Binary Regression Between Fruit Intake, Vegetable Intake, and Physical Activity and the Occurrence of Colorectal Cancer and BMI, Smoking Status, and Income Level as Confounders Among Whites

	Model 1 (*n*=1300)				Model 2 (*n*=511)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P*Value
Fruits(reference= non-recommended)								
Recommended fruits	1.392	.767	2.526	.277	2.161	.859	5.437	.102
Vegetables(reference= non-recommended)								
Recommended vegetables	1.158	.537	2.496	.709	1.153	.354	3.750	.814
Physical activity (reference= non-recommended)								
Recommended physical activity	.478	.296	.772	**.003**	.621	.312	1.237	.176

Note.*= adjusting for BMI, smoking status, and income level; *OR* = odds ratio; CI = confidence interval

Blacks:

Second, in research question 5, a binary regression was conducted to investigate if there is an association between fruit intake, vegetable intake, physical activity and the occurrence of CRC among African Americans after controlling for confounding factors such as BMI, smoking status, and income level. In Model 1, there was not a statistically significant association between any predictor's variables and the occurrence of CRC. Fruit intake unadjusted *OR* = .705, 95% *CI* = [.224- 2.220], $p = .550 > 0.05$; vegetable intake unadjusted *OR* = 1.081, 95% *CI* = [.222- 5.258], $p = .923 > 0.05$; physical activity unadjusted *OR* = 1.205, 95% *CI* = [.509- 2.854], $p = .672 > 0.05$ (Table 29)

In Model 2, there was still not a statistically significant association between predictors variables and the occurrence of CRC among African Americans after controlling for BMI, smoking status, and income level (Table 29). The HL goodness-of-fit was significant ($p = .216 > 0.05$), indicating the model is correctly specified. Also, the full model was not statistically significant $\chi 2$ (12, n = 73) = 17.340, $p = .137 > .05$, and the model was able to explain 22.6% (Cox & Snell R Square) to 52.1% (Nagelkerke R square) of the variance in CRC status. On the other hand, there was an association between African Americans with a healthy BMI (adjusted *OR* = .023, 95% CI = [.001- .782], $p = .036 < .05$), and the occurrence of CRC (Table 29). African Americans with a healthy BMI have less chance of getting CRC in comparison to the baseline of the African Americans who were underweight.

Table 29

Binary Regression Between Fruit Intake, Vegetable Intake, and Physical Activity and the Occurrence of Colorectal Cancer and BMI, Smoking Status, and Income Level as Confounders Among African Americans

	Model 1 (*n*=217)				Model 2 (*n*=73)			
Covariates	Unadjusted *OR*	95% CI Lower	95% CI Upper	*P* Value	Adjusted *OR**	95% CI Lower	95% CI Upper	*P* Value
Fruits(reference= non-recommended)								
Recommended fruits	.705	.224	2.220	.550	3.203	.063	164.032	.562
Vegetables(reference= non-recommended)								
Recommended vegetables	1.081	.222	5.258	.923	.000	.000	.	.999
Physical activity (reference= non-recommended)								
Recommended physical activity	1.205	.509	2.854	.672	.921	.049	17.331	.956

Note.* = adjusting for BMI, smoking status, and income level; *OR* = odds ratio; CI = confidence interval

Summary

In this chapter, I presented the demographic characteristics of the sample and the results of hypothesis testing. Data analysis was conducted on an overall sample of 14, 451 participants from HINTS 4 Cycles, 1, 2, 3, and 4 studies. The study suggested that race is an effect modifier in the association between fruit and vegetable consumption, physical activity, and CRC.

Only Research Question (3) and Research Question (5) for White showed a statistically significant association between physical activity and the occurrence of CRC. Income level had an impact on the association between physical activity and CRC among the whole population. The African American population did not show any association. It is important to note that income level showed some association with CRC for people under $40, 000 eventhou it did not change the association between the main predictors of variable fruit and vegetable intake; and physical activity with CRC. Interpretation of the findings, limitations of the study, recommendations, implications, and conclusion of the analysis will be discussed in Chapter 5.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The aim of this study was to assess the association between fruit and vegetable consumption, physical activity, and CRC among African Americans in comparison to Whites and the whole population. Ashktorab et al. (2013) noted that in the United States, African Americans exhibited greater incidence and death rates of CRC compared to their White counterparts. To date, there is no conclusive evidence as to whether income levels change the association between fruit and vegetable consumption and physical activity in preventing CRC among African Americans.

