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Association Between Vegan, Vegetarian, and Omnivorous Diets and Overweight and Obesity

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Abstract

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by

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MPH, University of Connecticut

MS, Rutgers University

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Overweight and obesity and associated health risks have become epidemic in several regions around the world. Numerous studies have addressed the dietary habits of vegetarians and vegans in terms of disease prevention and nutritional deficiencies but the relationship between overweight and obesity and the demographic, psychosocial, lifestyle, and dietary intake of omnivores, vegetarians, and vegans has received less attention. Guided by the social-ecological model, this study included a cross-sectional, quantitative, anonymous web-based survey to obtain dietary information on omnivores, vegetarians, and vegans. Vegans demonstrated a significantly lower mean and median body mass index (***p=0.00***) than omnivores, semi-vegetarians, and vegetarians. Multiple logistic regression analysis demonstrated no significant difference in the odds of overweight (OR=0.41; ***p=1.14***) and obesity (OR=0.47; ***p=0.28***) in vegans compared to omnivores. Alcohol was significantly protective against obesity for both 1-2 (OR=0.33; ***p=0.03***) and 3-30 (OR=0.20; ***p=0.01***) days drinking per month while binge drinking significantly increased the odds of obesity (OR=4.44; ***p=0.01***). Multiple logistic regression analysis stratified for levels of exercise revealed an interaction between diet and exercise. A vegan diet was significantly protective against obesity for low-level exercise in terms of frequency (OR=0.31; p***=0.02***) and total minutes per week (OR=0.23; ***p=0.02***) compared to omnivores. Coupled with prior studies these results may contribute to positive social change by facilitating a broad-based paradigm shift in the view of diet and exercise as well as providing evidence that can be implementated in broad-based obesity control programs to reduce the morbidity and mortality associated with obesity.

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Chapter 1: Introduction to the Study

Public health concerns over the American diet gained publicity during the middle of the 20th century. The US Department of Agriculture (USDA) published the four food group plan in 1957 to address nutrient deficiencies in the American diet. Originally published in 1977, the US Dietary Guidelines (USDG, 2010) and the USDA My Pyramid (2005) outline goals for dietary intake and activity to attain or maintain an optimal body mass index (BMI).

Despite these public health measures, individuals classified as overweight or obese represented 68% and 33.8% respectively of the 20 and older population in the United States in 2008. This represents a 7% increase over 2000 and is consistent with the trend of 6-8% increases every 10 years since 1988 (BRFSS, 2009).

Many individuals have experimented with one or more of the myriad quick-fix diets currently available while others have sought out behavioral lifestyle changes in an effort to limit their exposure to energy-dense foods. One approach is the adoption of a vegetarian or vegan lifestyle. Vegans avoid all animal products while vegetarians range from the inclusion of eggs and dairy to chicken and fish.

As the literature search will demonstrate, numerous studies have been done addressing the risk of overweight and obesity and related health concerns in vegetarians and vegans compared to that of omnivores. A review of the literature will reveal a gap in the research comparing these risks in vegetarians versus vegans. This cross-sectional study focused on the risk of overweight and obesity in several classifications of vegetarians versus omnivores and vegans.

Background of the Study

The epidemic of overweight and obesity is a multi-faceted issue drawing from both sides of the nature-nurture dichotomy including genetics (Paracchini, Pedotti, & Taioli, 2005; Gummesson et al., 2007; Rosskopf et al., 2007; Gueorguiev et al., 2009; Mueller et al., 2010; She, Li, Zhang, Graubard, & Li, 2010), demographics (Rohrer & Rohland, 2004; Borders, Rohrer, & Cardarelli, 2006; Salsberry & Reagan, 2009; Ziraba, Fotso, & Ochako, 2009), psychosocial factors (Rohrer & Rohland, 2004; Arif & Rohrer, 2006), lifestyle factors (Liebman et al., 2003; Villegas, Kearney, & Perry, 2008; Rohrer, Vickers-Douglas, & Stroebel, 2009), and dietary quality and food frequency (Haddad & Tanzman, 2003; Spencer, Appleby, Davey, & Key, 2003; Rosell, Appleby, & Key, 2004; Arif & Rohrer, 2005; Newby, Tucker, & Wolk, 2005; Rohrer, Vickers-Douglas, & Stroebel, 2009; Al-Rethaiaa, Fahmy, & Al-Shwaiyat, 2010). A significant contributor to this epidemic has been the availability of highly processed, energy-dense foods in Western cultures and more recently expanding to developing nations (Fraser, 2001; Pollan, 2006; Ziraba, Fotso, & Ochako, 2009).

Accessibility to foods high in fat, sugar, and salt can be traced back to changes in food production in the mid-19th century. Changes in agriculture and livestock production in the middle of the 20th century have resulted in a rapid progression from small, independent family farms to the corporate “factory” farms prevailing today. Intensive livestock operations first appeared during the 1940s with poultry production and are now common practice (Fraser, 2001). Confined Operational Animal Feeding (COAF) corporate farms currently predominate the agricultural landscape producing the majority of milk, eggs, beef, pork, and poultry consumed in the United States today (Folmann et al., 2007). Over 80% of the corn grown in the US is used to feed livestock such as cows, pigs, and poultry on large-scale, industrialized COAF operations (EPA, 2002).

The ubiquity of corn and soybean changed the entire mechanism of food production resulting in high fat, high sugar, inexpensive foods to satisfy the human predisposition to fat, sugar and salt. Increased access to highly processed foods is arguably the most significant contributor to the epidemic of overweight and obesity facing many societies today (Fraser, 2001; Drewnowski, 2007). While sweeteners have been part of the human diet for centuries primarily in the form of sucrose from sugar cane and beets, the widening availability of corn led to a gradual shift to high fructose corn syrup (HFCS) as the primary source of sweetener in the US. Grown in the Midwest, it is immune to price fluctuations and is chemically stable in acidic foods and beverages. The commercial acceptance of HFCS in the 1950s led to phenomenal growth that has paralleled the dramatic rise in overweight and obesity. The dramatic rise in the production of corn has impacted the diet in several ways but has primarily increased availability of energy-dense foods high in sugar, fat, and salt (White, 2008).

The primary public health concern resides in the reduction of both the quality and quantity of life associated with health risks. Both overweight and obesity increase the risk of cardiovascular disease (CVD), certain cancers, metabolic disorders, gall bladder disease, pancreatitis, insomnia, chronic fatigue, arthritis, psychosocial function, sleep apnea, insulin resistance, fatty liver disease, pre-hypertension and hypertension, pain, and type 2 diabetes (Rohrer, Takahashi, & Adamson, 2008; Rohrer, Anderson, & Furst, 2007; Bray, 2004).

Overweight and obesity have an adverse impact on health primarily via metabolic changes and the increased mass due to increased fat. The pathophysiology of fat is best ascertained when viewing adipose as an endocrine cell composing a larger endocrine organ. Excess dietary calories leads to an increase in the number and size of fat cells resulting in excess fat mass as well as metabolic changes. The risk of cardiovascular disease (CVD) and hypertension is elevated in overweight and obese individuals due to hypertrophy of the heart, thickening of vascular walls, and increasing the work of the heart through increased body mass (Bray, 2004).

A litany of studies have demonstrated a temporal relationship between the prevalence of overweight and obesity and several chronic conditions including CVD, hypertension, mycardial infarction, thrombosis, angina pectoris, osteoarthritis, varices, and diabetes mellitus (Pitsavos, Milias, Panagiotakos, Xenaki, & Panagopoulos, 2006; Calza, Decarli, & Ferraroni, 2008). The results from these two studies of large Mediterranean populations of adults correlate well with the results of similar studies done using Western cultures (Rohrer, Takahashi, & Adamson, 2008; Stray-Pedersen et al., 2009; Rohrer, Anderson, & Furst, 2007; Bray, 2004).

An aging population coupled with the current obesity epidemic threatens to overwhelm an already overburdened healthcare system. According to the Centers for Disease Control & Prevention (2009), individuals with the highest prevalence of obesity in the US are found among the 40-59 and ≥60 age groups for both males (34.3%; 37.1%)

and females (38.2%; 33.5%). According to the US Census Bureau (2010), individuals over the age of 45 constitute 41% of the US population and demographers estimate that number to reach 47% by 2050. This implies that almost one out of every two Americans will be age 45 or older by 2050. Cardiovascular disease and diabetes alone represented the leading and seventh leading causes of death in the United States in 2007, accounting for almost 700,000 deaths (CDC, 2010)

Annual increases in hospital discharges and costs associated with obesity are increasing in both children age 6 to 18 and adults (Vellinga, O'Donovan, & De La Harpe, 2008). Several hospital-based studies indicate that overweight and obesity may be somewhat protective with respect to morbidity in adults over the age of 65 (Kulminski et al., 2008; Taylor & Ostbye, 2001). Other studies indicate total healthcare utilization increases with obesity in the elderly (van Dijk, Otters, & Schuit, 2006). A study in Denmark found significantly higher use of hospital services including inpatient, outpatient and emergency room visits for obese versus normal weight male patients. The study also found that obese patients had 57.5% higher hospital costs than normal weight men (Folmann et al., 2007).

Using hospital records over a 20 year period to monitor duration of obesity, an adult life course analysis on long-term exposure found obesity increased both hospital admissions as well as length of stay. In addition to chronic obesity, individuals exposed at any point during the study had longer hospital stays (Schafer & Ferraro, 2007). A cohort study in Scotland found obese men had higher admission rates and bed day rates than underweight and normal BMI men. Both underweight and obese women had higher admission and bed day rates (Hart, Hole, Lawlor, & Smith, 2007). Rohrer, Takahashi, & Adamson (2008) demonstrated an association between obesity and the number of medical visits in adults 65 and under. From a public health perspective, obesity intervention strategies should target individuals under 65.

Costs associated with overweight and obesity are not limited to Western societies. Bovet, Shamlaye, Gabriel, Riesen, & Paccaud (2006), found rapidly increasing risk factors associated with overweight and obesity in the developing nation of Seychelles. The cost of treatment for these risk factors was prohibitive, exceeding available resources resulting in an untenable, nonsustainable situation which threatens to slow significant gains in the provision of healthcare.

Stigma and cosmetic concerns associated with overweight and obesity are trumped by myriad associated health risks. However, the impact of discrimination toward the psychological and physical health of overweight and obese individuals should not be trivialized. Discrimination against overweight and obese has risen to a level on par with other forms of discrimination (Maclean et al., 2009; Puhl & Heuer, 2010).

Problem Statement

In an effort to reduce susceptibility to overweight and obesity, large segments of the population have sought relief from the wide array of fad diets currently available. Americans spend over $40 billion annually on weight loss diets excluding exercise equipment (USFDA, 2011). After numerous failed attempts at dieting, many have attempted to incorporate lifestyle changes including diet and exercise to maintain a healthy BMI. One dietary approach has been the adoption of a vegetarian or vegan lifestyle. The problem to be researched is the lack of information on the relationship between the dietary intake of vegetarians versus vegans and the risk of obesity. There is a gap in the current literature regarding energy nutrient and alcohol intake in these specific groups as it relates to maintaining a healthy BMI. This study compared the BMI and dietary practices of these groups in order to determine the nature of their relationship. The dependent variable was overweight and obesity and the independent variables were the self-reported diets of omnivores, semi-vegetarians, vegetarians and vegans.

Nature of the Study

This study was a quantitative, cross-sectional survey study. Data collected included self-reported dietary patterns, demographic information and BMI. The ambiguous nature of vegetarianism made self-identified categories unreliable in terms of actual dietary intake. Vegetarian diet was verified and categorized by intake of energy nutrients and alcohol, e.g. high complex carbohydrates/low fat. Participants were classified as omnivorous, semi-vegetarian, vegetarian or vegan. The cross-sectional study design provided data for the development of a general hypothesis based upon the relatively rapid acquisition of data pertaining to dietary habits and BMI.

Participants consisted of a non-random convenience sample of 408 self-identified omnivores, semi-vegetarians, vegetarians and vegans (Openepi, 2010). Access to vegetarians and vegans was accomplished through mailing lists obtained through various vegetarian and vegan societies, magazines, word of mouth, and social network applications such as *Facebook* and *Twitter.*

Research Question

The original research question being addressed in this study: is there a difference in the risk of overweight and obesity (DV) among various vegetarian and vegan diets (IV) required revision due to a lack of power secondary to inadequate sample size. The amended research question became: is there a difference in the odds of overweight and obesity (DV) between omnivorous and vegan diets. The null hypothesis stated there is no difference in the odds of overweight and obesity between omnivorous and vegan diets.

Purpose of the Study

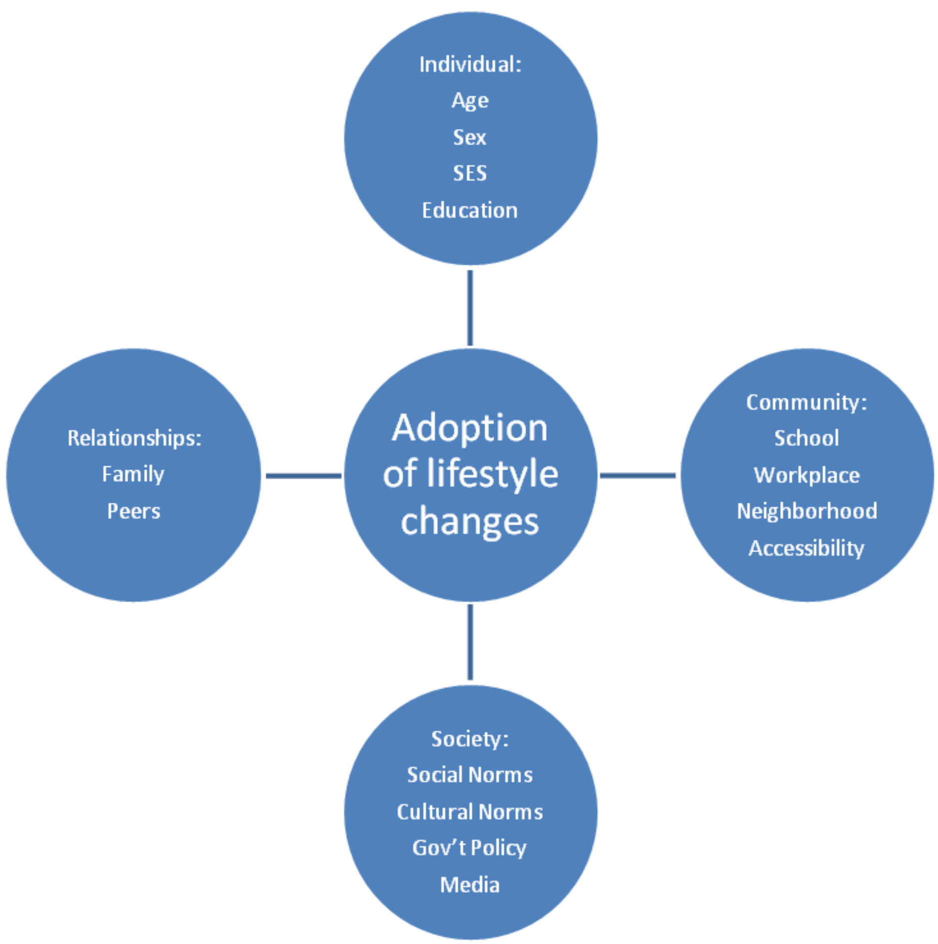
Overweight and obese are defined by Body Mass Index (BMI) which examines weight in relation to height (NIH, 2009). Overweight and obese are associated with an array of health risks including cardiovascular disease, metabolic syndrome, diabetes, and certain cancers (Rohrer, Rohland, Denison, & Way, 2005). Numerous studies have addressed the dietary habits of vegetarians and vegans in terms of disease prevention and nutritional deficiencies (Lampe, 2009; Craig, 2009). There is a gap in the literature addressing specific vegetarian diets in terms of dietary intake as it relates to BMI. The purpose of this study was to discover whether the risk of obesity is different for persons following omnivorous, semi-vegetarian, vegetarian and vegan diets.

Theoretical Base

Conceptual models provide the essential framework for health-related behavior changes. Historically, many theories isolate the individual in terms of personal responsibility as the focus of behavioral change (Maclean et al., 2009). Other theories approach modifiable behaviors such as dietary intake as a function of numerous inputs across several domains. The socio-ecological model (Morris, 1975) incorporates a combination of individual, relationship, community, and societal factors as a template for overweight and obesity as well as reasons for embracing significant lifestyle changes (Figure 1). Dietary choices are influenced by numerous variables often experienced on a daily basis. The decision to incorporate significant lifestyle changes does not take place

Figure 1

Elements contributing to lifestyle behavior changes according to the socio-ecological theory (CDC, 2007).



in a vacuum but is a function of myriad inputs across the Morris model. Personal characteristics, relationships, among family, friends, and the community, as well as society at large can facilitate or present roadblocks against the adoption of a non-traditional lifestyle.

The decision to adopt vegetarianism or veganism transcends dietary choices and signifies a true lifestyle choice. Success over the long term requires a sense of ownership in the process of change. While personal appearance and health are obvious inputs, factors such as education and awareness, treatment of animals, peer pressure and the accessibility to and preparation of vegetarian foods cannot be overlooked. The social-ecological theory provides a conceptual model for lifestyle changes such as the adoption of the vegetarian or vegan lifestyle.

Operational Definitions

Body Mass Index (BMI): measurement based upon weight in relation to height (BMI=weight (kg)/height (m^{2})); used to define normal, overweight, and obesity (NIH, 2009).

Lacto-vegetarian: the practice of not eating beef, poultry, fish, or eggs with the occasional consumption of dairy products (VRG, 2010).

Obese: defined as a BMI $\geq$ 30 kg/m^2 (NIH, 2009).

Overweight: defined as a BMI between 25 and 29.9 kg/m^2 (NIH, 2009).

Ovo-lacto vegetarian: the practice of not eating beef, poultry, or fish with the occasional consumption of eggs and dairy products (VRG, 2010).

Ovo-vegetarian: the practice of not eating beef, poultry, fish, or dairy products with occasional consumption of eggs (VRG, 2010).

Semi-vegetarian: the practice of not eating beef with occasional consumption of poultry, fish, eggs and/or dairy products (VRG, 2010).

Vegan: excludes consumption of all animal flesh or animal products including dairy products, eggs, gelatin, shellac or honey (VRG, 2010).

Vegetarian: the practice of not eating beef, poultry, or fish with or without the use of eggs and/or dairy products (VRG, 2010).

Assumptions & Limitations

There was no effort made to verify the data collected from respondents thus the truth and accuracy of said data was assumed. While anthropometric determinations of BMI demonstrate greater validity the study relied on self-reported data on height and weight for determination of BMI. The survey was administered in English only thus any language barriers went undetected. The survey contained questions specifically designed to ferret out incorrect designations as there are many interpretations of vegetarian and vegan diets. A tacit understanding of these designations was expected from respondents. While a survey validated by the Behavioral Risk Factor Surveillance System (BRFSS) was used, no attempt was made to pre-test modified questions thus the validity of the modified survey is implicit in the design.

Limitations are inherent in the cross-sectional study design including the reliance on self-reported data leaving the study open to recall bias. Physical measurements, e.g. BMI are more reliable than self-reports. The data collected must be considered a snap-shot in time and by no means temporal. The study was intended to assess the strength of associations and whether significant or not are simply that and may not be considered causal.

Scope of the Study

The study was designed to included a representative sample of adult vegetarians and vegans using societies, associations, social networking media, and word of mouth. The vegan and vegetarian diet is surrounded by many popular misconceptions resulting in several classifications of vegetarian. By targeting adults practicing a vegetarian or vegan lifestyle for a minimum of three months I hoped to minimize confusion associated with these lifestyles. Access to the instrument and careful analysis of responses enabled a ferreting out of non-vegetarians into a reference group of omnivores.

Significance of the Study

Changes in the agricultural landscape have fueled the current epidemic of overweight and obesity in the United States and other regions. Health risks associated with overweight and obesity are myriad and threaten to overwhelm an already overburdened healthcare system. In an attempt to lower their risk of overweight and obesity and associated health risks some individuals have adopted dietary lifestyle changes such as the adoption of a vegetarian or vegan diet. The theory behind the vegetarian diet is that a reduction in the consumption of meat products will result in a decrease in fat intake with a subsequent decline in BMI. The reduction of meat in the diet is often compensated for by calories from other sources such as dairy products and eggs. Vegan diets eliminate all animal products including dairy and eggs. This study contributed to a better understanding of the risk of overweight and obesity in terms of the vegetarian versus the vegan diet.

Transition Statement

Chapter one provided an introduction to the factors associated with overweight and obesity and its significance as a global health issue worthy of study. A concise problem statement was provided along with the nature of the study designed to answer the research questions. The purpose and theoretical basis of the study was clearly elucidated and assumptions and limitations associated with the study design are stated. The knowledge gap was clearly identified as is the contribution of this study to a better understanding of lifestyle changes such as vegetarian and vegan and the differing risk of obesity inherent in their dietary choices.

Chapter two will contain a search of the current literature pertaining to the theoretical and conceptual contribution to dietary lifestyle changes as well as the contribution of dietary choices to overweight and obesity. While the amount of research dedicated to the association between diet and overweight and obesity is voluminous, the search will illustrate a gap in the literature addressing this risk in vegetarian versus vegan diets. Chapter three will address the specific nature of the study, research design, setting and approach, study sample, survey instrument, data collection and analysis. Chapter four will address research tools, results and data analysis in the form of a narrative, tables, and graphs as indicated. Chapter five will provide an overview of the study along with an interpretation of the findings. The implications for social change to be derived from the study as well as recommendations for action and further study will be included.

Chapter 2: Literature Review

Background

Many have speculated over the causes of expanding waist lines including genetics, diet, technology, environment, demographics, marketing, lifestyle changes, and lack of physical activity. While overweight and obesity are certainly multi-factorial conditions, temporal relationships support a causal association between dietary changes and the current epidemic of overweight and obesity. Increasing morbidity rates associated with overweight and obesity have become a significant public health concern. To mitigate their risk of overweight and obesity many individuals have adopted nontraditional diets such as Mediterranean, vegetarian or vegan. Lifestyle changes associated with the vegetarian/vegan diet is thought to decrease the risk of overweight and obesity and their associated health risks. However, there is a gap in the literature comparing the risk of obesity in vegetarian versus vegan diets.

Search Strategy

The literature search was organized around the association between several predictor variables, especially the impact of dietary trends, on the risk of overweight and obesity. Following a brief search of the literature addressing the relationship between the dependent variable (overweight & obesity) and several predictor variables, the search focused on dietary predictor variables including diet quality, food frequency, culminating with vegetarian and vegan diets. While numerous studies were noted examining the relationship between diet and the dependent variable, the search exposed a gap in the literature addressing the risk of overweight and obesity and specific types of vegetarian and vegan diets.

Databases utilized for the search included High Wire, Pub Med, Cinahl, Medline, Psyc Info, Science Direct, BioMed Central and Dissertations and Theses and was limited to documents published between January 2000 and the present. Keywords reflected the dependent and independent variables appropriate to the subject of this study including overweight, obesity, genetics, demographics, lifestyle, psychosocial factors, vegetarian, vegan, alcohol, diet quality, food frequency and health risks.

Research studies were included if they addressed the impact of predictor variables on overweight and obesity, with a special emphasis on dietary factors. I was particularly interested in the quantitative, survey studies with overweight/obesity as the dependent variable as they were representative of my method of inquiry. A total of 22 studies met the criteria for inclusion in the literature matrix.

Theoretical Model

The long-term success or failure of a lifetime behavior change is often a function of the social and environmental landscape in which it occurs. The context in which change takes place can be proxy to not only individual success but to the transferability or external validity of an intervention. Significant dietary changes such as the incorporation of a vegetarian or vegan lifestyle is multi-faceted and therefore cannot take place in isolation (Armstrong et al., 2008).

The socio-ecological model (Morris, 1975) provides the framework for an investigation of the elements that fuel changes in modifiable behaviors including dietary choices (Figure 2). Rather than focusing on individual factors this model views behavior change as occurring within the context of the biological, environmental, and behavioral landscape. One could argue that models placing the onus of behavior change on the individual have met with limited long-term success. Lifetime behavior change requires a more comprehensive approach incorporating knowledge, peer and social support, and the collaborative efforts of both the private and public sector. This includes addressing factors which foster unhealthy behaviors (Caprio et al., 2008).

Maclean et al., (2009) noted that the increasing worldwide prevalence of overweight and obesity cannot be adequately explained by biology alone. Ciliska (2004) calls for a multi-disciplinary approach to fostering healthy behaviors through cooperative environmental and systems-based approaches through the private and public sector. Others have concurred that addressing the environmental rather than individual determinants of obesity demonstrate better long-term efficacy (Alderman, Smith, Fried, & Daynard, 2007: Schwartz & Brownell, 2007).

As a component of the socio-ecological model, public policy measures can impact dietary intake in terms of access to healthy foods. The emphasis behind changes in modifiable behaviors often resides in the realm of eliminating negative behaviors without providing positive alternatives. Moore & Tapper (2008) found the presence of school fruit tuck shops had a significant impact on the consumption of fruit during snack time for a cohort of school children age 4 – 7 of lower socioeconomic status. This illustrates the benefits of employing a holistic approach to creating an environment that fosters positive behavior changes.

