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Exploring Obesity Risk Factors in Five Regions of Virginia

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This is to certify that the doctoral dissertation by

Karen Carpenter

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Abstract

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by

Karen Carpenter

MS, Radford University, 1995

BS, Radford University, 1993

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

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Abstract

Obesity continues to weaken our nation physiologically, psychologically and financially with an overall prevalence rate of 34.9% or 78.6 million Americans affected. Variance in obesity prevalence rates, in the state of Virginia, account for over a 15% difference from one health district to the next. The purpose of this research was to better explore the regional obesogenic factors that may exist among five health districts in the state of Virginia. The socio ecological theory provides the conceptual framework of the study to understand the variance in regional obesity rates, as a function of the contributing risk factors that a region exhibits. This study was a quantitative retrospective secondary analysis that investigated four obesogenic risk factors using the Center for Disease Control's 2013 Behavior Risk Factor Surveillance Survey. Binary logistic regression analyses were conducted for each of the four obesity factors in five regions in Virginia and the results emphasized that specific regional obesity prevention efforts in targeted areas are identifiable and specifically, attention to ethnicity, poverty, and exercise intensity are warranted in all Virginia's health districts. Understanding obesogenic factors can further empower public policy makers to identify obesity prevention and treatment strategies most aligned with the health district needs such as exercise or nutrition campaigns targeting ethnic communities. Creating a statewide profile of regional obesogenic factors using this research model can bring about effective community intervention strategies leading to impactful improvements in individual health, wellness, and quality of life which can be a force in the community's positive social change.

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Dedication

This doctoral study is dedicated to my family who without their support and encouragement it would not be. To my husband, for being patient and being my cheerleader; to my mother, for being rock solid and making me finish; for my dad, for being my inspiration and my secret stat guy; for my children, Joshua, Jesse, James, and Jordan, for making me want to be a good example; for my brother, Allan, whose passion and intensity, in spirit, was needed to see this through. Thank you to my three special "sisters"; Aunt Kathy, Dee and Hope and for my friends, our lunches that kept me sane and their willingness to "go with" for residencies. Finally, to my Virginia Western Community College colleagues for always supporting, listening, and encouraging in getting DONE!!

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Chapter 1: Introduction to the Study

Introduction

Research continues to point to obesity prevalence rates as alarming and prompting a health crisis (Center for Disease Control [CDC], 2014;World Health Organization [WHO], 2014). Terms and phrases from the CDC such as *staggering, common*, *serious*, and *costly* are also combined with *preventable* and *lifestyle choices*. The good news is that obesity is preventable and much research has shown significant improvements in quality of life and mortality rates when energy balance is improved (Healthy People 2020, 2014).

As a nation, the United States is currently faced with a 34.9% (76 million) adult obesity rate and a 17.1% (12.7 million) child obesity rate (CDC, 2014). The state of Virginia ranks 31 out of 50 in the category of obesity prevalence with a 28.5% obesity rate (Virginia Department of Health, 2014). Within the state of Virginia, five geographic regions are identified by the Virginia Department of Health (VDH, 2014). There is a disparity in Virginia regional obesity rates with Eastern Virginia having a 30.1% obesity rate and the Northern Virginia region with a 21.4% obesity rate (VDH, 2014).

The purpose of this study was to investigate obesity risk factors within the five health districts of Virginia to identify regional characteristics and district obesity profiles. Investigating risk factors of obesity within the regions of Virginia enables the region's public health system to more effectively impact obesity prevalence rates. Halting the obesity prevalence rates can result in a 25% decrease in obesity mortality rates (WHO, 2013). That translates into 30 million Americans being able to attain not only decreased mortality, but an increased quality of life, which leads to positive social change.

The state of Virginia's public health system has defined regions as they apply to the dissemination of services (CITE). These regions for Virginia are: (a) Southwestern, VA ; (b) Central, VA; (c) Northwestern, VA; (d) Northern, VA; and (e) Eastern, VA (Virginia Department of Health, 2014). Segmenting (via secondary analysis) obesogenic and nonobesogenic data collected from the CDC 2013 Behavior Risk Factor Surveillance Survey (BRFSS) into the five regions of Virginia may allow a better understanding of the significance an obesity factor or combination of factors may have in a specific region.

Background of the Study

Obesity has been defined by the CDC (2014) as an individual having a body mass index (BMI) of 30 or above and overweight is defined as a BMI of 25–29.9. BMI is calculated by dividing body weight by height using the following equation: Weight (kg) / $[\text{height (m)}]^2$ (CDC, 2014). The limitation of using BMI as an indicator is it does not offer evidence of the type of weight or amount of adipose tissue, only height and weight. Measuring percent body fat with various tools is another means to measure obesity and overweight more accurately with respect to type of tissue, adipose or lean, or percent body fat (CITE). In 2009, the American Society of Bariatric Physicians categorized body fat, using an obesity algorithm, as a percent of adipose tissue of 25% or higher for males and 30% or higher for females (Seger et al., 2015). The limitation presented with the wide use of BMI may be underestimating our current obesity prevalence rates as type of tissue is not differentiated (Ogden, 2010).

Obesity data dates to 1980 for epidemiological study (CDC, 2014). Prior to 1980 data were not collected in any uniform manner (CDC, 2014). The trends are visually depicted in Figures 1 and 2 with maps that show the spread of obesity throughout the USA from 2011–2013.

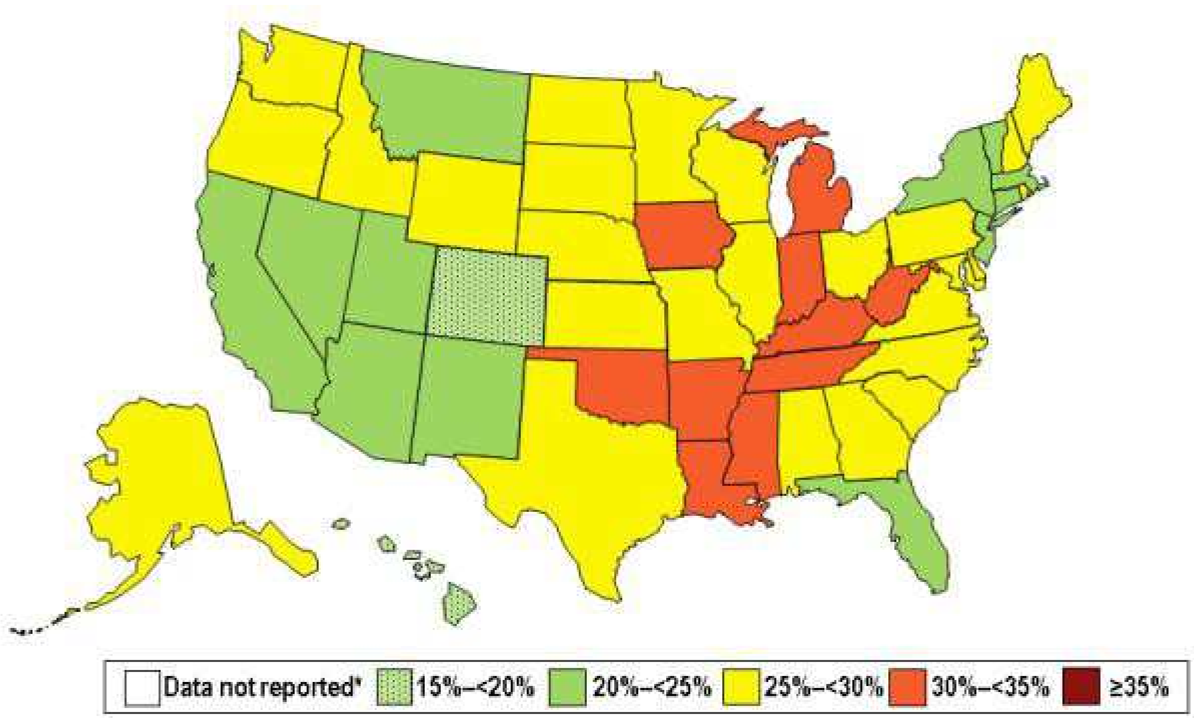

Figure 1. 2011 Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory. Adapted from "Vital Signs:Adult Obesity" by Center for Disease Control, 2010.

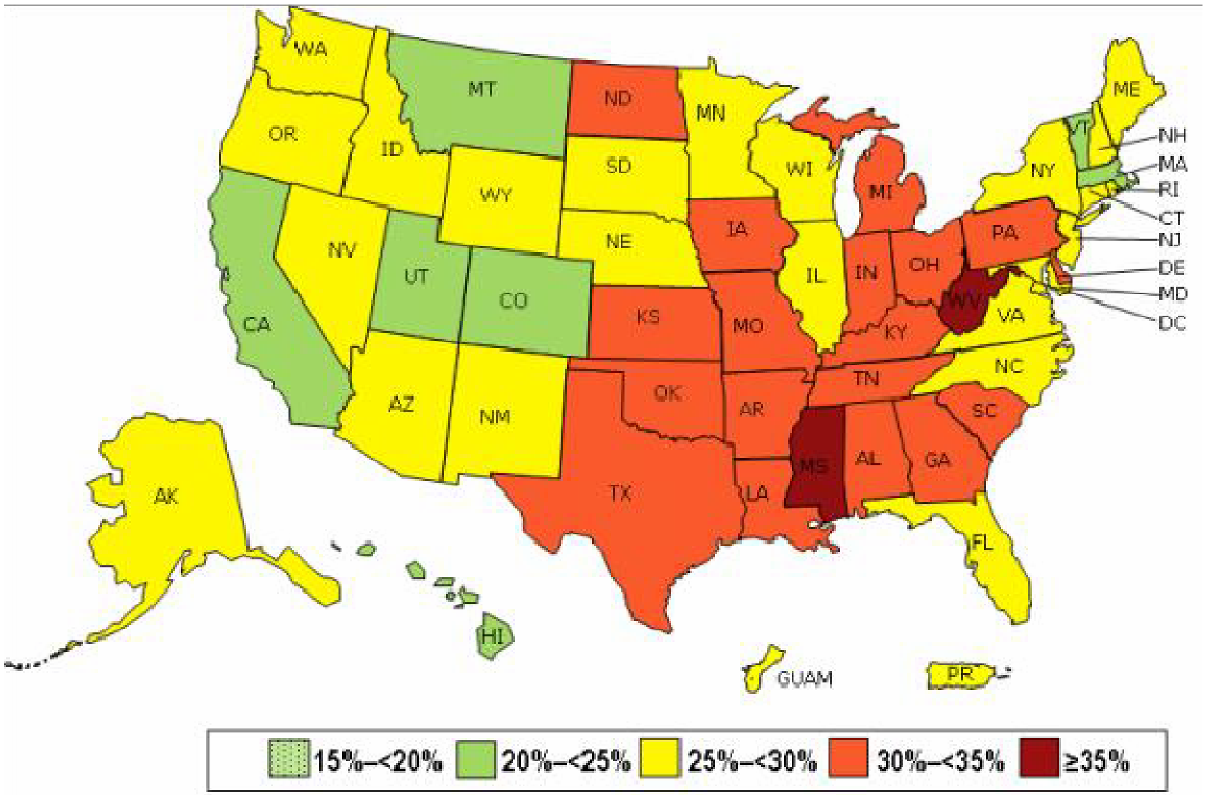

Figure 2. 2013 Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory. Adapted from "Vital Signs:Adult Obesity" by Center for Disease Control, 2010.

The data from prior to 2011 was not useful to compare with the current data as the data collection methods have changed (CDC, 2014). The BRFSS is a public health surveillance system that was modified in response to technological advances (CDC, 2014). The CDC reports that adjustments to large scale surveys such as the BRFSS must be periodically made as populations, technologies, or standards change (CDC, 2014).

Obesity has continued to be a national burden which requires a multifaceted approach to prevention and treatments. The federal government has labeled obesity as a current national health priority with an estimated $147 billion spent annually or 9.1% of medical spending on the direct and indirect costs of obesity (CDC, 2014). Finklestein, Trogdon, Cohen, and Dietz (2009) reviewed the National Health Expenditure Accounts dataset and estimated the cost of obesity (agreeing with the CDC's estimates) in 2006 at $147 billion, while Cawley and Meyerhoefer (2012) estimated higher values at $190 billion and 21% of medical spending after their review of 2005 Medical Expenditure Panel Survey.

Emerging from the literature are six causes of obesity: genetics, culture, metabolism, environment, behavior, and socioeconomic status (CDC, 2012; Jeffery & Utter, 2003; Nestle & Young, 2002; Virginia Department of Health[VDH], 2014). Studies that have been conducted nationally do show geographical specifications with regard to obesity causes and prevalence rates (Fisher, 2010; Segal & Gadola, 2007). There has been no evaluation of these specific causes and their associated risk factors on a state level. In Chapter 2, the six causes of obesity will be explored in detail.

Problem Statement

A quantitative descriptive study was necessary to evaluate which risk factors of obesity are most significant in the regions of Virginia that the public health system currently serves. The CDC and the state of Virginia each point to obesity being a continued health alarm for both the nation and the state (CDC, 2014;VDH, 2014). The obesity rate for adults in Virginia is 27.6% ranking 24th in the United States, with Colorado leading the nation (20.5%) and Tennessee the most obese state (31.1%;VDH, 2014). Furthermore, Jeffrey and Utter (2003) and Ford, Mokdad, Giles, Galuska, and

Serdula (2005) provided evidence that causal obesity factors (socioeconomic status, environment, and lack of opportunities for exercise) can contribute to obesity. Identification of predominant obesity risk factors within a region can strengthen efforts to combat obesity and lead to positive social change.

The Virginia Department of Health reports on five regions in the state as they relate to obesity prevalence rates (VDH, 2014). The Eastern region reports the highest levels of obesity prevalence at 35.6% followed by Southwestern (34.5%) and Central (31.1%; CITE). The Northern region has a 2012 rate of 20.1% which reveals a 15.5% difference regionally in the state (CITE). The problem that I focused on in this study was that we need further research towards understanding, within the context of obesity, why there is a discrepancy. This may allow public health practitioners to focus on specific prevention strategies with the limited resources.

In the state of Virginia, the Prevention Status Report offers a record of the public health policies designed to reduce the obesity rates and how the state is faring using a simple green, yellow, or red code assigned to the parameter regarding that obesity prevention policy (CDC, 2014). Green indicates there is supporting evidence that policy or practice is in accordance with expert recommendations; Yellow indicates partial accordance with expert recommendations; and Red indicated there is an absence of the policy or practice or it is not established in accordance with expert recommendations (CDC, 2014). The five markers as reported by the CDC (2014) are:

- Implementing nutrition standards to limit availability of less nutritious foods and beverages in schools.

- Implementing nutrition standards for foods and beverages in state government facilities.
- Implementing nutrition and physical activity standards in state regulations of licensed child care facilities.
- Establishing physical education time requirements in high schools.
- Promoting evidence-based practices that support breastfeeding in hospitals and birth centers.