I retrieved data from the 2011–2014 HINTS database for this study. The data collection process was described in Chapter 3. Five research questions and their corresponding hypotheses were tested to address the association, and the results of these tests were presented in Chapter 4. In Chapter 5, I discuss the interpretation of the findings, the limitations of the study, my recommendations for action, my recommendations for further studies, the implications for social change, and the conclusions.

Interpretation of Findings

Previous studies demonstrated that the risk of CRC was inversely associated with consumption of fruits and/or vegetables (Bradbury et al. 2014; Koushik et al. 2007; Lee et al., 2017; Luo et al. 2015; Nagle et al. 2015; Qiwen et al., 2015; Tayyem et al., 2014). On the other hand, Aoyama et al. (2014) and Nomura et al. (2016) suggested that low consumption and continued low consumption of fruits and vegetables were not strongly associated with CRC risk. Previous researchers showed that age, gender, BMI, and smoking status could have an impact on the occurrence of CRC. Macrae (2016) reported that age, gender, family history of CRC, obesity, tobacco, and alcohol are among CRC risk factors. There is also an association between a higher BMI and elevated risks of both colon and rectal cancers in both genders, but the increases are higher in men than in women (National Cancer Institute, 2017).

Alternate Hypothesis 1

Binary logistic regression for Research Question 1 showed that there was no statistically significant association between fruit and the occurrence of CRC among the whole population (*OR* = .948, 95% CI = .601-1.494, p = .818 > 0.05). The final model that controlled for smoking status and income level also did not show any association between fruit intake ($p > 0.05$) and CRC among the whole population. Therefore, with this finding, I failed to reject Null Hypothesis 1.

Several epidemiologic studies have demonstrated that there is an association between the consumption of a diet high in fruits and vegetables and the prevention of CRC. Which is why medical experts recommend a diet low in animal fats and high in fruits, vegetables, and whole grains, which may reduce the risk of CRC (CDC, 2018d; Macrae, 2016). Macrae (2016) found that the relative risk of CRC was around 0.5 when a comparison was made between the highest fruits and vegetables intake groups and the lowest.

One reason why I failed to demonstrate an association between fruit intake and CRC in this study could have been the lack of information on the type of fruits that were consumed by the participants. Tayyem et al. (2014) investigated the possible association between the number of servings and frequency of fruits and vegetables commonly consumed by Jordanians and the risk of developing CRC. They found that consuming various types of fruits showed no association with the risk of CRC, which concurred with the findings in this study. Furthermore, Luo et al. (2015) conducted a case-control study to investigate the association between the consumption of fruit and vegetable color groups and the risk of CRC in a Chinese population, finding that the intake of orange/yellow, red/purple, and white fruit was inversely related to the risk of CRC. Luo et al. also found that there was an inverse association between the intake of total fruit and CRC risk. Furthermore, the researchers determined that the consumption of green fruit was not associated with the risk of CRC (Luo et al., 2015).

Individuals who are obese are about 30% more likely than the normal-weight group to have CRC (National Cancer Institute, 2017). Ma et al. (2013) also found that general and central obesity had a positive association with the risk of CRC in their meta-analysis. Doleman et al. (2016) reported that obese and underweight patients demonstrated a higher risk of all-cause mortality and cancer-specific mortality compared to normal-weight patients. The addition of BMI as a confounder did not have any impact on the association between the predictor variable of fruit and CRC (DeSantis et al., 2016). Jandova et al. (2016) stated that patients with a high-income level had a lower incidence of CRC. However, the addition of income level as confounder in this study failed to change the association between fruit intake and CRC among the whole population, which can be explained by the fact that in this study income level was tested as a confounder to fruit intake and not as an independent variable that could have a direct influence on CRC.

Alternate Hypothesis 2

To answer Research Question 2, I conducted a binary regression to investigate if there is an association between vegetable intake and the occurrence of CRC. There was no statistically significant association between vegetable and the occurrence of CRC (*OR* = .834, 95% CI = .453-1.537, $p = .561 > 0.05$). After controlling for BMI and smoking status, there was still no statistically significant association between the predictor variable vegetable intake ($p > .05$) and the occurrence of CRC. Therefore, in this study I failed to reject Null Hypothesis 2.