Figure 2

Components of the socio-ecological theory as they relate to overweight & obesity (CDC, 2007).

Risk Factors Associated with Overweight & Obesity

Recent research has examined the risk of overweight and obesity associated with genetic factors (Paracchini, Pedotti, & Taioli, 2005; Herbert et al., 2006; Gummesson et al., 2007; Rosskopf et al., 2007; Gueorguiev et al., 2009; Muller et al., 2010; She, Li, Zhang, Graubard, & Li, 2010), demographics (Rohrer & Rohland, 2004; Borders, Rohrer,

& Cardarelli, 2006; Salsberry & Reagan, 2009; Ziraba, Fotso, & Ochako, 2009; Rohrer, Vickers-Douglas, & Stroebel, 2009), psychosocial factors (Rohrer & Rohland, 2004; Arif & Rohrer, 2006), exercise (Rohrer, Vickers-Douglas, & Stroebel, 2009) in addition to dietary factors (Haddad & Tanzman, 2003; Arif & Rohrer 2005; Newby, Tucker, & Wolk, 2005; Rohrer, Rohland, Denison, & Way, 2005; Weinrich et al., 2007; Rohrer, Vickers-Douglas, & Stroebel, 2009; Stray-Pederson et al., 2009; Tonstad et al., 2009; Ziraba, Fotso, & Ochako, 2009; Al-Rethaiaa, Fahmy, & Al-Shwaiyat, 2010; Roberto et al., 2010). A review of the literature found numerous articles assessing the risk of overweight and obesity associated with these independent variables.

Genetic Factors

Overweight and obesity are not immune to the interplay between genetic factors and the environment. Diet quality and levels of physical activity have changed significantly in recent times but genetic variability moves at a more gradual pace. According to the *thrifty gene* hypothesis, genes that conferred resistance to starvation during leaner times increase susceptibility to overweight and obesity in a land of plenty (CDC, 2010). While it has been difficult to pinpoint the extent of the contribution of each, body mass and susceptibility to overweight and obesity and associated health risks is most certainly a result of the impact of nurture on nature. The discussion lies not in the fact that both are contributing factors but the extent of their significance. The mapping of the human genome in 2000 was indeed a salient moment in human history. The question going forward is of course, what does it all mean? The challenge includes isolating individual genes, deciphering their function, and perhaps most critically, the interplay between genes themselves and the environment.

The primary basis for the pursuit of public health genomics lies in family history which provides a thread of genetic susceptibility coupled with environmental influences (CDC, 2010). Family studies indicate that having obese relatives increases one's risk independent of diet quality and physical activity (Cummings &Schwartz, 2003). Despite numerous association studies (Paracchini, Pedotti, & Taioli, 2005; Herbert et al., 2006; Gummesson et al., 2007; Rosskopf et al., 2007; Gueorguiev et al., 2009; Muller et al., 2010; She, Li, Zhang, Graubard & Li, 2010), individual genetic causes of obesity have been difficult to isolate. As of late 2005, single mutations in 11 genes (LEP, LEPA, POMC, MC4R, MC3R, CRHRI-2, GPR24, SIM1, PCSK1, etc.) have been associated with obesity in 176 cases, however these have been primarily linked to syndromic obesity (CDC, 2010). This is likely due to the fact that the risk of non-syndromic overweight and obesity is a function of the interplay of mutations at several loci or polygenic inheritance. To date, 113 candidate genes have been associated with polygenic obesity including ADRB1-3, UCP1-3, CIDEA, INSIG2, GHLR, FAAH, etc. (Martinez-Hernandez, Enriquez, Moreno-Moreno, & Marti, 2007). The mutated forms of these genes are known as single nucleotide polymorphisms (SNPs), and are responsible for the majority of genetic variation within the human gene pool. While the Human Genome Project (Venter, 2000) elucidated that differences among humans are far less significant than our similarities, genetic diversity within the human gene pool is primarily a result of SNPs.

Leptin is a chemical regulator of adiposity in the body and has received much attention since its isolation in 1950 as a primary cause of obesity in mice. It is thought to do so by regulating energy intake and expenditure. Several genes involved in the regulation of leptin have been considered candidates for a pre-disposition toward obesity. Mutations in leptin genes are thought to compromise leptin production resulting in reduced energy regulation. However, a meta-analysis of 73 studies measuring the relationship between leptin polymorphisms and obesity found no significant association (Paracchini, Pedotti, & Taioli, 2005).

Ghrelin and the ghrelin receptor (GHSR) help to regulate homeostasis and stimulate appetite. Thus far, 12 ghrelin and 8 GHSR SNPs have been isolated. In a European cohort of 1, 275 obese and 1,059 normal weight subjects, Gueorguiev et al., (2009) found a significant association between one GHSR variant (rs572169) and obesity (p=0.007; OR=1.73) and rs2232169 and overeating (p=0.02). They also noted similar associations between the ghrelin variant (rs4684677) and obesity (p=0.009) in obese families, rs26747 and glucose levels (p=0.009). However, none of these significant associations help up to logistic regression analysis implying Ghrelin and GHSR variants plat a limited role in appetite regulation and obesity.

The INSIG2 gene provides an excellent example of the complexity of isolating genetic predispositions to obesity. Regulated by insulin, INSIG2 is believed to regulate fatty acid synthesis in the body. Herbert et al., (2006) found significant associations between the INSIG2 SNF rs7566605 and the risk of obesity. However, using data from the Study of Health in Pomerania (SHIP) cross-sectional study in Germany, Rosskopf et al., (2007) found no significant association between the gene variant (*p*=0.6531) nor was the odds ratio (*OR*=1.13; *p*=0.1782) in normal weight participants (mean *BMI*=27.26). However, when repeating the study using overweight and obese (mean *BMI*=29.94) participants the authors found significant associations between homozygous and carriers of rs7566605 (*p*=0.0068) and BMI as was the odds ratio (*OR*=1.32; *p*=0.0378). These results imply the actions of INSIG2 are contingent upon environmental conditions such as insulin levels.

The literature indicates conflicting reports examining the association between the ADRB2 (rs1042713) gene and obesity. Coding for a *beta*-adrenergic receptor, ADRB2 is thought to assist in the regulation of metabolism. Using data from the Third National Health & Nutrition Examination Survey (NHANES III), She, Li, Zhang, Graubard, & Li (2010) linked population-based, cross-sectional phenotypic data with anthropometric data from 6,930 respondents, one-fifth homozygous for the SNP. The age-adjusted prevalence of obesity as per BMI was 23%. The authors found no significant trend of association (*p*=0.618) between the ADRB2 allele and obesity using Cochran-Armitage Trend analysis.

Fatty acid amide hydrolase (FAAH) codes for the synthesis of an enzyme charged with the catabolism of fatty acids. In a family trio study of 521 obese children and their parents, a significant association was noted between a genetic variant (rs2295632) of FAAH and early onset obesity (*p*=0.045). No such association was noted in 235 independent obese families (*p*=0.32). However, when both groups were combined (n=603) two significant associations (rs2295632, *p*=0.03; rs324420, *p*=0.02) were observed. Interestingly, no significant associations were found between any of the FAAH variants and adult obesity (Muller et al., 2010).

Recent studies have raised the possibility of the cell death-inducing DNA fragmentation factor-alpha-like effector (CIDEA) gene as having a role in human susceptibility to obesity. Evidence indicates the gene helps to modulate the basal metabolic rate (BMR) of brown adipose tissue. Expression of CIDEA limits energy (ATP) production and was shown to be inversely associated with metabolic rate (p=0.014) independent of age, sex, or body composition (Gummesson et al., 2007).

Using data from the Molndal Metabolic Study (n=92) and their own very low calorie diet (VLCD) study (n=24), the authors found a significant negative correlation between CIDEA gene expression and BMR (r = -0.22; p=0.042) as well as BMI (r = -.60; p<0.01). During the 18 week VLCD study, there were 1.9 (p<0.0001) and 2.4-fold (p<0.0001) increases in CIDEA expression respectively after 8 and 16 weeks. This indicates CIDEA expression may function to decrease energy production with decreasing energy intake as a compensatory mechanism to facilitate energy storage against starvation (Gummesson, 2007).

Despite low sample sizes, the authors were able to demonstrate an association between CIDEA gene expression and susceptibility to obesity. While the gene is likely a small piece of the genetic puzzle and the Gummesson et al., study is by no means causal, it substantiates the need for further large-scale study into the significance of CIDEA in the prevention and treatment of obesity.

The aforementioned studies are representative of the uncertainty surrounding the role of genetic variability in susceptibility to overweight and obesity. As is often the case with genetic studies, logical associations often fail to hold water upon closer analysis. Continuing advances in the technology of genetic research have resulted in discoveries on almost a weekly basis and hold great promise as contributors to a growing understanding going forward. The identification of additional individual genes and more significantly, their interactions, will elucidate the role of inheritance in the risk of obesity. Knowledge of inherent susceptibilities will help shape and facilitate the development of interventions aimed at reducing the prevalence of overweight and obesity and subsequent health issues.

Demographic Factors

Survey data from 5,078 in the 2003 Behavioral Risk Factor Surveillance System (BRFSS) in Texas found 36.48 of respondents of normal weight and 25.03 obese based upon BMI (Borders, Rohrer, & Cardarelli, 2006). Males demonstrated an increased crude (OR=1.27) and adjusted (OR=1.63) risk of obesity when compared to females. There was no significant difference noted between males and females in terms of residence. A combination of rural and suburban males had significantly higher crude and adjusted risk of obesity (OR=1.81, $p<0.001$) than urban males as was the crude rate for females (OR=1.37, $p<0.05$). Males of moderate economic status ($25,000 to $74,999) had a higher crude (OR=1.43, $p<0.05$) but not adjusted risk of obesity when compared to males of lower socioeconomic status (≤$25,000). Females of higher socioeconomic status (≥$75,000) demonstrated lower crude (OR=0.37, $p<0.0001$) and adjusted (OR=0.45, $p<0.0001$) risk of obesity when compared to females ≤$25,000. No significance difference in the risk of obesity was noted between males and females based upon educational status.

The results of this study demonstrated an increased risk of obesity associated with being male, rural residence, and lower socioeconomic status for females. While the study relied upon self-reported data and failed to incorporate other predictors such as genetics and physical activity, the results generalize to other regions similar to Texas in terms of demographic features (Borders, Rohrer, & Cardarelli, 2006).

Age and educational status may not be valid predictors of modifiable behaviors associated with overweight and obesity and risk factors for CVD. Data obtained from a questionnaire, anthropometric and biochemical measures a recent study of third-year medical students (mean age = 22) in Greece demonstrated relatively high levels of overweight and obesity. Using BMI, waist circumference (WC), waist-to-hip ratio (WHpR), and waist-to-height ratio (WHtR) the authors found 40% of males and 23% of women had BMI > 25 kg/m^2. Central body obesity from a combination of WC, WHpR, and WHtR found 33.4% of males and 21.7% of females obese (Bertsias, Mammas, Linardakis, & Kafatos, 2003).

Obese students had higher levels of CVD risk factors than did those of normal weight with the exception of blood glucose (BG). Systolic (SBP) and diastolic (DBP) blood pressure, total cholesterol (TC), triglyceride (TG), high-density (HDL) and low-density (LDL) cholesterol, as well as the TC:HDL ratio all trended higher with increasing BMIs (p<0.001 except for HDL, p=0.010, and LDL, p=0.018), WC (p<0.001 except for TC, p=0.011, LDL, p=0.002) and WHtR (p<0.001 except for SBP, P=0.022, DBP &

LDL, *p*=0.001). WHpR was a significant predictor of the risk factors TC (*p*=0.019), LDL (*p*=0.003) and TG, HDL, and TC:HDL (*p*=0.001). BMI was the single best predictor of elevated SBP and DBP in males and females. WC was predictive of TG, HDL, and TC:HDL, while WHtR was a better predictor of LDL in both groups (Bertsias et al., 2003).

Obese students had significantly higher odds ratios for hypertension and dyslipidaemia. Body mass index exceeding 30 kg/m2 was the most significant predictor of the risk of elevated SBP (OR=1.81 in males, 2.98 in females) and DBP (OR=2.73 for males and 3.15 for females). Males with WHtR $\geq$ 50 had the highest OR for TC (OR=2.26) and LDL (OR=1.83) while the highest WHpR ($\geq$ 0.9) demonstrated significantly higher risk of elevated TG (OR=2.51), HDL (OR=2.03), and TC:HDL (OR=2.78). Female participants with WHtR $\geq$ 50 demonstrated the highest risk of elevated DBP (OR=2.33), LDL (OR=2.60), and TC:HDL (OR=5.30) (Bertsias et al., 2003).

The results of this study imply that while elevated levels of all four indices were predictive of elevated risk factors for CVD, BMI was a better predictor of hypertension while WC better predicted dyslipidaemia. While the relatively young age of participants underscored the need for early intervention it seemed redundant, belying the educational level of a cohort of third-year medical students. Further research with this population might consider specific dietary patterns and levels of physical activity required in a cognitively and physically demanding occupation.

Childhood and adult socioeconomic status was found to be a predictor of midlife obesity in a cohort of white, Mexican and African American women (Salsberry & Reagan, 2009). Using data from the US National Longitudinal Survey of Youths, 1979-2002, the authors used parental education for children and own education & per capita income for adults as economic indicators. Among the 442 Mexican-American women, those with parents having less than a high school education had a higher adjusted risk of midlife obesity (OR=1.89) than those with at least a high school diploma as did those in the bottom third income level (OR=3.87). Women with less than a high school education were found at reduced risk of midlife obesity (OR=0.36). White women (n=2,090) had a higher adjusted risk of midlife obesity when using low parental education (OR=1.52), but there was no effect from own education. Low (OR=1.74) and middle (OR=1.42) income adults had a significantly higher risk of midlife obesity than the top income group. There were no significant adjusted risk factors among African-American (n=1,195) women (Salsberry & Reagan, 2009).

The apparent protective effect (OR=0.36) of low educational level found in Mexican-American women was curious. Further examination of the data revealed an increasing risk of obesity associated with nativity. Women whose parents were born in the United States were more likely to have midlife obesity than first generation, which in turn had a higher risk than immigrants. This may be a sign of acculturation as well as an indictment of the American diet. Low sample size, especially Mexican-American women in addition to the reliance of self-reported data limits this study (Salsberry & Reagan, 2009).

Socioeconomic and educational status was found to be a predictor of overweight and obesity in Demographic and Health Surveys of seven Sub-Saharan African countries between 1992 and 2005. Two surveys were completed in each of the seven indicator countries with a minimum of ten years between them (Ziraba, Fotso, & Ochako, 2009). Using the dependent variable BMI (not overweight/obese, overweight, obese) and the predictor variables time between surveys, education, and household wealth, the prevalence of overweight & obesity increased 35% among urban females over the survey period. The increase was most significant among the poorest demographic (50%) and least educated (45-50%) lowest among the wealthiest (+7%) and most educated (-10%).

Using multivariate analysis, the prevalence of overweight and obese increased between surveys in urban areas (OR=1.05, $p<0.01$) resulting in a 5% annual increase. Women from the wealthiest demographic (OR=3.20, $p<0.01$) as well as those with secondary or higher education (OR=1.59, $p<0.05$) were more likely to be overweight/obese than their poorest and less educated counterparts. Working women demonstrated a higher risk than non-working women as well (OR=1.13, $p<0.01$), (Ziraba et al., 2009).

The results of this study indicate that overweight and obesity are increasing among urban areas in Sub-Saharan Africa. Working, better educated, and women of higher socioeconomic class are at greater risk of obesity than their non-working, less educated, and lower socioeconomic class peers. This calls for further research including measures of dietary quality and physical activity as women shown to be at greater risk may be consuming diets composed of more refined and energy-dense foods and engaged in less physical activity. The inherent limitations of a cross-sectional study aside, the inclusion of males and a more precise definition of urban/rural may have increased the validity of the study.

The results of these studies indicate that demographic characteristics such as age, sex, education, socioeconomic status (SES), and geographic residence play significant roles in the risk of overweight and obesity. The relevance of demographics to this study is that its components provide a foundation for behaviors leading to dietary quality and food frequency. The decision to pursue a vegetarian or vegan lifestyle cannot be a hasty one and requires information and resources. Demographic characteristics such as SES, education, and geographic residence influence the knowledge and resources required to effect significant behavior change such as the decision to adopt a vegetarian or vegan lifestyle.

Psychosocial Factors

Recent research indicates that psychosocial elements may play a role in the prevalence of overweight and obesity. Factors such as stress, depression, family support, and anxiety may set the stage for impulsive eating. So called “comfort” foods tend to be energy-dense, high in sugars, lipids, and salt. A cross-sectional survey of 274 women over the age of 18, almost 48% of which were obese by BMI, found varying levels of association between family support and the risk of obesity. The prevalence of obesity among respondents was moderately associated with a lack of parental ((p=0.0542) and spousal (p=0.1607) support. and significantly with a lack of support from children (p=0.0390). No significant associations were noted between anxiety (p=0.6064), depression (*p*=0.1944), nor stress from parents (*p*=0.0988), spouse (*p*=0.8084), or children (*p*=0.1285), (Rohrer & Rohland, 2004).

Demographic variables were found to be more closely linked to the prevalence of obesity. Increasing number of individuals in the home (*p*=0.0047), decreasing levels of education (*p*=0.0060), being married (*p*=0.0183), and decreasing income levels (*p*=0.0328) were all significantly associated with obesity. Interestingly, no significant associations were noted between days of exercise per week and obesity (*p*=0.3857), perhaps owing to the relatively young age of participants (Rohrer & Rohland, 2004).

Predictor variables significant at $p < 0.10$ were included in a multiple regression analysis to assess the risk of obesity. Lack of parental support was significantly associated with obesity (AOR=2.17, *p*=0.0420) as was living in homes with four or more (AOR=4.05, *p*=0.0089). Falling within $10,000 to $20,000 was protective (AOR=0.4864, *p*=0.0267) compared to women in the < $10,000 income category (Rohrer & Rohland, 2004).

Despite the limitations inherent in the cross-sectional design using a convenience sample of younger women only, the results are compelling enough to warrant further research. The complexity of the psychosocial landscape adds to the difficulty of isolating independent risk factors for both adult and childhood obesity.

Recent research indicates there may be an association between several childhood psychosocial and physical factors and the risk of obesity. A 2002 telephone survey measured the pediatric health-related quality of life (HRQoL) of 5,503 male and female children and adolescents age 3 -18. The questionnaire included items addressing physical and emotional well-being, self-esteem, family, friends, social contacts, and school. Lower QoL scores were significantly associated with being overweight (P=0.008) as were low self-esteem (p=0.001) and fewer social contacts (p=0.05). Children with a family history of diabetes (p=0.014) and those having received a diagnosis of diabetes (p=0.03) also exhibited lower QoL scores. Children exhibiting symptoms of hyperglycemia were more likely to be perceived as unhealthy by their parents (p<0.001). These results indicate that overweight and hyperglycemic children may be at greater risk for overweight and obesity (Arif & Rohrer, 2006).

Psychosocial factors such as family support, depression, stress, and anxiety set the environment for behaviors such as dietary quality. Many people over-consume energy dense foods as a coping mechanism for the stressors of daily life. The results of the studies addressed in this section demonstrate that emotional and physical well-being is significantly associated with the risk of overweight and obesity.

Lifestyle Choices

Several studies evaluated the role of a healthy lifestyle behaviors such as low BMI, non-smoking, physical activity, and healthy dietary choices as protective against overweight and obesity chronic diseases. A recent cross-sectional survey study examined the role of lifestyle behaviors in minimizing the prevalence of hypertension and dyslipidaemia. Low-risk groups were defined by having a BMI $\leq$ 25 kg/m^2, waist-to-hip (WHR) ratio of <0.85 for women and <0.90 for men, never smoking, moderate to high levels of exercise, light alcohol consumption (3.5-7 units per day, unit=12g alcohol) and a healthy diet. A strongly significant inverse association was found between these protective factors and a diminished risk of hypertension and dyslipidaemia. Individuals with a BMI ≤ 25 kg/m^2 had a significantly lower risk of hypertension (OR=0.40, $p<0.001$) and dyslipidemia (OR=0.32, $p<0.01$). Participants with low WHR demonstrated a significantly lower risk of hypertension (OR=0.32, $p<0.01$) and dyslipidemia (OR=0.48, $p<0.01$), (Villegas, Kearney, & Perry, 2008).

The results of this study support prior research demonstrating that healthy dietary choices can play a significant role in the prevention of chronic diseases such as hypertension and dyslipidemia. It is critical to employ healthy eating patterns at an early age as chronic health disorders can become evident at a relatively early age. Stray-Pedersen et al., (2009) found a significant association between overweight and obesity and the risk of systolic and diastolic hypertension in 2,156 Norwegian and 669 Argentinean adolescent girls, age 15-18. The authors noted odds ratios of 28.3 and 11.4 for systolic hypertension in the obese Norwegian and Argentinean cohorts respectively.

Liebman et al., (2003) used a cross-sectional survey to assess the relationship between BMI and lifestyle factors such as eating patterns, dietary intake, and physical activity. The authors used data from a total of 928 males and 889 females, aged 18-99, living in rural communities throughout Wyoming, Idaho, and Montana that participated in the Wellness IN the Rockies project. While age was not a significant predictor of the risk of overweight or obesity, males (70%) were significantly more overweight ($p=0.0001$) but not obese ($p=0.22$) as compared to females (59%). Both males and females were found to be at significantly greater risk for overweight (BMI ≥ 25 kg/m^2) & obesity (BMI ≥ 30 kg/m^2) when consuming sweetened beverages ($p=0.0006$; $p=0.0143$), watching television (*p*=0.0050; *p*=0.0017), and the self-assessment of need for increased physical activity (*p*=0.001; *p*=0.0001). Significant associations were also noted between obesity and ordering supersized portions (*p*=0.0035), eating while engaged in other activities (*p*=0.0003), and response to a composite of energy-belief questions (*p*=0.0116).

The prevalence of overweight and obesity found in this study of rural populations in the western US are slightly higher than those found in the NHANES III and the 2000 BRFSS study. This may be due in part to the smaller sample size and the use of self-reported height and weight. Results are consistent with other studies implicating consumption of energy-dense foods coupled with decreased physical activity (Liebman et al., 2003).

The Contribution of Diet to Overweight & Obesity

Accessibility

A primary contributor to the current epidemic in overweight and obesity is the theory that human hunger and appetite regulation has yet to catch up with the ever expanding accessibility of energy-dense food. While the way the body processes food has not changed over the past 100+ years, diet has changed dramatically due to the over abundance of inexpensive, highly processed foods. The Paleolithic Diet was rich in fiber and contained very little sugar, sodium, or saturated fat. While little milk was available for consumption, the Paleolithic Diet was rich in calcium due to the ingestion of calcium rich vegetables. Major changes in dietary practices occurred in the early 20th Century with the advent of “sandwich shops” to meet the needs of working men and women. The increased production of processed foods to save time in the kitchen, improved food transport, refrigeration, and the cyclical view of which foods and food groups were "healthy" has changed the dietary landscape significantly.

In a review of dietary contributors to obesity, Drewnowski (2007) linked the current epidemic of overweight and obesity primarily to the increased availability and consumption of low-cost foods. These energy dense items tend to be high in refined grains, sugars, salt and fats which are inexpensive, convenient, and satisfying to the palate. Based upon disappearance trends, the per capita availability of refined flour and cereals increased 48% between 1974 and 2000. Added fats and oils reached a high of 77 pounds per capita in 2000, a 38% increase over 1974. Caloric sweeteners spiked from 124 to 149 pounds (20%) per capita while cane and beet sugar declined by 35% during the same period. Consumption of corn sweeteners such as HFCS increased by 277% (Putnam, Allshouse, & Kantor, 2002).

These figures lie in sharp contrast to the availability of fresh fruit and juices which declined to 1.4 servings per day in 2000. Vegetables supplied 3.8 daily servings, half of which was accounted for by fresh and frozen potatoes (French fries), potato chips, canned tomatoes, and iceberg lettuce. Dark green and deep yellow vegetables accounted for 0.4% servings per day (Putnam et al., 2002; Johnson, Taylor, & Hampl, 2000).

Changes in agricultural production have led to the widespread use of HFCS. Based upon food consumption tables maintained by the US Department of Agriculture (USDA), consumption of HFCS increased 1000% between 1970 and 1990. This represents the largest increase of any food or food group during this period. High fructose corn syrup accounts for 40% of all caloric sweeteners used in foods and beverages and is the sole sweetener used in soda. This translates into an average of 132 kcal per day for all Americans over the age of two. The increase in HFCS has mirrored increases in overweight and obesity. HFCS is metabolized differently by the body than other popular sweeteners. Unlike sucrose and glucose, HFCS does not stimulate the secretion of insulin or the production of leptin. Both are believed to strongly influence food intake (Bray, Nielsen, & Popkin, 2004).

