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Sleep Duration Associated with Cardiovascular Conditions among Adult Nevadans

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SLEEP DURATION ASSOCIATED WITH

CARDIOVASCULAR CONDITIONS

AMONG ADULT NEVADANS

By

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Abstract

Cardiovascular disease (CVD) is the leading cause of mortality in the United States accounting for 1 out of every 3 deaths. Additionally, 43.9% of the population is expected to have some form of cardiovascular disease by the year 2030, with direct and indirect costs expected to rise upwards of 58 percent. To successfully prevent cardiovascular disease conditions such as myocardial infarction, coronary heart disease, and stroke, research must be done to identify risk factors, both modifiable and non-modifiable. In the existing literature, sleep duration as a risk factor for cardiovascular disease conditions has shown inconsistent associations. According to the National Sleep Foundation, the average adult needs between 7 and 9 hours of sleep per day, yet 50-70 million adults in the U.S. have some form of chronic sleep disorder. Furthermore, both short and long sleep duration is associated with known cardiovascular disease risk factors such as diabetes, hypertension, obesity, high cholesterol, depression, and overall metabolic dysfunction. This study aimed to determine if an association exists between deficient, and/or excessive sleep duration and myocardial infarction, coronary heart disease, and stroke, in the state of Nevada. The 2013 Behavioral Risk Factor Surveillance System (BRFSS) for the state of Nevada was assessed utilizing multiple logistic regression analysis in order to quantify risk. Results from the multiple logistic regression identified a total of twelve predictors of cardiovascular conditions in the final model. It was also determined that both deficient and excessive sleep duration was significantly associated with myocardial infarction, coronary heart disease or angina, and stroke, throughout the study, even after adjustment for covariates. The findings from this study can be used as additional evidence to encourage further research on improving sleep by developing future treatment therapies, and recommendations, that may help lower the risk of cardiovascular disease conditions.

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Introduction

Cardiovascular disease, also termed heart disease or heart and blood vessel disease, is caused by an increase of plaque in the arteries. Plaque accumulation is termed atherosclerosis, a condition in which plaque builds up and narrows the arteries over time causing blood flow to be restricted. This restricted blood flow can lead to high blood pressure and blood clots, eventually causing angina, coronary heart disease, myocardial infarction, and/or strokes (American Heart Association, 2014). Angina, also known as chest pain, occurs when the area of the heart muscle doesn't get enough oxygen-rich blood due to lack of blood flow. Angina can feel similarly to pressure or squeezing inside the chest and is usually a symptom of coronary heart disease. Coronary heart disease (CHD) arises when plaque accumulates specifically inside the coronary arteries, and denies oxygen-rich blood to the heart (National Heart, Lung, and Blood Institute, 2011). Since coronary heart disease is chronic in nature, it progresses into atherosclerosis over time.

Myocardial infarction, or MI, is a technical term for 'heart attack' that occurs when blood supply to the myocardium i.e. heart muscle, is stopped (Bolooki & Askari, 2014). The causes for its cessation may be lack of blood flow, obstruction by a clot, or a plaque causes an artery to rupture. The end result of a diminished blood supply to the heart is cell death causing irreversible damage. Lastly, stroke or 'brain attack', occurs when the flow of oxygen rich blood is blocked causing brain cell death. During an ischemic stroke, an artery to the brain becomes blocked or obstructed by clots, whereas during a hemorrhagic stroke, an artery within the brain ruptures or leaks blood (National

Heart, Lung, and Blood Institute, 2014). Both types of strokes frequently cause paralysis of the face, arms, or legs, as well as vision loss, and difficulty with speech. Understanding cardiovascular disease and the various conditions it causes is essential for prevention of such debilitating, irreversible, life-long symptoms.

Background

Cardiovascular disease (CVD) is the leading cause of mortality in the United States accounting for 1 out of every 3 deaths (Go et al., 2014). Cardiovascular disease encompasses many vascular conditions such as myocardial infarction, coronary heart disease or angina, and stroke. Approximately 84 million American adults have 1 or more cardiovascular disease conditions with an estimated 42.2 million of these individuals aged 60 years or older (Go et al., 2014). Prevalence estimates for cardiovascular disease conditions in 2010 include: myocardial infarction with 7.6 million (2.9%) affected individuals, coronary heart disease with 15.4 million (6.4%) affected individuals, and stroke with 6.8 million (2.8%) affected individuals (Go et al., 2014). New, and recurrent stroke prevalence is estimated at 795,000 individuals with mortality at 129,476 individuals for 2010 (Go et al., 2014).

In 2010, direct and indirect costs of cardiovascular disease and stroke equaled $315.4 billion in the United States, and it is estimated these health expenditures and lost productivity costs will continue to rise with the aging population (Go et al., 2014). Broken down, approximately $193.4 billion goes to direct costs including cost of physicians, hospital services, medications, and home health care; $122.0 billion goes to indirect costs, specifically loss of future productivity from early death (Go et al., 2014).