Virginia scored Red in each of the five policies for obesity, indicating the state has not yet adopted the obesity prevention policies (CDC, 2014). Much research is available on obesity prevention and treatment on an individual basis but not necessarily integrated with the geographical, communal, or societal basis (Wang & Zhang, 2004). VDH (2014) reports that the ensuring the continued development of obesity prevention is a primary role of public health that must be coordinated and aggressive. Understanding fully the regional differences can assist in meeting that goal.

Purpose of the Study

The purpose of this study was to investigate obesity risk factors within the five health districts of Virginia to identify regional characteristics and district obesity profile. Exploration of the primary obesity risk factors specific for each region within the state of Virginia can allow for customization of prevention and treatment programs that may be most appropriate for that region to achieve positive social change. The approach of this study was to investigate four obesogenic factors within the each district of Virginia to identify regional characteristics and district obesity profiles.

With limited resources available to states for funding of programs, it is critical that programs are aligned with the contributory causes for that region, or that the programs are customized for that region or community based on their need. Proper alignment will ensure maximum impact for obesity prevention and treatment programs for a region. The five Virginia regions for this study will align with the Virginia public health system's Health Planning Regions Maps to include: Northwest, Southwest, Eastern, Central, and Northern regions (VDH, 2013). Creating a regionally specific plan can profoundly impact the obesity rates. This is a crises that with proper intervention can be not only reversed but that can create a synergistic effect towards healthy behaviors overall. The Virginia Department of Health (2013) reported that a small amount of change (~5%) can produce significant improvements in a personal health profile (VDH, 2014).

Research Questions and Hypotheses

The following research questions and hypotheses were used to guide this study. They were derived from the review of existing literature in the area of obesity, obesity causality, and obesity prevalence :

H_o 1: Within each defined region of Virginia, race/ethnicity is not an obesogenic factor .

H_a 1: Race/ethnicity will be an obesogenic factor within each defined region of Virginia.

H_o 2: Within each defined region of Virginia, socio economic status is not an obesogenic factor for obesity.

H_a 2: Socioeconomic Status will be an obesogenic factor within each defined region of Virginia.

H_o 3: Within each defined regions of Virginia, physical activity levels are not an obesogenic factor?

H_a 3: Within each defined regions of Virginia, physical activity levels are an obesogenic factor?

H_o 4: Within each defined region of Virginia, behavior regarding nutritional intake is an obesogenic factor for obesity.

H_a 4: Behavior regarding nutrition will be an obesogenic factor within each defined region of Virginia.

H_o 5: Region, in combination with each of the four risk factors in obesity: (a) race or ethnicity, (b) socioeconomic status, (c) physical activity levels, and/or (d) behavior regarding nutrition, will be an obesogenic factor?

H_a 5: Regions will not be a prevalent factor.

Theoretical Foundation

The effectiveness of a health promotion program can be influenced by using theories and defining concepts, constructs, variables, and models (National Cancer Institute, 2015). Regional obesity cause analysis using theories develops the foundation to answer the questions of how to best use resources to decrease obesity prevalence and subsequent cost. To understand the regional factors that contribute to obesity in this study, the social ecological theory was applied. Figure 3 provides a basic depiction of the sphere of influence and the need to look at these issues from a regional perspective

(CDC, 2014). In regards to obesity, the sphere of influence is apparent in the influence on individual behavior society/policy, community, or personal relationships may have on one's individual BMI. Attempting to affect personal or individual change regarding one's BMI has a scope beyond the individual. The community, and in this study, the regional influence will affect the obesity outcome.

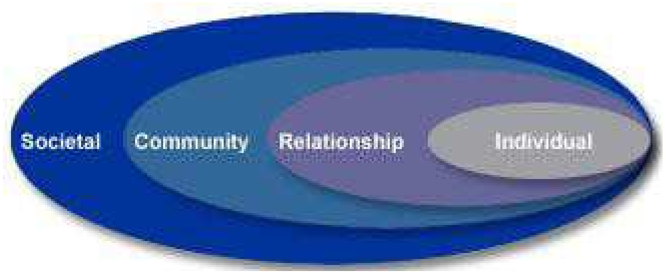

Figure 3. The Social Ecological Theory. Adapted from "The Social Ecological Model: A Framework for Prevention" by Center for Disease Control, 2015.

Significance of the Study

The significance of the study is to broaden and build upon the knowledge base for obesity, obesity causes, and the relationship that geography may have for the state of Virginia. National data from the CDC (2014) alerted public health officials that obesity trends were consistently rising since 1985. The data has only recently become consistent in collection, and therefore, more useful (CDC, 2014). As the rising trend of obesity begins to slow, there are noticeable variances in trends across the country and within the state of Virginia (VDH, 2012). Although, national research on regional obesity trends indicates areas of both high and low obesity prevalence rates with specific obesity causes that can be addressed (Fisher, 2004), there is a gap in the literature regarding a specific state and its regional obesity causality characteristics.

The acknowledged high priority obesity trends are associated with negative medical profiles and higher morbidity and mortality rates (CDC, 2014). Increased risks for cancers, diabetes, cardiovascular disease, psychological implications, and other chronic conditions keep obesity as a high priority for public health (CDC, 2014). With wide spread negative implications across many disciplines, the wide spread positive effect of improved obesity prevention and treatment can be synergistic and affect millions of Americans. The community approach to this health crisis must continue due to the complexity and individual nature of the condition.

Definitions

Behavior: As related to obesity, the value one puts on healthy eating, exercising, or maintaining a healthy weight (Maiman & Becker, 1974). Behavior, as related to nutrition, explores the healthy eating aspect (CITE).

Behavior Risk Factor Surveillance Survey (BRFSS): BRFSS is a state-based telephone survey that includes information on a number of health outcomes, risk behaviors, use of preventative services, and chronic conditions for noninstitutionalized adults who reside in each of the states and selected U.S. territories. Surveys include a core set of questions and multiple optional modules that focus on specific health issues (CDC, 2014).

Body mass index (BMI): A high body fatness indicator calculated by dividing body weight by height with the equation: Weight (kg)/[height(m)$\}^2$ with below 18.5 =

underweight, 18.5–24.9 = normal weight, 25–29.9 = overweight, and over 30 = obese (CDC, 2014).

Culture: As related to obesity, race and ethnicity (CITE).

Energy imbalance: As related to obesity, the consumption and expenditure of calories that may produce increased body fat storage or decreased body fat storage. Obesity is defined as excess body fat (CDC, 2012).

Metabolism: As related to obesity, an energy balance factor that may be influenced by age, gender, body size, thermogenesis, and physical activity (Mayo Clinic, 2012).

Regional obesity prevalence rates: The number of persons in a regionally defined population with disease or condition (in this case, obesity) at a particular point in time (WHO, 2015).

Obesity: A caloric imbalance that results in excess calories and excess fat storage and measured as 30% body fat or a 30+ BMI (CDC, 2014).

Obesogenic: Tending to cause or promote obesity (Swinburn, Eggert, & Rasa, 1999; WHO, 2014)

Leptogenic or Nonobesogenic: Tending to cause or promote leanness (Swinburn, Eggert, & Rasa, 1999)

Socioeconomic status: As related to obesity, the individual or community's economic and/or educational status (CDC, 2014: Plantinga, Johansen, Shillinger, Neil, & Powe, 2012).

Assumptions/Limitations

The use of the BRFSS (2013) introduces a limitation with the self-reported data used in the study. Additionally, I generally applied the questions to the obesity cause factors to glean the wanted information and correlations. Within the scope of public health, the usefulness of existing data was important and something that I wanted to achieve with this research. The CDC under federal budgets currently collects and disseminates public use BRFSS data and the state public health system already have regions segmented (CDC, 2014; VDH, 2014). For this study, to work towards maximum efficiency that is so important in public health, using these sets of data was both a limitation and necessity. It was assumed that participants answered truthfully. The anonymity and confidentiality of the BRFSS respondents was ensured. At no time was any identifiers associated with collected public use data.

Scope and Delimitations

The problem of obesity affects all profiles of people. The purpose of this study was to explore the obesogenic factors from a regional perspective in the state of Virginia. The scope or coverage of this study included all Virginia adults, regardless of their BMI, that provided data for the 2013 BRFSS. This study was limited to only those individuals who completed the 2013 BRFSS and provides only a snap shot of the regional obesogenic profile. It was too problematic and repetitive to create another instrument to survey and collect valid data regarding specific obesity variables when resources are already being allocated to effective data collection. Furthermore, if one takes a historical perspective the data have, more currently, begun to lend themselves more directly to obesogenic or nonobesogenic survey content questions.

Summary

Understanding the magnitude of the problem of obesity is important in working towards solutions for the condition. Although with this study, the focus was on adult obesity trends and prevention, the childhood rates are similarly alarming which is cause for continued efforts. The use of public health efforts is critical due to the complexity of the condition. This study continued to scrutinize the health emergency of obesity from a community perspective. Understanding the state of Virginia's role, limitations, and reach for a public health effort, can be the basis for understanding proper and aligned obesity prevention efforts. Positive social change can be achieved in the form of a significantly improved quality of life by the reduction in prevalence rates of obesity. In Chapter 2 I will present the current and relevant literature on obesity including trends, causes, and the public health response.

Chapter 2: Literature Review

Obesity continues to be a major health priority (CDC, 2014; WHO, 2014). In this chapter, I will review the current trends in obesity in the state of Virginia. Individual and societal factors that are thought to contribute to obesity will also be reviewed within the framework of the energy balance equation. Additionally, the current and historical research on each obesogenic factor and explore each as they relate to the energy balance equation and regional obesity rates in the state of Virginia. Finally, a review of the global, national, and state of Virginia's public health response to obesity, which will serve to further understand current efforts, gaps, and reveal the continued need for obesity prevention efforts.

Literature Search Strategy

The literature search for this study produced a wide variety of related articles from government websites including the CDC, National Institute of Health[NIH], WHO, and Virginia Department of Health. I also used the Walden University Library for the collection of information, mainly from the EBSCO and ProQuest databases. Hard copy and electronic versions of journals including *American Journal of Public Health, IDEA Fitness Journal,* and the *Obesity Journal* were also used. The premise of this research was that obesity prevalence rates vary regionally; this premise rested on the obesity prevalence data provided by health agencies. Key search terms used included: *obesity, obesogenic, metabolism, built environment, exercise, physical activity, culture and obesity, genetics and obesity, public health, interventions, energy imbalance, behavior and obesity, ethnic obesity trends, BMI,* and *community*.

Obesity Trends

The WHO (2014) reported being overweight or obese contributes to over 2.8 million deaths globally each year. With a worldwide prevalence of obesity doubling between 1980–2008, with an average of 35% of adults worldwide being overweight (BMI of 25 kg/m2–29 kg/m2) and another 10–14% being obese (BMI > 30 kg/m2; WHO, 2014). Southeast Asia reported the lowest obesity prevalence rates at 14% and 3% for overweight and obesity respectively; Europe, the Eastern Mediterranean, and the Americas have the highest rates at 50% and 26% for overweight and obesity respectively (WHO, 2014). Globally, women have a higher obesity prevalence rate for all regions of the world (WHO, 2014).

The CDC (2014) reported that in 2011 that 34.9% of U.S. adults were obese. This figure has remained level for the first time in decades (CDC, 2014). Colorado continues to lead the nation with the lowest obesity rate at 21.3% and Mississippi and West Virginia top the ranking at 35.1% (CITE). Understanding the difference exposed in the wide 13.8% variance with a regional framework has been researched by Fisher (2010) and Wang and Beydoun (2007) and added significant knowledge towards the prevention efforts for the U.S. regions. Although studies have been conducted for a particular variable or set of variables with Torres (2011) and Sobal and Stunkard (1989), research using obesity factors has not been done for the state of Virginia.

Virginia Performs is a report presented through the Virginia Department of Health, and specifically by the Council on Virginia's Future, that outlines and measures the state's performance in areas that affect the quality of life for Virginia families (VA

Performs, 2014). Obesity is listed as a key objective in the report (VA Performs, 2014). This division reported that in 2013, Virginia's obesity rate of 27.2% ranked 18th in the United States (VA Performs, 2014). Regionally, the bordering states were higher, including North Carolina (29.4%), Maryland (28.3%) and Tennessee (33.1%); two states (Maryland and Tennessee) saw increased rates from 2012 (VA Performs, 2014). Within the state of Virginia, the Northern region had the lowest obesity prevalence rate at 20.1%, the Eastern region had the highest rate at 35.6%, and notably the Southwest region showed the biggest improvement with a 4% decrease to 34.5% (VA Performs, 2014). The national obesity rate goal as reported by the CDC is 15% or less, of which, zero states are achieving the goal. Zero is a number that requires continued research as this to understand how best and most efficiently to move states towards an obesity rate of less than 15%.

Energy Imbalance

Physiologically, excess calories are stored by the body as fat (American Council on Exercise [ACE], 2014). Humans both consume and expend calories and an imbalance occurs when individuals are in a caloric deficit or caloric excess; this determines our fat or adipose tissue storage (ACE, 2014). At its root, obesity is a result of the caloric imbalance that results in excess calories and excess fat storage (above 30% body fat or a BMI of 30+; ACE, 2014). The reason for the imbalance has been defined by the CDC (2014) with six key factors that I will explore in this study: socio-economic status, behavior, metabolism, genetics, culture, and environment.

Today's society has begun a trend of engineering energy balance. We are beginning to see indication that energy balance education is "sticking" with the insertion of caloric content beginning to show up on restaurant menus (CITE). Laws regarding sweetened beverages also reveal public health's attempts to understand and manipulate energy balance (CITE). Furthermore, devices, programs, or apps are also becoming readily available that assist in the calculation of the energy expenditure based on individual biometric data (Nike Fuel, Fit Bit, JawBone, etc.; CITE).

Obesity Causes

Genetics

The National Library of Medicine (2014) defined genetics as the method and consequences by which components of biological inheritance are transmitted from generation to generation. The effect our genetic makeup has on energy balance, and ultimately one's obesity predisposition, has been reported by Coady et al. (2002) in a longitude study using the Framingham data Castelli presented from 1977. Their conclusion indicated an appearance of an important genetic contribution, especially during the midlife years (Coady et al., 2002). Interestingly, research has indicated the obesity genotype predisposition combined with environment encouraging obesity, may influence the susceptibility to obesity (Sonestedt et al., 2009). Perusse (2000) reviewed 20 years of research regarding obesity and genetics and concluded that clearly there is a significant genetic link. One's predisposition towards obesity has unequivocally been identified and can be further influenced by environmental factors, sedentary lifestyle, and unlimited access to food (Boutin & Froquel, 2001). Research continues in identification of genes and genetic architecture specific to obesity to continue to locate paths for prevention and treatment (Boutin & Froquel, 2001).