While it is likely that HFCS leads to weight gain, the impact of HCFS on global obesity is no different from that of fats, proteins, alcohol and other carbohydrates. The similar composition and metabolization to other sugars such as sucrose, glucose, honey, and fruit juice concentrate make it difficult to single out HFCS. Increased caloric intake since 1970 was due to increased consumption of all energy nutrients, in particular fats, flour, and cereals, not HFCS. It is difficult to implicate HFCS in global overweight and obesity. HCFS and sucrose are consumed in equal amounts in the US, but HFCS accounts for less than 10% of sugars worldwide. Per capita consumption of HFCS has recently declined slightly while obesity has not (White, 2008).

Some argue that over-consumption, not HFCS, is the primary culprit in the overweight and obesity epidemic. Overweight and obesity are multifactorial conditions influenced by numerous independent variables. Dietary contributors alone are numerous and to single out a lone component such as HFCS over-simplifies the issue. Since the acidity of soda hydrolyzes most of the sucrose to fructose in the can, the amount of glucose and fructose metabolized is the same for sucrose and HFCS. While soda has played a major role in the overweight and obesity epidemic (Raben et al., 2002), it is the dramatic increases in the availability and serving sizes of soft drinks that are causal (Jacobson, 2004).

Farley, Baker, Futrell, & Rice (2010) found widespread availability of energy-dense snack foods during a 19 city survey of 1,082 retail stores whose primary focus was not food. The authors found snack food available at 41% of all stores including 96% of pharmacies, 94% of service stations, 22% of furniture stores, and 16% of apparel stores. The most common snack foods were candy (33%), sweetened beverages (20%), salty snacks (17%) and baked goods (12%). No significant differences in the availability of these foods were noted along socioeconomic or racial lines.

The increasing availability of energy-dense, low-cost food has mirrored the increase in the amount of food consumed outside of the home over the past several decades. Recent research has demonstrated that the consumption of food outside the home has increased significantly over the past several decades. Using data from the USDA nationwide survey of food consumption, Guthrie, Lin, & Frazao (2002) found the total calories from food prepared outside the home increased from 18 to 32% ($p<0.01$) from 1977-78 (n=17,752) to 1994-96 (n=10,039). Consumption of food from so-called fast-food restaurants increased from 2 to 10% of total caloric intake.

Historically associated with Western cultures, the availability of energy-dense foods outside of the home environment continues to spread across the globe as it follows accelerating economies. Much of the developing world is experiencing dramatic increases in the rate of overweight and obesity as fast-foods associated with Western culture infiltrate the food choices and eating habits of the developing world (Ziraba, Fotso, & Ochako, 2009).

Recent research demonstrated a significant inverse association between BMI (*p*=0.005) and visceral fat level (VFL), (*p*=0.007) and the frequency of eating with family. Similar inverse associations were noted between BMI and the consumption of snacks (*p*=0.018) and VFL and the consumption of dates (*p*=0.013) in 357 male college students (age 18-24) in the Kingdom of Saudi Arabia. The self-reported questionnaire found 22% of student's overweight and 16% obese. The infrequent consumption of fruits (32%) and vegetables (36%) was common with the exception of dates (61%), (Al-Rethaiaa, Fahmy, & Al-Shwaiyat, 2010). The results of this study correlated with those from other middle eastern countries (Yahia, Achkar, Abdallah, & Rizk, 2008; Musaiger, Lloyd, Al-Neyadi, & Bener, 2003).

With the ubiquity of fast-food restaurants, these numbers can only be expected to grow. According to the Nutrition, Health and Nutrition Examination Survey (NHANES, 2010), the percentage of daily calories consumed outside the home by adults age 20 and older reached 37% in 2008. In an effort to address this growing problem, many public health departments have considered mandating the posting of caloric information at establishments whose primary business is the production and serving of food. The idea behind this strategy is that individuals are less likely to consume energy-dense foods away from than at home when confronted with the caloric cost. In 2006, New York City passed such a mandate and now requires all establishments serving food to include calorie contents in their menus.

Recent research implies that the public may not be ready to take advantage of this legislation and actually access nutritional information. Roberto, Agnew, & Brownell, (2009) observed 1,501 individuals entering a McDonalds, 482 entering a Burger King,1,671 an Au Bon Pain restaurant, and 657 a Starbucks in New York City and suburban Connecticut. Nutritional information was displayed on a wall poster in McDonalds and Burger King, a pamphlet at Starbucks, and a self-service computer at Au Bon Pain. The authors observed two of 1,501 in McDonalds (0.6%), three of 482 in Burger King (0.6%), one of 1,671 in Au Bon Pain (0.06%), and none of the 657 in Starbucks accessing the nutritional information for a total of six of the 4,311 (0.1%) observations (Roberto et al., 2009).

While it is possible some individuals accessed this information online prior to entering the restaurant, these results are troubling. Many people underestimate the caloric content of their meals especially in fast-food restaurants. A recent randomized survey study demonstrated that access to nutritional information may be beneficial in reducing the consumption of energy-dense foods (Roberto, Larsen, Agnew, Baik, & Brownell, 2010). A total of 303 participants were randomly assigned to one of three groups in a study meal. One group was assigned a menu with no calorie content (n=96), one group was given menus with the calorie content (n=97) and the third group was supplied with caloric content as well as the recommended daily caloric intake (RDA) for adults (n=110).

A significant difference was noted between the number of calories ordered between the no caloric information and a combination of the two groups given nutritional information (*p*=0.04). Comparisons between the no information group and both groups given the caloric content also produced significant results when treated individually (*p*=0.03). No significant differences were noted in comparisons between the two groups given nutritional information. While no significant difference was noted for calories consumed when comparing the groups individually (*p*=0.12), results were significant when combining the two groups provided with caloric content (*p*=0.04). The results of this study imply that individuals will order and consume fewer calories when confronted with the caloric content of their choices (Roberto et al., 2010).

Another issue relating to food choices is the accessibility of healthier food choices. A survey study comparing food options between less (n=348) and more affluent (n=311) areas of Los Angeles County, California found restaurants located in affluent areas (1 restaurant per 542 residents) demonstrated significant differences in access to healthier food choices (*p*<0.001), health promotions (*p*<0.001), labeling (*p*<0.05), and nutritional information (*p*<0.05) than those in lower socioeconomic regions (1 restaurant per 1911 residents). While the results of this study need to be replicated across numerous geographic regions, they indicate the environment plays a significant role in the accessibility of healthier dietary choices (Lewis et al., 2005).

The availability of energy-dense foods is of special concern to individuals having difficulty controlling the quantity of food they consume. Overweight and obesity is in part due to uncontrolled eating in regions where food is readily accessible and inexpensive. A random sample of 944 primary care patients found 47% of respondents reported uncontrolled eating, 42.2% of which were obese by BMI. Over 70% of obese patients and 37% of normal weight individuals admitted having at least some difficulty controlling their eating. Only 9.4% of those reporting no difficulties with uncontrolled eating were found to be obese by BMI. Over 27% of non-obese individuals reported no difficulties controlling consumption while 9.4% of obese patients reported the same. Patients having some or no control over food consumption demonstrated a strong independent association with obesity (OR=6.67, p=0.000), (Rohrer, Vickers-Douglas, & Stroebel, 2009).

Energy dense, or diets composed primarily of fats, refined sugars and grains cost less than diets high in fruit and vegetables. Energy density and energy cost are inversely related. Drewnowski, Darmon, and Briend (2004) used the Val-de-Marne dietary survey in a study of 837 adult males (361) and women (476) in France. Participants were divided into quintiles of energy intake. Increases in the intake of fats and sucrose (grams/day) increased diet but decreased energy costs when controlling for energy intake. Conversely, increases in the daily consumption of fruits and vegetables produced an increase in diet and energy costs when adjusted for energy intake, gender, and age.

Individuals consuming the highest amount of fats and sucrose (grams/day) consumed more energy and had higher diet costs (5.90 Euros per day (EPD)) than those in the lowest consumption group (4.37 EPD; $p<0.001$). However, after controlling for energy intake significant changes in energy cost were noted. Energy costs associated with the highest fat/sucrose quintile energy decreased to 5.2 EPD while the energy costs of the lowest fat/sucrose quintile increased to 7.59 EPD ($p<0.001$). Lower energy costs were also associated with high fat ($p<0.001$) and high sucrose ($p<0.001$) individually.

Individuals in the highest quintile of fruit and vegetable consumption had the highest dietary (5.95 EPD) and energy (6.62 EPD) costs of any of the groups studied ($p<0.001$). Regression models reveal that each 100 gram increase in fats and sugars yields net savings of 0.40 Euros per day. Conversely, fruit and vegetable consumption was associated with a 0.18 – 0.29 Euros per day increase in food costs (Drewnowski et al., 2004).

As the previous studies illustrate, accessibility to energy-dense foods is a primary contributor to the epidemic of overweight and obesity across the globe. The constant bombardment of fast food restaurants as one drives a typical main drag tests the strongest of willpowers, especially with the recent expansion of breakfast foods. The adoption of a vegetarian, or more significantly, a vegan diet ostensibly limits dietary choices, quickly eliminating all but a few restaurants as many energy-dense foods are anathema to these diets. However, some animal products such as dairy and eggs are components of the vegetarian but not the vegan landscape. This is critical to the focus of this study as the presence or absence of items such as cheese and eggs may spell the difference in the risk of overweight and obesity between the two lifestyles.

Preparation

Food preparation cannot be overlooked when assessing the contribution of diet to overweight and obesity. Certain foods such as chicken and fish can be prepared in a way that enhances or diminishes fat content. Cultural practices may promote unhealthy eating behaviors by influencing the way certain foods are prepared and cooked. Weinrich et al., (2007) examined the association between obesity and the dietary consumption of fats, vegetables, and fruits in a cohort of 204 African-American males residing in the Southern United States. The authors administered the Brief Dietary Scale for Selected Food Intake and Preparation to individuals between the ages of 40 and 70 attending a prostate cancer education and screening program. Cross-sectional, self-reported dietary consumption collected data on food frequency intake of fat, fruit, and vegetables as well as height and weight.

Thirty-four percent of respondents were overweight and 47% were obese. Many men reported consuming fried chicken (81%) and fish (67%) and one-third always left the skin on when preparing chicken. Most used butter on their bread (79%) or grits (92%), and 19% ate vegetables cooked with butter and the majority used regular salad dressing (71%) while 32% used butter, margarine, or sour cream on potatoes. Interestingly, 62% consumed low-fat cheese and 70% used low-fat or skim milk. However, few ate cooked vegetables with dinner (29%) or lunch (16%) and fruit consumption was mostly limited to snacking (77%) but fruit juice intake was high (90%) (Weinrich et al., 2007).

Leaving the skin on chicken (p=0.03), intake of low-fat or skim milk (p=0.02), and cooking vegetables with butter (p=0.03) were significantly associated with BMI. No significant differences were noted between normal weight and obese men in the consumption of fried potatoes (p=0.15) but the consumption of baked, boiled, or mashed potatoes was significantly higher (p=0.03) among the overweight and obese. Daily consumption of fruit was inversely associated with overweight and obesity (p<0.01), (Weinrich et al., 2007).

The surprising association between overweight and obesity and the consumption of low-fat or skim milk was submitted to logistic regression analysis. Many (86%) of the obese men reported changes in their diet over the past year. Regression analysis demonstrated that dietary change is a significant predictor or drinking skim milk (p=0.0013). The addition of BMI to the analysis revealed that categories of BMI are not significant predictors of skim milk consumption however changes in diet remained significant (p=0.003). Despite its limitations, the results of this study imply simple changes in dietary preparation and consumption can have a significant impact on the risk of overweight and obesity (Weinrich et al., 2007).

Food prepared outside of the home often consists of energy-dense foods higher than at-home foods in total calories, total and saturated fat. While total fat consumption from all sources declined from 41.8% in 1977-78 to 33.6% in the 1994-96 survey, total fat as a percentage of daily calories was 37.7% in foods prepared outside the home compared to 31.6% in home foods (p<0.01). Saturated fat composed 12.4% of “outside” calories compared to 10.7% at home. Food prepared outside the home contained significantly less fiber (6.4 v 8.6 g/kcal, p<0.01), calcium (307 v 403 mg/1000kcal, p<0.01) and iron density (6.3 v 8.3 mg/kcal, p<0.01) than food prepared in the home (Guthrie, Lin, & Frazao, 2002).

Alcohol

The consumption of alcoholic beverages is generally considered to increase the BMI. Alcohol provides seven kilocalories/kg of energy, some of which is absorbed directly through the stomach. This results in calories from energy-dense foods being stored as fat. However, other studies have indicated that moderate alcohol consumption may be protective against the risk of overweight and obesity (Arif & Rohrer, 2005; Rohrer, Rohland, Denison, & Way, 2005).

Using data from the National Health & Nutrition Examination Survey, Arif & Rohrer (2005) found the odds of obesity was 0.73 for current drinkers ($\leq$2 drinks/day) when compared to non-drinkers in a sample of 8,236 non-smoking respondents. Those consuming three drinks per day had a higher risk of both overweight (OR=1.40) and obesity (OR=1.07) as did those consuming four (OR=1.30 & 1.46). Individuals consuming one or two drinks per day had a diminished risk of both overweight (OR=0.71 & 0.46) and obesity (OR=0.83 & 0.59) respectively. Those engaged in binge drinking had a significantly higher risk of overweight (OR=1.45) and obesity (OR=1.77) as well. Consumption of less than five drinks per week resulted in a reduced risk of obesity (OR=0.62) as compared to non-drinkers.

Similar results were found in a cross-sectional convenience sample of 747 respondents from three community medicine clinics. The number of days consuming alcohol (p=0.001) and drinks (p=0.010) per month were inversely associated with obesity. Individuals consuming alcohol three or more days per month demonstrated a significantly decreased risk of obesity (OR=0.49, p=0.037) than non-drinkers. Even binge and daily drinkers were less likely to be obese (Rohrer et al., 2005).

The results of both studies indicate that moderate alcohol consumption may be protective against overweight and obesity although neither demonstrates cause and effect.

Supportive research in additional settings may reveal additional covariates acting independently or in concert with alcohol to reduce the risk of overweight and obesity.

The type and frequency of alcohol consumption does not significantly differ between omnivorous and vegetarian diets. However, it may play a role in the focus of this study. While many types of alcohol are vegan, many beers utilize animal products such as honey and gelatin as part of the production process. Some wine clarifiers are animal based such as egg whites, casein (milk protein), gelatin and isinglass, which is derived from the bladder of the sturgeon (Vegetarian Resource Group, 2010). This could potentially impact the amount of alcohol consumed by vegans especially out of the home environment.

The Vegetarian and Vegan Lifestyle

The ubiquity of fad diets has resulted in few long-term success stories. Society's obsession with weight loss has given rise to innumerable quick fix weight loss programs. Many of these diets actually do succeed in reducing the risk of overweight and obesity provided they are strictly adhered to and include physical activity (Thomas, Hyde, Karunaratne, Kausman, & Komesaroff, 2008; Malinauskas, Raedeke, Aeby, Smith, & Dallas, 2006). The default problem lies in the term "diet" itself, suggesting an endpoint and short-term fix. Regardless of the diet's efficacy, the dieter will eventually revert to prior dietary patterns and return to or exceed pre-diet BMI.

A long-term reduction in BMI requires a paradigm change from the prevailing "magic bullet" mentality of Western culture to one of a lifetime behavior change. This generally requires a nontraditional approach that by definition requires more energy and effort to deviate from societal norms. Numerous recent studies have found a decreased risk of overweight and obesity associated with adherence to nontraditional lifestyle choices such as the Mediterranean diet (Schroder, Marrugat, Vila, Covas, & Elosua, 2004), and vegetarian and vegan diets (Haddad & Tanzman, 2003; Newby, Tucker, & Wolk, 2005; Jenkins et al., 2003; Barnard et al., 2006; Tonstad, Butler, Yan, & Fraser, 2009). The final component of the literature search focused on current research evaluating the impact of vegetarian and vegan diets on the risk of overweight and obesity and associated health risks.

In a meta-analysis of vegetarian diet studies, Sabate & Wien (2010) found an average reduction in weight among adult males (7.6 kg) and females (3.3 kg) for those practicing vegetarian versus omnivore diets. This translated into an average decline of 2 kg/m^2 in BMI among vegetarians. The study revealed similar reductions in BMI among children, increasing with adolescence.

Using 1993 – 1999 survey data from 37, 875 healthy males and females, aged 20-97, participating in the European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford), Spencer, Appleby, Davey, & Key (2003) found significant differences in the BMI of four diet groups. The mean BMI of both men (24.49 kg/m^2) and women (23.69 kg/m^2) meat-eaters were significantly higher than male (22.34 kg/m2) and female (21.75 kg/m2) vegans ($p<0.01$). The difference in mean BMI was reduced, but remained significant when adjusting for lifestyle factors such as such as smoking, physical activity, education, physical activity, etc. Dietary factors most associated with increasing BMI were high protein (% calories) and low fiber. Mean BMI for male (23.29 kg/m2) and female (22.60 kg/m^2) fish-eaters as well as male (23.28 kg/m^2) and female (22.51kg/m^2) vegetarians was significantly higher than vegans and significantly lower than meat-eaters (p=0.01) when adjusted for age and lifestyle factors. No significant differences were noted between the adjusted mean BMI of fish-eaters and vegetarians in either sex.

The results of this study are consistent with others measuring the association between diet and BMI and encourage further study in non-European populations. The sample size adds to internal validity, especially vegans (n=570 males, 983 females). The choice of "fish-eaters" as a separate category from "meat-eaters" is somewhat curious as it implies that fish is somehow independent of other animal products such as beef, poultry, dairy products, and eggs. Less of an issue was the classification of "white" as an ethnicity.

In a similar study using EPIC-Oxford data, Rosell, Appleby, & Key (2004) found no significant difference between the mean weight or BMI of male or female lifelong vegetarians versus those becoming vegetarian at or after age 20 (p=0.07). A total of 10,000 men and 36,000 women included 4,008 and 12,075 vegetarian men and women respectively were included in the study designed to assess the risk of overweight and obesity associated with length of time employing a vegetarian diet.

Males adopting the vegetarian diet between ages 1-9 and non-vegetarians were an average of 3.2 kg ($p<0.05$) and 3.0 kg ($p<0.001$) heavier than those becoming vegetarian $\geq$ 20. This trend was also apparent in BMI with corresponding differences of 1.2 kg/m^2 ($p<0.01$) and 0.9 kg/m^2 ($p<0.001$) respectively. Mean body weight of females was significantly higher in those becoming vegetarian between ages 1-9 (+1.5 kg; $p<0.05$), ages 10-14 (+1.0 kg; $p<0.05$), and omnivorous women (+2.2kg; $p<0.001$). The same applied to BMI for those becoming vegetarian between ages 1-9 (+0.3 kg/m^2; $p<0.01$) as well as non-vegetarians (+0.7 kg/m^2; $p<0.001$).

The results of this study are useful for those questioning the efficacy of adopting a vegetarian diet from birth. Many have demonstrated concern over whether vegetarian diets provide adequate nutrients for proper development during childhood. Assuming the decision is based upon adequate nutrition versus the decreased risk of overweight and obesity, the results provide some insight into the latter. As with the prior study (Spencer, Appleby, Davey, & Key, 2003), the authors chose to place the consumption of fish in a separate category from "meat-eaters". Vegans were combined with vegetarians due to the small sample of lifelong vegans (n=2).

The Continuing Survey of Food Intake by Individuals (CSFII) compared the dietary patterns of 13,313 participants (age $\geq$ 6) self-identified as vegetarian or non-vegetarian. Both groups were further identified as "ate meat" or "no meat." A total of 334 (2.5%) self-identified as vegetarian, 120 (36%) of which ate no meat and 12,979 (97.5%) as non-vegetarian, 436 (3.4%) of which ate no meat (Haddad & Tanzman, 2003).

The CSFII survey revealed that self-defined vegetarians $\geq$ age 20 had significantly lower BMI and energy intake ($p<0.001$) than self-identified non-vegetarians that ate meat independent of meat consumption. The mean BMI of participants age $\geq$ 20 self-identified as non-vegetarian was 26.1 and 25.6 kg/m^2 for meat and non-meat consumers respectively. Mean BMI for self-identified vegetarians in the same age group was 23.9 for meat and 22.8 kg/m^2 for no-meat eaters (Haddad & Tanzman, 2003).

The Adventist Health Study of 2002-2006 distributed food frequency questionnaires to 22,434 men and 38,469 women $\geq$ age 30 across North America to measure the association between diet, body weight, and the prevalence of type 2 diabetes. The results of the 50 page questionnaire demonstrated significant differences between the BMI and risk of type 2 diabetes between omnivores and several classifications of vegetarians. Mean BMI of vegan (23.6), lacto-ovo vegetarian (25.7), pesco-vegetarian (26.3), semi-vegetarian (27.3), and non-vegetarian (28.8) revealed a significant, positive trend (p<0.0001). The prevalence of type 2 diabetes increased incrementally across dietary patterns and BMI. Type 2 diabetes prevalence rates for BMI $\geq$ 30 kg/m^2 and BMI < 30 kg/m^2 respectively for vegan (8.0, 2.0), lacto-ovo vegetarian (9.4, 2.1), pesco-vegetarian (10.4, 3.3), semi-vegetarian (11.4, 3.7), and non-vegetarian (13.8, 4.6), (p<0.0001), (Tonstad, Butler, Yan, & Fraser, 2009).

All vegetarian diets were protective of type 2 diabetes when compared to the non-vegetarian diet for vegan (OR=0.51), lacto-ovo vegetarians (OR=0.54), pesco-vegetarians (0.70), and semi-vegetarians (0.76) when adjusted for several demographic and socioeconomic factors including BMI. The risk factor declined further when BMI was eliminated for vegan (OR=0.32), lacto-ovo vegetarians (OR=0.43), pesco-vegetarians (0.56), and semi-vegetarians (0.69). Despite questionable generalizability and failure to account for physical activity the results of this study correspond to other studies assessing the association between diet, BMI, and risk of type 2 diabetes (Tonstad et al., 2009).

Several recent studies have demonstrated an inverse relationship between BMI and a vegetarian or vegan diet (Newby & Tucker, 2004; Togo, Osler, Sorenson, &

Heitmann, 2001). Using 1987-1990 data from the Swedish Mammography Study, Newby, Tucker, & Wolk (2005) found significantly lower prevalence rates and risk of overweight and obesity in a cross-sectional study of 55, 459 women. Participants born between 1914 and 1948 completed a six-page questionnaire addressing anthropometric, reproductive, sociodemographic and dietary factors using a 67 item food frequency. Respondents self-identified as omnivorous (n=54,257), semi-vegetarian (n=960; ovo, lacto-vegetarian, dairy & fish), lacto-vegetarian (n=159; dairy only), or vegan (83); no meat, eggs or dairy).

Omnivorous women were significantly heavier (66.9 kg) with significantly higher BMI (24.7 kg/m^2) than any of the three vegetarian groups ($p<0.05$). Prevalence rates for overweight and obesity (BMI ≥ 25 kg/m^2) were 40%, 29%, and 25% for omnivore, semi-vegetarian and vegan, and lacto-vegetarian. Omnivores demonstrated significantly higher energy ($p<0.005$) and protein ($p< 0.0003$) intakes and significantly lower carbohydrate intakes ($p< 0.001$) compared to all three vegetarian groups respectively (Newby et al., 2005).

Multivariate, adjusted, linear regression analysis revealed significantly lower BMI for semi-vegetarian ($p<0.005$), lacto-vegetarian ($p< 0.005$) and vegan ($p< 0.005$) than omnivores. Vegans weighed the least compared to omnivores ($p< 0.005$). All three vegetarian diets were protective of overweight and obesity with OR = 0.35, 0.52, & 0.54 for vegan, semi-vegetarian, and lacto-vegetarian respectively when compared to omnivores (Newby et al., 2005).

The results of this study substantiate the reduced risk of overweight and obesity associated with plant-based diets in a cross-section of healthy women between the ages of 57 and 91 in Sweden. As noted by the authors, the advanced ages of participants made it less likely they had adopted a non-traditional diet for weight loss. While the study population is representative of other western-style cultures the small sample sizes of semi-vegetarian (1.73%), lacto-vegetarian (0.29%), and vegan (0.15%), (Newby et al., 2005) may limit generalizability. Further study should seek larger samples of vegetarian and vegan as well as the inclusion of younger and male participants.

Summary of Research Methods

Studies measuring the association between dietary intake and food frequency and the risk of overweight and obesity employed the cross-sectional, survey design using energy intake and food frequency questionnaires. Most utilized retrospective data from large-scale health studies such as the European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford), Swedish Mammography Study, Continuing Survey of Food Intake by Individuals (CSFII), and the Adventist Health Study. Prospective studies utilized modified versions of diet quality and food frequency questionnaires such as the Behavioral Risk Factor Surveillance Survey (BRFSS). The advantage of using retrospective data from large health studies was access to large sample sizes over extended periods of time. This was particularly critical in achieving adequate samples of vegans. Incomplete surveys were eliminated from analysis as were those considered to contain unreliable data.