Furthermore, incidence and morbidity of cardiovascular disease conditions are increasing for this cohort with estimates suggesting 43.9% of the population of the United States is expected to have some form of cardiovascular disease by the year 2030. Additionally, both direct and indirect costs will increase substantially by 2030 with estimations upwards of 58% (Go et al., 2014). Direct costs from 2012-2030 are expected to rise to $918 billion with the majority attributed to hospital costs; furthermore, indirect costs will rise to $290 billion. Based on economic cost alone, primary prevention is critical for cardiovascular conditions, especially myocardial infarction, coronary heart disease or angina, and stroke (Charles & Zhang, 2012; Goldstein et al., 2011).

To successfully prevent cardiovascular disease conditions such as myocardial infarction, coronary heart disease, and stroke, research must be done to identify risk factors e.g., modifiable and non-modifiable, that may precede these diseases. Established risk factors in the literature include: age, low birth weight, race/ethnicity, genetic factors/family history, obesity, gender, high blood pressure, diabetes, high cholesterol, unhealthy diet, physical inactivity, tobacco use, alcohol abuse, and depression (Grandner, Sands-Lincoln, Pak, & Garland, 2013; Hoevenaar-Blom, Kromhout, Berg, Spijkerman, & Verschuren, 2011; Sabanayagam & Shankar, 2010). Non-modifiable risk factors include age, race/ethnicity, and genetics/family history. Modifiable risk factors may include both co-morbid e.g. high blood pressure, diabetes, high cholesterol, depression, obesity; and behavioral factors e.g. unhealthy diet, physical inactivity, tobacco use, and alcohol abuse.

Prevalence risk factor statistics for age, gender, and cardiovascular conditions are as follows: for those aged 35-44 years, 3 per 1000 men will experience their first cardiovascular event versus, 74 per 1000 men aged 85-94 years old (Go et al., 2014). Although, women have similar rates with a 10 year delay, this disparity declines with increasing age. Furthermore, women have a higher proportion of events attributed to stroke, prior to 75 years of age, with men having an increased proportion of cardiovascular disease events caused by coronary heart disease. Cardiovascular prevalence statistics for race/ethnicity have established that Blacks have a higher prevalence of coronary heart disease (6.5%), hypertension (32.9%), and stroke (2.5%), compared to whites (6.1%, 22.9%, and 2.5% respectively) (Go et al., 2014). Concerning genetics/family history, the likelihood of a person having a heart attack increases with one or both parents having a heart attack and if they were younger or older than 50 years. For example, an individual with both parents who've had a heart attack younger than 50 years of age are 6.56 times more likely to have a heart attack compared to those with no family history (OR= 6.56, CI=1.39, 30.95) (Go et al., 2014). Prevalence statistics in the United States for selected modifiable cardiovascular risk factors are as follows: approximately 78.4 million or 34.6% of adults in the U.S. are obese, and 98.9 million or 43.4% have high cholesterol. Prevalence rates of high blood pressure is estimated at 77.9 million or 33.0% U.S. adults with n=63,100 mortalities; 19.7 million or 8.3% adults have diabetes mellitus i.e. type II diabetes, with n=69,071 mortalities attributed to this disease (Go et al., 2014). Comparatively, 42.1 million or 18.1% of U.S. adults currently use tobacco, and an estimated 16 million (6.9%) suffer from depression.

Additionally, other modifiable risk factors not well established in the literature show inconsistent associations is of particular interest. For instance, epidemiological studies have observed strong associations with obstructive sleep disorders (OSD) and cardiovascular diseases indicating obstructive sleep apnea (OSA), and sleep disordered breathing (SBD), may be strong risk factors (Al Lawati, Patel, & Ayas, 2009; Arzt, Young, Finn, Skatrud, & Bradley, 2005; Butt, Dwivedi, Khair, & Lip, 2010; Wallace, Ramos, & Rundek, 2012). Most notably, insufficient sleep was linked to numerous chronic diseases, and conditions. With more than one third of the United States population reporting less than 7 hours of sleep per night on average, deficient sleep may be associated with cardiovascular diseases and/or its conditions (CDC Fact Sheet, 2013).

According to the National Sleep Foundation, the average adult needs between 7 and 9 hours of sleep per day, yet in 2008, 28% adults in the United States reported having deficient sleep (MMWR, 2011). It's estimated that 50-70 million adults in the U.S. have some form of a chronic sleep disorder, such as chronic insomnia, sleep talking or walking, sleep apnea, narcolepsy, and restless leg syndrome (MMWR, 2011). Almost one third of adults have additionally reported getting insufficient sleep the previous 14 days or more in the past 30 days. Ineffectual sleep can cause many negative side effects and can potentially be dangerous by increasing the risk of falling asleep at the wheel. Other potential dangers from inadequate sleep duration include causing an individual to have an increased BMI, and may potentially increase ones risk for depression, substance abuse, type II diabetes, and heart problems (National Sleep Foundation, 2014). Further research is needed to provide evidence for the effects sleep duration can cause, whether it be deficient or excessive sleep (not in the average 7 to 9 hour range per night). This research will provide some evidence towards if an association truly exists between sleep duration and cardiovascular disease conditions.