Metabolism

Metabolism is a component that relates to energy balance and is an obesity risk factor (CDC, 2005). Caudwell et al. (2007) reported that effective weight management and metabolic response to exercise do have significant individual and regional variability. The Mayo Clinic (2012) reported that metabolism is a function of age, sex, body size, thermo genesis, and physical activity. As early as 1918, Harris and Benedict (1918) reported on human basal metabolism in a mathematical form with various factors such as nutritional status and body surface that may impact the heat dissipation or caloric expenditure. Tremblay, Simoneau, and Bouchard (1994) studied the effect of exercise on metabolism and specifically high intensity interval training and concluded vigorous exercise favors negative energy more than low to moderate intensity exercise.

Behavior

Behavior is another obesity risk factor as defined by the CDC (2014). Behavior or one's actions as they relate to obesity were identified by Sussman (2005) as being related to one's basic value system. The health belief model can be used and readily found in the public health and psychology research as the framework for health behavior decisions. It is theorized that behavior depends of two variables: (a) belief that action will result in expected outcome and (b) the value one places on the expected outcome (CDC, 2014). Individuals may or may not value eating healthy, exercising, or maintaining a healthy weight. Behavior modification on an individual level requires engagement for the intended outcomes of weight loss as well as maintenance long term adherence (Stalonas, Johnson, & Christ, 1978).

The literature showed that much research has also been conducted specifically on the idea that stress influences eating behavior (Torres & Nowson, 2007). It has been reported that stress influences eating in two forms--over or under—the extent of which may vary due severity of stressor, and for chronic stress it is concluded that the food choice is of higher density which leads to energy imbalance towards weight gain (Torres & Nowson, 2007). Stress as it relates to obesity is itself a complex acute and chronic condition that is impacted by regional factors such as community, environment, and/or policy.

Environment

Environment is another obesity risk factor that can have many factors associated with it that may prevent or encourage obesity. Beginning with the communities that people live in and how conducive to healthy behaviors they may be, thinking of environment as a risk factor introduces ideas such as: food maps, recreational access, neighborhood safety concerns, food type access (farm markets or fast food), school programs or lack of, general health promotion and education, and overall community design. The CDC (2014) indicated communities can either be part of the problem or part of the solution.

Social and environmental deterrents for physical activity are numerous. The environment we reside in or work in provides indicators for an individual's amount of physical activity. Giles and Donovan (2002) conducted a study involving 1,803 surveys of 18–59 years examining social and physical environmental influence on physical activity determinants. The results showed that physical environment was secondary to social environmental and individual determinants (Giles & Donovan 2002). There was a significant parallel between immediate supportive environment and increased community saturation of physical activity (Giles & Donovan 2002).

The complexity of obesity warrants similarly complicated treatments; built environments must be reviewed and explored within communities to promote positive personal behaviors. Another study by Brownson, Baker, Housemann, Brennan, and Bacak (2001) reported physical activity personal barriers as including tired, lack of time, unavailability at work, and no motivation. Presence of sidewalks, enjoyable scenery, and hills were associated with increased physical activity (Brownson et al., 2001). Both sets of research suggest the environment is relevant.

The impact of fast food access and what are being termed as *food deserts,* where access to grocery stores is limited especially associated with low socio economic neighborhoods, has shown to increase obesity prevalence and thus become a federal health priority (Fielding & Simon, 2011). Understanding the local food environment, as reported by Fielding and Simon (2011) may assist in identification of the combination(s) of interventions that may be most impactful. Interestingly, Poti, Duffy, and Popkin (2013) viewed the overconsumption of fast food as part of the overarching issue of poor nutrition as a function of access to poor quality, low nutrient, and processed food. The quick fix at a convenience store or mini mart and meals that are not prepared at home is more the issue, fast food feeds the low cost, high density need we have created (Poti, Duffy, &

Popkin, 2013). Due to the physiology of the energy balance equation the continued high density food and sugar drinks are not healthy choices that can easily precipitate obesity.

Culture

As it relates to culture, the roots of obesity are laid early and have an influence on eating patterns, physical activity, and overall wellness behaviors that are learned early (CDC, 2014). The convergence of many trends involving less physical activity and a higher consumption of high density and high caloric food has resulted in a hostile environment in relation to health and wellness. Culture also contributes to obesity in relation to environment, values, and culturally influenced food choices. Croll, Hannan, Neumark-Sztainer, and Story (2002) suggested food intake patters can be based on gender, race and ethnicity, and socio economic factors. As related to culture, food mapping, food preferences, preparation methods, and even consumption behaviors may offer insight into the aspect of culture and increased obesity prevalence . Brown (1991) wrote that cultural predisposition to obesity does occur and is based on gender, ethnicity, social class, and economic modernization. The complexity of culture is intriguing as stark contrasts can be identified and cross cultural comparisons are useful (Brown, 1991).

In May 2012, the CDC's Division of Nutrition, Physical Activity, and Obesity presented the *State of Obesity Control and Prevention Progress* (CDC, 2012). The Weight of the Nation Conference highlighted the undeniable influence culture has in the creation of a mismatch between today's environment and the genetically thrifty genotype of the past (CDC, 2014). The evolution of eating is fascinating as humans began as hunters, moved to producers (farmers), and now have an unending supply of processed or an industrialized food supply (CDC, 2014). The problem is that the human DNA has not changed along with that evolution of our environment (CDC, 2014).

The spread of obesity within one's environment is discussed in Fisher (2010), where the author describes the phenomenon of how being surrounded by or living with obese people may increase obesity prevalence. Christakis and Fowler (2007) reported up to a 57% increased chance of becoming obese if one has an obese friend and 40% increase when siblings were studied. The genetic link obesity may have is indicative that we are all born with particular genetic range and it is through manipulation of the energy balance equation via expenditure or consumption of calories that we have some ability to reverse this predisposition.

Socioeconomic Status

Dr. O'Dell (2013) with the Virginia Department of Health reports overall obesity is a health disparity with disproportionate increases in subsets of the population including lower socio economic status. Additionally, an inverse relationship is also observed with obesity and family income among white females and white males but a weaker association among other groups (O'Dell, 2013). Allison et al. (2007) concluded a higher cost associated with healthy food; those with higher incomes consumed more fruits and vegetables in Birmingham, Alabama, more evidence of the impact socioeconomic status has on obesity and specifically low socioeconomic status and higher obesity prevalence rates.

In a powerful documentary compiled by a collaboration of Kaiser Permanente, Centers for Disease Control, *National Weight of America* Dr. Iton M.D., Senior Vice

President of Healthy Communities from The California Endowment, exemplifies the socioeconomic disparity with the life expectancy difference of a town in Ohio; Hough Street in Cuyahoga County Ohio is a poverty stricken, inner city area with a life expectance of 64 years, 8 miles down the street, where a dramatically higher income neighborhood Lyndhurst is located the life expectancy is 91 years (Home Box Office Studios, 2012).

We see the strongest inverse relationship of socioeconomic status and obesity with Caucasian women in developed countries from a literature review conducted on 144 published studies (Sobal & Stunkart, 1989). Understanding the issue of obesity from solely a biological perspective is not enough, Sobal and Stunkart, (1989) report that cultural, psychological and social influences must be considered.

Public Health Response to Obesity

A review of the literature reveals a problematic situation and prognosis for obesity and its continued impact. Globesity is the term used to describe the global obesity epidemic requiring immediate action as millions are suffering from serious health disorders by the World Health Organization (WHO, 2014). The organizations continue to define obesity as a predominantly social and environmental disease (WHO, 2014). The WHO has activated a collaboration to analyze factors to promote obesogenic environments (WHO, 2014).

The Centers for Disease Control is a leading organization in the nation's organization and strategies for obesity prevention. They have a page titled State and Community Programs that outlines strategies and recommendations from the Division of

Nutrition and Physical Activity, and Obesity (DNAPO) (CDC, 2014). The DNPAO was originally organized in 1999 to fund six states in the US, and currently funds twenty-five (CDC, 2014). They have six target areas and have prepared a well detailed implementation strategy for states to begin to assess and make changes to each target (CDC, 2014). Utilizing the theoretical framework of the Social Ecological Model that describes broadening layers of influence, the CDC obesity interventions are prescribed to practitioners along with the Health Equity Toolkit (CDC, 2014).

A Prevention Status Report 2013 was generated by the CDC for states to align state and national targets and health priorities as well as expose problem states or health alarms and targeted prevention efforts (CDC, 2014). The topic of Nutrition, Physical Activity and Obesity has six targets that were measured and reported on (CDC, 2014). Outlined below are each target and the nations' score on each:

1. Percentages of secondary schools where less nutritious foods and beverages were not offered for sale - 10 states GREEN, 16 states YELLOW, and 20 states RED (5 states no data)
2. Status of state policies on nutrition standards for foods and beverages sold or provided by government agencies, US 2012 - 0 states GREEN, 5 states YELLOW, and 46 states RED
3. Inclusion of nutrition and physical activity standards in the state regulations of licensed childcare facilities, US 2012 - 50 states and the District of Columbia RED

4. Status of state physical education time requirements for high school students, US 2012 - 10 states GREEN and 41 states RED

5. Status of state average birth facility scores for breastfeeding support, US 2011 - 5 states GREEN, 19 states YELLOW, and 27 states RED

When examined overall, the percentages are heavily in the red which indicates improvements are needed as a nation. The specific targets and tools needed for obesity prevention programming are available. The literature shows obesity is a relatively recent health issue and empirical organization for all 50 states has been slow. Utilizing empirical evidence for community planning tools is critical if national and state efforts are to align.

The Prevention Status Report Virginia 2012 reveals the state has work to do. Of the nine standards Virginia met only four: vending machine standards, physical education, health education and farm to school programs were met, while school meal standards, vending machine access, physical activity, collection of health information (BMI) and diabetes screening were not met (VA Performs, 2014).

The Virginia Department of Health reports the Healthy Eating and Active Living (HEAL) Program is being developed in local communities (VDH, 2015). The state of Virginia has seven HEAL communities spread across the state as well as seven Obesity Prevention Projects (five overlap a Health Community Project) (VDH, 2015). The VA Department of Health has also launched HealthBites which is an online interactive nutrition education tool targeting families with best nutritional care for children from birth on up (VDH, 2015). Interestingly, this program is also ties into the Women, Infant and Children (WIC) subsidy program with credits. The literature on the programs available to communities suggests that the smaller and more precise the program the more significant the results tend to be (VDH, 2015).

Critique of Literature

Use of the BRFSS data throughout the literature is widespread as it is a surveillance tool (CDC, 2014). Morbidity and Mortality Weekly Report is a reporting system dedicated to health surveillance using the data from the BRFSS (CDC, 2014). It is the premise of public health that surveillance is a critical function and BRFSS is one contributing systems for health surveillance in the US (CDC, 2014).

Ford, Mokdat, Giles, Guluska and Serdula (2005) provide research titled Geographic Variation in the Prevalence of Obesity, Diabetes, and Obesity Related Behaviors that utilized BRFSS data from 2000. Those authors required a minimum of 300 BRFSS respondents for a metropolitan area to be considered as a region (Ford, Mokdat, Giles, Guluska & Serdula, 2005). Furthermore, they utilized a logistic regression model with obesity as the dependant and factors (age, sex, race, education, ethnicity, and metropolitan area) as the independent factors. The results were that Youngstown-Warren, OH residents had almost a three times higher odds (using an odds ratio) of being obese as residents in Miami, FL.

Fisher (2010) also relied on BRFSS data to complete the Inquiry to Explore Significant Regional Obesity Prevalence Factors in the United States. The unobtrusive research method of using BRFSS data with known obesity factors were examined in regions of the US. The authors coded the data and used an ANOVA to assess differences across the regions and to compare raked ordered means for the variables. Pearson's correlation was utilized to show any relationships and a multiple regression analysis was conducted for determination of which factor contributed most to obesity prevalence (Fisher, 2010). Results indicated that overall obesity predictors of consuming sufficient fruits and vegetables daily, the poverty level and the prevalence of college graduates were significant in all regions (Fisher, 2005). Each factor had a ranking of regions with highest positive responses for that variable (Fisher, 2010). The analysis for this research will closely model that of Fisher 2010.

Chapter Summary and Overview

In this chapter, I provided a review of the current literature regarding the sharply increasing obesity prevalence trends, obesity causal factors, and the national and state of Virginia's response. Upon close examination within the framework of energy imbalance, obesity related factors of genetics, culture, socioeconomic status, behavior and metabolism and environment each play a role in the condition of obesity. What emerges is mostly individual or localized relationships and correlations to further explain the epidemic of obesity. Although significant research has been conducted in the area of obesity, public health practitioners continue to pour resources into obesity prevention efforts. Organizing those efforts on a state level and exploring and utilizing regional characteristics can continue to move the efforts towards stabilizing and perhaps even reversing the toxic trends. In Chapter three, I will outline the methodology design and rationale to test the research questions.

Chapter 3: Research Methodology

The purpose of this research was to better understand any regional correlations that exist within the state of Virginia between obesity prevalence differences and four primary risk factors. This study was a quantitative retrospective secondary analysis of BRFSS data in which I examined the relationships and correlations between obesity prevalence rates and four separate obesity risk factors in five health districts of Virginia. With a further understanding of Virginia obesity trends, causes, and their regional significance, improved critical obesity prevention efforts can be further customized and specified for regions as defined by the Virginia Department of Health (VDH, 2014). In this chapter, I will describe the target population, research method design, and rationale for data assignment for each of the four causes of obesity to understand regional trends. I will also describe the use of the BRFSS and the collection and analysis of data.

Target Population

The target population for this research was the adult population of the state of Virginia. Specifically, the use of the Virginia Department of Health regional segmentation was used for practical application. Figure 4 details the map of the VDH Local Health Districts.