Studies relied on self-reported data with respect to BMI, calculated by dividing weight by height after converting height to m^2 and weight to kg. Diet classifications showed some variability in particular with respect to vegetarians. Some used omnivores, vegans, and semi-, and ovo-lacto-vegetarians (Newby, Tucker, & Wolk, 2005), while others chose to separate fish from other animal products arriving at meat-eaters, fish-eaters, vegetarians, and vegans (Spencer, Appleby, Davey, & Key, 2003; Rosell, Appleby, & Key, 2005). The standardization of vegetarian classifications may be useful in establishing the validity of studies going forward.

Covariates included diet quality, food frequency, and time in diet, age, height, weight, education, marital status, SES, physical activity, smoking, alcohol consumption, and parity. Statistical analysis was comprised of means and standard deviations (SD) for continuous variables and frequencies using Tukey's honestly significant differences test (Newby, Tucker, & Wolk, 2005), F and T-Tests (Rosell, Appleby, & Key, 2005) and ANOVA (Spencer, Appleby, Davey, & Key, 2003). Diet classification represented the indicator variable during linear and logistic regression. BMI and weight were outcomes analyzed separately during linear regression adjusted for age, energy intake, alcohol, education, marital status, smoking, and parity (females). Odds ratios for overweight and obese and obese alone were calculated for each diet classification using logistic regression analysis (Newby, Tucker, & Wolk, 2005).

Summary of Findings

There is no clear consensus on the most significant dietary causes of overweight and obesity. The dominant theme of the literature search points to the increase in access and consumption of low cost, energy-dense foods as the primary culprit. The reduction in total caloric intake from any source must be considered beneficial, and calories from sweetened soft drinks are a significant contributor. The health risks associated with dietary variables is very real. The unprecedented prevalence rates for CVD, type-II diabetes, metabolic diseases and other morbidities threaten to overwhelm healthcare systems across the globe.

A search of the literature found that vegetarian and vegan diets make a significant contribution to reducing the risk of overweight and obesity as well as associated health risks. However, there was a gap in this literature search assessing differences in the risk of overweight and obesity in the vegetarian versus the vegan diet in the United States. Vegetarians often replace calories normally supplied by meat products with dairy, eggs, and additional carbohydrates. The purpose of this cross-sectional survey study was to provide data on the risk of overweight and obesity in omnivorous versus vegan diets.

Chapter 3: Research Method

Introduction

This chapter will include a detailed description of a cross-sectional survey study designed to obtain diet quality and food frequency data from individuals practicing vegetarian or vegan diets. The literature search has substantiated the risk factors associated with the global increase in the prevalence of overweight and obesity and related health risks. Based upon the socio-ecological model as an impetus for altering modifiable behavioral risks, many individuals have adopted a vegetarian or vegan lifestyle in an effort to reduce their risk. The purpose of this study was to assess the risk of overweight and obesity in vegetarian versus vegan diets. This chapter will provide an overview of the research design and its limitations, study setting and sample, methods for data collection and analysis, instrumentation, ethical concerns, and the dissemination of findings.

Research Design

This study utilized the quantitative, cross-sectional, survey design to obtain data on the dietary composition and food frequency of practicing omnivores (control), semi-vegetarians, vegetarians and vegans. The primary advantage of the cross-sectional study design is that it affords a snap-shot of the prevalence of a specific dependent variable (disease) among the study population with a given independent variable(s) or exposure. In this study the dependent variables (disease) are overweight and obesity with the primary independent variables (exposure) being the diets of omnivores, semi-vegetarians,

vegetarians and vegans. Additional independent variables included demographic, psychosocial, and lifestyle factors.

The one-time cross-sectional design afforded the most practical method for obtaining prevalence data on a specific condition, in this case overweight and obesity, within a population of omnivores, semi-vegetarians, vegetarians, and vegans. It is important to note that the cross-sectional design provides only point prevalence, or the proportion of omnivores, semi-vegetarians, vegetarians, and vegans at risk of overweight and obesity at a single moment in time. The intention of this study was to provide data and analysis on association and does not purport to provide information on incidence nor evidence of causality (Checkoway, Pearce, & Kriebel, 2004).

One of the primary limitations inherent in the cross-sectional design is the susceptibility to information bias and confounding (Checkoway et al., 2004). Concerns associated with information bias are two-fold; miss-perceptions surrounding omnivorous, semi-vegetarian, vegetarian, and vegan diets and recall bias. Individuals adopt a vegetarian or vegan lifestyle for various reasons, some more in earnest than others. As a result, there is a great deal of variability regarding practical definitions, especially vegetarian, that may range from elimination of beef all the way to eliminating all animal products including gelatin and honey and everything in between. Special attention was paid to survey design in an effort to properly categorize respondents based upon self-reported diet composition and frequency. The second concern, that of recall bias stems from the ability of respondents to recall their diet history with any degree of accuracy.

As noted by McGuire & Beerman (2007), dietary assessment may be accomplished using either retrospective or prospective methods. Commonly employed retrospective approaches include the 24 hour recall and food frequency questionnaires. They are considered the most accurate assessment of food composition and frequency in theory, however, they are tedious and at high risk of recall bias during practical application. Prospective methods utilize a diet record that records dietary intake going forward, usually encompassing three, five, or seven day periods. Potentially more accurate than the retrospective design, they are also tedious and prone to respondent fatigue. In an effort to compensate for the limitations inherent in both, this study employed a retrospective approach focusing on general dietary intake and food frequency over a typical time period, e.g., "typically, how many times per month do you consume beef, poultry, and/or fish ?"

A second limitation is that the cross-sectional design lends itself to confounding in the form of selection bias. This refers to the fact that individuals with the exposure and no disease are more likely to participate in and provide accurate responses to a survey than those with the condition in question. In terms of this study, individuals with normal BMI's may have been more likely to participate in the survey than those with higher BMI's. This may have resulted in skewed data and provide an artificially low prevalence of overweight and/or obesity.

Setting & Sample

Survey studies provide an excellent opportunity to obtain prevalence data in a rapid manner. Data included in this study was obtained from practicing omnivores, semi-vegetarians, vegetarians, and vegans using an online, modified version of the Behavioral Risk Factor Surveillance System (BRFSS) survey. The population was recruited using social media outlets, the *Walden University Participant Pool*, several vegetarian and vegan society web sites, vegetarian and vegan restaurants and markets, as well as employees at *Gateway Community College,* New Haven, Connecticut.

An estimation of sample size was obtained by performing a power analysis. This essentially calculated the number of respondents necessary to detect an actual effect or to avoid a Type II Error (false negative), (Burkholder, ND). Sample size is a function of the alpha level, power level, and effect size. The alpha level corresponds to Type I Error (false positive) and is typically set at 0.05. This means there is only a 5% chance the null hypothesis will be incorrectly rejected. Beta refers to Type II Error or the probability of failing to identify a true effect (false negative). The power is equal to 1 – beta, or the probability that a statistical test will correctly reject the null hypothesis or that a real effect will be detected (Diebold, 2009). The power is often set at 0.80, meaning there is an 80% chance of detecting a true effect (Burkholder, ND).

When alpha is set at .05 and power at .80, sample size becomes a function of effect size, or the relationship or degree of significance between variables (mean difference/standard deviation). There are numerous indices to estimate effect size; however, barring prior empirical data a medium effect size may be estimated to be small (.20), medium (.50), or large (Cohen, 1992). Another strategy is to base the effect size on data from prior relevant research. A review of the literature finds a 13% effect of a vegetarian diet on the risk of obesity when compared to omnivores (Haddad & Tansman, 2003; Newby, Tucker, & Wolk, 2005). The average risk of overweight and obesity for several classes of vegetarians and vegans versus omnivores was found to be 0.52 and 0.48 respectively when adjusted for age and energy and .47 and .59 respectively using multivariate analysis.

The original research question being addressed in this study: is there a difference in the risk of overweight and obesity (DV) among various vegetarian and vegan diets (IV) required revision due to a lack of power secondary to inadequate sample size. The amended research question became: is there a difference in the odds of overweight and obesity (DV) between omnivorous and vegan diets.

The term vegetarian has taken on many degrees of rationalization but the data was limited to five categories (vegan, ovo- vegetarian, lacto-vegetarian, ovo-lacto vegetarian, and semi-vegetarian). Due to limited sample sizes, the ovo-(7), lacto-(15), and ovo-lacto-vegetarian (50) groups were combined to form one category known as vegetarians (87). Semi-vegetarians were defined as respondents consuming no beef, occasional poultry and fish (≤ 5x's per month each), and unlimited dairy and/or eggs.

Since the research question essentially seeks the strength of the relationship between continuous variables, descriptive data included means, standard deviation, bivariate analysis (chi square), multivariate, and reduced multiple logistic regression analysis. The sample size was large enough to accommodate both bivariate and multivariate regression analysis which often requires a larger sample (Rudestam & Newton, 2007).

Based upon alpha = 0.05, power = 0.80 and an average effect size of 13, the sample size should have been a total of 432 survey respondents (Newby, Tucker, & Wolk, 2005; Table 1). Using an average odds ratio of .59, the total sample size should have been 542 (Haddad & Tanzman, 2003; Table 1). These calculations represented an average total sample size of 487 (Table 1) or approximately 122 individuals for each of the four classifications.

Table 1

Sample size calculation using average of 13% exposed & unexposed with outcome (Newby, Tucker, & Wolk, 2005) and using odds ratio of 0.59 (multivariate adjusted), (Haddad & Tanzman, 2003).

Sample Size Calculation for Cross-Sectional Study

Parameter	Based upon predicted % exposed/unexposed with outcome	Based upon predicted odds ratio
Two-sided significance level(1-alpha):	95	95
Power(1-beta, % chance of detecting):	80	80
Ratio of sample size, Unexposed/Exposed:	1	1
Percent of Unexposed with Outcome:	**40**	40
Percent of Exposed with Outcome:	**27**	28
Odds Ratio:	0.55	**0.59**
Sample Size	432	542
Average Sample Size	**487**	

Voluntary participants were limited to adults age 18 and older. Three respondents under the age of 18 were eliminated from data analysis. Data cleaning revealed several individuals failing to meet the criteria for semi-vegetarian, vegetarian or vegan and were re-categorized based upon responses to survey questions. There were no incomplete surveys or those containing implausible data.

Instrumentation & Materials

The survey instrument was a modified version of the Behavioral Risk Factor Surveillance System (BRFSS), (Table 2; Appendix B). The survey included demographic questions and was modified to include questions pertaining to lifestyle, psychosocial, and diet composition and food frequency. A consent form providing background information, procedures, voluntary nature of the study, risk and benefits of participation, compensation, confidentiality, and contacts was also posted at the online survey site *SurveyMonkey* for access. The survey was available for three months from May 1 to July 31, 2011.

Established by the Centers for Disease Control & Prevention (CDC) in 1984, the BFRSS is a state-based survey encompassing a 350,000 telephone survey respondents to collect data on risky health behaviors, prevention practices, and access to health care. Parameters salient to this study such as weight, BMI, and demographic characteristics have been determined to be of high reliability and validity (Nelson, Holtzman, Bolen, Stanwyck, & Mack, 2001). Numerous studies using BMI as the outcome variable have successfully employed modified versions of the BRFSS questionnaire owing to its reliability and validity (Andreyeva, Long, Henderson, & Grode, 2010; Kim, Y., Pike, J., Adams, J., Cross, D., Doyle, C., & Foreyt, J., 2010; Amarasinghe, D'Souza, Brown, Oh, & Borisova, 2009; Zhao, Ford, LI, & Mokdad, 2009; Ramsay, et al., 2008; Kilmer, et al., 2008).

The dependent variable in this study was overweight and obesity as a function of BMI. Height and weight were converted to m^2 and kg respectively using conversion tables. The BMI was calculated by dividing the self-reported weight (kg) by the self-reported height (m^2) of respondents (Table 2). The primary independent variables were the diets of vegetarians, vegans, semi-vegetarians, and omnivores (Table 2). Covariables (Table 2) included demographic information (age, sex, education, SES, marital status, # of individuals in the home), lifestyle factors (physical activity, smoking, alcohol), psychosocial factors (anxiety, motivation to lose weight, hunger, appetite) and diet (self-categorization, length of time in category, reasons for choosing diet, source of information on diet, consumption of beef, fish, poultry, dairy, eggs, fruits & vegetables, fast food, food preparation, and grocery & farmer's market shopping).

Table 2

Variables, measures, coding & scoring to be utilized during survey assessment.

Variable	**Variable Type & Field**	**Measure**	**Field Name**	**Coding**
I. Demographic Information				
Respondent ID	Independent, Continuous, Text		RespondID	0001 – 9999
Age	Independent, Continuous, Number	Q1. What was your age on your last birthday	Age	Age in years (table continues)

Sex	Independent, Categorical, Text, Legal Value	Q2. Are you male or female?	Male Female	male=0 female=1
BMI Category	Dependent, Continuous, Number	Q3. How tall are you in feet and inches? Q4. What is your weight in pounds?	Height (inches) Weight (pounds).	Inches will be converted to m^2, pounds converted to kg using conversion table. BMI = kg/m^2
Education	Independent, Categorical, Number	Q5. What is your highest level of education completed?	Education	less than high school graduate=1, high school graduate or GED =2, some college or two year degree=3, four year college graduate=4, graduate degree=5.
Socioeconomic status (SES)	Independent, Categorical, Number	Q6. Which of the following best represents your annual, household income?	SES	$\leq$ \$25,000=1, \$25 – 39,999=2, \$40,000-49,999=3, \$50,000-74,999=4, $\geq$\$75,000=5.
Marital Status	Independent, Categorical, Text, Legal Value	Q7. What is your current marital status?	MarStatus	single=1, married=2, divorced=3, widow=4, widower=5.
Residence	Independent, Categorical, Text, Legal Value	Q8. Which of the following best describes your residence?	Res	Urban=1, rural=2, suburban=3.
Home	Independent, Continuous, Number	Q9. How many people live in your household including yourself?	Home#	Number of adults & children
II. Lifestyle				
Physical Activity	Independent, Continuous, Number	Q10. How many times did you exercise at least 20 minutes during the past week? Q11. How many minutes did you spend in moderate exercise (e.g. weight training, cardiovascular, etc.)	ExerciseTimes ExerciseMinutes	Frequency Time (minutes) (table continues)

Smoking	Independent, Continuous, Number	Q12. How many cigarettes do you smoke on a typical day?	Cigs	Number of cigarettes
Alcohol	Independent, Continuous, Number	Q13. How many days do you consume alcoholic beverages during a typical week? Q14. How many days during the past month did you consume 5 or more alcoholic drinks?	AlcoholDays AlcoholMonths	Number of days Number of days
III. Psychosocial				
Anxiety	Independent, Continuous, Number	Q15. How many days during the past month have you felt worried, tense or anxious?	Anx	Number of days
Motivation	Independent, Continuous, Option	Q16. How motivated are you to control your weight?	Motive	not at all motivated=1, somewhat motivated=2, moderately motivated=3, very motivated=4, extremely motivated=5
Eating	Independent, Continuous, Option	Q17. How strongly would you agree with the statement, "I eat too much?"	Eating	strongly disagree=1, disagree=2, somewhat agree=3, agree=4, strongly agree=5
Hunger	Independent, Continuous, Option	Q18. How often do you eat when you are not hungry?	Hunger	never=1, rarely=2, sometimes=3, often=4, very often=5
IV. Diet Quality				
Diet Type	Independent, Categorical, Number	Q19. Which of the following best describes your dietary habits?	DietType	Omnivore=0, Semi-vegetarian=1, Ovo-veg. =2, Lacto-veg=3, Ovo-lacto-veg.=4, Vegan=5, Not sure=6, Do not know=7 (table continues)

Diet Reason	Independent, Categorical, Number	Q20. Which of the following best represents your reasons for practicing the diet identified in Question #19?	DietReas	Religious beliefs=1, Health concerns=2, Weight loss=3, Environmental concerns=4, Animal welfare=5, Other=0
Diet Knowledge	Independent, Categorical, Number	Q21. Which of the following best represents your primary source of information relating to the dietary choice identified in Question #19?	DietKnow	Physician or healthcare provider=1, Internet=2, Print media=3,Religious practices=4, Family member or friend=5, Other=0
Diet Time	Independent, Continuous, Number	Q22. How long have you been practicing this diet?	DietTime	Period of time (# of months)
Beef	Independent, Continuous, Number	Q23. How many days did you consume beef during the past month?	Beef	Number of days
Poultry	Independent, Continuous, Number	Q24. How many days did you consume poultry or fish during the past month?	PoultryFish	Number of days
Preparation	Independent, Continuous, Text, legal Value	Q25. If you consume beef, fish or poultry, how is it typically prepared?	Prep	baked=1, boiled=2, broiled=3, fried=4, N/A=5
Dairy Products	Independent, Continuous, Number	Q26. How many days did you consume dairy products during the past month?	Dairy	Number of days
Eggs	Independent, Continuous, Number	Q27. How many days did you consume eggs during the past month?	Eggs	Number of days
Importance of Meat	Independent, Categorical, Text, Legal Value	Q28. How important is it to you to consume beef, poultry or fish?	ImportMeat	not important at all=1, somewhat important=2, moderately important=3, very important=4, extremely important=5 (table continues)

Fruits & Veggies	Independent, Continuous, Number	Q29. How many servings of fruits &/or vegetables do you typically consume each day?	Veggies	Number of servings
Fast Food	Independent, Continuous, Number	Q30. How many fast food meals do you typically consume each week?	FastFood	Number of meals
Groceries	Independent, Continuous, Number	Q31. How many times per week do you shop for groceries?	Groceries	Frequency
Nutrition Facts	Independent, Categorical, Yes/No	Q32. When I shop at the grocery store, I routinely read ingredient lists and nutrition facts.	Ingredients	yes = 0 no = 1
Grocery Convenience	Independent, Categorical, Text, Legal Value	Q33. How convenient is the nearest grocery store to you home?	ProxGS	very inconvenient=1, somewhat inconvenient=2, convenient=3, very convenient=4, extremely convenient=5
Farmers Market Convenience	Independent, Categorical, Text, Legal Value	Q34. How convenient is the nearest farmers market to you home?	ProxFM	very inconvenient=1, somewhat inconvenient=2, convenient=3, very convenient=4, extremely convenient=5

Source: Modified version of the Behavioral Risk Factor Surveillance System (BRFSS), Mayo Clinic Primary Care Health Survey, (2008) with the exception of * (Newby, Tucker & Wolk, 2005).

Data Collection & Analysis

The study sample population was accessed through Internet social media outlets, the *Walden University Participant Pool*, employees at *Gateway Community College,* as well as word of mouth. The study was provided with its own social networking site on *Facebook* entitled, *Vegetarian and Vegan Study Group*. The site provided a direct link to the consent form and the survey at *SurveyMonkey*. After gaining their permission an advertisement (Appendix C) for the survey was forwarded and posted by several vegan and vegetarian associations including *The Vegetarian Resource Group, the Vegan Society, Vida Vegan Bloggers, Fooducate, Veggie One on One Group, and the Vegetarian Times, and VegNews*.

After gaining permission, the ad was also posted on bulletin boards in several vegetarian and vegan restaurants including *It's Only Natural (CT)*, *Water Course (CO)*, *City O' City (CO)*, *Veggie Grill (CA)*, *The Spot (CA)*, and *Native Foods (CA)* as well as local health food stores such as *HealthWorks (CT)* and *Whole Foods (National)*.

The *Walden University Participant Pool* is designed to afford access to potential research participants throughout the *Walden University* community. A mass email alerting the college community of the study as well as a link to the survey was distributed by the college through the participant pool.

While the number of vegan and vegetarian participants was deemed adequate following one month of availability, the sample sizes of semi-vegetarians and omnivores was considered low. In an effort to bolster their numbers, a request was made and subsequently approved by the *Walden University Internal Review Board (IRB)* to include employees at *Gateway Community College*, New Haven, Connecticut through a mass email. *Gateway* is the largest of the 12 Connecticut Community Colleges with approximately 6,500 students and 375 employees. The college is located in the urban setting of New Haven, Connecticut (pop. 123,000), serving the city as well as surrounding communities.

Participants were asked to identify themselves as vegan, ovo-vegetarian, lacto-vegetarian, ovo-lacto-vegetarian, or semi-vegetarian, however the final determination was based upon responses to food frequency responses. Several respondents had to be re-categorized based upon their dietary intake: omnivores to semi-vegetarian (2), semi-vegetarian to omnivore (5), vegetarian to semi-vegetarian (17), vegan to semi-vegetarian (5). Vegan was defined as the practice of not eating beef, poultry, or fish without the use of eggs and/or dairy products, gelatin, or honey. Semi-vegetarians were defined as those not eating beef with the occasional ($\leq$ 5x's per month) consumption of poultry and fish with unlimited consumption of eggs and/or dairy products. Ovo-vegetarians practice not eating beef, poultry, fish or dairy products with occasional consumption of eggs, whereas lacto-vegetarians practice not eating beef, poultry, fish or eggs with the occasional consumption of dairy products, and ovo-lacto vegetarians refrain from eating beef, poultry, or fish with the occasional consumption of eggs and dairy products. As noted, these three groups were combined to form the vegetarian group defined as those refraining entirely from the consumption of beef, poultry, or fish.

Research Question & Hypothesis

The research question pertained to the risk of overweight and obesity in the semi-vegetarian and vegetarian versus vegan diet. This reconciled with the null hypothesis (H_o) that there is no difference in the risk of overweight and obesity among vegetarian and semi-vegetarian versus vegan diets. Due to inadequate sample sizes the research question and hypothesis were deemed untestable. The inclusion of omnivores as the comparison group necessitated a revision to the research question pertaining to the odds of overweight and obesity in the omnivorous versus the vegan diet. The H_o was modified to read: there is no significant difference in the odds of overweight and obesity in the omnivorous versus the vegan diet.

Statistical Analysis

The survey was open for a total of three months from May 1 to July 31, 2011. Data collected through *SurveyMonkey* was transferred to a *Microsoft Excel* spreadsheet, cleaned, and exported into *EpiInfo 3.5.3* for analysis. A total of 412 responses were collected, 408 of which met the inclusion criteria and were used in the study. Four responses were eliminated from analysis due to a failure to meet the minimum age requirement of 18. Data was stored in the form of a spreadsheet in a secure external hard drive.

Statistical analysis was accomplished through the use of *EpiInfo 3.5.2,* a public domain statistical package available through the Centers for Disease Control & Prevention (CDC). Descriptive statistics included means and standard deviations for continuous and frequencies for categorical variables for all participants (Tables 3-6). Tests of significance to compare categorical variables for all respondents were carried out using 2x2 tables (Table 7). To obtain odds ratios for overweight (BMI $\geq$ 25) and obesity (BMI $\geq$ 30), multiple logistic regression analysis (Table 8) was performed for each group with omnivores as a reference (Newby et al., 2005). A second regression analysis included female participants only as they comprised 80% of respondents. Results were not included as they did not differ from those including males. Due to the surprising (lack of) impact of exercise on overweight and obesity, two additional sets of reduced regression analyses were performed using all respondents which included stratification of the exercise variables (incidence & duration per week) into high and low levels (Tables 9-12).

Variable Recoding

Several independent variables were recoded to categorical variables due to a wide range of responses and/or small sample sizes. Marital status, binge drinking, and cigarette smoking were recoded to yes/no categories. Age, alcohol days per week, education, income, exercise, fast food, shopping frequency, duration of diet, and consumption of beef, poultry, fish, dairy products, eggs, and fruits and vegetables were all recoded into categorical variables as triads, quartiles, or quintiles based upon the range of responses. Several responses were combined to satisfy sample size requirements of the chi-square and logistic regression analyses. Responses to the duration of diet question demonstrated a wide range of chronology and label thus all responses were converted to months. The dependent variables overweight and obesity were categorized based upon their operational definitions.

The variables for exercise incidence and duration were stratified into low and high levels. Low levels of exercise were classified as 0-3 times for a total of $\leq$ 59 minutes per week. High levels included $\geq$ 4 times per week for a total of 60 minutes or longer.

Ethical Considerations

Walden University engages an Internal Review Board (IRB) that reviews all proposals to maintain participant rights and protections. The IRB is charged with ensuring that the methods of data collection utilized in this study presented minimal risk to participants, complied with ethical principles, and satisfied requirements for confidentiality. Approval to conduct research (#04-29-11-0115072) was granted by the IRB on April 29, 2011. Participation in the survey was voluntary and limited to adults age 18 and older. Respondents under the age of 18 (n=3) were eliminated from data analysis. An online informed consent form preceded the survey at the site. No clinical information or treatment was involved.

Dissemination of Findings

In consideration of their participation, the results of the study will be accessible to respondents at the study *Facebook* site. Walden University stages bi-annual poster session during PhD residencies. My plan is to participate in the January, 2012 poster session in Miami, Florida. This will provide an opportunity to present the results of this study to the Walden community.

Chapter 4: Results

Descriptive Statistics

The purpose of this study was to discover whether the risk of obesity is different for persons following several types of vegetarian and vegan diets. The research question pertaining to the risk of overweight and obesity in the semi-vegetarian, vegetarian, and vegan diets reconciles with the null hypothesis (H_o) that there is no difference in the risk of overweight and obesity among the four vegetarian versus vegan diets. The research question and hypothesis were subsequently modified to achieve adequate power during data analysis. The dependent variables were overweight and obesity and independent variables included demographic, lifestyle, psychosocial, and dietary factors.