As I previously mentioned, many epidemiologic studies have demonstrated that there is an association between the consumption of a diet high in fruits and vegetables and the prevention from CRC. Which is the reason why medical experts recommend a diet low in animal fats and high in fruits, vegetables, and whole grains because it may reduce the risk of CRC (CDC, 2018d; Macrae, 2016). Macrae (2016) found that the relative risk of CRC is around 0.5 when a comparison is made between the highest fruits and vegetables intake groups and the lowest.

Tayyem et al. (2014) investigated the possible association between the number of servings and frequency vegetables commonly consumed by Jordanians and the risk of developing CRC, finding that total vegetable consumption was associated with the risk of developing CRC. Lee et al. (2017) conducted a case-control study with 923 CRC patients and 1,846 controls from the National Cancer Center in Korea to identify the association between the colors of vegetables and the risk of CRC in Korea. Lee et al. found that high total consumption of vegetables was highly related with a reduced risk of CRC in females (*OR* = 0.32, 95% CI: 0.21–0.48 for highest versus lowest tertile) and similarly with men (*OR* = 0.60, 95% CI: 0.45–0.79). There was an inverse association between green and white vegetables and the risks of CRC in male, and an inverse association between the green, red/purple, and white vegetables in females (Lee et al., 2017). On the other hand, orange/yellow vegetable consumption was associated with an elevated risk of CRC (*OR* = 1.61, 95% CI: 1.22–2.12) in men (Lee et al., 2017). Lee et al. concluded that fruit and vegetable consumption from different color groups might prevent CRC. The reason why the Research Question 1 failed to show any association could have been that there were no details about the types of vegetables that were consumed.

The contradictory findings between the association of fruit and vegetable consumption and CRA risk aligned with the findings of by Qiwen et al. (2015). After a thorough meta-analysis of 22 studies that implicated 11,696 CRA participants, Qiwen et al. concluded that vegetable intake does not have a significant protective impact on CRA. It is important to note that findings in these studies varied from one population to another one; therefore, the plausible association between fruit and vegetable intake and CRC could be genetic or due to a combination of risk factors.

Luo et al. (2015) conducted a case-control study to investigate the association between the consumption of fruit and vegetable color groups and the risk of CRC in a

Chinese population and found that the intake of orange/yellow, red/purple, and white fruit was inversely related to the risk of CRC. Luo et al. also reported that there was an inverse association between the intake of total fruit and CRC risk. Furthermore, the consumption of green fruit was not associated with the risk of CRC (Luo et al., 2015).

Luo et al.'s (2015) findings could help explain why this study did not show any association. This lack of association could have been caused by the quality of fruits and vegetables or the genetics of the participants. In other words, I did not collect any details about the colors or the different types of fruits and vegetables consumed by the participants.

Individuals who are obese are about 30% more likely to have CRC than the normal-weight group (National Cancer Institute, 2017). Ma et al. (2013) also found that general and central obesity had a positive association with the risk of CRC in their meta-analysis. Doleman et al. (2016) found that obese and underweight patients demonstrated a higher risk of all-cause mortality and cancer-specific mortality compared to normal-weight patients. The addition of BMI as a confounder in this study did not change the association between the predictor variable of vegetable and CRC. The socioeconomic disparity risk of newly diagnosed CRC patients is 33% to 50% due to potentially modifiable behaviors like physical activity, unhealthy diet, smoking, and obesity (Doubeni, Major, et al., 2012; Willet, 2005). In this study, smoking status did not alter the association between vegetable intake and CRC among the whole population. HINTS did not code smoking status in a way that accurately tracked participants. The smoking status was limited to the current status of the participants and the past (i.e., the question was:

"How often do you smoke cigarette?"); therefore, it was hard to determine if the participants just started smoking or not.

Alternate Hypothesis 3

In Research Question 3, I conducted a binary regression and found that there was a statistically significant association between physical activity and the occurrence of CRC (*OR* = .596, 95% CI = .421-844, $p = .04 < .05$). The final model had income level (*OR* = .671, 95% CI = .458-.983, $p = .04 < .05$) as a confounder and showed a statistically significant association between physical activity, and CRC. Therefore, I rejected Null Hypothesis 3.