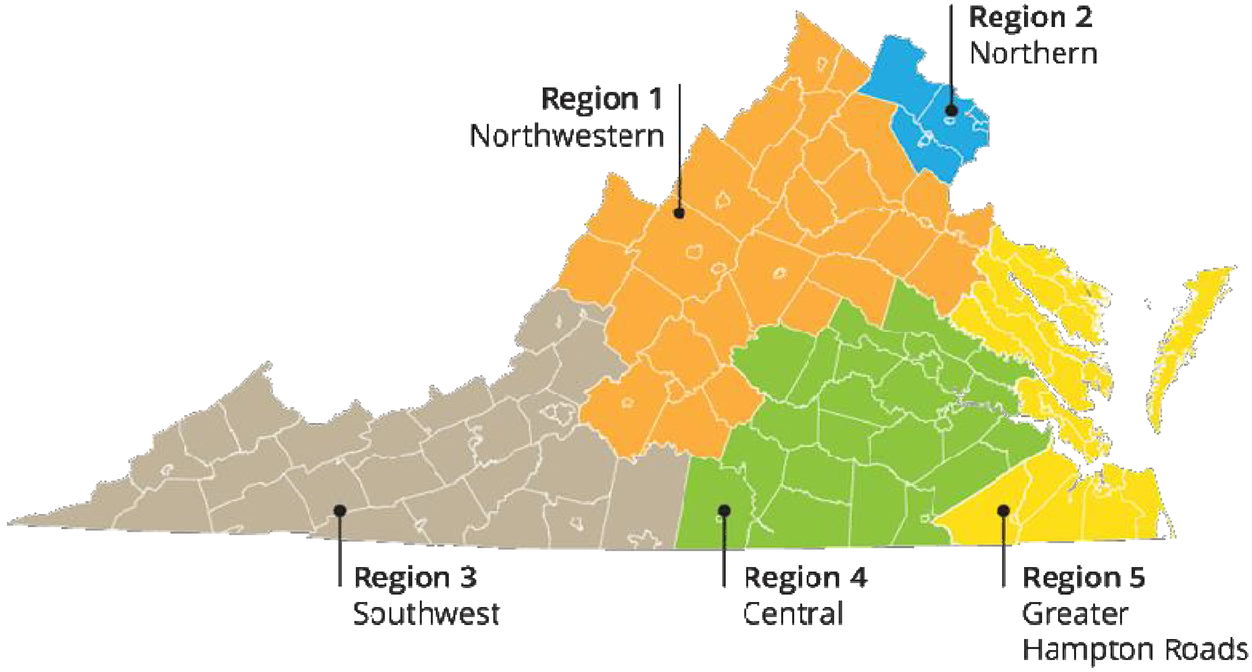

Figure 4. Virginia Department of Health Local Health Districts (2014)

In this study, I used five distinct regions with the included communities:

1. Northwestern: Central Shenandoah, Thomas Jefferson, Henrico, Rappahannock-Rapidan, Lord Fairfax, and Rappahannock
2. Northern: Loudoun, Fairfax, Arlington, Alexandria, Prince William
3. Southwestern: Lenowisco, Cumberland, Mount Rogers, New River, West Piedmont, Roanoke City, Pittsylvania-Danville, Allegheny and Central Virginia
4. Central: Piedmont, Southside, Crater, Chesterfield, and Chickahominy
5. Greater Hampton Roads (Eastern): Three Rivers, Peninsula, Western Tidewater, Portsmouth, Virginia Beach, Hampton, Norfolk, and Eastern Shore

Sample Size Calculation

Sample size was calculated through power analysis using the G*Power 3.1.7 software (Faul, Erdfelder, Buchner, & Lang, 2013). The power analysis was conducted using the established guidelines in Lipsey and Wilson (2001) for binary logistic regression with an alpha of 0.05, a power of 0.80, a medium effect size (odd ratio = 1.72), and two-tailed test. From the input parameters, the computed minimum sample size was 177. This means that to achieve the power of 0.80 for each test, the minimum number of observations per region should be 177, making a total of 885 samples.

Research Design and Approach

This study was a quantitative retrospective secondary analysis of BRFSS data in which I examined the relationships and correlations between obesity prevalence rates and four separate obesity risk factors in five health districts of Virginia. The independent variables were the factors of the constructs of race or ethnicity, socioeconomic status, physical activity, and behavior regarding nutrition. The dependent variable was the binary variable of obesity. Due to the nature of the dependent variable of obesity being binary (not obese or obese), binary logistic regression was found to be most appropriate to test the study hypotheses. The use of binary logistic regression allowed the examination of the probability of predicting the dependent variable of obesity with the categorical and continuous independent variables. Archival data were used for data analysis; the archival data were collected from the BRFSS in Richmond, Virginia.

In this study, I aimed to relate geographic factors with obesity cause data. An unobtrusive approach was used with use of CDC 2013 BRFSS data. This secondary analysis lends itself in an efficient way to assign a numerical approach to the data in a geographically defined context. The BRFSS is an ongoing national telephone survey that tracks self-reported health data in all 50 states in the United States (CDC, 2014). The health data collection began in 1984, uses standardized procedures, and is funded by the CDC (CDC, 2014). Regional obesity prevalence data were compared with the obesity cause factor data for each region so that insight could be rendered to help explain why, in that area of Virginia, the population obesity rate was higher or lower.

The BRFSS is set up with 16 Core Sections and 34 Optional Modules. For this study, questions from two Core sections and three Optional Modules were used. Appendix A is included as a full listing of the 2013 BRFSS Questionnaire Table of Contents with all Core Sections and Optional Modules listed (CDC, 2014). Four obesity causes were measured within the appropriate regions in Virginia.

Archival Data

The secondary archival data that were used were responses from a BRFSS survey. Data files are available for public use, so no specific use approvals were needed. Responses for the following sections were collected: exercise and physical activity, fruits and vegetable intake, as well as some portions of the demographic section such as BMI category, race/ethnicity, annual household income, and highest educational attainment.

Operational Definition of Variables

Obesity: Obesity was computed using data gathered from the demographic section of the BRFSS. From the BRFSS, the data that were used to compute obesity will be weight and height. As discussed earlier, obesity is based from BMI, where BMI is computed as: weight (kg) / height (m^2). A BMI of 30 or above would indicate obesity. As such, using the computed information for BMI, a person would be considered overweight or not. Obesity is the dependent variable of the study.

Factor-specific measurements: Factor specific variables and measurements on 2013 BRFSS are summarized in Table 1. Each factor is outlined is Table 1 with the: (a) risk factor that is under investigation, (b) variable that will be used to define the risk factor, and (c) measurement source that will be used for that variable. Further discussion per variable is included for each factor after Table 1.

Table 1

Obesity Risk Factors Aligned with BRFSS Questions

Risk Factor	Variable	Measurement(s)
Physical Activity	Exercise frequency, time and mode	BRFSS data Section 10
Behavior regarding nutrition	Fruits and vegetables Intake	BRFSS data Section 9 BRFSS data Section 10
Race/Ethnicity	Race - Ethnicity	BRFSS data

Physical activity: Physical activity as a risk factor for obesity was assessed using BRFSS questions to represent physical activity by reporting exercise mode, duration, and frequency from Core Section 10: Exercise and Physical Activity (8 questions;CDC, 2011). Appendix B lists 2011 BFRSS qualified questions. Frankenfeild, Roth-Yousen, and Cammeron (2005) completed a systematic review of metabolic rate in healthy nonobese individuals and concluded lean body mass can account for up to 62% of the variation. Chronic physical activity improves lean body mass and reduces fat mass thus an effective indicator of metabolism (ACE, 2014).

Behavior: The obesity causal factor of behavior was assessed using BRFSS questions representative of behavior relating to nutritional eating from Core Section 9: Fruits and Vegetables (5 questions).

Race/Ethnicity: The race/ethnicity of the participants was assessed using race responses from the demographic section of the BRFSS.

Region: The region of Virginia where the participants were living was a factor, both for grouping (Hypotheses 1 to 4) and for comparison (Hypothesis 5).

Socio-economic status (SES): The obesity causal factor of SES was measured using BRFSS questions representative of annual household income (1 question) and highest grade or year of school completed (1 question). The National Center for Education Statistics (NCES) convened a panel of nine experts to define SES and included several components including "parental educational attainment, parental occupational status, and household or family income, with appropriate adjustment for household or family composition. An expanded SES measure could include measures of additional household, neighborhood, and school resources" (NCES, 2003, p. 4). The panel additionally noted the "big three" that could be considered the core of SES included parental educational attainment, family income, and occupational status (NCES, 2003).

Data Analysis Plan

I conducted the data analysis using SPSS, version 19 statistical data management software. SPSS is a proven reliable tool for statistical inference and powerful and sensitive output. A database of regional codes and variable identification codes was generated and appropriately classified. The dependent variable of the study was obesity, which was a binary variable, which categorizes the sample into obese or not obese based on the computed BMI from the BRFSS data. Examination of obesity within the five regions of Virginia was examined through each of the formulated hypotheses, with the data analysis procedures outlined below. For all statistical tests, the confidence level was 95%, which means that for the results of a statistical test to be statistically significant, the resulting p-value should be < 0.05. The statistical tests addressed the following research questions through testing their respective hypotheses:

The following research questions and hypotheses were used to guide this study. They were derived from the review of existing literature in the area of obesity, obesity causality, and obesity prevalence :

H_o 1: Within each defined region of Virginia, race/ethnicity is not an obesogenic factor .

H_a 1: Race/ethnicity will be an obesogenic factor within each defined region of Virginia.

H_o 2: Within each defined region of Virginia, SES is not an obesogenic factor for obesity.

H_a 2: SES will be an obesogenic factor within each defined region of Virginia.

H_o 3: Within each defined regions of Virginia, physical activity levels are not an obesogenic factor.

H_a 3: Within each defined regions of Virginia, physical activity levles are an obesogenic factor.

H_o 4: Within each defined region of Virginia, behavior regarding nutrition is an obesogenic factor for obesity.

H_a 4: Behavior regarding nutrition will be an obesogenic factor within each defined region of Virginia.

H_o 5: Region, in combination with each of the four risk factors in obesity: (a) race or ethnicity, (b) SES, (c) physical activity levels, and/or (d) behavior regarding nutrition, will be an obesogenic factor?

H_a 5: Regions will not be a prevalent factor.

Hypothesis 1

The first null hypothesis stated that race or ethnicity will not be an obesogenic factor within each defined region of Virginia. To test the first hypothesis, I performed a binary logistic regression analysis. The independent variable was the single factor for the construct of race or ethnicity, and the dependent variable was obesity, a binary variable. Analysis was conducted for each of the five regions of Virginia, so I conducted five binary logistic regression analyses to test the hypothesis. Standard covariates were adjusted for with multiple regressions using cross sectional data.

Hypothesis 2

The second null hypothesis stated that SES will not be an obesogenic factor within each defined region of Virginia. To test the second hypothesis, a binary logistic regression analysis was performed. The independent variables are the two factors for the construct of SES, which are the annual household income, and highest educational attainment, and the dependent variable is obesity, a binary variable. Analysis was conducted for each of the five regions of Virginia, thus, five binary logistic regression analyses were conducted to test the hypothesis. Standard covariates can be adjusted for with multiple regression using cross sectional data.

Hypothesis 3

The third null hypothesis stated that physical activity levels will not be an obesogenic factor within each defined region of Virginia. To test the third hypothesis, a binary logistic regression analysis was performed. The independent variable was the single factor for the construct of physical activity, and the dependent variable is obesity, a binary variable. Analysis was conducted for each of the five regions of Virginia, thus, five binary logistic regression analyses were conducted to test the hypothesis. Standard covariates can be adjusted for with multiple regression using cross sectional data.

Hypothesis 4

The fourth null hypothesis stated that behavior related to nutrition will not be an obesogenic factor within each defined region of Virginia. To test the fourth hypothesis, a binary logistic regression analysis was performed. The independent variables were the construct of behavior, which is composed of the fruit and vegetable intake, and the dependent variable was obesity, a binary variable. Analysis was conducted for each of the five regions of Virginia, thus, five binary logistic regression analyses were conducted to test the hypothesis. Standard covariates can be adjusted for with multiple regression using cross sectional data.

Hypothesis 5

The fifth null hypothesis stated that regions will not have a prevalent obesogenic factor in Virginia. To test the fifth hypothesis, binary logistic regression analysis was performed, which would include all five regions. Analysis was performed for each obesogenic factor construct. As such, four binary logistic regressions were performed for each of the constructs: physical activity, socioeconomic status, race/ethnicity, and behavior related to nutrition. The variable of region was recoded into dummy variables, with each dummy variable representing each region. A reference region was selected, of which the outcome of the logistic regression analysis will be a contrast of the reference region.

Ethical Considerations

All ethical considerations as put forth by the Walden University Internal Review Board (IRB), the VDH IRB, in accordance with the *Publication Manual of the American Psychological Association, Sixth Edition* were carefully planned and accounted for in this research. The approval number received from the Walden University Office of Research Ethics and Compliance on December 15, 2015 is 12-15-15-0056418. The Virginia BRFSS Data as it is defined as public use data. Informed consent forms are not necessary when using archival data. However, the researcher should still maintain and ensure confidentiality of the data (Cozby, 2009).

Summary

In Chapter 3, I reviewed the research design rationale for organizing the CDC's 2013 BRFSS obesity factor data into five regions as segmented by the VDH. The secondary analysis design utilized credible data and allows for exploration of disparities among and within regions in Virginia. Each obesity causal variable is quantified for relationship analysis that can result in a clearer understanding of regional obesity prevalence variations. Ethical considerations are summarized. The results of these analyses will be presented in Chapter 4.

Chapter 4: Results

Introduction

The purpose of this research was to better understand any regional correlations that exist within the state of Virginia between obesity prevalence differences and four primary risk factors. With further understanding of Virginia obesity trends, causes, and their regional significance, improved critical obesity prevention efforts can be further customized and specified for regions as defined by the VDH (2014). In this chapter, I will present the results of the binary logistic regressions conducted to test the hypotheses and address the respective research questions as discussed in the previous chapter. Archival data were used, as discussed in Chapter 3, using the data from the BRFSS from the year 2013. BRFSS is widely used public health data collected annually, and the 2013 dataset was the most current complete dataset at the onset of this research. The research questions and hypotheses that guided this study were as follows:

H_o 1: Within each defined region of Virginia, race/ethnicity is not an obesogenic factor .

H_a 1: Race/ethnicity will be an obesogenic factor within each defined region of Virginia.

H_o 2: Within each defined region of Virginia, SES is not an obesogenic factor for obesity.

H_a 2: SES will be an obesogenic factor within each defined region of Virginia.

H_o 3: Within each defined regions of Virginia, physical activity levels are not an obesogenic factor.

H_a 3: Within each defined regions of Virginia, physical activity levles are an obesogenic factor.

H_o 4: Within each defined region of Virginia, behavior regarding nutrition is an obesogenic factor for obesity.

H_a 4: Behavior regarding nutrition will be an obesogenic factor within each defined region of Virginia.

H_o 5: Region, in combination with each of the four risk factors in obesity: (a) race or ethnicity, (b) SES, (c) physical activity levels, and/or (d) behavior regarding nutrition, will be an obesogenic factor?

H_a 5: Regions will not be a prevalent factor.

In Chapter 4, I will review the baseline demographic information on the entire state population including ethnicity, obesity, below poverty level, and highest educational attainment. Then, within each of the five regions of Virginia (Central, Eastern, Northern, Northwestern and Southwestern), I will report demographics for each obesogenic factor identified in the research questions.

Data Collection

I retrieved the archival data from the 2013 BRFSS from the CDC website. The CDC provides public use data that organizes data according to the state health district. Specifically, the responses for relevant BRFSS questions comprised the data for this study. Relevant survey question responses from the following sections were collected:

- Exercise and physical activity;
- Fruits and vegetables intake;

- Race/ethnicity;
- Annual household income; and
- Highest educational attainment.

Results

In this section, I will present the demographic results for the entire population of all regions combined followed by demographics for each region in Virginia. Secondly, each research question's results will be presented with the research hypothesis being accepted or rejected. The baseline demographic information of the total population analyzed, which includes: ethnicity, obesity, below poverty level, and highest educational attainment, are presented below.