Of the 412 respondents, 408 met the inclusion criteria for this quantitative, cross-sectional survey study. The survey consisted of 34 questions addressing demographic (9), lifestyle (5), psychosocial (4), and dietary (16) characteristics.

Of the 408 respondents, there were 87 (21.3%) semi-vegetarians, 7 (1.7%) ovo-vegetarians, 15 (3.7%) lacto-vegetarians, 50 (12.3%) ovo-lacto-vegetarians, and 136 (33.3%) vegans following data cleaning. The small number of ovo-, lacto-, and ovo-lacto-vegetarians necessitated collapsing them into a single group to be known as vegetarians (n=87; 21.3%). The 98 (24.0%) remaining participants were categorized as omnivores representing the control group. Demographic, lifestyle, and psychosocial characteristics of respondents may be found in Tables 3-5. Dietary characteristics of participating omnivores, semi-vegetarians, vegetarians, and vegans are located in Table 6.

The majority of participants were female (79.7%) compared to males (20.3%). Nearly one-third fell into the 25-34 (30.6%) age group with other categories evenly represented. The mean and median age of respondents was 38 and 36 respectively. The mean and median height and weight were 65.7 and 66 inches and 160 and 148 pounds representing a mean and median BMI of 26.1 and 24.0. Participants were well-educated with 71.6% indicating four-year (30.9%) or graduate degrees (40.7%). Married (51%) and unmarried (49%) participants were equally represented. Household income was relatively high with over 40% indicating incomes over $75,000 per annum. Over half (54.9%) of respondents resided in suburban environments with a mean and median of 2.7 and 2.0 individuals per household (Table 3).

Table 3

Demographic characteristics of individuals participating in this study.

Demographic Characteristics	***N* = 408**	**% [95% CI]**
Age (*y*):		
18-24	65	15.9% [12.6, 19.9%]
25-34	125	30.6% [26.2, 35.4%]
35-44	88	21.6% [17.7, 25.9%]
45-54	81	19.9% [16.2, 24.1%]
55-75	49	12.0% [(9.1, 15.7%]
[*M(Mdn)]*	[38(36)]	
Sex:		
Females	325	79.7% [75.4, 83.4%]
Males	83	20.3% [16.6, 24.6%]
Weight (*lb*): [*M(Mdn*)]	[160(148)]	
Height (*in*): [*M(Mdn)]*	[65.7(66)]	

(Table continues)

Demographic Characteristics	*N* = 408	% [95% CI]
BMI (kg/m^2):		
normal	236	57.8%[52.9, 62.7%]
overweight	88	21.6%[17.7, 25.9%]
obese	42	10.3%[6.8, 14.9%]
morbidly obese	42	10.3%[6.8, 14.9%]
[*M(Mdn)]*	[26.1(24)]	
Education:		
not a college graduate	116	28.4% [24.2-33.1%]
college graduate	126	30.9% [26.5-35.7%]
graduate degree	166	40.7% [35.9-45.6%]
Marital Status:		
Yes	208	51.0% [46.0-55.9%]
No	200	49.0% [44.1-54.0%]
Number in Household: [*M(Mdn)]*	[2.7(2.0)]	
Residence:		
Urban	127	31.1% [26.7, 35.9%]
Rural	57	14.0% [10.8, 17.8%]
Suburban	224	54.9% [49.9, 59.8%]

Lifestyle factors indicate that the majority of respondents were non-smokers (91.7%), and exercise between one and five times (66.9%) for less than one hour (41.9%) total per week. Nearly half (47.3%) refrain from alcohol however, over a quarter (27.5%) admit to binge drinking (>5/day) at least one day per month (Table 4).

Exhibiting frequent mental distress (anxiety, tense, worried) between two and 13 days per month was found in more than half of respondents (50.7%) with an additional one-quarter (26.5%) occurring between 14 and 30 days per month. More than half (55.4%) indicated they were either very (40.2%) or extremely (15.2%) motivated.

Over 60% admitted to eating too much and 68.9% to eating when not hungry (Table 5).

Table 4

Lifestyle characteristics of the 408 individuals participating in this study.

Lifestyle Characteristics	***N* = 408**	**% [95% CI]**
Smoking Status:		
Yes	34	8.3% [5.9-11.6%]
No	374	91.7% [88.5-94.2%]
Exercise: (times/week)		
None	85	20.8% [17.1-25.2%]
1-5	273	66.9% [62.1-71.4%]
6-20	50	12.3% [9.3-15.9%]
Exercise: (min/week)		
None	79	19.4% [15.7-23.6%]
1-60	171	41.9% [37.146.9%]
61-100	24	5.9% [3.9-8.7%]
101-200	53	13.0% [10.0-16.7%]
201-1000	81	19.9% [16.2-24.1%]
Alcohol: (days drinking/week)		
None	193	47.3% [42.4-52.3%]
1-2	117	28.7% [24.4-33.4%]
3-30	98	24.0% [20.0-28.5%]
Alcohol: (binge drinking days/mo.) (>5/day)		
No (0)	296	72.5% [67.9-76.8%]
Yes (1-30)	112	27.5% [23.2-32.1%]

Table 5

Psychosocial characteristics of 408 individuals participating in this study.

Psychosocial Characteristics	***N* = 408**	**% [95% CI]**
Frequent Mental Distress: (days/month)		
0-1	93	22.8% [18.9-27.2%]
2-13	207	50.7% [45.8-55.7%]
14-30	108	26.5% [22.3-31.1%]
Motivation:		
poorly	76	18.6% [14.8-24.2%]
moderately	106	26.0% [21.8-30.6%]
very	164	40.2% [35.4-45.1%]
extremely	62	15.2% [11.9-19.1%]
Eat too much:		
strongly disagree	54	13.2% [10.2-17.0%]
disagree	108	26.5% [22.3-31.1%]
somewhat agree	142	34.8% [30.2-39.7%]
agree	71	17.4% [13.9-21.5%]
strongly agree	33	8.1% [5.7-11/3%]
Eat when not hungry:		
rarely	127	31.1% [26.7-35.9%]
sometimes	210	51.5% [46.5-56.4%]
often	71	17.4% [13.9-21.5%]

Dietary Habits

Several significant differences were noted between the dietary habits and preferences of omnivores, semi-vegetarians, vegetarians, and vegans as noted by $p < 0.05$ [95% CI]. Significant values are indicated in **bold** print (Table 6). Omnivores (26.5%) and semi-vegetarians (48.3%) were more likely to select health concerns as primary reasons for practicing their diet while vegetarians (36.6%) and vegans (77.0%) chose animal welfare (***P=0.0000***). Overall (5.8%), few respondents chose weight loss as their primary focus. The majority of respondents (36%) utilize the internet as their primary source of dietary information, in particular vegetarians (44.8%) and vegans (47.8%), (***P=0.0000***). Omnivores (68.4%) overwhelmingly (***P=0.0000***) have the longest duration of diet (253-900 months), with a gradual decline noted in semi-vegetarians (16.1%), vegetarians (14.9%), and vegans (4.4%). Beef, poultry, and fish consumption was significantly higher (***P=0.0000***) in omnivores versus the other groups. Poultry and fish consumption was relatively equal in omnivores (97.9%) and semi-vegetarians (96.6%). Baked or broiled was the overwhelming method of preparation in both groups. Omnivores chose baked (42.9%) and broiled (41.8%) evenly while semi-vegetarians preferred baked (52.9%) over broiled (23%) by more than two to one. Consumption of dairy products was similar for omnivores (95.9%), semi-vegetarians, (90.8%), and vegetarians (92%). The number of eggs consumed decreased summarily among omnivores (94%), semi-vegetarians (75%), and vegetarians (60%). Omnivores revealed the consumption of beef, poultry, and/or fish was either moderately (48%) or very (42.9%) important while 46% of semi-vegetarians indicated it was not important at all. The daily consumption of fruits and vegetables was significantly higher (***P=0.0000***) in vegans and vegetarians versus semi-vegetarians and omnivores. The number of fast food meals per week was significantly higher in omnivores (***P=0.0000***) versus the other three groups. Vegetarians (37.9%) were more likely to consume fast food than semi-vegetarians (29.9%). The weekly number of grocery shopping trips was significantly higher (***P=0.0317***) among vegans than the other three groups. Vegetarians and vegans were significantly (***P=0.0000***) more likely to read nutrition facts and nutritional information on food labels than were semi-vegetarians and omnivores. There were no significant differences noted between the convenience of grocery stores (*P=0.0713*) or farmers markets (*P=0.3051*) among the four groups (Table 6).

Table 6

Dietary characteristics of individuals participating in this study.

Dietary Characteristics	**Omnivores (*n*=98)**	**Semi-vegetarian (*n*=87)**	**Vegans (*n*=136)**	**Vegetarians (*n*=87)**	***P***
Reason for diet:					
health concerns	26 (26.5%)	42 (48.3%)	27 (19.9%)	29 (33.3%)	***P=0.0000***
weight loss	15 (15.3%)	7 (8.0%)	0 (0%)	2 (2.3%)	
environment	3 (3.1%)	6 (6.9%)	10 (7.4%)	5 (5.7%)	
animal welfare	2 (2.0%)	15 (17.2%)	77 (56.6%)	32 (36.8%)	
other	52 (53.1%)	17 (19.5%)	22 (16.2%)	19 (21.8%)	
Diet information:					
physician	22 (22.4%)	10 (11.5%)	0 (0%)	5 (5.7%)	***P=0.0000***
internet	16 (16.3%)	27 (31%)	65 (47.8%)	39 (44.8%)	
print media	18 (18.4%)	20 (23%)	37 (27.2%)	16 (18.4%)	
family or friend	14 (14.3%)	15 (17.2%)	5 (3.7%)	6 (6.9%)	
other	28 (28.6%)	15 (17.2%)	29 (21.3%)	21 (24.1%)	
Length of time in diet (months):					
0-24	15(15,3%)	35 (40.2%)	50 (36.8%)	29 (33.3%)	***P=0.0000***
25-72	5(5.1%)	18 (20.7%)	43 (31.6%)	23 (26.4%)	
73-252	11(11.2%)	20 (23.0%)	37 (27.2%)	22 (25.3%)	
253-900	67(68.4%)	14 (16.1%)	6 (4.4%)	13 (14.9%)	
Beef (days/month):					
0	0 (0%)	55 (63.2%)	136(100%)	87(100%)	***P=0.0000***
1-14	67 (68.4%)	32 (36.8%)	0 (0%)	0 (0%)	
15-31	31 (31.6%)	0 (0%)	0 (0%)	0(0%)	

(Table continues)

Dietary Characteristics	Omnivores (*n*=98)	Semi-vegetarian (*n*=87)	Vegans (*n*=136)	Vegetarians (*n*=87)	*P*
Preparation:					
baked	42 (42.9%)	46 (52.9%)	0 (0%)	0 (0%)	*n/a*
broiled	41 (41.8%)	20 (23.0%)	0 (0%)	0 (0%)	
fried	9 (9.2%)	6 (6.9%)	0 (0%)	0 (0%)	
n/a	6(6.1%)	15 (17.2%)	136(100%)	87 (100%)	
Dairy Products (days/month):					
0	4 (4.1%)	8 (9.2%)	136(100%)	7 (8.0%)	***P=0.0000***
1-14	23 (23.5%)	17 (19.5%)	0 (0%)	30 (34.5%)	
15-31	71 (72.4%)	62 (71.3%)	0 (0%)	50 (57.5%)	
Eggs (days/month):					
0	4 (4.1%)	12 (13.8%)	136	27 (31.0%)	***P=0.0000***
1-14	64 (65.3%)	54 (62.1%)	(100%)	45 (51.7%)	
15-31	30 (30.6%)	21 (24.1%)	0 (0%)	15 (17.2%)	
Importance of beef/poultry/fish:					
not important	9 (9.2%)	40 (46.0%)	134(99%)	83 (95.4%)	***P=0.0000***
mod important	47 (48.0%)	41 (47.1%)	0 (0%)	1 (1.1%)	
very important	42 (42.9%)	6 (6.9%)	2 (1.5%)	3 (3.4%)	
Fruits & Vegetables (servings/day):					
0-3	56 (57.1%)	41 (47.1%)	12 (8.8%)	25 (28.7%)	***P=0.0000***
4-5	26 (26.5%)	30 (34.5%)	56 (41.2%)	31 (35.6%)	
6-7	6 (6.1%)	3 (3.4%)	17 (12.5%)	12 (13.8%)	
8-20	10 (10.2%)	13 (14.9%)	51 (37.5%)	19 (21.8%)	
Fast food (meals/week):					
0	44 (44.9%)	61 (70.1%)	106(78%)	54 (62.1%)	***P=0.000***
1	32 (32.7%)	18 (20.7%)	21 (15.4%)	18 (20.7%)	
2-21	22 (22.4%)	8 (9.2%)	9 (6.6%)	15 (17.2%)	

(Table continues)

Dietary Characteristics	Omnivores (*n*=98)	Semi-vegetarian (*n*=87)	Vegans (*n*=136)	Vegetarians (*n*=87)	*P*
Read ingredients & nutrition facts:					
yes	73 (74.5%)	65 (74.7%)	133 (98%)	78 (89.7%)	***P=0.0000***
no	25 (25.5%)	22 (25.3)	3 (2.2%)	9 (10.3%)	
Grocery store convenience:					
very inconvenient	17 (17.3%)	15 (17.2%)	16 (11.8%)	8 (9.2%)	*P=0.0713*
s'what inconv.	23 (23.5%)	8 (9.2%)	27 (19.9%)	12 (13.8%)	
convenient	13 (13.3%)	21 (24.1%)	40 (29.4%)	25 (28.7%)	
very convenient	17 (17.3%)	15 (17.2%)	34 (25.0%)	24 (27.6%)	
extremely conv.	20 (20.4%)	19 (21.8%)	19 (14%)	18 (20.7%)	
Farmer's market convenience:					
very inconvenient	20 (20.4%)	16 (18.4%)	27 (19.9%)	13 (14.9%)	*P=0.3051*
s'what inconv.	43 (43.9%)	30 (34.5%)	54 (39.7%)	36 (41.4%)	
convenient	13 (13.3%)	25 (28.7%)	38 (27.9%)	25 (28.7%)	
very convenient	17 (17.3%)	10 (11.5%)	12 (8.8%)	10 (11.5%)	
extremely conv.	5 (5.1%)	6 (6.9%)	5 (3.7%)	3 (3.4%)	

Chi-square Analysis

Several variables had significant impacts on the numbers of overweight and obese among respondents. The percent of participant's that were normal weight, overweight, or obese and *p* value using two-way tests unadjusted for covariates is indicated in Table 7. Males were significantly (***P=0.0460***) more likely to be overweight than females participants but not obese (*P=0.1315*). Increasing age was significant for both overweight (***P=0.0003***) and obesity (***P=0.0288***) with the exception of the oldest group (55-75). The level of education (*P=0.1093; 0.6885*), marital status *P=0.2668; 0.1303*), or number of people in the household (*P=n/a; 0.5136*) were not significant factors for either overweight or obesity. Increasing income was significantly higher

(***P=0.0089***) for overweight but not obesity (*P=0.1332*). Overweight and obesity were not significantly impacted by smoking (*P=0.1835; 0.0763*), drinking days per month (*P=0.7322; 0.1918*) or binge drinking (*P=0.8601; 0.1752*). The number of days per week engaging in exercise was not a factor for either overweight (*P=0.4590*) or obesity (*P=0.1642*), however the total number of minutes per week spent exercising was somewhat significant (***P=0.0479***) for obesity. Frequent mental distress was not a significant factor in either overweight (*P=0.1750*) or obesity (*P=0.0978*), (Table 7).

Several dietary practices had significant impacts on the numbers of overweight and obese. The percentage of overweight (***P=0.0203***) and obese (***P=0.0015***) was significantly higher for omnivores (50.0%; 27.6%), semi-vegetarians (44.8%; 25.3%), and vegetarians (47.1%; 25.6%) versus vegans (31.6%; 9.6%). The amount of time (duration) spent practicing a specific diet was a significant factor in the prevalence of overweight (***p=0.0020***) and obesity (***p=0.0139***). The numbers of overweight and obese were also significantly associated with motivation to lose weight (***P=0.0394; 0.0219***), eating too much (***P=0.0000; 0.0001***), eating when not hungry (***P=0.0214; 0.0002***), and reasons for practicing a diet (***P=0.0000; 0017***). The consumption of beef (***P=0.0116***), poultry/fish (***P=0.0060.),*** dairy (***P=0.0039***), and less so eggs (***P=0.0456***) were significantly associated with obesity but not overweight. The importance of beef, poultry and fish significantly impacted the numbers of overweight (***P=0.0102***) but not obese (*P=0.0743*). Baking or broiling beef, poultry and fish was significant for overweight (***P=0.0156***) and obesity (***P=0.0001***) as compared to frying for omnivores and semi-vegetarians. Daily servings of fruits and vegetables were not significant factors in the percentages of overweight (*p=0.7048*) or obese (*p=0.1274*). The number of fast food meals consumed per week was significant for both overweight (***P=0.0001***) and obesity (***P=0.0000***). The number of days per week shopping for groceries was not significant for overweight (*P=0.2525*) but was significant for obesity (***P=0.0394***) in increasing fashion. Neither grocery store nor farmers market convenience were significant factors for either overweight (*P=0.2668; 0.6372*) or obesity (*P=0.6776; 0.7992*), (Table 7).

Table 7

Percent of participant's normal weight, overweight, or obese and p value using two-way tests unadjusted for covariates.

Independent Variable	**Percent Normal Weight**	**Percent Overweight**	***P***	**Percent Obese**	***P***
Age (*y*)					
18-24	67.7	21.5	***P=0.0003***	10.8	***P=0.0288***
25-34	42.4	40.8		16.8	
35-44	28.4	42.0		29.5	
45-54	14.8	59.3		25.9	
55-75	36.7	44.9		18.4	
Sex:					
Male	21.7	51.8	***P=0.0460***	*26.5*	*P=0.1351*
Female	41.2	39.7		*19.1*	
Education:					
not c'lge grad.	37.0	39.7	*P=0.1093*	23.3	*P=0.6885*
college grad.	44.5	36.5		19.0	
grad. Degree	31.9	48.2		19.9	
Household income:					
< $25,000	56.9	26.4	***P=0.0089***	16.7	*P=0.1332*
$25-49,999	37.9	40.0		22.1	
$50-74,999	14.6	54.7		30.7	
>$75,000	38.2	44.8		17.0	

(Table continues)

Independent Variable	Percent Normal Weight	Percent Overweight	*P*	Percent Obese	*P*
Residence:					
urban	50.4	36.2	*P=0.2615*	13.4	***P=0.0469***
rural	28.1	45.6		26.3	
suburban	32.2	44.6		23.2	
Number in household:					
1	59.0	27.9	*n/a*	13.1	*P=0.5136*
2	42.7	36.8		20.5	
3	5.8	65.2		29.0	
4	37.3	43.3		19.4	
5	34.6	46.2		19.2	
6	27.2	45.5		27.3	
7	50.0	50.0		0.0	
Smoking:					
yes	14.7	52.9	*P=0.1835*	32.4	*P=0.0763*
no	39.3	41.2		19.5	
Alcohol: (days drink/wk)					
none	33.2	43.5	*P=0.7322*	23.3	*P=0.1918*
1-2	35.9	42.7		21.4	
3-30	46.9	38.8		14.3	
Alcohol (binge drinking days/mo.) (>5/day):					
No (0)	39.2	41.9	*P=0.8601*	18.9	*P=0.1752*
Yes (1-30)	32.1	42.9		25.0	
Exercise minutes/week:					
0	26.6	45.6	*P=0.0917*	27.8	***P=0.0479***
1-60	31.0	46.8		22.2	
61-100	20.8	50.0		29.2	
101-200	62.3	28.3		9.4	
201-1000	49.4	35.8		14.8	

(Table continues)

Independent Variable	Percent Normal Weight	Percent Overweight	*P*	Percent Obese	*P*
Exercise: (Times/week)					
0	29.4	43.5	*P=0.4590*	27.1	*P=0.1642*
1-5	37.0	43.2		19.8	
6-20	52.0	34.0		14.0	
Frequent Mental Distress: (days/month)					
0-1	47.3	34.4	*P=0.1750*	18.3	*P=0.0978*
2-13	39.1	43.0		17.9	
14-30	25.0	47.2		27.8	
Motivation to lose weight:					
poorly mot.	12.8	53.9	***P=0.0394***	33.3	***P=0.0219***
mod. mot.	33.0	47.2		19.8	
very mot.	50.0	35.4		14.6	
extremely mot.	40.3	37.1		22.6	
"I eat too much":					
strongly disagree	63.0	25.9	***P=0.0000***	11.1	***P=0.0001***
disagree	58.3	27.8		13.9	
somewhat agree	44.4	37.3		18.3	
agree	0.0	69.0		31.0	
strongly agree	21.2	33.3		45.5	
Eat when not hungry:					
rarely	53.5	34.6	***P=0.0214***	11.8	***P=0.0002***
sometimes	37.1	42.4		20.5	
often	8.4	54.9		36.6	
Dietary habit:					
omnivore	22.4	50.0	***P=0.0203***	27.6	***P=0.0015***
semi-veg.	29.9	44.8		25.3	
vegetarian	27.6	47.1		25.3	
vegan	58.8	31.6		9.6	

(Table continues)

Independent Variable	Percent Normal Weight	Percent Overweight	*P*	Percent Obese	*P*
Days/month consuming beef:					
0	44.2	38.5	P=0.0524	17.3	***P=0.0116***
1-14	28.3	47.5		24.2	
15-31	3.2	58.1		38.7	
Days/month consuming poultry/fish:					
0	47.3	37.3	*P=0.0801*	15.4	***P=0.0060***
1-10	21.1	48.6		30.3	
11-31	29.6	47.9		22.5	
Days/month consuming dairy:					
0	52.9	34.8	*P=0.0514*	12.3	***P=0.0039***
1-14	21.4	50.0		28.6	
15-31	30.0	45.4		24.6	
Days/month consuming eggs:					
0	48.6	36.3	*P=0.0754*	15.1	***P=0.0456***
1-14	25.8	48.5		25.8	
15-31	34.8	42.4		22.7	
Food preparation:					
baked	25.8	46.1	***P=0.0156***	28.1	***P=0.0001***
broiled	27.8	49.2		23.0	
fried	26.7	13.3		60.0	
n/a	48.2	37.0		14.8	
Importance of beef, poultry, & fish:					
not important	45.9	36.8	***P=0.0102***	17.3	*P=0.0743*
mod. important	20.3	53.9		25.8	
very important	22.6	49.1		28.3	
Servings/day fruit/vegs:					
0-3	29.1	44.8	*P=0.7048*	26.1	*P=0.1274*
4-5	43.3	40.6		16.1	
6-7	26.3	47.4		26.3	
8-20	44.1	38.7		17.2	(Table con’t)

Independent Variable	Percent Normal Weight	Percent Overweight	*P*	Percent Obese	*P*
Times/week shop for groceries:					
0-1	26.0	47.5	*P=0.2525*	26.5	***P=0.0394***
2	45.4	36.4		18.2	
3	44.6	40.0		15.4	
4-7	51.2	39.0		9.8	
Routinely read ingred./nut. facts:					
yes	41.9	39.8	***P=0.0205***	18.3	***P=0.0063***
no	10.2	55.9		33.9	
Grocery store convenience:					
very inconv.	28.6	51.8	*P=0.2668*	19.6	*P=0.6776*
somewhat inconv.	45.8	37.1		17.1	
convenient	32.4	43.4		24.2	
very conv.	37.3	44.9		17.8	
extremely conv.	42.1	34.2		23.7	
Farmer's market convenience:					
very inconv.	27.6	47.4	*P=0.6372*	25.0	*P=0.7992*
somewhat inconv.	35.5	43.6		20.9	
convenient	41.6	40.6		17.8	
very conv.	42.9	36.7		20.4	
extremely conv.	52.6	31.6		15.8	
Primary Source of Information:					
physician/healthcare	8.1	59.5	*P=0.2006*	32.4	*P=0.2744*
internet	37.5	40.1		22.4	
print media	43.9	38.5		17.6	
family/friend	32.5	47.5		20.0	
other	44.1	39.8		16.1	

Multiple Logistic Regression Analysis

A multiple logistic regression analysis was performed using all participants (n=408) to estimate the independent associations. In this way, potential confounders were held constant providing a more reliable measure of the hypothesis (Table 8). The cut-off point for inclusion in the regression analysis was $p \leq 0.25$ during two by two analyses. The table supplies unadjusted odds ratios [95%CI] with statistically significant ($p<0.05$) associations indicated **bold** print.

Increasing age was associated with significantly higher odds of overweight in the 25-34 (OR=3.4045; ***p=0.0179***), 35-44 (OR=3.6113; ***p=0.0213***), and 45-54 (OR=5.6142; ***p=0.0073***) age groups and obesity in the 35-44 (OR=13.2135; ***p=0.0009***) and 45-54 (OR=9.1649; ***p=0.0124***) age categories. Male respondents were at significantly higher odds of obesity (OR=2.9149; ***p=0.0470***) than their female counterparts. Those indicating a household income of $75,000 or greater were at significantly higher odds of obesity (OR=1.1916; ***p=0.0055***).