Physically active people have a lower risk of colon cancer compared to those who are not active (CDC, 2018e). Kyu et al. (2013) stated that several observational studies noted that constant physical activity (i.e., occupational or leisure) is associated with CRC protection. Li et al. (2016) did a meta-analysis of 126 studies to assess the association between leisure-time physical activity and the risk of all cancer based on the WHO recommendations and found that the present WHO recommendation of physical activity may impact the cancer risk by reducing it (7%), which is likely associated with its protective role against breast cancer and CRC. Several researchers have reported an association between higher physical activity and reduced colon cancer risk (Morris et al., 2018). In the same sense, people who are partaking in aerobic physical activity at a moderate pace or higher for 3–4 hours weekly have around a 30% reduction in colon cancer (Physical Activities Guidelines Advisory Committee, 2018). The findings concerning this research question concurred with that of the extant literature mentioned in this paragraph.

Furthermore, people with lower socioeconomic status are more likely to indulge in behaviors that elevate the risk of cancer (DeSantis et al., 2016). The income level could play a role in some of those modifiable behaviors such as physical activity, diet, and smoking (DeSantis et al., 2016). Jandova et al. (2016) stated that patients with high-income level had a lower incidence of CRC. In this study, the odds of not getting CRC increase from unadjusted OR=.421 to adjusted OR = .671 (see Table 26) once the income level was added as a confounder. Therefore, income level changed the measure of association between physical activity and CRC among the whole population in this study.

Alternate Hypothesis 4

In Research Question 4, I conducted a binary regression to investigate if there is an association between fruit and vegetable consumption, physical activity, and the occurrence of CRC after controlling for confounding factors such as BMI, smoking status, and income level. In the first model, there was a statistically significant association between physical activity and the occurrence of colorectal (adjusted OR = .617, 95% CI = .432- .880, $p = .008 < 0.05$). In the second model, the confounders as BMI, smoking status, and income level were added, and there was no statistically significant association between fruit and vegetable intake, and physical activity and the occurrence of CRC. Therefore, I failed to reject the Null Hypothesis 4.

As stated above, under the first three research questions interpretation, many studies showed an association between fruit and vegetable intake and CRC. Few studies showed an association between all three predictors variables and CRC. As already mentioned above, researches done by Doubeni, Major, et al. (2012) and Willet (2005) posited that the socioeconomic disparity risk of newly diagnosed CRC patients is 33% to 50% due to potentially modifiable behaviors like physical activity, unhealthy diet, smoking, and obesity. This means that the combination of consuming recommended fruit and vegetable and practicing recommended physical activity as modifiable behaviors could be more significant in the diagnostic of CRC as much as 33 - 50% which is a considerable percentage. The reasons why in this research question I failed to demonstrate association with all the predictor variables could be the fact that the fruit and vegetable intake measurement was not specific as far as the type of products that the participants consumed. Moreover, the reason why the addition of the confounders failed to show statistically significant associations could fall into the format of the answers of the questions, especially for smoking status variable. As stated above, smoking status variable did not asses the past or the time period of participants' smoking status.

Alternate Hypothesis 5

Research Question 5 binary regression was done to investigate if there was an association between fruit and vegetable intake, physical activity and CRC among the white population then the African American population. Among whites, in the first model there was a statistically significant association between physical activity and CRC (adjusted *OR* =.478, 95% CI = .296- .772, p = .003= 0.05). Once I added the confounders BMI, smoking status, and income level, there was still no statistically significant association between fruit and vegetable intake, and physical activity and the occurrence of CRC. The results among Whites were very close to the one among the whole population. Furthermore, there was no association among the African American population,

Amidst all the ethnic groups in the United States, African Americans have the highest CRC rates (American Cancer Society, 2018; Macrae, 2016). African Americans demonstrate a higher incidence of CRC and mortality caused by CRC (Zaharek-Girgasky et al., 2015). This study also showed that African American CRC incidence was higher than their counterpart of the White population (Table 8). Macrae (2016) stated that it is still not clear if these racial differences are due to the genetic or low frequency of access to screening and polypectomy within the African Americans population in the United States.

Busch, Galanko, Sandler, Goel, & Keku (2018) stated that race could modify associations between lifestyle factors and colorectal tumor methylation. In this research question, the White population had a result that was close to the one of the whole populations, and African American failed to show any association. Busch et al. posited that higher fruit intake was related to higher odds of high CRC tumor methylation among European Americans but not among African Americans. The finding of Busch et al. concurred with the one of this study.