Statewide Sample Demographic

Ethnicity population demographic. A majority of the sample are Caucasian (n = 2,808, 80.7%), followed by African American (n = 451, 13.0%), and other minorities which consisted of Hispanic (n = 72, 2.1%), Asian (n = 48, 1.4%), American Indian/Alaskan Native (n = 29, 0.8%), and Other (n = 73, 2.1%).

Obesity population demographic. The second demographic variable, obesity, was categorized using the BMI category data from the BRFSS, where nonobese categories were categorized as "not obese." There were 956 samples (27.5%) who were categorized as obese, while a majority (n = 2,525, 72.5%) were not obese, which meant that they were underweight, normal, or overweight but not obese.

Below poverty level population demographic. Below poverty level was categorized using the total household income from the BRFSS, where the categorization was based from the U.S. Department of Health and Human Services website (https://aspe.hhs.gov/poverty-guidelines). Households with a total number of one person were categorized as below poverty level if income was below $15,000 (CITE). Households with a total number of two to four persons were categorized as below poverty level if income was below $25,000 (CITE). Households with five to six persons were categorized as below poverty level if income was below $35,000 (CITE). Households with more than seven persons were categorized as below poverty level if income was below $50,000. Table 2 presents the frequency table of whether the sample was from a household of below poverty level or not.

Table 2

Below Poverty Level (N = 3,481)

	Frequency	Percent
No	2,965	85.2
Yes	516	14.8
Total	3,481	100.0

Highest educational attainment population demographic.

Table 3

Highest Educational Attainment (N = 3,481)

	Frequency	Percent
Did not graduate high school	215	6.2
Graduated high school	737	21.2
Attended college or technical school	878	25.2
Graduated from college or technical school	1,651	47.4
Total	3,481	100.0

Table 4

Virginia Health Region Samples (N = 3,481)

	Frequency	Percent
Central	691	19.9
Eastern	889	25.5
Northern	565	16.2
Northwestern	551	15.8
Southwestern	785	22.6
Total	3,481	100.0

Health District Demographics

The following demographic information and descriptive statistics are categorized according to each of the five health districts.

Ethnicity

As observed, a majority of the samples in every health region was composed of Caucasian (72.2% to 88.9%), and then followed by a wide margin, by African American (6.4% to 22.4%). These are then followed by the other minority ethnicities of Asian, Hispanic, American Indian/Alaskan Native, and Other races.

Obesity

Table 5 presents all the data for each region.

Table 5

Obesity by Virginia Health Region

	Central		Eastern		Northern		Northwestern		Southwestern	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Not obese	486	70.3	621	69.9	444	78.6	407	73.9	567	72.2
Obese	205	29.7	268	30.1	121	21.4	144	26.1	218	27.8
Total	691	100.0	889	100.0	565	100.0	551	100.0	785	100.0

Note. fq=frequency

Obesity across the different Virginia health regions are similar, where a majority were considered not obese (ranging from 69.9% to 78.6%). However, tt should be noted that the Northern Virginia region had the least obese samples (*n* = 121, 21.4%), while the Eastern Virginia region had the most obese samples (*n* 268, 30.1%), in terms of percentage.

Socioeconomic Status (SES)

A frequency table of population below the poverty level across the different Virginia health regions is presented in Table 6.

Table 6

Below Poverty Level by Virginia Health Region

	Central		Eastern		Northern		Northwestern		Southwestern	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
No	584	84.5	769	86.5	539	95.4	475	86.2	598	76.2
Yes	107	15.5	120	13.5	26	4.6	76	13.8	187	23.8
Total	691	100.0	889	100.0	565	100.0	551	100.0	785	100.0

Highest educational attainment by Virginia health region is presented in Table 7.

Table 7

Highest Educational Attainment by Virginia Health Region

	Central		Eastern		Northern		Northwestern		Southwestern	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Did not graduate high school	46	6.7	43	4.8	5	.9	32	5.8	89	11.3
Graduated high school	154	22.3	177	19.9	41	7.3	121	22.0	244	31.1
Attended college or technical school	185	26.8	276	31.0	91	16.1	124	22.5	202	25.7
Graduated from college or technical school	306	44.3	393	44.2	428	75.8	274	49.7	250	31.8
Total	691	100.0	889	100.0	565	100.0	551	100.0	785	100.0

Physical Activity

In terms of exercise, several variables were taken into account. First is the intensity of activity, second is frequency of physical activity per week, third is the minutes spent in the each session of the physical activity. For physical activities, a participant may perform one or two physical activities, or none, and as such, there is a first and second physical activity. A participant may also not perform physical activities, but go into strength training instead, and as such, a fourth exercise variable, strength activity per week was included. The descriptive statistics or frequency tables, as appropriate, are presented in this section.

Activity intensity is categorized by not moderate or vigorous or no activity, moderate, and vigorous. Table 8 reports intensity of activity per region. These were considered as a continuous variable in the regression analysis where the least value represents least vigorous while the highest value represents most vigorous. Table 9 presents the descriptive statistics of continuous exercise variables by Virginia health region such as frequency per week of physical activities, minutes spent per session of physical activities, and strength training frequency per week.

Table 8

Intensity of Physical Activity by Virginia Health Region

	Central		Eastern		Northern		Northwestern		Southwestern	
	Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
Activity intensity for first activity (exercise)										
Not moderate or vigorous or no activity	58	8.4	83	9.3	61	10.8	45	8.2	66	8.4
Moderate	423	61.2	516	58.0	322	57.0	322	58.4	493	62.8
Vigorous	210	30.4	290	32.6	182	32.2	184	33.4	226	28.8
Total	691	100.0	889	100.0	565	100.0	551	100.0	785	100.0
Activity intensity for second activity (exercise)										
Not moderate or vigorous or no activity	311	45.0	378	42.5	233	41.2	236	42.8	350	44.6
Moderate	188	27.2	282	31.7	181	32.0	163	29.6	242	30.8
Vigorous	192	27.8	229	25.8	151	26.7	152	27.6	193	24.6
Total	691	100.0	889	100.0	565	100.0	551	100.0	785	100.0

Table 9

Continuous Exercise Variables by Virginia Health Region

	N	Minimum	Maximum	*M*	*SD*
Physical activity frequency per week for first activity					
Central	691	0.00	30.00	3.8034	3.01189
Eastern	889	0.00	25.00	3.5228	2.57180
Northern	565	0.00	33.00	3.8428	2.83427
Northwestern	551	0.00	14.00	3.6410	2.40524
Southwestern	785	0.00	35.00	3.8428	2.85154
Physical activity frequency per week for second activity					
Central	691	0.00	30.00	1.8400	2.59979
Eastern	889	0.00	36.00	2.0400	2.80900
Northern	565	0.00	75.00	2.2515	4.91478
Northwestern	551	0.00	17.50	1.9911	2.40968
Southwestern	785	0.00	75.00	1.9679	3.66410
Minutes of first activity					
Central	691	0	540	59.79	72.769
Eastern	889	0	599	64.99	80.945
Northern	565	0	585	53.83	53.856
Northwestern	551	0	540	64.77	74.651
Southwestern	785	0	540	61.76	74.712
Minutes of second activity					
Central	691	0	540	49.41	82.283
Eastern	889	0	599	50.87	81.937
Northern	565	0	540	43.08	63.609
Northwestern	551	0	599	50.71	84.622
Southwestern	785	0	540	49.88	82.804
Strength activity per week					
Central	691	0.00	28.00	1.5155	2.27368
Eastern	889	0.00	21.00	1.6278	2.30530
Northern	565	0.00	21.00	1.8201	2.28344
Northwestern	551	0.00	21.00	1.6419	2.48104
Southwestern	785	0.00	30.00	1.4005	2.44425

Behavior Regarding Nutrition

Table 10 presents the descriptive statistics of the fruits and vegetables intake per day by Virginia health region. There are a total of five variables that were included for fruits and vegetables intake: fruit intake per day, bean vegetable intake per day, green vegetable intake per day, orange vegetable intake per day, and other vegetable intake per day. These are all continuous variables.

Table 10

Fruits and Vegetables Intake Variables by Virginia Health Region

	N	Minimum	Maximum	*Mean*	*Std. Deviation*
Fruit intake per day					
Central	691	0.00	6.00	1.0211	.84454
Eastern	889	0.00	6.00	1.0868	.91884
Northern	565	0.00	7.00	1.2289	1.05341
Northwestern	551	0.00	7.00	1.2208	1.03400
Southwestern	785	0.00	6.00	1.0387	.90192
Bean vegetable intake per day					
Central	691	0.00	4.57	.2606	.32689
Eastern	889	0.00	4.00	.2771	.34019
Northern	565	0.00	5.14	.2779	.35626
Northwestern	551	0.00	5.00	.3348	.43267
Southwestern	785	0.00	3.00	.3140	.33500
Green vegetable intake per day					
Central	691	0.00	3.00	.5817	.47010
Eastern	889	0.00	5.00	.6398	.56972
Northern	565	0.00	4.00	.6628	.50476
Northwestern	551	0.00	4.00	.6017	.46626
Southwestern	785	0.00	3.00	.5280	.51282
Orange vegetable intake per day					
Central	691	0.00	3.00	.3119	.35833
Eastern	889	0.00	3.00	.3275	.33741
Northern	565	0.00	4.86	.3377	.36798
Northwestern	551	0.00	4.86	.3539	.39465
Southwestern	785	0.00	3.14	.2886	.35819
Other vegetable intake per day					
Central	691	0.00	5.00	.8145	.63783
Eastern	889	0.00	5.00	.8206	.61861
Northern	565	0.00	5.00	.9164	.71422
Northwestern	551	0.00	4.00	.9069	.64235

Southwestern	785	0.00	5.00	.8849	.67088

Research Question 1. The first research question was to determine if race or ethnicity is an obesogenic factor for obesity within each defined region of Virginia. As such, five binary logistic regressions, one for each region, were conducted with obesity as the dependent variable, and race or ethnicity as the independent variable. As race is a categorical variable, a reference variable was selected. For the following binary logistic regressions, White was selected as the reference variable. The following race variables are coded as: Race (1) = African American, Race (2) = Asian, Race (3) = American Indian/Alaskan Native, Race (4) = Hispanic, and Race (5) = Other race, while the reference race of Caucasian was excluded.

Central Virginia. For Central Virginia, the independent variable of race explains 8% of variance in the dependent variable of obesity as reported in Table 10. As observed in Table 11, only Black (Race (1)) was found to add significantly to the model ($p < 0.001$). This indicates that, individuals of African American ethnicity were 3.07 times more likely to be obese than individuals of Caucasian ethnicity in Central Virginia.

Table 11

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	800.419b	.056	.080

Table 12

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Race			35.122	5	.000			
	Race (1)	1.121	.191	34.288	1	.000	3.069	2.109	4.467
	Race (2)	-20.043	15191.515	.000	1	.999	.000	0.000	
	Race (3)	.467	.872	.287	1	.592	1.595	.289	8.816
	Race (4)	.244	.843	.084	1	.772	1.276	.244	6.661
	Race (5)	.937	.679	1.905	1	.168	2.552	.675	9.655
	Constant	-1.160	.104	123.970	1	.000	.313		

Eastern Virginia. For Eastern Virginia, the independent variable of race explains 2.1% of variance in the dependent variable of obesity as reported in Table 13. As observed in Table 14, only Black (Race (1)) was found to add significantly to the model (p = 0.001). This indicates that, individuals of African American ethnicity were 1.8 times more likely to be obese than individuals of Caucasian ethnicity in Eastern Virginia.

Table 13

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	1075.247b	.015	.021

Table 14

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Race			13.296	5	.021			
	Race (1)	.588	.180	10.629	1	.001	1.800	1.264	2.564
	Race (2)	-.007	.683	.000	1	.992	.993	.260	3.785
	Race (3)	-.125	.821	.023	1	.879	.883	.176	4.414
	Race (4)	.625	.387	2.608	1	.106	1.869	.875	3.993
	Race (5)	-.258	.439	.347	1	.556	.772	.327	1.824
	Constant	-.974	.088	121.120	1	.000	.378		

Northern Virginia. For Northern Virginia, the independent variable of race explains 3.1% of variance in the dependent variable of obesity as reported in Table 15.. As observed in Table 16, none of the race categories were found to add significantly to the model ($p > 0.05$). This indicates that race was not a factor in predicting the odds of being obese in Northern Virginia.

Table 15

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	575.471b	.020	.031

Table 16

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Race			1.085	5	.955			
	Race (1)	.129	.399	.104	1	.747	1.137	.520	2.486
	Race (2)	-19.939	9220.900	.000	1	.998	.000	0.000	
	Race (3)	-19.939	28420.722	.000	1	.999	.000	0.000	
	Race (4)	.347	.496	.491	1	.483	1.415	.536	3.739
	Race (5)	-.528	.772	.468	1	.494	.590	.130	2.677
	Constant	-1.264	.111	129.486	1	.000	.283		

Northwestern Virginia. For Northwestern Virginia, the independent variable of race explains 3.7% of variance in the dependent variable of obesity as reported in Table 17. As observed in Table 18, African American (Race (1)) and Hispanic (Race (4)) were found to add significantly to the model ($p = 0.019, 0.016$, respectively). This indicates that, individuals of African American ethnicity were 2.31 times more likely to be obese than individuals of Caucasian ethnicity in Northwestern Virginia, and individuals of Hispanic ethnicity were 7.69 times more likely to be obese than individuals of White ethnicity in Northwestern Virginia.

Table 17

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	619.039b	.025	.037

Table 18

Variables in the equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Race			11.027	5	.051			
	Race (1)	.836	.357	5.468	1	.019	2.306	1.145	4.646
	Race (2)	-.263	1.123	.055	1	.815	.769	.085	6.945
	Race (3)	-20.080	20096.485	.000	1	.999	.000	0.000	
	Race (4)	2.040	.843	5.850	1	.016	7.687	1.472	40.137
	Race (5)	.142	.685	.043	1	.835	1.153	.301	4.416
	Constant	-1.123	.105	114.260	1	.000	.325		

Southwestern Virginia. For Southwestern Virginia, the independent variable of race explains 2.5% of variance in the dependent variable of obesity as reported in Table 19. As observed in Table 20, only African American (Race (1)) was found to add significantly to the model (p = 0.009). This indicates that, individuals of African American ethnicity were 2.1 times more likely to be obese than individuals of Caucasian ethnicity in Southwestern Virginia.

Table 19

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	913.645b	.018	.025

Table 20

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Race			10.257	5	.068			
	Race (1)	.740	.283	6.812	1	.009	2.095	1.202	3.651
	Race (2)	-20.176	16408.711	.000	1	.999	.000	0.000	
	Race (3)	1.250	.676	3.419	1	.064	3.492	.928	13.144
	Race (4)	.516	.735	.493	1	.482	1.676	.397	7.083
	Race (5)	-.071	.821	.008	1	.931	.931	.186	4.654
	Constant	-1.027	.086	142.991	1	.000	.358		

Following the results of the binary logistic regression analyses with race as the independent variable and obesity as the dependent variable, it was found that race or ethnicity is an obesogenic factor Central, Eastern, Northwestern, and Southwestern Virginia, but not in Northern Virginia. As such, the null hypothesis was rejected in favor of the alternate, race or ethnicity is an obesogenic factor within each defined region in Virginia, with the exception of Northern Virginia.