The number of days per month consuming alcohol was significantly protective at frequencies of 1-2 (OR=0.3299; ***p=0.0342***) and 3-30 (OR=0.2028; ***p=0.0085***) days per month. Binge drinking had the opposite effect by increasing the odds of obesity (OR=4.4421; ***p=0.0069***).

Individuals indicating they are moderately (OR=0.1446; ***p=0.0040***) or very (OR=0.1863; ***p=0.0064***) motivated to lose weight were significantly protected from obesity. As to eating too much, those strongly disagreeing found it strongly protective (OR=0.0745; ***p=0.000***) against overweight. Those that disagreed (OR=0.0925; ***p=0.0000***), or somewhat agreed (OR=0.2153; ***p=0.0000***) with the statement found it strongly protective against overweight as well as obesity (OR=0.2153; ***p=0.0121***), (OR=0.2366; ***p=0.0073***). Respondents indicating they eat when not hungry only on rare occasions found it protective against obesity (OR=0.1307; ***p=0.0037***) when compared to those admitting they often eat when not hungry.

When compared to animal welfare as the primary reason for their dietary practices, those indicating weight loss were at a strongly higher odds (OR=20.4312; p=0.0003) of being overweight. Health concerns (OR=2.2462; ***p=0.0413***) and “other” (OR=2.5135; ***p=0.0340***) were also at significantly higher odds of overweight. Examples of “other” included religious practices, personal preference, upbringing, family, individual taste, etc.

Those indicating they were in the mid-range of time spent in their diet found it protective against overweight. Durations of 25-72 months (OR=0.4397; ***p=0.0477***) and 73-252 months (OR=0.4017; ***p=0.0241***) were at significantly lower odds when compared to those practicing their diet for 24 months or less.

Respondents consuming poultry or fish between 1-10 days per month were at significantly greater odds of overweight (OR=1.5922; p=0.0483) and obesity (OR=2.3944; p=0.0017) as compared to those refraining from fish or poultry. The odds of obesity declined along with increasing number of times shopping for groceries each week. Those respondents indicating that they shop for groceries 4-7 times per week were significantly protected from obesity (OR=0.1227; ***p=0.0204***) as compared to those shopping 0-1 times per week.

While odds ratios fluctuated there were no other statistically significant associations with the odds of overweight or obesity noted including educational level, marital status, type of diet, days consuming beef, dairy, or eggs, number of fast food meals per week, primary source of dietary information, reading nutrition labels or area of residence (Table 8).

Table 8

Multiple logistic regression analysis of all participants (n=408) showing odds ratios (ORs), 95% CIs, and p for overweight & obesity for all independent variables & covariates p≤0.25 in chi-square analysis.

Independent Variable	**OR**	**Overweight (BMI≥25) 95% CI**	***P***	**OR**	**Obese (BMI≥30) 95% CI**	***P***
Age (y):						
18-24	1.0			1.0		
25-34	3.40	1.24, 9.39	**0.0179**	2.62	0.68, 10.76	0.1817
35-44	3.61	1.21, 10.78	**0.0213**	13.21	2.87, 60.90	**0.0009**
45-54	5.61	1.59, 19.81	**0.0073**	9.16	1.61, 52.03	**0.0124**
55-75	3.20	0.88, 11.65	0.0774	2.05	0.31, 13.58	0.4560
Sex:						
female	1.0			1.0		
male	1.98	0.94, 4.18	0.0725	2.91	1.01, 8.38	**0.0470**
Education:						
not college grad.	1.0			1.0		
college graduate	0.54	0.25, 1.15	0.1090	0.53	0.19, 1.51	0.2344
graduate degree	0.78	0.38, 1.62	0.5123	1.09	0.43, 2.75	0.8514
Household income:						
< $25,000	0.73	0.29, 1.86	0.5137	0.64	0.18, 2.32	0.4964
$25-49,999	1.0			1.0		
$50-74,999	1.71	0.74, 3.98	0.2104	1.40	0.48, 4.06	0.5393
>$75,000	0.86	0.39, 1.88	0.7055	1.19	0.06, 0.62	**0.0055**
Married:						
no	1.0			1.0		
yes	1.43	0.72, 2.85	0.3095	1.59	0.62, 4.09	0.3348

(Table continues)

Independent Variable	OR	Overweight (BMI≥25) 95% CI	*P*	OR	Obese (BMI≥30) 95% CI	*P*
Residence:						
rural	1.0			1.0		
urban	1.04	0.41, 2.63	0.9356	0.50	0.14, 1.78	0.2858
suburban	1.25	0.53, 2.97	0.6140	1.06	0.34, 3.26	0.9191
Smoking:						
no	1.0			1.0		
yes	1.47	0.57, 3.83	0.4283	1.40	0.39, 5.11	0.6068
Alcohol (days drinking/month):						
none	1.0			1.0		
1-2	0.73	0.34, 1.55	0.4100	0.33	0.12, 0.92	**0.0342**
3-30	0.65	0.29, 1.47	0.2999	0.20	0.06, 0.67	**0.0085**
Alcohol (binge drinking (≥5/day) days/month):						
no (0)	1.0			1.0		
yes (1-30)	1.21	0.54, 2.71	0.6358	4.44	1.50, 13.11	**0.0069**
Exercise (times/week):						
0	1.0			1.0		
1-5	1.41	0.55, 3.61	0.4740	0.44	0.13, 1.55	0.2007
6-20	1.28	0.37, 4.41	0.6970	0.29	0.05, 1.76	0.1772
Exercise (minutes/week):						
0	1.0			1.0		
1-60	1.20	0.45, 3.21	0.7182	2.17	0.60, 7.91	0.2387
61-100	1.81	0.44, 7.48	0.4126	3.19	0.51, 19.95	0.2152
101-200	0.51	0.15, 1.73	0.2790	0.66	0.10, 4.28	0.6654
201-1000	0.89	0.28, 2.83	0.8385	1.04	0.20, 5.31	0.9604

Table continues

Independent Variable	OR	Overweight (BMI≥25) 95% CI	*P*	OR	Obese (BMI≥30) 95% CI	*P*
Frequent mental distress (days/mo.):						
0-1	1.0			1.0		
2-13	1.74	0.87, 3.48	0.1150	0.72	0.27, 1.96	0.5342
14-31	2.29	0.99, 5.28	0.0509	1.74	0.57, 5.33	0.3310
Motivation to lose weight:						
poor	1.83	0.68, 4.95	0.2346	0.82	0.24, 2.83	0.7481
moderate	1.05	0.43, 2.57	0.9170	0.15	0.04, 0.54	**0.0040**
very	0.55	0.24, 1.26	0.1540	0.19	0.06, 0.62	**0.0064**
extreme	1.0			1.0		
"I eat too much":						
strongly disagree	0.07	0.02, 0.24	**0.0000**	0.23	0.05, 1.04	0.0557
disagree	0.09	0.04, 0.23	**0.0000**	0.22	0.06, 0.71	**0.0121**
somewhat agree	0.17	0.08, 0.39	**0.0000**	0.24	0.08, 0.68	**0.0073**
agree	1.0			1.0		
strongly agree	1.68	0.50, 5.63	0.3991	0.78	0.22, 2.80	0.7013
Eat not hungry:						
Rarely	1.75	0.66, 4.67	0.2615	0.13	0.03, 0.52	**0.0037**
Sometimes	1.47	0.66, 3.28	0.3422	0.40	0.16, 1.04	0.0595
Often	1.0			1.0		
Dietary habit:						
Omnivore	1.0			1.0		
Semi-vegetarian	1.89	0.51, 6.94	0.3402	0.88	0.17, 4.51	0.8773
Vegetarian	2.35	0.31, 17.66	0.9164	1.55	0.09, 26.92	0.7640
Vegan	1.14	0.10, 13.62	0.4062	0.28	0.01, 8.87	0.4678

(Table continues)

Independent Variable	OR	Overweight (BMI≥25) 95% CI	*P*	OR	Obese (BMI≥30) 95% CI	*P*
Duration of diet (months):						
0-24	1.0			1.0		
25-72	0.44	0.19, 0.99	**0.0477**	0.30	0.09, 1.07	0.0641
73-252	0.40	0.18, 0.89	**0.0241**	0.36	0.12, 1.05	0.0614
253-900	1.40	0.55, 3.61	0.4811	0.54	0.17, 1.73	0.3021
Reason for diet:						
health concerns	2.25	1.03, 4.89	**0.0413**	1.21	0.39, 3.83	0.7397
weight loss	20.43	4.02, 104	**0.0003**	3.95	0.66, 23.61	0.1319
environment	1.54	0.42, 5.60	0.5157	1.57	0.25, 9.99	0.6348
animal welfare	1.0			1.0		
Oother	2.51	1.07, 5.89	**0.0340**	1.66	0.50, 5.49	0.4059
Primary source of dietary information:						
physician/h' care	2.20	0.56, 8.56	0.2563	1.73	0.31, 9.73	0.5361
internet sources	1.78	0.62, 5.07	0.2824	4.56	0.95, 21.8	0.0577
print media	1.57	0.52, 4.77	0.4265	2.64	0.52, 13.4	0.2400
family or friend	1.0			1.0		
other	1.25	0.41, 3.75	0.6959	1.07	0.21, 5.33	0.9338
Days/month consuming beef:						
0	1.0			1.0		
1-14	0.55	0.15, 2.02	0.3681	0.60	0.11, 3.18	0.5439
15-31	0.68	0.12, 3.79	0.6571	4.27	0.47, 39.0	0.1978
Days/month consuming poultry/fish:						
0	1.0			1.0		
1-10	1.59	1.00, 2.53	**0.0483**	2.39	1.39, 4.13	**0.0017**
11-31	1.56	0.90, 2.65	0.1121	1.60	0.83, 3.11	0.1624

(Table continues)

Independent Variable	**OR**	**Overweight (BMI≥25) 95% CI**	***P***	**OR**	**Obese (BMI≥30) 95% CI**	***P***
Days/month Consuming dairy:						
0	1.0			1.0		
1-14	0.96	0.22, 4.29	0.9623	2.38	0.37, 15.5	0.3653
15-31	0.73	0.18, 2.97	0.6597	1.56	0.27, 0.07	0.6186
Days/month Consuming eggs:						
0	1.0			1.0		
1-14	0.79	0.29, 2.10	0.6328	0.37	0.11, 1.28	0.1180
15-31	0.52	0.16, 1.62	0.2557	0.25	0.06, 1.06	0.0597
Fast food meals/week:						
0	1.0			1.0		
1	1.56	0.77, 3.18	0.2190	2.24	0.90, 5.58	0.0840
2-21	2.12	0.88, 5.09	0.0944	1.60	0.52, 4.90	0.4099
Times/week shop for groceries:						
0-1	1.0			1.0		
2	0.91	0.47, 1.77	0.7875	1.07	0.44, 2.62	0.8793
3	0.77	0.34, 1.73	0.5280	0.69	0.21, 2.28	0.5396
4-7	0.90	0.34, 2.37	0.8355	0.12	0.02, 0.72	**0.0204**
Routinely read ingredients/ nutrition facts:						
no	1.0			1.0		
yes	0.91	0.39, 2.15	0.8344	0.62	0.21, 1.89	0.403

Since females composed almost 80% of participants a multiple logistic regression stratified for gender was run to address potential differences in the impact of interactions between confounding variables on females compared to the general analysis. No significant differences were noted therefore the results are not presented here.

Four additional reduced models of multiple logistic regression analysis stratified for exercise times and total minutes per week were done to test for covariate interactions. This became compelling in light of the lack of a significant impact of exercise on overweight and obesity. Inclusion of covariates was limited to age, sex, and type and duration of diet. Tables 9-12 supply odds ratios [95%CI]; statistically significant ($p<0.05$) associations are indicated **bold** print.

Age was strongly associated with the odds of being overweight and obese across most age groups compared to 18-24 year olds. This held true for low exercisers in times and total minutes per week although it did not correlate to increasing age (Tables 10 & 12). For example, while most age groups demonstrated a higher risk with increasing age, 45-54 year old low-exercisers (total minutes) had significantly lower odds of overweight (OR=0.0248; ***p=0.0001***) than the 18-24 year old group (Table 12). Males exercising a high number of times per week were at significantly higher risk (OR=4.1247; ***p=0.*0177**) of overweight than females (Table 9).

Table 9

Reduced model of multiple logistic regression analysis stratified for participants classified as high exercisers in terms of times per week (n=103) showing odds ratios (ORs), 95% CIs, and p for overweight & obesity.

Independent Variable	*OR*	Overweight (BMI $\geq$ 25) 95% CI	*P*	*OR*	Obese (BMI $\geq$ 30) 95% CI	*P*
Age (y)						
18-24	1.0			1.0		
25-34	2.74	0.46, 16.18	0.2673	0.88	0.09, 7.58	0.8719
35-44	3.49	0.61, 19.76	0.1584	3.07	0.45, 20.79	0.2498
45-54	15.06	2.30, 98.56	**0.0047**	1.61	0.21, 12.4	0.6477
55-75	2.75	0.34, 21.89	0.3400	0.45	0.03, 7.24	0.5713
Sex:						
Male	4.12	1.28, 13.31	**0.0177**	1.24	0.28, 5.37	0.7722
Female	1.0			1.0		
Diet type:						
omnivore	1.0			1.0		
semi-veg.	2.63	0.49, 13.95	0.2573	1.48	0.23, 9.37	0.6795
vegetarian	1.41	0.23, 8.64	0.7114	1.18	0.17, 8.27	0.8696
vegan	1.33	0.27, 6.65	0.7305	0.48	0.07, 3.24	0.4477
Time in diet (months):						
0-24	1.0			1.0		
25-72	0.19	0.04, 0.84	**0.0291**	0.22	0.02, 2.28	0.2034
73-252	0.50	0.14, 1.83	0.2967	1.57	0.37, 6.72	0.5399
253-900	0.49	0.10, 2.49	0.3922	0.93	0.14, 6.18	0.9432

Those practicing a vegan diet had significantly lower odds of obesity for both low exercisers by times per week (OR=0.3063; ***p=0.0204***) and total minutes per week (OR=0.2312; ***p=0.0160***) as compared to omnivores (Tables 10 & 12). Vegetarians that exercise a high total of minutes per week actually had a significantly higher odds of overweight (OR=3.7384; ***p=0.0258***) than omnivores (Table 11).

Duration of time spent in diet was significant for both overweight and obesity across all levels of exercise. The odds of overweight and obesity was significantly lower for high level exercisers (time and minutes) than for those practicing their diet for the shortest time period (≤ 6 months). Those exercising a high number of times per week had significantly lower odds of overweight (OR=0.1851; **p=0.0291**) when practicing their diet for 6 months or less (Table 9).

Table 10

Reduced model for multiple logistic regression analysis stratified for participants classified as low exercisers in terms of times per week (n=304) showing odds ratios (ORs), 95% CIs, and p for overweight & obesity.

Independent Variable	***OR***	**Overweight (BMI ≥ 25)** **95% CI**	***P***	***OR***	**Obese (BMI ≥ 30)** **95% CI**	***P***
Age (y)						
18-24	1.0			1.0		
25-34	3.03	1.35, 6.81	**0.0072**	2.41	0.08, 7.25	0.1170
35-44	2.93	1.24, 6.95	**0.0145**	4.28	1.39, 13.16	**0.0111**
45-54	3.36	1.37, 8.26	**0.0083**	3.23	1.01, 10.38	**0.0486**
55-75	2.65	0.98, 7.20	0.0554	2.16	0.59, 7.96	0.2474
Sex:						
Male	1.09	0.60, 2.01	0.7707	1.90	0.94, 3.83	0.0728
Female	1.0			1.0		
Diet type:						
omnivore	1.0			1.0		
semi-vegetarian	0.98	0.45, 2.09	0.9490	1.03	0.43, 2.43	0.9492
vegetarian	1.43	0.67, 3.06	0.3580	1.14	0.48, 2.67	0.7676
vegan	0.64	0.30, 1.38	0.2576	0.31	0.11, 0.83	**0.0204**
Time in diet (months):						
0-24	1.0			1.0		
25-72	0.73	0.37, 1.44	0.3643	0.37	0.15, 0.89	**0.0272**
73-252	0.56	0.28, 1.10	0.0942	0.26	0.10, 0.65	**0.0037**
253-900	1.35	0.63, 2.89	0.4393	0.62	0.26, 1.44	0.2637

These results are consistent with those in the early stages of a diet and exercise program designed to achieve a healthy BMI. Individuals spending a high total number of minutes per week exercising significantly decreased their odds of being overweight (OR=0.3300; ***p=0.0320***) and obese (OR=0.0963; ***p=0.0293***), (Table 11). For low exercisers (times per week), those spending 25-72 months (OR=0.3679; ***p=0.0272***) and 73-252 months (OR=0.2596; ***p=0.0037***) decreased their odds of obesity (Table 10).

Table 11

Reduced model for multiple logistic regression analysis stratified for participants classified as high exercisers in terms of total minutes per week (n=184) showing odds ratios (ORs), 95% CIs, and p for overweight & obesity.

Independent Variable		**Overweight (BMI ≥ 25)**			**Obese (BMI ≥ 30)**	
	OR	**95% CI**	***P***	***OR***	**95% CI**	***P***
Age (y)						
18-24	1.0			1.0		
25-34	1.97	0.67, 5.77	0.2146	0.86	0.21, 3.47	0.8316
35-44	1.56	0.50, 4.86	0.4417	1.56	0.39, 6.23	0.5326
45-54	1.86	0.55, 6.31	0.3164	0.90	0.19, 4.22	0.8889
55-75	1.62	0.43, 6.10	0.4755	0.87	0.15, 5.00	0.8754
Sex:						
Male	1.78	0.79, 4.02	0.1662	0.78	0.26, 2.37	0.6666
Female	1.0			1.0		
Diet type:						
omnivore	1.0			1.0		
semi-vegetarian	2.18	0.73, 6.54	0.1648	1.55	0.43, 5.53	0.5011
vegetarian	3.74	1.17, 11.92	**0.0258**	2.25	0.61, 8.31	0.2250
vegan	1.44	0.48, 4.32	0.5121	0.72	0.19, 2.79	0.6346
Time in diet (months):						
0-24	1.0			1.0		
25-72	0.33	0.12, 0.91	**0.0320**	0.09	0.01, 0.79	**0.0293**
73-252	0.79	0.34, 1.86	0.5859	0.51	0.18, 1.48	0.2169
253-900	2.44	0.80, 7.42	0.1159	1.08	0.30, 3.85	0.9029

Table 12

Reduced model for multiple logistic regression analysis stratified for participants classified as low exercisers in terms of total minutes per week (n=224) showing odds ratios (ORs), 95% CIs, and p for overweight & obesity.

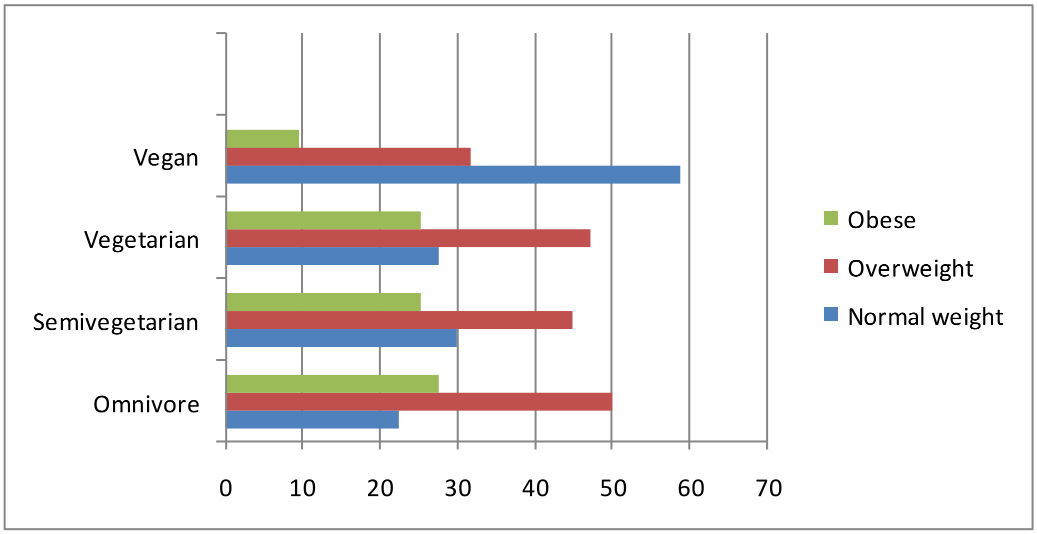
Independent Variable	**Overweight (BMI ≥ 25)**			**Obese (BMI ≥ 30)**		
	OR	**95% CI**	***P***	***OR***	**95% CI**	***P***
Age (y)						
18-24	1.0			1.0		
25-34	3.59	1.31, 9.82	**0.0128**	3.28	0.81, 13.20	0.0952
35-44	4.89	1.65, 14.47	**0.0041**	7.99	1.94, 32.82	**0.0040**
45-54	0.02	3.05, 26.69	**0.0001**	5.81	1.40, 24.04	**0.0152**
55-75	3.90	1.18, 12.91	**0.0254**	2.99	0.61, 14.59	0.1765
Sex:						
Male	1.41	0.70, 2.86	0.3407	2.13	0.98, 4.66	0.0570
Female	1.0			1.0		
Diet type:						
omnivore	1.0			1.0		
semi-vegetarian	0.72	0.28, 1.83	0.4889	0.69	0.25, 1.93	0.6795
vegetarian	0.76	0.31, 1.86	0.5460	0.77	0.29, 2.10	0.8696
vegan	0.54	0.22, 1.35	0.1910	0.23	0.07, 0.76	**0.0160**
Time in diet (months):						
0-24	1.0			1.0		
25-72	0.52	0.23, 1.17	0.1148	0.38	0.14, 1.03	0.0581
73-252	0.38	0.16, 0.90	**0.0267**	0.37	0.13, 1.06	0.0643
253-900	0.58	0.23, 1.45	0.2388	0.42	0.15, 1.15	0.0911

Summary of Findings

The results of this study indicate that vegans had a significantly lower percentage of overweight and obesity than omnivores, semi-vegetarians, and vegetarians (Figure 3). In addition to diet type, increasing age (up to 54), motivation to lose weight, eating when not hungry, eating too much, duration of time in diet, food preparation, fast food consumption, and reading nutrition labels were significant factors affecting the percentages of overweight and obesity.

Figure 3

*Percentage of normal, overweight, and obese among the four diet categories. Overweight significant at **p=0.0203**; obese significant at **p=0.0015**.*



Vegans had a significantly lower (***p=0.0007)*** mean (24.1485) and median (22.5830) BMI than did omnivores (M=28.7462;Mdn=25.1433), semi-vegetarians (M=26.0656;Mdn=24.5870), and vegetarians (M=26.2034;Mdn=24.3636). The mean BMI of vegetarians was slightly higher than semi-vegetarians however the median was lower (Figure 4).

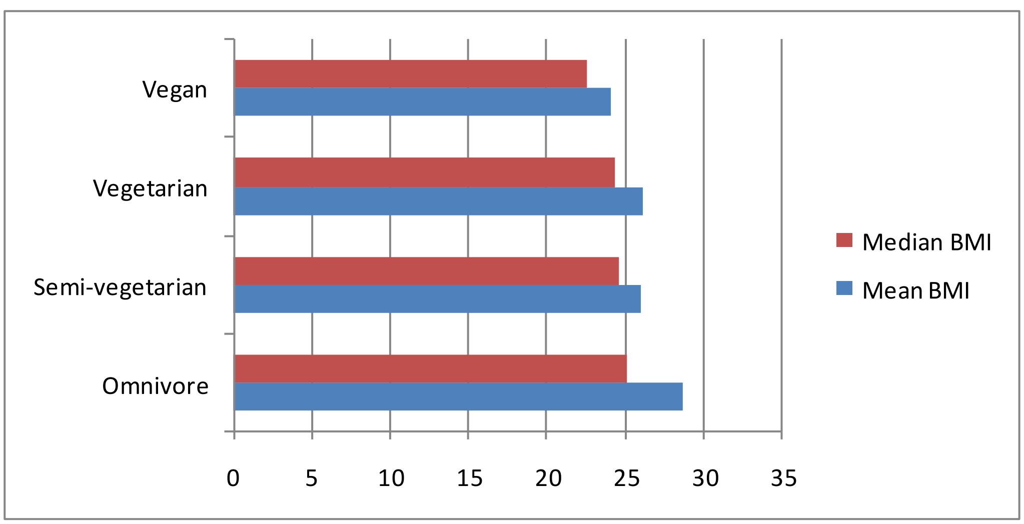
The original research question and hypothesis were untestable due to inadequate sample sizes. A combined group of semi-vegetarians and vegetarians had significantly higher percentages of overweight (***p=0.0103***) and obesity (***p=0.0004***) compared to vegans (Figure 5). However, these results must not be considered definitive.