Satia-Abouta, Galanko, Martin, Ammerman, & Sandler (2004) examined the associations between different food groups and colon cancer in African Americans and whites in a case-control study. After examining the associations of dietary patterns which included fruit and vegetable intake with colon cancer risk in African Americans and

Whites from a case-control study in North Carolina, Satia, Tseng, Galanko, Martin, & Sandler (2009) concluded the findings explained that the presence of racial differences in colon incidence highlighted the importance of studying diet-cancer associations in various population subgroups. In the same sense, Satia-Abouta et al. (2004) mentioned that even though plant foods may have a protective effect against colon cancer, this impact changes by ethnic group. These findings aligned with the results of his study because African Americans and Whites had different results.

The health belief model is based on psychological and behavioral theory (LaMorte, 2016). The desire for wellness, the avoidance of illness, and the belief that one's actions will contribute to wellness by treating, preventing, or curing illness are the main components of HBM (LaMorte, 2016). Practicing recommended physical activity fall within the desire of wellness that will contribute to preventing CRC.

Limitations of the Study

The use of secondary data from HINTS is a limitation of this study because data could not be verified. Secondary data can raise eventual data error because it has missing and unusual values. Another limitation is the sample size. The original sample had 14,451 participants, but due to data filtering and processing, the ending sample size varied from one research question to another one depending on the variables in use. Missing data, as shown in Table 6, could be the cause of this limitation because it influenced sample size, effect size, and confidence, which are used for data interpretation. Also, the final sample size limited generalization from HINTS samples to the whole U.S. population only.

The outcome variable was not coded as CRC in HINTS, but instead, there were a colon and rectal cancer variables in some cycles. The stratification was limited to only two races, white and black because the other races did not have consistent representation, which led to another limitation in this study. The White population results were very close to the whole population, while the Black population had no association among all the research questions with stratification by race. The lack of association among the Black population could be due to the low sample size within this population. There was a mixed population that was not specified which could be another reason for the nonexistence of association among African Americans. The independent variables fruit intake, vegetable intake, and physical activity had only two outcomes recommended and non recommended, which could cause some bias in the results. Finally, the variables retrieved in HINTS 4 2011 - 2014 data meshed with this study, but these data may minimize more complex problems that are related to CRC, and covariates such as family history that could also impact the outcome variable was missing. In order to find out cause and effect associations with confidence, a strong experimental study with random assignment, experimental control treatments, and control groups included, as stated by Creswell (2014), is needed.

Recommendations for Action

Recommendations are raised from this research according to the findings that showed that there is a significant association between physical activity and CRC among the whole population and Whites. There was no statistically significant association between fruit and vegetable intake, physical activity and the occurrence of CRC among

African Americans. Based on these findings, it will be essential to ensure that efforts are made to disseminate those findings through publication. health care and public health professionals must acknowledge the impact of variables such as physical activity in developing CRC. Recommendations are to assess recommended physical activity within the whole population and each race while controlling for BMI, smoking status, and income level. In other words, the income level, for example, is a factor that needs attention because the lack of physical activity could be linked to the financial rank of the population. These recommendations include the implementation and services that will take into consideration socioeconomic status and other variables like BMI and smoking status.

Recommendations for further Studies

As many other studies, this study looked at the predictive abilities of several variables on a single dependent variable based on the HINTS 2011 - 2014. A model was developed for the association of several independent variables and CRC, with the addition of covariates and race as effect modifier. One covariate that is important in cancer research that was missing in this study was family history. Additional studies with the inclusion of family history as a covariate variable would be critical. Also, recommended fruit and vegetable intake, and physical activity failed to demonstrate an association with CRC among African Americans. Use of a larger sample size, especially for the African American population in future studies, will give us a better representation of that population. Income levels will need to be taken into consideration in future studies. Moreover, to better understand CRC, it is recommended to retrieve data from other countries in a meta-analysis of the effect of fruit and vegetable intake, and physical activity on CRC.

In the future, scholars should also distinguish between fruits and vegetables that are low in glycemic load and higher in fiber from fruit juices and starchy fruits and vegetables, consistent with Bertoia et al. (2015). That approach will aid public health workers and educators in pinpointing the benefice of fruits and vegetables in interventions to reduce CRC in the African American population. Because the physical activity was associated with CRC in the present study among the whole population and the White population and not African Americans, future research is needed to examine ways to effectively promote frequent and vigorous physical activity in African Americans along with their counterparts, including measures of adherence to exercise programs. Future public health scholars may look to use accelerometer data as an objective measure of physical activity, as it was done in the study conducted by Camhi et al. (2015), to supplement or replace the use of self-report of physical activity levels. There are opportunities for future studies to look at the possible association between recommended fruit and vegetable intake, and physical activity while taking into consideration the income level not only within the whole population but also each race especially the African Americans.