Research Question 2. The second research question asked if socioeconomic status is an obesogenic factor for obesity within each defined region of Virginia. As such, five binary logistic regressions; one for each region, were conducted with obesity as the dependent variable, and below poverty level and highest educational attainment as the independent variables. For below poverty level, the reference category was not below poverty, and was excluded in the binary logistic regression, while for highest educational attainment, the first category, did not graduate high school was selected as the reference variable, and was excluded as well. The following highest educational attainment variables are coded as: Education (1) = graduated high school but did not attend college or technical school, Education (2) = attended but did not finish college or technical school, and Education (3) = graduated from college or technical school.

Central Virginia. For Central Virginia, the socioeconomic variables explain 2.5% of variance in the dependent variable of obesity as reported in Table 21. As observed in Table 22, only below poverty was found to add significantly to the model (p = 0.003). This indicates that, individuals belonging to households below the poverty line were 2.02 times more likely to be obese than individuals not belonging to households below the poverty line in Central Virginia.

Table 21

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	828.090b	.017	.025

Table 22

Variables in the Equation

	B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper

Step 1b	Below poverty(1)	.702	.235	8.940	1	.003	2.018	1.274	3.198
	Education			.546	3	.909			
	Education (1)	-.180	.360	.249	1	.618	.836	.412	1.693
	Education (2)	-.079	.357	.049	1	.825	.924	.459	1.860
	Education (3)	-.196	.356	.304	1	.581	.822	.409	1.651
	Constant	-.837	.336	6.220	1	.013	.433		

Eastern Virginia. For Eastern Virginia, the socioeconomic variables explain 2.6% of variance in the dependent variable of obesity as reported in Table 22. As observed in Table 23, below poverty and graduated from college or technical school (Education (3)) were found to add significantly to the model (p = 0.009, 0.049, respectively). This indicates that, individuals belonging to households below the poverty line were 1.76 times more likely to be obese than individuals not belonging to households below the poverty line in Eastern Virginia, and individuals who graduated from college or technical school were 0.51 times more likely to be obese than individuals who did not graduate from high school in Eastern Virginia.

Table 23

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1072.015b	.018	.026

Table 24

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step	Below	.562	.216	6.796	1	.009	1.755	1.150	2.678

1b	poverty(1)								
	Education			4.126	3	.248			
	Education (1)	-.487	.352	1.907	1	.167	.615	.308	1.226
	Education (2)	-.588	.344	2.921	1	.087	.555	.283	1.090
	Education (3)	-.681	.346	3.882	1	.049	.506	.257	.996
	Constant	-.348	.329	1.120	1	.290	.706		

Northern Virginia. For Northern Virginia, the socioeconomic variables explain 2.4% of variance in the dependent variable of obesity. As observed in Table 28 only below poverty was found to add significantly to the model (p = 0.029). This indicates that, individuals belonging to households below the poverty line were 2.66 times more likely to be obese than individuals not belonging to households below the poverty line in Northern Virginia.

Table 25

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	578.258b	.015	.024

Table 26

Variables in the equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Below pov(1)	.980	.448	4.777	1	.029	2.664	1.106	6.415
	Educ			1.178	3	.758			
	Educ(1)	20.286	17608.417	.000	1	.999	645605160.512	0.000	
	Educ	20.569	17608.41	.000	1	.99	857008735.63	0.000	

(2)		7			9	2	
Educ (3)	20.280	17608.417	.000	1	.999	641716204.008	0.000
Const	-21.672	17608.417	.000	1	.999	.000	

Northwestern Virginia. For Northwestern Virginia, the socioeconomic variables explain 1.6% of variance in the dependent variable of obesity. As observed in Table 30, none of the variables were found to add significantly to the model ($p > 0.05$). This indicates that socioeconomic status is not an obesogenic factor in Northwestern Virginia.

Table 27

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	626.813b	.011	.016

Table 28

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Below poverty(1)	.048	.300	.026	1	.873	1.049	.582	1.890
	Education			5.963	3	.113			
	Education (1)	-.405	.436	.863	1	.353	.667	.284	1.567
	Education (2)	-.036	.441	.007	1	.935	.964	.406	2.290
	Education (3)	-.579	.428	1.829	1	.176	.560	.242	1.297
	Constant	-.674	.409	2.711	1	.100	.510		

Southwestern Virginia. For Southwestern Virginia, the socioeconomic variables explain 5.8% of variance in the dependent variable of obesity. As observed in Table 32 only below poverty was found to add significantly to the model (p = 0.018). This indicates that, individuals belonging to households below the poverty line were 1.57 more likely to be obese than individuals not belonging to households below the poverty line in Southwestern Virginia.

Table 29

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	895.553b	.040	.058

Table 30

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Below poverty(1)	.450	.190	5.604	1	.018	1.569	1.081	2.278
	Education			18.582	3	.000			
	Education (1)	.347	.275	1.595	1	.207	1.415	.826	2.426
	Education (2)	.412	.286	2.081	1	.149	1.510	.863	2.644
	Education (3)	-.482	.306	2.479	1	.115	.618	.339	1.125
	Constant	-1.174	.259	20.595	1	.000	.309		

Following the results of the binary logistic regression analyses with the socioeconomic status variables of below poverty and highest educational attainment as the independent variables, and obesity as the dependent variable, it was found that socioeconomic status is an obesogenic factor Central, Eastern, Northern, and Southwestern Virginia, but not in Northwestern Virginia. As such, the null hypothesis was rejected in favor of the alternate, socioeconomic status is an obesogenic factor within each defined region in Virginia, with the exception of Northwestern Virginia.

Research Question 3. The third research question asked if physical activity level is an obesogenic factor for obesity within each defined region of Virginia. As such, five binary logistic regressions; one for each region, were conducted with obesity as the dependent variable, and exercise variables (activity intensity for first and second activities, physical activity frequencies per week for first and second activities, minutes per session of first and second activities, and strength activity per week) as the independent variables.

Central Virginia. For Central Virginia, the exercise variables explain 4.2% of variance in the dependent variable of obesity. As observed in Table 34, only intensity of the first exercise was found to add significantly to the model (p = 0.001). With an odds ratio of lower than 1, this indicates that individuals engaging in higher intensity in the first exercise have lower odds of being obese in Central Virginia.

Table 31

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	819.383b	.030	.042

Table 32

Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Intensity (first exercise)	-.491	.153	10.223	1	.001	.612	.453	.827
	Intensity (second exercise)	-.200	.122	2.690	1	.101	.819	.645	1.040
	Frequency per week for first physical activity	-.017	.030	.317	1	.573	.983	.928	1.042
	Frequency per week for second physical activity	-.013	.038	.119	1	.730	.987	.916	1.063
	Minutes per session for first physical activity	.000	.001	.078	1	.780	1.000	.997	1.002
	Minutes per session for second physical activity	.000	.001	.017	1	.898	1.000	.998	1.002
	Strength activity per week	-.038	.041	.844	1	.358	.963	.888	1.044
	Constant	.044	.232	.036	1	.849	1.045		

Eastern Virginia. For Eastern Virginia, the exercise variables explain 1.9% of variance in the dependent variable of obesity. As observed in Table 36, only frequency of strength training per week was found to add significantly to the model (p = 0.028). With an odds ratio of lower than 1, this indicates that individuals having more frequent strength training per week have lower odds of being obese in Eastern Virginia.

Table 33

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	1076.090b	.014	.019

Table 34

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Intensity (first exercise)	-.142	.129	1.217	1	.270	.868	.674	1.117
	Intensity (second exercise)	-.199	.107	3.430	1	.064	.820	.664	1.012
	Frequency per week for first physical activity	-.009	.030	.088	1	.766	.991	.934	1.051
	Frequency per week for second physical activity	-.003	.029	.014	1	.907	.997	.941	1.056
	Minutes per session for first physical activity	.000	.001	.103	1	.748	1.000	.999	1.002
	Minutes per session for second physical activity	.000	.001	.037	1	.848	1.000	.998	1.002
	Strength activity per week	-.081	.037	4.820	1	.028	.923	.859	.991
	Constant	-.374	.205	3.308	1	.069	.688		

Northern Virginia. For Northern Virginia, the exercise variables explain 4.4% of variance in the dependent variable of obesity. As observed in Table 38, only intensity of the first exercise was found to add significantly to the model (p = 0.013). With an odds ratio of lower than 1, this indicates that individuals engaging in higher intensity in the first exercise have lower odds of being obese in Northern Virginia.

Table 35

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	570.658b	.028	.044

Table 36

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Intensity (first exercise)	-.432	.173	6.228	1	.013	.649	.462	.911
	Intensity (second exercise)	-.079	.146	.290	1	.590	.924	.694	1.231
	Frequency per week for first physical activity	-.062	.043	2.108	1	.147	.940	.864	1.022
	Frequency per week for second physical activity	.021	.019	1.251	1	.263	1.021	.984	1.060
	Minutes per session for first physical activity	-.001	.002	.262	1	.609	.999	.995	1.003
	Minutes per session for second physical activity	-.003	.002	1.579	1	.209	.997	.993	1.002
	Strength activity per week	-.072	.049	2.136	1	.144	.930	.845	1.025
	Constant	-.261	.294	.787	1	.375	.770		

Northwestern Virginia. For Northwestern Virginia, the exercise variables explain 5.2% of variance in the dependent variable of obesity. As observed in Table 40, only intensity of the first exercise was found to add significantly to the model (p = 0.013). With an odds ratio of lower than 1, this indicates that individuals engaging in higher intensity in the first exercise have lower odds of being obese in Northwestern Virginia.

Table 37

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	613.022b	.036	.052

Table 38

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Intensity (first exercise)	-.449	.180	6.218	1	.013	.639	.449	.908
	Intensity (second exercise)	-.109	.154	.501	1	.479	.897	.663	1.213
	Frequency per week for first physical activity	-.047	.042	1.245	1	.265	.954	.878	1.037
	Frequency per week for second physical activity	.017	.052	.111	1	.739	1.017	.920	1.126
	Minutes per session for first physical activity	-.003	.002	3.518	1	.061	.997	.994	1.000
	Minutes per session for second physical activity	-.001	.001	.703	1	.402	.999	.996	1.002
	Strength activity per week	-.028	.042	.440	1	.507	.972	.895	1.057

Constant	.019	.272	.005	1	.944	1.019

Southwestern Virginia. For Southwestern Virginia, the exercise variables explain 5.3% of variance in the dependent variable of obesity. As observed in Table 42, intensity of the first exercise (p = 0.002), intensity of the second exercise (p = 0.025), and frequency of strength activity per week (p = 0.008), were found to add significantly to the model. With an odds ratios of lower than 1, this indicates that individuals engaging in higher intensity in the first and second exercises, as well as those who engage in more frequent strength training per week, have lower odds of being obese in Southwestern Virginia.

Table 39

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	897.995b	.037	.053

Table 40

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Intensity (first exercise)	-.487	.158	9.440	1	.002	.615	.451	.838
	Intensity (second exercise)	-.286	.127	5.055	1	.025	.751	.585	.964
	Frequency per week for first physical activity	-.010	.030	.105	1	.746	.990	.934	1.050
	Frequency per week for second physical activity	.007	.023	.090	1	.764	1.007	.962	1.054
	Minutes per session for first physical activity	.001	.001	.272	1	.602	1.001	.998	1.003
	Minutes per session for second physical activity	.000	.001	.073	1	.786	1.000	.997	1.002
	Strength activity per week	-.113	.042	7.136	1	.008	.893	.822	.970
	Constant	-.026	.226	.014	1	.907	.974		

Following the results of the binary logistic regression analyses with the exercise variables as the independent variables, and obesity as the dependent variable, it was found that exercise is an obesogenic factor in all five health regions of Virginia, where higher intensity physical activity or more frequent strength training leads to lower chances of being obese. As such, the null hypothesis was rejected in favor of the alternate, physical activity levels is an obesogenic factor within each defined region in Virginia.

Research Question 4. The fourth research question asked if behavior regarding nutrition such as fruits and vegetables intake is an obesogenic factor for obesity within each defined region of Virginia. As such, five binary logistic regressions; one for each region, were conducted with obesity as the dependent variable, and fruits and vegetables intake behaviors (fruit intake per day, bean vegetable intake per day, green vegetable intake per day, orange vegetable intake per day, and other vegetable intake per day) as the independent variables.

Central Virginia. For Central Virginia, the fruits and vegetables intake behaviors variables explain 1.7% of variance in the dependent variable of obesity. As observed in Table 45, none of the fruits and vegetables intake behaviors variables were found to add significantly to the model ($p > 0.05$). This indicates that fruits and vegetables intake behavior is not an obesogenic factor for obesity in Central Virginia.

Table 41

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	831.802b	.012	.017

Table 42

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Fruit intake per day	.105	.108	.954	1	.329	1.111	.900	1.372
	Bean vegetable intake per day	-.643	.348	3.412	1	.065	.526	.266	1.040
	Green vegetable intake per day	-.104	.198	.274	1	.601	.901	.611	1.330
	Orange vegetable intake per day	-.343	.279	1.515	1	.218	.709	.411	1.225
	Other vegetable intake per day	-.042	.144	.087	1	.768	.959	.723	1.270
	Constant	-.617	.176	12.290	1	.000	.540		

Eastern Virginia. For Eastern Virginia, the fruits and vegetables intake behaviors variables explain 0.6% of variance in the dependent variable of obesity. As observed in Table 47, none of the fruits and vegetables intake behaviors variables were found to add significantly to the model ($p > 0.05$). This indicates that fruits and vegetables intake behavior is not an obesogenic factor for obesity in Eastern Virginia.

Table 43

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	1084.366b	.004	.006

Table 44

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Fruit intake per day	-.033	.092	.127	1	.722	.968	.809	1.158
	Bean vegetable intake per day	.203	.213	.903	1	.342	1.225	.806	1.861
	Green vegetable intake per day	-.153	.156	.961	1	.327	.858	.632	1.165
	Orange vegetable intake per day	-.127	.245	.269	1	.604	.881	.545	1.423
	Other vegetable intake per day	-.074	.130	.324	1	.569	.929	.720	1.198
	Constant	-.665	.151	19.479	1	.000	.514		

Northern Virginia. For Northern Virginia, the fruits and vegetables intake behaviors variables explain 1.3% of variance in the dependent variable of obesity. As observed in Table 49, none of the fruits and vegetables intake behaviors variables were found to add significantly to the model ($p > 0.05$). This indicates that fruits and vegetables intake behavior is an obesogenic factor for obesity in Northern Virginia.