Overweight and obesity are multi-faceted issues thus multiple logistic regression analysis was performed revealing that the odds of being overweight or obese were not significantly different among the four diet types (Figure 6). The odds of overweight and obesity were higher for vegetarians than omnivores in this sample (Figure 6). Increased age (up to age 55) and the consumption of fish and poultry significantly increased the odds of both overweight and obesity. The odds of overweight alone was significantly increased by being male; the odds of obesity was significantly greater in the highest level of income. Increased days drinking alcohol, motivation to lose weight, not eating too much or when not hungry were all significantly protective while binge drinking increased the odds of obesity.

Increasing the number of weekly grocery shopping trips significantly decreased the odds of obesity. Those citing health concerns or weight loss as their primary reason for practicing a diet were at significantly greater risk of overweight. Those practicing their diet in the mid-range (2-21 years) found it protective.

Figure 4

*Mean and median BMI among the four diet types significant at **p=0.0007**.*



Reduced logistic regression analysis demonstrated that a vegan diet was significantly protective against obesity in low level exercisers in terms of frequency and total minutes per week. Vegetarians exercising at high durations per week were at significantly higher of odds of being overweight.

The following chapter will provide an overview of the research, an interpretation of findings, and limitations of this study. Implications for societal change along with recommendations for action and further study will also be addressed.

Figure 5

Chi-square analysis comparing overweight & obesity between combined vegetarians & semi-vegetarians versus vegans. Overweight is statistically significant at ***p=0.0103*** *and obese at* ***p=0.0004***.

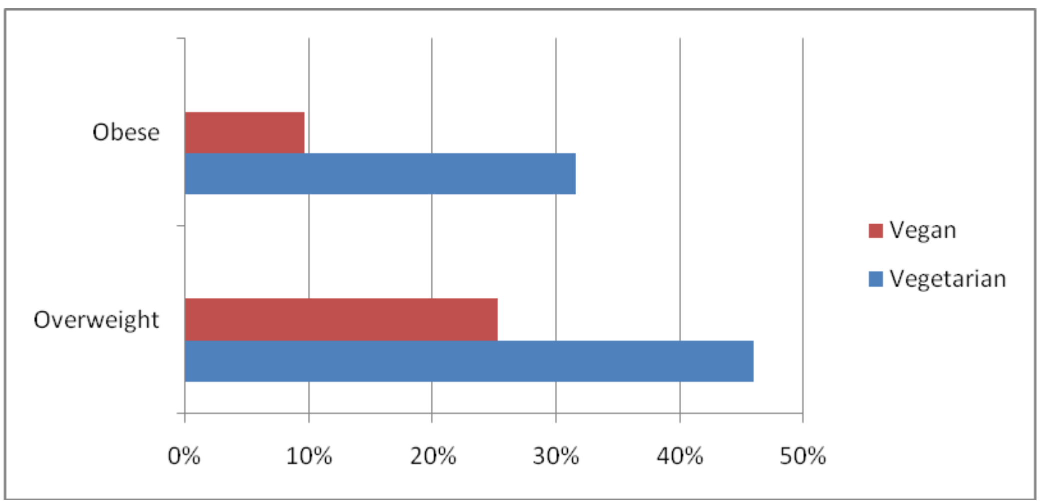
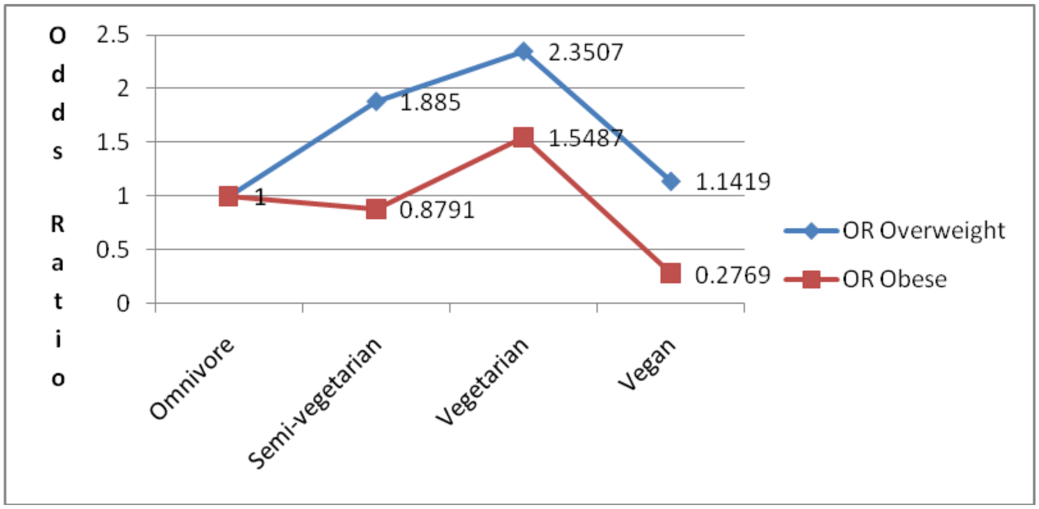


Figure 6

Odds ratios for overweight and obesity among the four diet types. Test of significance for overweight (p=0.3402 (semi), 0.9164(veg),0. 4062(vegan)) and obesity (p=0.8773(semi), 0.7640(veg),0.4678(vegan)).



Chapter 5: Discussion, Conclusions, and Recommendations

Overview

This was a quantitative, cross-sectional, online survey study addressing the risk of overweight and obesity in the vegetarian versus the vegan diet. Access to the 408 participants was gained primarily through social media outlets, vegetarian and vegan societies, publications, restaurants, and grocery stores, *Walden University Participant Pool* and employees at *Gateway Community College*, New Haven, Connecticut. Participation was voluntary, anonymous, and limited to individuals age 18 and over. The online survey was a modified version of the *BRFSS* survey and contained 34 questions addressing demographics, lifestyle, psychosocial, and dietary patterns.

Research was based upon components of the socio-ecological theory as it pertains to modifiable behavioral risk factors. An earnest attempt was made to include covariates salient to the multi-faceted issue of overweight and obesity.

Following careful data cleaning, analysis included descriptive statistics, chi-square analysis, and multi-variate and reduced multiple logistic regression analysis. The intent was to provide data on association and was not meant to imply causality.

The study revealed an association between diet type, level of exercise, and obesity. Several other demographic, lifestyle, and psychosocial covariates also demonstrated significant associations with overweight and obesity. The type of diet in conjunction with other covariates such as exercise may be a reliable predictor of overweight and obesity. A shift to a more plant-based diet may be a useful tool in maintaining a healthy BMI.

Interpretation Of Findings

The original research question asked whether or not there is a difference in the risk of overweight and obesity in vegetarian versus vegan diets. The H_o stated that there is no difference in the risk of overweight and obesity in the vegetarian versus vegan diet. Reduced power due to inadequate sample size rendered the research question and hypothesis untestable. Omnivores were included in data analysis to compensate for low power and the research question and hypothesis were modified. The revised research question was whether or not there is a difference in the odds of overweight and obesity in the omnivorous versus vegan diet. The revised H_o stated that there is no significant difference in the odds of overweight and obesity in the omnivorous versus vegan diet.

The results of this study indicate that the mean and median BMI of vegans was lower than omnivores, semi-vegetarians, and vegetarians. Reduced logistic regression analysis stratified for levels of exercise revealed that a vegan diet is significantly protective against obesity for low-level exercise in terms of frequency (OR=0.3063; p=***0.0204***) and total minutes per week (OR=0.2312; ***p=0.0160***). The significant positive trend between a healthy BMI and a reduction in the consumption of animal products coincided with prior studies (Spencer, Appleby, Davey, & Key, 2003; Haddad & Tanzman, 2003; Tonstad, Butler, Yan, & Fraser (2009); Newby, Tucker, & Wolk, 2004).

Participants in this study exhibited mean BMI well below national averages as well as lower numbers of overweight (68.0%) and obese (33.8%). Most of this was due to the significantly lower percentages exhibited by vegans (31.6%; 9.6%). Omnivores

(50.0%; 27.6%), semi-vegetarians (44.8%; 25.3%), and vegetarians (47.1%; 25.3%) were only slightly less overweight or obese than national averages.

Overall, demographic factors demonstrated little impact on the odds of overweight and obesity in this study. The percentages as well as the odds of overweight and obesity followed expected lines with respect to age with a gradual upward trend peaking at middle age followed by a drop-off in those over age 55. The odds of overweight were significantly higher in the 25-34 (OR=3.4045; ***p=0.0179***), 35-44 (OR=3.6113; ***p=0.0213***), and 45-54 (OR=5.6142; ***p=0.0073***) age groups when compare to 18-24 years old. The odds of obesity were also significantly higher in the 35-44 (OR=13.2135; ***p=0.0009***) and 45-54 (OR=9.1649; ***p=0.0124***) as compared to the 18-24 cohort.

The fact that males demonstrated significantly higher odds (OR=2.9149; ***p=0.0470***) of overweight than females may be a function of the relatively low number of men (20.3%) participating in the survey. The elevated odds (OR=1.1916; ***p=0.0055***) of obesity in the $50,000-74,999 income group and higher numbers of obese among suburbanites coincided with age-related trends.

The lack of a significant difference in the odds of being overweight or obese among diet types may have been due to a confounding effect of one or more covariates, possibly the emergent significance of alcohol consumption on two fronts. The number of days per month consuming alcohol was significantly protective for both 1-2 (OR=0.3299; ***p=0.0342***) and 3-30 (OR=0.2028; ***p=0.0085***) days drinking per month while binge drinking significantly increased the odds of obesity (OR=4.4421; ***p=0.0069***) compared to nondrinkers. These results coincide with the earlier findings of Arif & Rohrer (2005) who noted a diminished odds ratio associated with moderate alcohol consumption of up to two drinks per day (OR=0.73; 95%CI=0.55-0.97) and <5 drinks per week (OR=0.62; 95%CI=0.46-0.82) when compared to nondrinkers. The authors also noted increased odds of both overweight (OR=1.45; 95%CI=1.02-2.05) and obesity (OR=1.77; 95%CI=1.18-2.65) associated with binge drinking.

Rohrer, Rohland, Denison, & Way (2005) found similar results with individuals consuming alcohol 1-2 days per month (OR=0.61; ***p=0.074***) as well as $\geq$3 days per month found it protective against obesity (OR=0.49; ***p=0.037***). Binge drinking was not significantly associated with obesity perhaps owing to a small sample size.

No significant differences were noted between alcohol consumption and diet type in this study increasing the generalizability of this study to prior research not addressing diet type. Vegetarians and vegans had fewer days drinking per month than semi-vegetarians and omnivores but not significantly less (***p=0.1499***). The number of days per month spent binge drinking was similar (***p=0.4403***) among the four diet types. Newby, Tucker, & Wolk (2005) found significantly (***p<0.005***) lower alcohol consumption by vegans and vegetarians compared to omnivores as measured by grams/alcohol/day. The difference in findings may be a function of the fact that this study was limited to a population of Swedish women ages 57-91.

There is a wide range of vegan alcohol varieties, however it can be more difficult to ascertain the nature of alcoholic drinks than food choices. Depending upon the individual diligence of a vegan some may consume alcohol containing animal products creating a possible interaction between alcohol consumption and diet type and the odds of overweight and obesity when controlling for other covariates.

The impact of physical activity on BMI is well-documented in the previous literature when not accounting for diet type (Liebman et al., 2003). However, in studies where diet type is considered, the impact of physical activity appears to be diminished. While Spencer, Appleby, Davey, & Key (2003) noted a statistically significant impact of lifestyle factors including physical activity on the BMI of both males and females, methodology makes it impossible to tease out the individual effect as physical activity was combined with other lifestyle factors including smoking, education, marital status, and ethnicity. Tonstad, Butler, Yan, & Frasier (2009) found a decrease, albeit not significant, in BMI (OR=0.65; CI=0.58-0.72) as well as risk of Type II diabetes (OR=0.52; CI=0.47-0.58) concomitant with increasing levels of physical activity.

Vegans (32.6%) proved to exercise more frequently than omnivores (17.3%), semi-vegetarians (24.1%), or vegetarians (24.2%) but not significantly (***p=0.0657***). Vegans (54.4%) did significantly (***p=0.0170***) exercise at higher levels in terms of total minutes per week than omnivores (33.7%), semi-vegetarians (46.0%), and vegetarians (42.5%). However, when controlling for other covariates neither exercise times nor total minutes per week significantly impacted the odds of overweight or obesity.

The curious lack of a significant impact of physical activity compelled a reduced logistic regression analysis stratified for physical activity when controlling for age, gender, diet type, and time in diet. The only significant effect noted for high-level exercisers were a significantly higher odds of overweight (OR=3.7384; ***p=0.0258***) among high minutes per week vegetarians, possibly due to a low sample size (n=21). Low-level exercisers in terms of times (OR=0.3063; p=***0.0204***) and total minutes per week (OR=0.2312; ***p=0.0160***) found a vegan diet highly significant protection against obesity, modifying the effect of a vegan diet on BMI. The small number of vegans (n=0) indicating weight loss as a reason for their diet must be considered. It is possible that leaner individuals are more likely to adopt a vegan lifestyle. Having noted that, these results coupled with previous findings implies a positive interaction between a totally plant-based diet and a lack of physical activity on the odds of being obese. At the risk of providing an excuse not to exercise, individuals unwilling or unable to participate in physical activity on a regular basis may consider the choice of a vegan diet as a compensatory strategy to minimize their odds of obesity.

Participants strongly disagreeing (OR=0.0745; ***p=0.0000***), disagreeing (OR=0.0925; ***p=0.0000***), or somewhat agreeing (OR=0.1733; ***p=0.0000***) with the statement "I eat too much" found it significantly protective against overweight compared to those in agreement. Those strongly disagreeing (OR=0.2250; ***p=0.0557***), disagreeing (OR=0.2153; ***p=0.0121***), and somewhat agreeing (OR=0.2366; ***p=0.0073***) found it significantly protective against obesity as well.

Individuals that were moderately (OR=0.1446; ***p=0.0040***) or very (OR=0.1863; ***p=0.0064***) motivated to control their BMI found it strongly protective against obesity compared to the extremely motivated group. Compared to those admitting to often eating when they are not hungry, individuals claiming to rarely eating when not hungry found it significantly protective (OR=0.1307; ***p=0.0037***) against obesity. These relationships imply that stress eating and/or boredom may be a significant contributor to obesity and overweight.

As for reasons for their dietary choice, those indicating health concerns (OR=2.2462; ***p=0.0413***) and weight loss (20.4312; ***p=0.0003***) where at significantly higher odds of being overweight when compared to those choosing animal welfare. This draws comparison to diet type as the majority of vegans (56.6%) cited animal welfare as the primary reason for their choice of diet compared to 2.0% of omnivores. No vegans (0.0%) noted weight loss and only (19.9%) cited health concerns as their primary motivation contrasting with weight loss (15.3%) and health concerns (26.5%) cited by omnivores. Although their number was surprisingly small (n=24), those indicating weight loss as their primary reason had the highest percentage of obese (45.8%). What was unknown is whether an individual has significantly improved their BMI while on a specific diet type. Perhaps some obese individuals may have lost a significant amount of weight on their current diet yet remain obese by BMI. This raises a second issue of causality as to whether obesity was the motivation for the diet or if the diet was the reason for obesity. The nature of the cross-sectional study design precludes a definitive answer however, the data argue against reverse causality. The lower levels of overweight and obesity in vegetarians and especially vegans makes it unlikely.

As to the duration of time on a diet, the mid-range found it significantly protective of overweight compared to those in diet $\leq$ 2 years. Individuals practicing their diet for 25-72 (OR=0.4397; ***p=0.0477***) and 73-252 (OR=0.4017; ***p=0.0241***) months found their odds of overweight diminished. Individuals indicating shorter durations may be indicative of a weight loss diet. As a note of caution, it is possible that some omnivores currently on a special diet (e.g. weight loss) used this period as their response to the duration survey question thereby reducing the overall time spent in diet for this group. Further studies may wish to investigate the existence of a dose-response relationship between diet type and duration.

No significant associations were found between consumption of beef, dairy, eggs, fruits and vegetables, and fast food which was extremely low or nonexistent in vegans by definition. Those consuming fish and/or poultry between 1-10 days per month were at significantly higher odds of both overweight (OR=1.5922; ***p=0.0483***) and obesity (OR=2.3944; ***p=0.0017***) than those refraining from these foods. These findings may coincide with individuals attempting to maintain a healthier BMI through the consumption of more fish and poultry.

Frequent shopping for groceries was significantly protective against obesity as individuals shopping from 4-7 times per week found it significantly protective (OR=0.1227; ***p=0.0204***) compared to those making 0-1 trips per week. Upon face value this may seem curious, however it supports prior research (Frank, et al., 2009) indicating daily shopping trips is more supportive of a healthier BMI than buying large quantities in warehouse settings. Volume shopping lends itself to larger quantities of energy-dense, animal-based, and highly processed foods as well as increased accessibility to food in the home. Frequent shopping trips may result in fresher, healthier food choices. However, it is beyond the scope of this dissertation to imply that a plant-based diet inherently fosters consumption of a higher percentage of locally produced food nor improved food safety.

Limitations

The one-time cross-sectional design afforded the most expeditious, reliable, and valid method for obtaining prevalence data on overweight and obesity within a population of omnivores, semi-vegetarians, vegetarians and vegans. The nature of the cross-sectional design is that it provides only point prevalence, or the proportion of semi-vegetarians, vegetarians and vegans at risk of overweight and obesity at a single moment in time. The intention of this study was to provide data and analysis on association and does not purport to provide information on incidence nor evidence of causality (Checkoway, Pearce, & Kriebel, 2004).

The lack of power secondary to small sample sizes of vegetarians and vegans necessitated the inclusion of omnivores in data analysis. This rendered the original research question and hypothesis untestable and required revised versions of both. While this presents an inherent limitation, it in no way undermined the reliability or validity of the results.

One of the primary limitations inherent in the cross-sectional design is the susceptibility to information bias and confounding (Checkoway, et al., 2004). Concerns associated with information bias are two-fold; miss-perceptions surrounding semi-vegetarian, vegetarian and vegan diets and recall bias. There is a great deal of variability regarding practical definitions, especially vegetarian, that may range from elimination of beef all the way to eliminating all animal products including gelatin and honey and everything in between. Special attention was paid to survey design and definitions in an effort to properly categorize respondents based upon self-reported diet composition and frequency. Several respondents were re-categorized during the data cleaning process based upon responses to questions concerning the monthly consumption of beef, poultry, fish, dairy, and eggs.

Some respondents may have misinterpreted the meaning of the survey question pertaining to duration of diet. Several individuals listed short periods of time on a specific diet relative to their age, in particular omnivores. It is likely they interpreted the question at its face value in terms of a specific diet, possibly for health reasons, not as to how long have you been an omnivore. This may have resulted in reduced duration of diet during data analysis.

While online surveys have demonstrated reliability and validity (Andreyeva, Long, Henderson, & Grode, 2010; Kim, Y., Pike, J., Adams, J., Cross, D., Doyle, C., & Foreyt, J., 2010; Amarasinghe, D'Souza, Brown, Oh, & Borisova, 2009; Zhao, Ford, LI, & Mokdad, 2009; Ramsay, et al., 2008; Kilmer, et al., 2008), the potential for inaccurate responses to demographic questions is real. Recall bias stems from the ability of respondents to recall their psychosocial, lifestyle, and diet history with any degree of accuracy. As noted by McGuire & Beerman (2007), dietary assessment may be accomplished using either retrospective or prospective methods. In an effort to compensate for the limitations inherent in both, this study employed a retrospective approach focusing on general dietary intake and food frequency over a typical time period, e.g., "typically, how many times per month do you consume beef, poultry, and/or fish ?"

A second limitation is the threat of confounding stemming from the assumption that a vegan diet is inherently lower in energy. Clearly, a vegan is just as susceptible to over consumption of energy as a non-vegan. Adopting a vegan diet requires research and a commitment to mindful eating. Vegans may be more diligent versus non-vegans in monitoring energy intake independent of their dietary practice resulting in a lower BMI.

A third limitation is that the research design lended itself to selection bias. The targeting of vegans may have limited external validity and possibly resulted in a larger sample size of vegans relative to the other three groups. Vegans as well as members of the other three groups with normal BMI's may have been more likely to participate in the survey than those with higher BMI's as evidenced by the fact that the average BMI of participants in this survey was well below national averages. This may have resulted in skewed data and provide an artificially low prevalence of overweight and/or obesity.

Implications for Societal Change

The results of this study further emphasize the urgent need for a paradigm shift in dietary intake. As noted in chapters one and two, overweight and obesity and related health concerns are rapidly approaching epidemic levels in the US and abroad. In addition to the cost to both quality and quantity of human life it threatens to overwhelm in many cases already overburdened healthcare systems. This is a broad-based, multi-factorial issue but the results of this along with prior supporting research indicate that a diet based less upon animal products and other energy-dense foods may be one approach to dealing with this issue.

The accumulating evidence of the benefits of a plant-based diet provide an excellent opportunity for public health policy makers to facilitate a shift in the way the world looks at food and their dietary intake. Proponents of animal and highly processed foods claim it is the only way to feed a human population rapidly approaching seven billion. While an effective talking point, it is difficult not to take a cynical view of an idea promoted by an industry motivated primarily by profit. The dramatic changes in food production instituted over the 20th century were financially based with little concern for nutrition and health. Public health educators, policy makers, and practitioners must re-double their efforts to achieve the goals set forth in the Healthy People 2020 initiative.

Recommendations for Action

Broad-based change is often difficult especially on a national let alone on a global scale. Reversing current dietary trend is no small task. Governments can and should institute policy changes to limit the growth in animal products and highly processed foods so readily available in many cultures.

Government subsidies to factory farms and growers of corn should be reduced and reallocated to promote local farms. Programs such as *Women, Infants, & Children* (WIC) and the *Supplemental Nutrition Assistance Program* (SNAP), (formerly *Food Stamp Program*) are perfectly positioned to promote healthier eating among their constituents and their children. The SNAP could be modified to provide financial assistance towards the purchase of nutritious plant-based foods and not the relatively inexpensive, energy-dense foods commonly purchased with these funds today.

Infrastructure is necessary to support these changes. Providing financial support is critical but ineffective unless accompanied by places to spend it. As noted previously, access to healthy food choices is limited in many areas. It is incumbent on governments to support financial subsidies to the public with incentives to promote healthier alternatives in underserved regions.

These strategies must be employed in conjunction with informational and educational programs. The US Dietary Goals & Guidelines along with *MyPyramid* were an excellent beginning but the government must do more to make these instruments more users friendly to the general public. Since the beginning of this process*, MyPyramid* was replaced with a more user friendly program called *ChooseMyPlate* in June, 2011. The US Department of Agriculture (USDA) 2010 United States Dietary Guidelines and the 2011 *ChooseMyPlate* address moving to a more plant-based diet to manage weight and improve health. *ChooseMyPlate*, which is based upon the 2010 USDG, clearly depicts an understandable graphic which prominently highlights the inclusion of more fruits, vegetables, and grains with less emphasis on animal products such as meat, dairy, and eggs in the daily diet.

The *ChooseMyPlate* graphic is a useful tool in public health education that should be prominently displayed in school cafeterias, grocery stores, restaurants, and community and daycare centers. Programs such as *ChooseMyPlate* must become an integral part of the educational process beginning with preschoolers. The media has proven to be an effective tool in shaping modifiable behaviors including dietary choices, e.g., "*Got Milk?"* and *"Beef, it's what's for dinner!"* A public health campaign can be equally effective in promoting healthier eating and weight management. Companies and organizations who wish to promote a healthy life style will benefit from the useful graphic as well as the supporting information on the *ChooseMyPlate* web site. The evidence based supporting information at the website will allow users to personalize their diet and to include fewer animal products while emphasizing more high fiber fruits, vegetables, and whole grains as well as monitoring activity to attain and maintain a healthy BMI. *ChooseMyPlate.gov* offers personalized, interactive diet planning to assist Americans in making healthier, plant based food choices. While *ChooseMyPlate* represents an advance in graphic depiction of the American plate, like *MyPyramid*, it still requires online access to fully benefit from diet information and planning.

Recommendations for Further Study

Further research of this kind should include a more detailed review of energy, nutrient, and food group intake of participants. This would help delineate the specific contribution of diet type to BMI. A categorization of alcohol consumption into beer, wine, and liquor would be useful in assessing the protective nature of moderate alcohol consumption demonstrated in this study. A more precise stratification of physical activity, e.g. metabolic equivalent (METs) would clarify the interaction between physical activity and diet type.

The results of this and other studies of its kind indicate a need for further research in the form of case-control and/or cohort studies. While the cross-sectional format provides an expeditious means to assess prevalence at a specific point in time it is limited to identifying possible associations but not causality. Sufficient evidence now exists of an association between a vegan diet and a reduction in the number of overweight and obese to justify further research to assess causality.

The prospective cohort study represents the "gold-standard" of epidemiological research. A study of this kind would follow a cohort of vegans (unexposed) and non-vegans (exposed) and assess the incidence of overweight and obesity over a period of time. However, the prospective cohort study is tedious and potentially expensive thus short of that, a case-control study would provide an excellent next step in the progression of dietary assessment. Either method would begin the process of assessing causality and possibly evidence to fuel public health policy decisions to affect a paradigm shift in the ways the public views food and ultimately their dietary choices. A passive approach is no longer adequate to quell the epidemic of overweight and obesity and associated health concerns. The time has arrived for practitioners of public health to assume an aggressive approach to establishing causality between dietary choices and obesity much like the manner in which it approached cigarette smoking and lung cancer.