Implications for Social Change

The results of this study involve several positive social changes. For individuals, the current study concurred with the literature that people should consider following the recommended physical activity to reduce their chances of developing CRC. Also, people should practice recommended physical activity to reduce their likelihood of developing CRC. On the family level, individuals are encouraged to include physical activity at least three times a week in their family regimen.

In the same sense, at the organizational level, public and private institutions should promote a broader approach to the cause of CRC and put in place preventive strategies that will take into consideration individuals' income levels. Next, on the society/policy, CRC is known as one of the causes of death among other types of cancer that require more research and testing. Finally, on the research level, this study will add to the body of knowledge as required by Walden University's mission statement. It is important to note that it is also crucial that public health and medical professionals acknowledge the impact of physical activity in the development of CRC among all races. Additionally, this study pinpoints the importance of variables such as income level in the association among the physical activity within various races.

Conclusions

This study was conducted to identify if recommended fruit and vegetable intake; and physical activity are associated with CRC while taking into consideration race. African Americans' results were compared to the whole population and the White population. Also, covariates like age, gender, BMI, and smoking status were included in the study. The strength of this study lies in the use of a national database HINTS 2011-2014 for people residing in the U.S. who are at least 18 years old. The results of this study should serve to inform and develop productive efforts towards diminishing and preventing CRC among all populations, but especially African Americans, who have one of the highest incidence rates of CRC.

The results of this study showed that the association between recommended physical activity and CRC is statistically significant among the whole population and the white population only. Physical activity was the only independent variable that demonstrated a statistically significant association with CRC among the whole population and the White population. The African American population did not show association here. Further studies need to be done with a larger sample of African Americans to understand the association among these variables within this population better. This research highlights the need for more studies that will investigate the impact of fruit and vegetable intake and physical activity among different races, especially African Americans.

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Appendix: List of Fruits and Vegetables from Choose MyPlate (2018)

CUP OF FRUIT TABLE		
	AMOUNT THAT COUNTS AS 1 CUP OF FRUIT	OTHER AMOUNTS (COUNT AS 1/2 CUP OF FRUIT UNLESS NOTED)
Apple	½ large (3 ¼" diameter) 1 small (2 ¼" diameter) 1 cup, sliced or chopped, raw or cooked	½ cup, sliced or chopped, raw or cooked
Applesauce	1 cup	1 snack container (4oz)
Banana	1 cup, sliced 1 large (8" to 9" long)	1 small (less than 6" long)
Cantaloupe	1 cup, diced or melon balls	1 medium wedge (1/8 of a med. melon)
Grapes	1 cup, whole or cut-up 32 seedless grapes	16 seedless grapes
Grapefruit	1 medium (4" diameter) 1 cup, sections	½ medium (4" diameter)
Mixed fruit (fruit cocktail)	1 cup, diced or sliced, raw or canned, drained	1 snack container (4 oz) drained = 3/8 cup

CUP OF FRUIT TABLE

	AMOUNT THAT COUNTS AS 1 CUP OF FRUIT	OTHER AMOUNTS (COUNT AS 1/2 CUP OF FRUIT UNLESS NOTED)
Orange	1 large (3 1/16" diameter) 1 cup, sections	1 small (2 3/8" diameter)
Orange, mandarin	1 cup, canned, drained	
Peach	1 large (2 ¾" diameter) 1 cup, sliced or diced, raw, cooked, or canned, drained 2 halves, canned	1 small (2" diameter) 1 snack container (4 oz) drained = 3/8 cup
Pear	1 medium pear (2 ½ per lb.) 1 cup, sliced or diced, raw cooked, or canned, drained	1 snack container (4 oz) drained = 3/8 cup
Pineapple	1 cup, chunks, sliced or crushed, raw, cooked or canned, drained	1 snack container (4 oz) drained = 3/8 cup