Table 45

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	582.160b	.008	.013

Table 46

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Fruit intake per day	.026	.106	.061	1	.805	1.026	.834	1.263
	Bean vegetable intake per day	.142	.289	.241	1	.624	1.152	.654	2.030
	Green vegetable intake per day	-.276	.248	1.236	1	.266	.759	.467	1.234
	Orange vegetable intake per day	-.076	.318	.057	1	.811	.927	.497	1.728
	Other vegetable intake per day	-.237	.178	1.776	1	.183	.789	.557	1.118
	Constant	-.963	.218	19.449	1	.000	.382		

Northwestern Virginia. For Northwestern Virginia, the fruits and vegetables intake behaviors variables explain 1.3% of variance in the dependent variable of obesity. As observed in Table 51, none of the fruits and vegetables intake behaviors variables were found to add significantly to the model ($p > 0.05$). This indicates that fruits and vegetables intake behavior is an obesogenic factor for obesity in Northwestern Virginia.

Table 47

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	628.059b	.009	.013

Table 48

Variables in the Equation

		B	*S.E.*	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Fruit intake per day	-.050	.106	.223	1	.637	.951	.772	1.171
	Bean vegetable intake per day	.132	.226	.340	1	.560	1.141	.733	1.776
	Green vegetable intake per day	-.394	.273	2.084	1	.149	.675	.395	1.151
	Orange vegetable intake per day	-.049	.303	.026	1	.872	.952	.526	1.724
	Other vegetable intake per day	-.076	.171	.196	1	.658	.927	.662	1.297
	Constant	-.712	.205	12.023	1	.001	.491		

Southwestern Virginia. For Southwestern Virginia, the fruits and vegetables intake behaviors variables explain 1.2% of variance in the dependent variable of obesity. As observed in Table 53, only orange vegetable intake per day was found to add significantly to the model (p = 0.046). With an odds ratio of lower than 1, this indicates individuals with a behavior of having more orange vegetable intake per day have lower chances of being obese in Southwestern Virginia.

Table 49

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	920.840b	.008	.012

Table 50

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Fruit intake per day	-.039	.104	.140	1	.708	.962	.785	1.179
	Bean vegetable intake per day	.372	.246	2.294	1	.130	1.451	.896	2.348
	Green vegetable intake per day	.046	.180	.064	1	.800	1.047	.735	1.490
	Orange vegetable intake per day	-.592	.297	3.973	1	.046	.553	.309	.990
	Other vegetable intake per day	-.001	.134	.000	1	.994	.999	.768	1.299
	Constant	-.896	.158	32.347	1	.000	.408		

Following the results of the binary logistic regression analyses with the behavior of fruits and vegetables intake as the independent variables, and obesity as the dependent variable, it was found that fruits and vegetables intake is an obesogenic factor, but only in Southwestern Virginia, specifically, orange vegetable intake. As such, the null hypothesis was rejected in favor of the alternate, behavior regarding nutrition such as fruits and vegetables intake is an obesogenic factor, but only in Southwestern Virginia.

Research Question 5. The fifth null hypothesis states that regions will not have a prevalent obesogenic factor in Virginia in combination with the other obesogenic factors. To test this hypothesis, four binary logistic regressions were conducted, each with obesity as the dependent variable, with the independent variables being each of the four obesogenic factors for each regression analysis in combination with the Virginia health regions. For the following binary logistic regression analyses, Central Virginia was chosen as the reference category for region, which was exempt from the analyses, and the other regions were categorized as: Region (1) = Eastern, Region (2) = Northern, Region (3) = Northwestern, and Region (4) = Southwestern.

Region and race. The dependent variable for this analysis is obesity, and the independent variables are region and race. For the independent variable of race, the reference category and categorization of other races were the same with Research Question 1. White was selected as the reference variable. The following race variables are coded as: Race (1) = African American, Race (2) = Asian, Race (3) = American Indian/Alaskan Native, Race (4) = Hispanic, and Race (5) = Other race, while the reference race of Caucasian was excluded. As observed in Table 54, African American (Race (1)) and Asian (Race (2)) were found to significantly add to the model ($p < 0.001$, $= 0.018$, respectively). These indicate that individuals of African American race were 2.15 times more likely to be obese than individuals of Caucasian race, while Asians were 0.29 times more likely to be obese than individuals of Caucasian race. However, none of the regions significantly added to the model ($p > 0.05$). As such, in combination with race, region was not a prevalent obesogenic factor in Virginia.

Table 51

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	4012.047a	.023	.033

Table 52

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Race			62.783	5	.000			
	Race (1)	.764	.107	50.558	1	.000	2.147	1.740	2.651
	Race (2)	-1.241	.525	5.583	1	.018	.289	.103	.809
	Race (3)	.261	.404	.416	1	.519	1.298	.588	2.866
	Race (4)	.674	.247	7.425	1	.006	1.963	1.208	3.188
	Race (5)	-.021	.276	.006	1	.938	.979	.570	1.682
	Region			8.743	4	.068			
	Region (1)	-.264	.142	3.430	1	.064	.768	.581	1.015
	Region (2)	.077	.126	.368	1	.544	1.080	.843	1.383
	Region (3)	.044	.131	.114	1	.735	1.045	.809	1.350
	Region (4)	.083	.124	.450	1	.503	1.087	.853	1.385
	Constant	-1.098	.098	124.862	1	.000	.333		

Region and socioeconomic status. The dependent variable for this analysis is obesity, and the independent variables are region, below poverty, and highest educational attainment. For the independent variables of below poverty and highest educational attainment, the reference categories and categorization of educational attainment were the same with Research Question 2. For below poverty level, the reference category was not below poverty, and was excluded in the binary logistic regression, while for highest educational attainment, the first category, did not graduate high school was selected as the reference variable, and was excluded as well. The following highest educational attainment variables are coded as: Education (1) = graduated high school but did not attend college or technical school, Education (2) = attended but did not finish college or technical school, and Education (3) = graduated from college or technical school. As observed in Table 57, individuals belonging to households below the poverty level were found to be 1.68 times more likely to be obese than those belonging to households not below the poverty level ($p < 0.001$). However, none of the regions significantly added to the model ($p > 0.05$). As such, in combination with socioeconomic status, region was not a prevalent obesogenic factor in Virginia.

Table 53

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	4025.166a	.019	.028

Table 54

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Region			8.736	4	.068			
	Region (1)	-.130	.144	.821	1	.365	.878	.662	1.164
	Region (2)	-.025	.128	.040	1	.842	.975	.759	1.252
	Region (3)	.150	.129	1.361	1	.243	1.162	.903	1.496
	Region (4)	.183	.123	2.228	1	.136	1.201	.944	1.527
	Below poverty(1)	.519	.109	22.814	1	.000	1.680	1.358	2.078
	Education			14.163	3	.003			
	Education (1)	-.045	.167	.073	1	.787	.956	.689	1.327
	Education (2)	.017	.168	.010	1	.919	1.017	.732	1.414
	Education (3)	-.319	.168	3.613	1	.057	.727	.523	1.010
	Constant	-.962	.181	28.126	1	.000	.382		

Region and physical activity level. The dependent variable for this analysis is obesity, and the independent variables are region and the exercise variables (activity intensity for first and second activities, physical activity frequencies per week for first and second activities, minutes per session of first and second activities, and strength activity per week). As observed in Table 59, intensity in first exercise ($p < 0.001$), intensity in second exercise ($p < 0.001$), and frequency of strength training per week ($p < 0.001$), were found to be obesogenic factors, where higher intensity in the first and second exercises, as well as higher frequency in strength training per week, lowers the odds of being obese. However, none of the regions significantly added to the model ($p > 0.05$). As such, in combination with physical activity levels, region was not a prevalent obesogenic factor in Virginia.

Table 55

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	3997.467a	.027	.039

Table 56

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Region			14.965	4	.005			
	Region (1)	-.268	.143	3.515	1	.061	.765	.578	1.012
	Region (2)	.047	.127	.136	1	.713	1.048	.817	1.344
	Region (3)	.161	.129	1.541	1	.214	1.174	.911	1.513
	Region (4)	.192	.123	2.429	1	.119	1.211	.952	1.541
	Intensity (first exercise)	-.373	.069	29.460	1	.000	.688	.602	.788
	Intensity (second exercise)	-.199	.056	12.467	1	.000	.820	.734	.915
	Frequency per week for first physical activity	-.023	.015	2.330	1	.127	.978	.949	1.006
	Frequency per week for second physical activity	.009	.012	.582	1	.446	1.009	.985	1.034
	Minutes per session for first physical activity	.000	.001	.265	1	.607	1.000	.999	1.001
	Minutes per session for second physical activity	.000	.001	.722	1	.396	1.000	.998	1.001
	Strength activity per week	-.069	.018	13.853	1	.000	.934	.900	.968
	Constant	-.215	.140	2.363	1	.124	.806		

Region and behavior regarding nutrition. The dependent variable for this analysis is obesity, and the independent variables are region and fruits and vegetables intake behaviors (fruit intake per day, bean vegetable intake per day, green vegetable intake per day, orange vegetable intake per day, and other vegetable intake per day). As observed in Table 61, orange vegetable intake per day was found to be an obesogenic factor (*p* = 0.038), where higher behavior orange vegetable intake lowers the odds of being obese. However, none of the regions significantly added to the model (*p* > 0.05). As such, in combination with behavior regarding nutrition such as fruits and vegetables intake, region was not a prevalent obesogenic factor in Virginia.

Table 57

Model Summary

Step	-2 Log likelihood	Cox & Snell *R* Square	Nagelkerke *R* Square
1	4061.261a	.009	.013

Table 58

Variables in the Equation

		B	*S.E.*	Wald	*df*	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1b	Region			14.484	4	.006			
	Region (1)	-.252	.142	3.168	1	.075	.777	.589	1.026
	Region (2)	.056	.126	.201	1	.654	1.058	.826	1.355
	Region (3)	.162	.129	1.595	1	.207	1.176	.914	1.514
	Region (4)	.196	.122	2.579	1	.108	1.217	.958	1.546
	Fruit intake per day	-.002	.046	.002	1	.969	.998	.913	1.091
	Bean vegetable intake per day	.082	.110	.561	1	.454	1.086	.876	1.346
	Green vegetable intake per day	-.134	.088	2.324	1	.127	.875	.736	1.039
	Orange vegetable intake per day	-.265	.128	4.317	1	.038	.767	.597	.985
	Other vegetable intake per day	-.076	.066	1.361	1	.243	.926	.815	1.053
	Constant	-.827	.121	46.355	1	.000	.437		

Following the results of the binary logistic regression analyses, with the combination of region and the four obesogenic factors for each regression as the independent variables, and obesity as the dependent variable, it was found that region was not a prevalent obesogenic factor in Virginia. As such, there was not enough evidence to reject the fifth null hypothesis, region is not a prevalent obesogenic factor in Virginia.

Summary

I conducted a series of binary logistic regression analyses to test each of the five formulated hypotheses and address their respective research questions. In testing for the first hypothesis, it was found that race or ethnicity is an obesogenic factor in Virginia, with the exception of Northern Virginia. In testing for the second hypothesis, it was found that SES is an obesogenic factor in Virginia, with the exception of Northwestern Virginia. In testing for the third hypothesis, it was found that physical activity levels are an obesogenic factor within each defined region in Virginia. In testing for the fourth hypothesis, it was found that behavior regarding nutrition such as fruits and vegetables intake is an obesogenic factor, but only in Southwestern Virginia. In testing for the fifth null hypothesis, region was found to not be a prevalent obesogenic factor, in combination with each of the four identified obesogenic factors. In the next chapter, I will further discuss the findings presented in this chapter and provide directions and suggestions for future studies.

Chapter 5: Summary, Conclusion, and Recommendations

Introduction

Although much research has been conducted on obesity, obesity causes, and the reasons for obesity prevalence rate differences, very little research has addressed more than one obesity cause along with regional prevalence trends. The results of this study offer insight into four obesity causes (SES, ethnicity, behaviors regarding nutrition, and physical activity) within the context of statewide regional obesity prevalence rates in an effort to further understand variances that may not become apparent when studied independently. The complex nature of obesity requires the interaction of variables to be examined. The opportunities for improved community obesity education and positive social change become apparent with the continued increase in mortality and morbidity due to obesity (CDC, 2016).

The results of this study yielded important information from archived public health data that can contribute to critical obesity prevention efforts. The purpose of this research was to explore obesity prevalence from a regional perspective by analyzing four known obesity causes using BRFSS data in the five health districts of Virginia. Using current public health systems, such as the VDH's districts and CDC's 2013 BRFSS, data were purposeful as these important public resources are the ongoing funded public data. Understanding and exploring these obesogenic factors in each region can further the efforts for obesity prevention and education on a wide scale. This meaningful analysis allows for a more comprehensive obesity health profile to be created for health districts who are consumers of obesity education and prevention efforts. The results and key findings of this data analysis assisted in the creation of the Virginia health district profile and exploration of the obesogenic characteristics of each health district. The exploratory nature of this project furthers positive social change by offering information on specific factors of obesity that may require more attention.

Interpretations of the Findings

The impact obesity has on American society continues to decrease quality of life as well as have a huge economic consequence on the healthcare system. Research demonstrates that not only current but future generations will also carry the burden obesity places on populations (CITE). Although great strides have been made with regard to obesity data collection, treatments, and prevention efforts, there are still great challenges for the United States with this continued preventable ongoing health issue.

This study used the CDC's BRFSS 2013 data to examine four of the six identified obesity factors with respect to the region of Virginia and their obesity prevalence differences. Understanding contrasts and comparisons that may exist within health regions, and therefore, impact obesity prevalence rates, can provide signals for effective targeted prevention and treatment efforts. Preventing and reversing obesity trends further can provide significant health benefits, improved morbidity and mortality rates, and a higher quality of life.