Conclusions

Prior research comparing the odds of overweight and obesity among various diet types were found wanting. Individuals considering lifestyle changes to reduce their risk require empirical data to make informed decisions. The results of this research demonstrated a clear association between diet type and mean and median BMI as well as the percentage of overweight and obese among a well-diversified group of 408 participants. Similar to prior studies of this kind, the number of overweight and obese inversely correlated with the consumption of animal-based products. Low level exercisers in terms of frequency and duration found significant protection from obesity while practicing a vegan diet.

The use of a modified, online version of the reliable and valid BRFSS survey speaks to internal validity. While the nature of the study focused primarily on vegetarians and vegans, access to the survey was broad-based and results coincided with prior research thus they should be considered generalizable to larger populations.

The results of this research coupled with those of prior studies of this nature provide empirical data of a compelling enough to justify further study of a more exhaustive nature. Short of this, the results stand alone in providing an option for those seeking an effective method of maintaining a healthy BMI and limiting their exposure to the myriad health issues associated with overweight and obesity.

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Appendix A: Literature Matrix

Dependent Variable: Overweight & Obesity

Independent Variable: Dietary Quality & Food Frequency

Study	Sample	Design	Findings
(Al-Rethaiaa, Fahmy, & Al-Shwaiyat, 2010).	357 male college students, age 18-24	Random, cross-sectional survey, Kingdom of Saudi Arabia DV = BMI, VFL, %BF IV = freq. meals consumed at home, snacks, dates.	BMI (p=0.005) and VFL (p=0.007) and the frequency of eating with family, BMI and consumption of snacks (p=0.018), VFL and consumption of dates (p=0.013). 22% of students were overweight and 16% obese. The infrequent consumption of fruits (32%) and vegetables (36%) was common with the exception of dates (61%).
Arif & Rohrer (2005)	8,236 non-smoking male & female adults	NHNESurvey DV= overweight & obesity IV=alcohol consumption	Odds of obesity was 0.73 for current drinkers ($\leq$2 drinks/day) when compared to non-drinkers. Three drinks per day had a higher risk of both overweight (OR=1.40) and obesity (OR=1.07) as did those consuming four (OR=1.30 & 1.46). One or two drinks per day had a diminished risk of both overweight (OR=0.71 & 0.46) and obesity (OR=0.83 & 0.59) respectively. Binge drinkers had a significantly higher risk of overweight (OR=1.45) and obesity (OR=1.77) as well. Consumption of less than five drinks per week resulted in a reduced risk of obesity (OR=0.62) as compared to non-drinkers.
Borders, Rohrer, & Cardarelli (2006)	5, 078 adults	Self-reported survey data from 2003 Texas BRFSS DV= obesity IV = residence, economic & educational status	Male OR=1.27 and adjusted OR=1.63 to females. Rural and suburban males (OR=1.81, P<0.001) than urban males as was the crude rate for females (OR=1.37, P<0.05). Males of moderate economic status OR=1.43, P<0.05) compared to males of lower socioeconomic status. Females of higher socioeconomic status OR=0.37, P<0.0001) and adjusted (OR=0.45, P<0.0001) risk of obesity when compared to females of lower SES.
Gueorguiev, et al., (2009)	1,275 obese & 1,059 normal weight	German cohort study. DV = obesity IV = ghrelin SNPs	GHSR variant (rs572169) and obesity (*p*=0.007; *OR*=1.73) and rs2232169 and overeating (*p*=0.02). Ghrelin variant (rs4684677) and obesity (*p*=0.009) in obese families, rs26747 and glucose levels (*p*=0.009).

Gummesson, et al. (2007).	Molndal Metabolic Study (n=92) and their own very low calorie diet (VLCD) study (n=24),	Cross-sectional and a population-based study. DV = BMI, BMR IV = CIDEA SNPs	Significant negative correlation between CIDEA gene expression and BMR (r = -0.22; p=0.042) as well as BMI (r = -.60; p<0.01). During the 18 week VLCD study, there were 1.9 (p<0.0001) and 2.4-fold (p<0.0001) increases in CIDEA expression respectively after 8 and 16 weeks.
Haddad & Tanzman, (2003)	13,313 non-vegetarians (12,979) & vegetarians (334) $\geq$ age 6 from CSFII survey study.	Continuing Survey of Food Intake by Individuals, 1994-96, 1998 conducted by USDA DV = overweight & obesity IV = vegetarian & non-vegetarian diet	Self-defined vegetarians $\geq$ age 20 had significantly lower BMI and energy intake (P<0.001) than self-identified non-vegetarians that ate meat independent of meat consumption. The mean BMI of participants age $\geq$ 20 self-identified as non-vegetarian was 26.1 and 25.6 kg/m^2 for meat and non-meat consumers respectively. Mean BMI for self-identified vegetarians in the same age group was 23.9 and 22.8 kg/m^2 for meat and no-meat eaters respectively.
Liebman, et al., (2003)	928 males and 889 females, aged 18-99, living in rural communities throughout Wyoming, Idaho, and Montana	Cross-sectional, Wellness IN the Rockies survey. DV = BMI IV = Dietary intake, eating patterns & physical activity	Age was not a significant predictor of the risk of overweight or obesity. Males (70%) were significantly more overweight (p=0.0001) but not obese (p=0.22) as compared to females (59%). Males and females at significantly greater risk for overweight (BMI $\geq$ 25 kg/m^2) & obesity (BMI $\geq$ 30 kg/m^2) when consuming sweetened beverages ($p=0.0006$; p=0.0143), watching television (p=0.0050; p=0.0017), and the self-assessment of need for increased physical activity (p=0.001; p=0.0001). Significant associations were also noted between obesity and ordering supersized portions (p=0.0035), eating while engaged in other activities (p=0.0003), and response to a composite of energy-belief questions (p=0.0116).
Muller, et al. (2010)	521 obese children & parents, 235 independent obese participants.	Trio and independent obese family studies. DV = obesity IV = FAAH SNPs	Significant association was noted between a genetic variant (rs2295632) of FAAH and early onset obesity (p=0.045) in trio study. No such association was noted in 235 independent obese families (p=0.32). Combined groups found (n=603) two significant associations (rs2295632, p=0.03; rs324420, p=0.02) with early-onset obesity. No significant associations were found between any of the FAAH variants and adult obesity.

Newby, Tucker, & Wolk (2005)	55, 459 women born between 1914 & 1948. Omnivorous (n=54,257), semi-veg (960), lacto-veg (159), vegan (83)	Swedish Mammography Study, 1987-1990, 67 item food frequency. DV= obesity IV= vegetarian or vegan diet	Omnivores significantly heavier (66.9 kg) & higher BMI (24.7 kg/m^2) than three vegetarian groups (P<0.05). Prevalence rates for overweight & obesity (BMI $\geq$25 kg/m^2) was 40%, 29%, and 25% for omnivores, semi-vegetarians & vegans, and lacto-vegetarians. Omnivores demonstrated significantly higher energy (P<0.005)and protein (P< 0.0003) intakes and significantly lower carbohydrate intakes (P< 0.001). Protective of overweight & obesity, vegans (OR=0.35), semi (0.52), & lacto (0.54). Small n of 3 veggie groups, no males, older females.
Rohrer & Rohland, (2004)	Convenience sample of 274 women > age 18	Cross-sectional survey, family planning clinic. DV =obesity IV = exercise, mental health status, stress, social support, & demographics	Prevalence of obesity moderately associated with a lack of parental ((P=0.0542) and spousal (P=0.1607) support, significantly with a lack of support from children (P=0.0390). No significant associations were noted between anxiety (P=0.6064), depression (P=0.1944), nor stress from parents (P=0.0988), spouse (P=0.8084), or children (P=0.1285). Increasing number of individuals in the home (P=0.0047), decreasing levels of education (P=0.0060), being married (P=0.0183), and decreasing income levels (P=0.0328) were all significantly associated with obesity. No significant associations were noted between days of exercise per week and obesity (P=0.3857). Multiple regression analysis to assess the risk of obesity found lack of parental support significantly associated with obesity (AOR=2.17, P=0.0420) as was living in homes with four or more (AOR=4.05, P=0.0089). Falling within $10,000 to $20,000 was protective (AOR=0.4864, P=0.0267) compared to women in the < $10,000 income category.
Rohrer, Rohland, Denison, & Way. (2005)	747 adults from 3 community medicine clinics	Cross-sectional convenience DV = obesity IV = alcohol consumption	Number of days consuming alcohol (P=0.001) and drinks (P=0.010) per month inversely associated with obesity. Consumption of alcohol three or more days per month demonstrated a decreased risk of obesity (OR=0.49, P=0.037) than non-drinkers. Binge and daily drinkers were less likely to be obese.

Rohrer, Vickers-Douglas, & Stroebel (2009)	944 primary care patients	Random sample survey. DV = obesity IV = uncontrolled eating	47% of respondents reported uncontrolled eating, 42.2% of which were obese by BMI. Over 70% of obese patients and 37% of normal weight individuals admitted having at least some difficulty controlling their eating. Only 9.4% of those reporting no difficulties with uncontrolled eating were found to be obese by BMI. Over 27% of non-obese individuals reported no difficulties controlling consumption while 9.4% of obese patients reported the same. Patients having some or no control over food consumption demonstrated a strong independent association with obesity (OR=6.67, P=0.000).
Rossell, Appleby, & Key. (2004)	6,234 omnivorous men and 23,645 women, 125 (M) & 265 (F) lifelong vegetarians, age 1-9, 76 (M) 7 264 (F), age 10-14, 121 (M) & 1,077 (F), age 15-19, 564 (M) & 2,332 (F), & $\geq$ 20, 3,122 (M) & 8,137 (F).	EPIC-Oxford cross-sectional survey, 1993-1999 data from Britain. DV=BMI IV = meat & fish eaters, & vegetarians and age on onset.	No significant difference between BMI of lifelong vegetarians and becoming vegetarian $\geq$ age 20. Males adopting the vegetarian diet between ages 1-9 and non-vegetarians were an average of 3.2 kg (p<0.05) and 3.0 kg (p<0.001) heavier than those becoming vegetarian $\geq$ 20. This trend was also apparent in BMI with corresponding differences of 1.2 kg/m^2 (p<0.01) and 0.9 kg/m^2 (p<0.001) respectively. Mean body weight of females was significantly higher in those becoming vegetarian between ages 1-9 (+1.5 kg; p<0.05), ages 10-14 (+1.0 kg; p<0.05), and omnivorous women (+2.2kg; p<0.001). The same applied to BMI for those becoming vegetarian between ages 1-9 (+0.3 kg/m^2; p<0.01) as well as non-vegetarians (+0.7 kg/m^2; p<0.001).
Rosskopf, et al. (2007)	4,310	SHIP cross-sectional survey, Germany, DV = obesity IV = INSIG2 SNPs	Normal weight (mean *BMI*=27.26): no significant association between the gene variant (p=0.6531) nor was the odds ratio (*OR*=1.13; p=0.1782 Overweight and obese (mean *BMI*=29.94) participants found significant associations between homozygous and carriers of rs7566605 (p=0.0068) and BMI as was the odds ratio (*OR*=1.32; p=0.0378).
Sabate & Wien (2010)	N/A	Meta-analysis DV = Childhood & adult BMI IV = Vegetarian diets	Reduced weight of 7.6 kg for men and 3.3 kg for women consuming vegetarian diets versus omnivores resulting in a lower BMI (2 kg/m). Childhood difference in BMI more significant during adolescence.

Salsberry & Reagan (2009)	422 Mex-Amer, 2,090 whites, & 1,195 Afr-Americans, age 14-21 in 1979	Cross-sectional, US Nat'l Longitudinal Survey of Youths, 1979-2002. DV = midlife obesity IV = economic & educational status	Childhood and adult socioeconomic status was found to be a predictor of midlife obesity in a cohort of white & Mexican-American women. Among the 442 Mexican-American women, those with parents having less than a high school education had a higher adjusted risk of midlife obesity (OR=1.89) than those with at least a high school diploma as did those in the bottom third income level (OR=3.87). Women with less than a high school education were found at reduced risk of midlife obesity (OR=0.36). White women (n=2,090) had a higher adjusted risk of midlife obesity when using low parental education (OR=1.52), but there was no effect from own education. Low (OR=1.74) and middle (OR=1.42) income adults had a significantly higher risk of midlife obesity than the top income group. There were no significant adjusted risk factors among African-American (n=1,195) women. Limit: low Mex-American sample & self-reported data.
She, Li, Zhang, Graubard, & Li (2010)	6,930 respondents	Cross-sectional survey. DV = obesity IV = ADRB2 SNPs	No significant trend of association (p=0.618) between the ADRB2 allele and obesity.
Spencer, Appleby, Davey, & Key, (2003)	37, 875 healthy men & women, aged 20-97 in Europe	EPIC-Oxford cross-sectional survey, 1993-1999 data. DV=BMI IV = meat & fish eaters, vegetarians, & vegans, smoking, education, sex, age, physical activity, marital status, ethnicity.	Mean BMI of both men (24.49 kg/m^2) and women (23.69 kg/m^2) meat-eaters were significantly higher than male (22.34 kg/m2) and female (21.75 kg/m2) vegans (p<0.01). Mean BMI was reduced, but remained significant when adjusting for lifestyle factors such as such as smoking, physical activity, education, physical activity, etc. Dietary factors most associated with increasing BMI were high protein (% calories) and low fiber. Mean BMI for male (23.29 kg/m2) and female (22.60 kg/m^2) fish-eaters as well as male (23.28 kg/m^2) and female (22.51kg/m^2) vegetarians was significantly higher than vegans and significantly lower than meat-eaters (p=0.01) when adjusted for age and lifestyle factors.
Stray-Pederson, et al. (2009)	2,156 Norwegian & 669 Argentine fem 15-18	Cross-sectional survey, questionnaire	Obesity strongly associated with systolic hypertension in both groups with OR=11.4 and 28.3 in Argentine & Norwegian girls respectively.

Tonstad, et al. (2009)	22,434 males and 38,469 females, members of Adventist Church, ≥ age 30	Survey, 50 question food-frequency, Adventist Health Study 2002-06 DV = BMI, Type II Diabetes. IV=Diet quality	Significant differences between the BMI and risk of type 2 diabetes between omnivores and several classifications of vegetarians. Mean BMI of vegans (23.6), lacto-ovo vegetarians (25.7), pesco-vegetarians (26.3), semi-vegetarians (27.3), and non-vegetarians (28.8), ($P<0.0001$). Type 2 diabetes prevalence rates for BMI ≥ 30 kg/m^2 and BMI < 30 kg/m^2 respectively for vegans (8.0, 2.0), lacto-ovo vegetarians (9.4, 2.1), pesco-vegetarians (10.4, 3.3), semi-vegetarians (11.4, 3.7), and non-vegetarians (13.8, 4.6), ($P<0.0001$). All vegetarian diets were protective of type 2 diabetes when compared to the non-vegetarian diet: vegan (OR=0.51), lacto-ovo vegetarians (OR=0.54), pesco-vegetarians (0.70), and semi-vegetarians (0.76) when adjusted for several demographic and socioeconomic factors including BMI. Risk factor declined when BMI was eliminated: vegan (OR=0.32), lacto-ovo vegetarians (OR=0.43), pesco-vegetarians (0.56), and semi-vegetarians (0.69). Questionable generalizability, no physical activity.
Weinrich, et al, (2007)	204 Southern US, African-American males	Cross-sectional, BDSSFI survey during prostate cancer education & screening. DV = overweight & obesity IV = daily intake of fats, vegetables & fruit	34% overweight & 47% obese. 81% consumed fried chicken, 67% fish, 33% left the skin on when preparing chicken. Butter on bread, (79%) or grits (92%), and 19% ate vegetables cooked with butter, regular salad dressing (71%), 32% used butter, margarine, or sour cream on potatoes, 62% consumed low-fat cheese and 70% used low-fat or skim milk. Few ate cooked vegetables with dinner (29%) or lunch (16%) and fruit consumption was mostly limited to snacking (77%) but fruit juice intake was high (90%). Leaving the skin on chicken ($p=0.03$), intake of low-fat or skim milk ($p=0.02$), and cooking vegetables with butter ($p=0.03$) were significantly associated with BMI. No significant differences were noted between normal weight and obese men in the consumption of fried potatoes ($p=0.15$) but the consumption of baked, boiled, or mashed potatoes was significantly higher ($p=0.03$) among the overweight & obese. Daily consumption of fruit was inversely associated with overweight & obesity ($p<0.01$). Many (86%) of the obese men reported changes in their diet over the past year. Regression analysis demonstrated that dietary change is a significant predictor or drinking skim milk ($P=0.0013$). The addition

			of BMI to the analysis revealed that categories of BMI are not significant predictors of skim milk consumption however changes in diet remained significant (p=0.003).
Ziraba, Fotso, & Ochako, (2009)	19,992 women from 7 Sub-Saharan, African countries	Cross-sectional, Demographic & Health Surveys, 1992-2005. DV = overweight& obesity IV = time between surveys, education, & household wealth	Prevalence of overweight/obesity increased 35% among urban females over the survey period. The increase was most significant among the poorest demographic (50%) and least educated (45-50%) lowest among the wealthiest (+7%) and most educated (-10%). Using multivariate analysis, the prevalence of overweight & obese increased between surveys in urban areas (OR=1.05, P<0.01) resulting in a 5% annual increase. Women from the wealthiest demographic (OR=3.20, P<0.01) as well as those with secondary or higher education (OR=1.59, P<0.05) were more likely to be overweight/obese than their poorest and less educated counterparts. Working women demonstrated a higher risk than non-working women as well (OR=1.13, P<0.01). Limit: women, no physical activity, no dietary quality, definition of urban/rural.

Appendix B:

Consent Form for Online Survey

CONSENT FORM

You are invited to take part in a research study assessing the risk of being obese and/or overweight while adhering to a vegetarian versus a vegan diet. You were chosen for the study because you have identified yourself as a vegetarian or vegan adult age 18 or older. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part. This study is being conducted by a researcher named Daniel Sullivan, who is a doctoral student at Walden University.

Background Information:
Overweight and obese are defined by Body Mass Index (BMI) which examines weight in relation to height. Overweight and obese are associated with an array of health risks including cardiovascular disease, metabolic syndrome, diabetes, and certain cancers. The purpose of this study is to discover whether the risk of obesity is different for persons following several types of vegetarian and vegan diets.

Procedures:
If you agree to be in this study, you will be asked to complete the anonymous, online survey as honestly and accurately as you can. Completion of the survey should require approximately 10-15 minutes. Please note, only surveys in which all questions have been answered will be used.

Voluntary Nature of the Study:
Your participation in this study is voluntary. This means that everyone will respect your decision of whether or not you want to be in the study. No one at Walden University will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind during the study. Please note, only surveys in which all questions have been answered will be used. If you do not wish to answer a question, please feel free to discontinue your participation in the survey. Please feel free to discontinue participation at any time should you feel stressed or for any other reason(s).

Risks and Benefits of Being in the Study:
There are no inherent risks associated with participation in this study. The results of this study will contribute to a better understanding of the differing risk of overweight and obesity with respect to the individual pursuit of a vegetarian or vegan diet and will be made available to participants at the Vegetarian/Vegan Group study site on *Facebook*.

Compensation:
No compensation will be provided for completion of the survey.

Confidentiality:
Any information you provide is anonymous. The researcher will not use your information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in any reports of the study.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via daniel.sullivan@waldenu.edu or 2032852181. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-800-925-3368, extension 1210. Walden University's approval number for this study is **#04-29-11-0115072** and it expires on **April 28, 2012.**

Please feel free to print a copy of this form for your own records.

Statement of Consent:

In order to protect your privacy, no consent signature is requested. Instead, please click here to begin the survey if you consent to anonymously participate in the study as described above.

The survey may be accessed by clicking on the following link:

https://www.surveymonkey.com/s/FJVXJGC

Appendix C:

Cross-Sectional, Online, Self-Reported, Anonymous, Survey to Measure Diet Quality of Omnivores, Vegetarians, and Vegans. Created in *SurveyMonkey.*

1. What was your age on your last birthday?

2. Are you male or female? (drop-down male/female)

3. How tall are you in inches?

4. What is your weight in pounds?

5. What is your highest level of education completed?

- less than high school graduate
- high school graduate or GED
- some college or 2 year degree
- four year college graduate
- graduate degree

6. Which of the following best represents your annual household income?

- less than $25,000
- $25,000 - 39,999
- $40,000 - 49,999
- $50,000-74,999
- greater than $75,000

7. What is your current marital status?

- single
- married
- divorced
- widow
- widower

8. Which of the following best describes your residence?

- urban
- rural
- suburban

9. How many people live in your household including yourself?

10. How many times in the past week did you exercise for 20 minutes or more, with intensity sufficient to breathe heavily or raise your heart rate?

11. How many minutes did you spend in moderate exercise (e.g. weight training, cardiovascular, gardening, etc.) during the past week?

12. How many cigarettes do you smoke on a typical day?

13. How many days do you consume alcoholic beverages during a typical week?

14. How many days during the past month did you consume 5 or more alcoholic drinks?

15. How many days during the past month have you felt worried, tense or anxious?

16. How motivated are you to control your weight?

- not at all motivated
- somewhat motivated
- moderately motivated
- very motivated
- extremely motivated

17. How strongly would you agree or disagree with the statement, "I eat too much"?

- strongly disagree
- disagree
- somewhat agree
- agree
- strongly agree

18. How often do you eat when you are NOT hungry?

- never
- rarely
- sometimes
- often
- very often

19. Which of the following best describes your dietary habits?

- omnivore
- semi-vegetarian
- ovo-vegetarian
- lacto-vegetarian
- ovo-lacto-vegetarian
- vegan
- not sure
- do not know

20. Which of the following best represents your reasons for practicing the diet identified in Question #19?

- religious beliefs
- health concerns
- weight loss
- environmental concerns
- animal welfare
- other (please specify)

21. Which of the following best represents your primary source of information relating to the dietary choice identified in Question #19?

- physician or healthcare provider
- internet sources
- print media
- religious practices
- family member or friend
- other (please specify)

22. How long have you been currently practicing this diet?

23. How many days did you consume beef during the past month?

24. How many days did you consume poultry or fish during the past month?

25. If you consume beef, fish, or poultry, how is it typically prepared?

- boiled
- baked
- broiled
- fried
- n/a

26. How many days did you consume dairy products during the past month?

27. How many days did you consume eggs during the past month?

28. How important is it to you to consume beef, poultry, or fish?

- not important at all
- somewhat important
- moderately important
- very important
- extremely important

29. How many servings of fruits &/or vegetables do you typically consume each day?

30. How many fast food meals do you typically consume each week?

31. How many times per week do you shop for groceries?

32. When I shop at the grocery store, I routinely read ingredient lists and nutrition facts. (drop-down yes/no)

33. How convenient is the nearest grocery store to your home?

- very inconvenient
- somewhat inconvenient
- convenient
- very convenient
- extremely convenient

34. How convenient is the nearest farmer's market to your home?

- very inconvenient
- somewhat inconvenient
- convenient
- very convenient
- extremely convenient

Appendix D:

Advertisement to solicit respondents for the survey to be posted in restaurants and health food stores:

Attention Vegetarians & Vegans

Your participation in an anonymous, cross-sectional survey study is requested.

As part of a Doctoral Dissertation at Walden University, the

study is designed to assess the risk of overweight and obesity

in vegetarian versus vegan diets.

Survey may be accessed directly at: https://www.surveymonkey.com/s/FJVXJGC

Or through the Vegetarian/Vegan Group site on Facebook at:

http://www.facebook.com

Results may be accessed via the *Facebook* site.

Your participation is greatly appreciated!

Appendix E:

Curriculum Vitae

Daniel Sullivan
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Objective

PhD in Public Health with a concentration in Epidemiology at Walden University.

Professional Experience

Gateway Community College, New Haven, Connecticut 06511, Sept. 1992 – Present.
Professor, Biology
Primary teaching responsibilities include didactic and laboratory preparations for 3 sections per semester of BIO235, Microbiology. I am also responsible for one section of BIO113, Physiology of Aging taught during winter and summer sessions.

Middlesex Community College, Middletown, Connecticut 06457, Sept. 1987 – 1994.
Instructor, Biology
Primary teaching responsibilities included didactic and laboratory preparations for Microbiology, Anatomy & Physiology and General Biology.

Education

Master of Public Health, (MPH). (2004). University of Connecticut, Storrs, Connecticut, 06268
Master of Science (MS), Zoology. (1985). Rutgers University, Newark, New Jersey, 07102
Bachelor of Science (BS), Biology. (1981). Ramapo College of New Jersey, Mahwah, New Jersey, 07430

Additional Experience

2009-present, Assessment Task Force, Gateway Community College, New Haven, Connecticut, 06511.
2004 - 2006, Faculty Co-Chair, NEASC Accreditation, Gateway Community College, New Haven, Connecticut, 06511
1999 - 2008, Chairperson, Curriculum Issues Committee, Gateway Community College, New Haven, Connecticut, 0651