CUP OF FRUIT TABLE		
	AMOUNT THAT COUNTS AS 1 CUP OF FRUIT	OTHER AMOUNTS (COUNT AS 1/2 CUP OF FRUIT UNLESS NOTED)
Plum	1 cup, sliced raw or cooked 3 medium or 2 large plums	1 large plum
Strawberries	About 8 large berries 1 cup, whole, halved, or sliced, fresh or frozen	½ cup whole, halved, or sliced
Watermelon	1 small (1" thick) 1 cup, diced or balls	6 melon balls
Dried fruit (raisins, prunes, apricots, etc.)	½ cup dried fruit	¼ cup dried fruit or 1 small box raisins (1 ½ oz)
100% fruit juice (orange, apple, grape, grapefruit, etc.)	1 cup	½ cup

CUP OF VEGETABLE TABLE			
		AMOUNT THAT COUNTS AS 1 CUP OF VEGETABLE	AMOUNT THAT COUNTS AS 1/2 CUP OF VEGETABLES
DARK GREEN VEGETABLES	Broccoli	1 cup, chopped or florets 3 spears 5" long raw or cooked	
	Greens (collards, mustard greens, turnip greens, kale)	1 cup, cooked	
	Spinach	1 cup, cooked 2 cups, raw	1 cup, raw
	Raw leafy greens: Spinach, romaine, watercress, dark green leafy lettuce, endive, escarole	2 cups, raw	1 cup, raw
RED AND ORANGE VEGETABLES	Carrots	1 cup, strips, slices, or chopped, raw or cooked 2 medium 1 cup baby carrots (about 12)	1 medium carrot About 6 baby carrots

CUP OF VEGETABLE TABLE			
		AMOUNT THAT COUNTS AS 1 CUP OF VEGETABLE	AMOUNT THAT COUNTS AS 1/2 CUP OF VEGETABLES
	Pumpkin	1 cup, mashed, cooked	
	Red peppers	1 cup, chopped, raw, or cooked 1 large pepper (3" diameter, 3 3/4" long)	1 small pepper
	Tomatoes	1 large raw whole (3") 1 cup, chopped or sliced, raw, canned, or cooked	1 small raw whole (2 1/4" diameter) 1 medium canned
	Tomato juice	1 cup	½ cup
	Sweet potato	1 large baked (2 ¼" or more diameter) 1 cup, sliced or mashed, cooked	
	Winter squash (acorn, butternut, hubbard)	1 cup, cubed, cooked	½ acorn squash, baked = ¾ cup

CUP OF VEGETABLE TABLE			
		AMOUNT THAT COUNTS AS 1 CUP OF VEGETABLE	AMOUNT THAT COUNTS AS 1/2 CUP OF VEGETABLES
BEANS AND PEAS	Dry beans and peas (such as black, garbanzo, kidney, pinto, or soybeans, or black-eyed peas or split peas)	1 cup, whole or mashed, cooked	
STARCHY VEGETABLES	Corn, yellow or white	1 cup 1 large ear (8" to 9" long)	1 small ear (about 6" long)
	Green peas	1 cup	
	White potatoes	1 cup, diced, mashed 1 medium boiled or baked potato (2 ½" to 3" diameter)	
OTHER VEGETABLES	Bean sprouts	1 cup, cooked	
	Cabbage, green	1 cup, chopped or shredded raw or cooked	
	Cauliflower	1 cup, pieces or florets raw or cooked	

CUP OF VEGETABLE TABLE

		AMOUNT THAT COUNTS AS 1 CUP OF VEGETABLE	AMOUNT THAT COUNTS AS 1/2 CUP OF VEGETABLES
	Celery	1 cup, diced or sliced, raw or cooked 2 large stalks (11" to 12" long)	1 large stalk (11" to 12" long)
	Cucumbers	1 cup, raw, sliced or chopped	
	Green or wax beans	1 cup, cooked	
	Green peppers	1 cup, chopped, raw or cooked 1 large pepper (3" diameter, 3 ¾" long)	1 small pepper
	Lettuce, iceberg or head	2 cups, raw, shredded or chopped	1 cup, raw, shredded or chopped
	Mushrooms	1 cup, raw or cooked	
	Onions	1 cup, chopped, raw or cooked	
	Summer squash or zucchini	1 cup, cooked,	

CUP OF VEGETABLE TABLE			
		AMOUNT THAT COUNTS AS 1 CUP OF VEGETABLE	AMOUNT THAT COUNTS AS 1/2 CUP OF VEGETABLES
		sliced or diced	