The purpose of this research was to explore regional differences that may exist within the state of Virginia between obesity prevalence differences and four primary obesity risk factors. Five health districts of Virginia were identified and each of the four obesity risk factors was examined in each region. In this study, I analyzed 3,481 responses from the 2013 BRFSS from the state of Virginia. Regional demographics and descriptive information allowed me to more fully understand the region's obesogenic characteristics. The obesity counts as measured by this research using 2013 BRFSS data and Virginia Health Districts are depicted in the following Figure 5 bar chart:

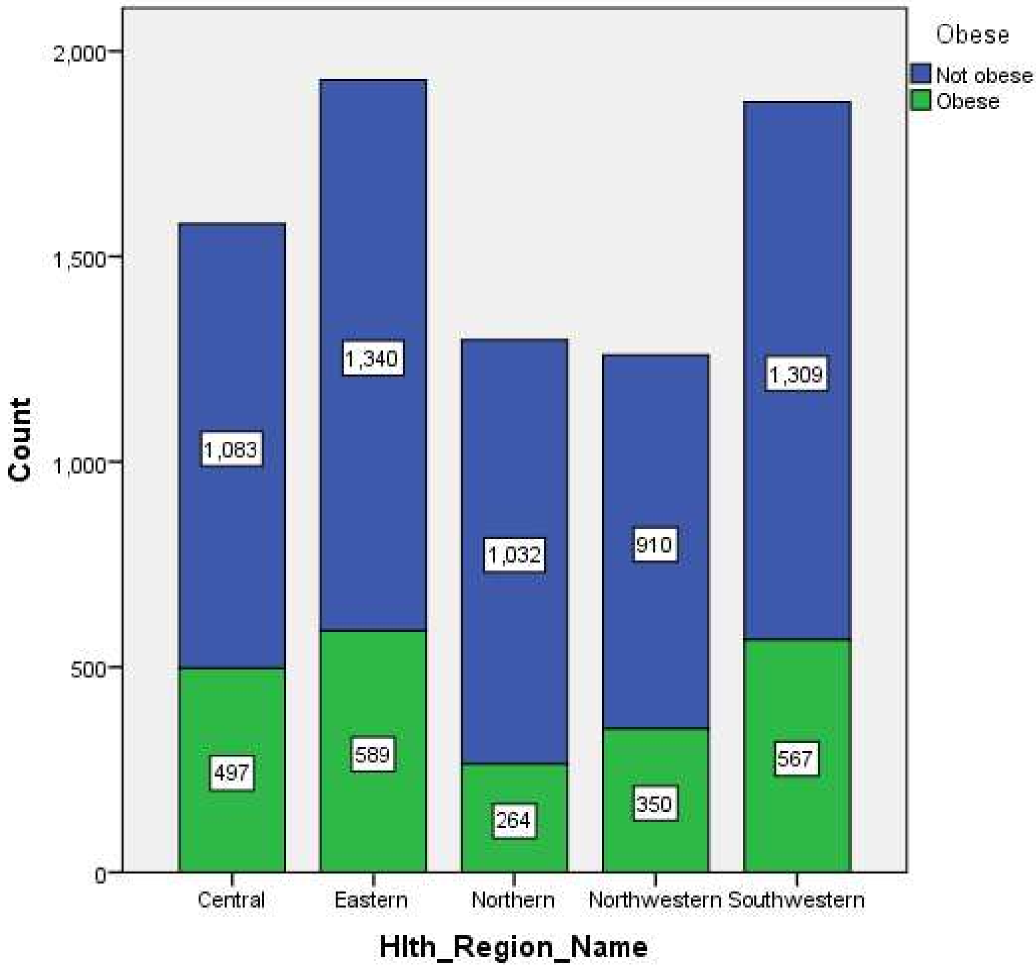

Figure 5. Obesity count per health region in VA.

Some important highlights from the demographics for regions in Virginia include notable variances. It was observed across all region's demographics that ethnicity was predominantly Caucasian (72.2%–88.9%), followed by African American (6.4%–22.4%) and then minority races of Asian, Hispanic, American Indian/Alaskan Native, and Other. Obesity prevalence within the regions ranged from 21.4% to 30.1%, with Northern Virginia being the lowest and Eastern Virginia being the highest. The poverty levels in the regions varied from a high of 23.8% in Southwest Virginia to a low of 4.6% in Northern Virginia. Similarly, Northern Virginia had the highest educational attainment percentage at 75.8% and Southwest Virginia had the lowest levels of educational attainment at 31.8%. Percentages of those engaging in physical activity was more closely related regionally, with Southwestern Virginia at the lowest percent of 28.8% and Northwestern Virginia revealing the highest percentage of individuals engaging in recommended vigorous activity at 33.4%. Frequency per week of physical activity as well as minutes of activity composed two of the four aspects of the frequency, intensity, type, and time exercise principles, those 2 are frequency and time. The descriptive statistics reveal that all regions have similar frequency of physical activity per week with a range of 3.5 session per week in the Eastern part of the state to a higher frequency of 3.8 in both the Northern and the Southwestern region of Virginia. Finally, fruit and vegetable intake per day was also compiled to show that the Northern and the Northwestern regions of Virginia have the greatest intake of fruit, beans, green vegetables, orange vegetables, and other vegetables. These important descriptions and organization of the 3,418 surveyed individuals allowed for further analysis to be conducted that was designed to specifically answer my five research questions. To summarize the most notable outcomes per region, a profile for each region was created that may indicate those most at risk and reveal indicators of resource alignment.

- The Central district analysis revealed a profile with increased obesity for African Americans (3.07 times more likely), those below the poverty level

(2.02 times more likely), and those individuals not engaging in intense physical activity as being at most risk.

- The Eastern district analysis revealed a profile with increased obesity for African Americans (1.8 times more likely), those below the poverty level (1.76 times more likely), and an unexpected outcome of those who have graduated from college or technical school were .51 times more likely to be obese. Additionally, those from the Eastern health district that did participate in weekly strength activity were at lower risk of obesity.
- The Northern district analysis revealed a profile with increased obesity risk for those below the poverty line (2.66 times more likely) and those not engaging in intense physical activity.
- The Northwestern district analysis revealed a profile with increased obesity risk for Hispanics (7.69 times more likely) and African Americans (2.31 times more likely) and those individuals not engaging intense activity.
- The Southwestern health district in Virginia analysis revealed a profile that indicated an increase in obesity risk for African Americans (2.1 times more likely), those below the poverty level (1.57 times more likely), and those not participating in strength training weekly and not consuming orange vegetables.

The following represents specific bullet point items that are recommended to be addressed:

- Recommendations for Region 1: Northwestern - 26.1% Obesity Prevalence Rate:
    - Race/Ethnicity - Hispanic population education
    - Target Heart Rate
- Recommendations for Region 2: Northern - 21.4% Obesity Prevalence Rate:
    - Target Heart Rate
    - Poverty Level
- Recommendations for Region 3: Southwest - 27.8% Obesity Prevalence Rate:
    - Target Heart Rate
    - Poverty level
    - Education level
    - Race/Ethnicity
    - Strength Training
    - Increase Orange vegetable intake
- Recommendations for Region 4: Central - 29.7% Obesity Prevalence Rate:
    - Target Heart Rate
    - Race/Ethnicity - African American population education
    - Poverty Level
- Recommendations for Region 5: Greater Hampton Roads - Eastern - 30.1% Obesity Prevalence Rate:
    - Race/Ethnicity

- Poverty Level
- Education Level
- Strength Training

When reviewed in totality, one can see that race/ethnicity, exercise intensity, and poverty levels are the three obesogenic factors most influencing obesity rates in the regions of Virginia. Getting into the communities and understanding why the African American or Hispanic races/ethnicities have higher obesity levels should be a priority for public health. Being able to deliver the education in a manner where it will be received by the target audience must be a priority.

Social and economic policies and influences must be addressed if we are to impact obesity and its costs, as poverty continues to be a significant obesogenic factor. Employment and education opportunities must be strengthened in these communities. Investing in strong community colleges that are available to all at more affordable costs to working and parenting students offers a bridge or a pathway for individuals to impact earning potential.

Limitations

I consulted the Walden University Quantitative Research advisors to obtain a clarification of Research Question 5. A request to clarify language to ascertain if region can be identified as an obesogenic factor was made to improve the analysis. The use of BRFSS introduced self-reported data, which may have introduced limitations shown in previous research. Additionally, the results of this study were limited to represent respondents to the 2013 BRFSS, who in summary were adults, 80% Caucasian and 13%

African American. This study did not address gender which may introduce further obesity predictors. Although the use of BRFSS data was purposeful, it introduced the limitation of how the obesogenic factors were defined. Regarding nutrition behaviors and physical activity, only a part of what comprises these factors was represented in the chosen BRFSS questions.

Recommendations for Action

The results of this study can be useful in application in that comparison to the prevention and intervention strategies currently being employed within each health district can be reviewed. Resources are always in demand, especially in public health, and the demonstration that in the Northwestern district of Virginia that Hispanics are over seven times more likely to be obese can be an indicator that we need intervention in the Hispanic communities. Population initiatives in schools and the workplace designed for this specific race/ethnicity need to be funded and facilitated for increased opportunity for success.

The results of this study indicated that exercise intensity, as it relates to cardiovascular activity, needs to be improved. Working in communities with education on how we measure this component of fitness, target heart rate, and why it matters could be a very effective initiative in all but the Eastern district. Understanding the basic gap in this component of fitness can further facilitate the use of technology (smart phones and Fit Bit-type devices) that measures and compares the data to assist individuals and communities with that specific aspect for intensity of exercise. These small adjustments on an individual level can produce significant results in individual wellness, and if employed on a population scale, may also illicit significant results for improvements in community wellness. Understanding that exercise is occurring but not in the proper intensity zone (55%–85% of target heart rate), allows practitioners to educate individuals on how to get their heart rates up more effectively.

Understanding obesogenic factors such as those outlined in this research can further empower public policy makers to identify public strategies most suited for the local community. The crossroads of individual obesity with those of population public policy makers is important must be grounded in research. The Health and Human Services Department has the authority to propose new legislation regarding limiting the impact and reach of obesity. Defined educational programs funded with grants and executed by the public health community that can be implemented effectively with proper identification of goals as outlined in this research. Establishing benchmarks and goals regarding timelines and what is actually available at the local health district level is a key component in public health administration. Obtaining support beginning at the national level where sound policy can be introduced and carried out by local public health districts as needed based on their specific demographics can produce a powerful impact on reducing obesity.

Creating a climate that reverses current obesity trends and improves morbidly, mortality and overall quality of life is a complicated process that requires ongoing research and continuation of identification of population trends as they relate to obesogenic behaviors. Understanding the causes of obesity becomes difficult as we apply population data to individual behavior. Research such as this that can identify specifically within health regions what factors in the obesity equation may produce the most positive social change will continue to evolve and morph as the American population becomes more transient and adapted.

Future studies of obesity need to incorporate how identified risk factors are working in conjunction with each other verses independent studies. As population obesity prevalence rates change over time continued efforts to target factors that are strong predictors such as race will continue to be vital in the fight against obesity. Additionally, future studies on how factors effect populations and not individuals would illicit important community health information useful to practitioners. Continuing analyses to address gender differences and include children are warranted. Finally, understanding the effects of current public policy and obesity initiatives need to be examined. This research can add to the resources available and the knowledge base public health officials can utilize for action.

Implications for Social Change

The results of this study are vital for social change to occur in the state of Virginia. Exploring four known obesity causes within health districts in the state was conducted in order to illustrate the needs of the public health community and U.S. policy makers who are working towards obesity intervention and ultimately social change. Obesity is a very complex condition that has been proven in research to have a major social impact and influence. Creating strategies that enable individuals in communities to better intervene and reverse the obesity trends and negative impact on individual health has the potential to improve morbidity and mortality rates. This research offers public health practitioners another tool in the prevention and treatment of obesity. Utilizing these results to more customize and align current efforts should be a priority. Additionally, research such as this offers a tool that can be applied again to different variables to glean a further understanding of the health districts in Virginia. Finally, these results may be applied both at an individual level and within community health and population initiatives. The social ecological theory introduces the impact of national health policy, local communities, and family relationships have on individual behavior. Improvements in individual obesity rates have the potential to impact not just the individual, but their communities thereby catalyzing positive social change.

Conclusions

Although the CDC has termed obesity as a national epidemic, efforts to prevent and treat the condition have mostly been on a small scale are targeted toward individual behaviors. Public health has seen a decline in the rise but not yet a reversal of the treading of this costly and preventable condition. As the nation continues to debate healthcare and improvements we must approach obesity from a prevention standpoint to thwart the astronomical costs associated with treatment and lower quality of life. The results of this study demonstrated the need to wide scale obesity program initiatives customized for the health districts that are attempting to disseminate them.

American culture is one of excess and a never ending food supply combined with continued efforts to reduce needed physical activity for convenience. This is the perfect synergy to create what we are seeing in obesity and overweight prevalence being at a combined 62% of the population (CDC, 2014). Application of basic exercise science energy balance equations require calories to be expended and consumed at a balanced rate for maintenance of body weight. Encouraging and creating a culture that offers options that allow for individuals and populations to "feel good" and not impose limitations of overweight and obesity can significantly impact our nation's health. As we see more young children burdened with the condition of obesity at very young ages their lives become a constant battle and the life expectancy of Americans decrease. Health practitioners agree this is indeed a major health issue and it is indeed preventable. We must continue to work hard and use studies such as this to understand the best ways we can assist our nation in getting the percentage of overweight and obese individuals down, these national initiatives cannot wait.

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Appendix A: Behavioral Risk Factor Surveillance System 2013 Draft Questionnaire

Table of Contents

Public Use Data

2013 BRFSS/Final/January 27, 2013

Appendix B: 2013 Behavior Risk Factor Surveillance System Questionnaire Selected Questions

Public Use Data

	2013 Behavior Risk Factor Surveillance System Questionnaire Selected Questions *M - Metabolism, B - Behavior, E - Environment			
Core Section				
9	Fruits and Vegetables	M*	B*	E*
9.2	During the past month, not counting juice, how many times per day, week, or month did you eat fruit?		x	
9.3	During the past month, how many times per day, week, or month did you eat cooked or canned beans, such as refried, baked, black, garbanzo beans, beans in soup, soybeans, edamame, tofu, or lentils.		x	
9.4	During the past month, how many times per day, week or month did you eat dark green vegetables for examples broccoli or dark leafy greens including romaine, chard, collard greens, or spinach?		x	x
9.5	During the past month, how many times per day, week or month did you eat orange colored vegetables such as		x	x

	sweet potatoes, pumpkin, winter squash or carrots?			
9.6	Not counting what you just told me about, during the past month, about how many times per day, week, or month did you eat OTHER vegetables?		x	x
10	Exercise (Physical Activity)	M	B	E
10.1	During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?	x	x	x
10.2	What type of physical activity or exercise did you spend the most time doing during the past month?	x		x
10.4	How many times per week or per month did you take part in this activity during the past month?	x		
10.5	And when you took part in this activity, for how many minutes or hours did you usually keep at it?	x		
10.6	What other type of physical activity gave you the next most exercise during the past month?	x		x
10.8	How many times per week or per month did you take part in this activity during the past month?	x		
10.9	And when you took part in this activity, for how many minutes or hours did you usually keep at it?	x		

10.10	During the past month, how many times per week or per month did you do physical activities or exercise to STRENGTHEN your muscles?	x		x
Optional Module				
4	Sugar Sweetened Beverages and Menu Labeling	M	B	E
4.1	About how often do you drink regular soda or pop that contains sugar?		x	x
4.2	About how often do you drink sweetened fruit drinks, such as Kool-aid, cranberry, and lemonade?		x	x
4.3	When calorie information is available in the restaurant, how often does this information help you decide what to order?		x	x
28	Social Context	M	B	E
28.1	How often in the past 12 months would you say you were worried or stressed about having enough money to pay your rent/mortgage?		x	
28.2	How often in the past 12 months would you say you were worried about having enough money to buy nutritious meals?		x	

30	Emotional Support and Life Satisfaction			
30.1	How often do you get the social and emotional support you need?		x	x