Literature Review

In the current literature, both quality of sleep, and sleep duration studies have not observed consistent associations, and have shown uncertain causality with cardiovascular conditions such as myocardial infarction, coronary heart disease or angina, and stroke. Studies specifically for the state of Nevada are sparse, and are only included in conjunction with other states e.g. multi-state, population-based studies. These multi-state, population-based studies have shown short, and long sleep duration, is associated with known cardiovascular risk factors such as diabetes, hypertension, obesity, high cholesterol, depression, and overall metabolic dysfunction (Buxton & Marcelli, 2010; Hoevenaar-Blom et al., 2011; Khawaja, Sarwar, Albert, Gaziano, & Djoussé, 2013; Krueger & Friedman, 2009; Liu, Wheaton, Chapman, & Croft, 2013;). Additionally, deficient and excessive sleep deficiencies have shown associations with respiratory disorders, and overall, poor self-rated health (Aggarwal, Loomba, Arora, & Molnar, 2013). However, less is known specifically about sleep duration, and its relation to cardiovascular diseases and its conditions, not its risk factors (Harvard Health Letter, 2013).

Various studies have assessed associations between sleep duration versus sleep insufficiency and cardiometabolic outcomes, general sleep disturbance and cardiovascular diseases, daytime sleepiness as a risk factor for CVD, and sleep duration, quality and CVD morality among the elderly (Altman et al., 2012; Grandner, Jackson, Pak & Gehrman, 2012; Gangwisch et al., 2014; Suzuki et al., 2009). Short and long sleep duration have both been variably cited as potential risk factors for cardiovascular diseases, yet an assorted studies repetitively state uncertain association and causality. A prospective and meta-analysis study examined short sleep duration, and cardiovascular disease; results found that those who slept less than 6 hours were not at risk for cardiovascular disease after adjustment, yet were at risk for incident type II diabetes (Holliday, Magee, Kritharides, Banks, & Attia, 2013). Another study showing less consistent results, found sleep duration as an independent risk factor for cardiovascular disease, and mortality for women, but not for men (Kronholm, Laatikainen, Peltonen, Sippola, & Partonen, 2011).

Furthermore, inconsistent findings among studies have shown differing risks between sleep duration and various cardiovascular disease conditions. A cohort study in Sweden found short sleep duration to only be associated with myocardial infarction, whereas stroke was not significant (Westerlund et al., 2013). Conversely, a cohort in the United States found an association between short sleep duration and only stroke (Ruiter Petrov, Letter, Howard, & Kleindorfer, 2014). According to Aggarwal et al. (2013), short sleep duration was associated with stroke, myocardial infarction, and congestive heart failure, whereas more than 8 hours of sleep was associated with coronary artery disease and angina. Moreover, deficient and excessive sleep were both found to be associated with myocardial infarction and stroke in a study by Altman et al. (2012). Although these studies found associations between various cardiovascular disease conditions, as stated previously, the study by Holliday et al. (2013), a combined meta-analysis and prospective cohort, found short sleep duration was not a risk for cardiovascular disease after adjustment, and only for diabetes mellitus. The uncertain association between sleep duration and cardiovascular disease conditions in the literature shows the need for more confirmatory studies, specifically prospective cohort studies, in order to determine a true relationship.

Research Objectives

Given this ambiguity of the literature, this cross-sectional, population-based study utilizes the chronic health data from the 2013 Nevada Behavioral Risk Factor Surveillance System which includes data on cardiovascular disease conditions such as myocardial infarction, coronary heart disease or angina, and stroke. The primary objective of this study is to investigate the association between deficient and/or excessive sleep duration and myocardial infarction, coronary heart disease or angina, and stroke (i.e. cardiovascular disease conditions in adult Nevadans). The second objective of this study is to identify which demographic, co-morbid, and behavioral variables are associated with the combined cardiovascular condition variable. Once the significant variables from each of these groups have been identified, the significant variables will then be re-analyzed with the cardiovascular condition variable. Lastly, the remaining significant variables and deficient sleep (4 hours or less) and/or excessive sleep (10 hours or more) was determined to be associated with a cardiovascular condition i.e. myocardial infarction, coronary heart disease or angina, and stroke.

Research Questions

Research Question #1: Is deficient sleep duration significantly associated with myocardial infarction, coronary heart disease or angina, and stroke (cardiovascular condition variable)?

Hypothesis #1:

H_O= Deficient sleep duration is not associated with myocardial infarction, coronary heart disease or angina, and stroke

H_A= Deficient sleep duration is associated with myocardial infarction, coronary heart disease or angina, and stroke

Expected Outcome:

It is expected that deficient sleep duration will be significantly associated with myocardial infarction, coronary heart disease or angina, and stroke.

Research Question #2: Is excessive sleep duration significantly associated with myocardial infarction, coronary heart disease or angina, and stroke (cardiovascular condition variable)?

Hypothesis #1:

H_O= Excessive sleep duration is not associated with myocardial infarction, coronary heart disease or angina, and stroke .

H_A= Excessive sleep duration is associated with myocardial infarction, coronary heart disease or angina, and stroke .

Expected Outcome:

It is expected that excessive sleep duration will be significantly associated with myocardial infarction, coronary heart disease or angina, and stroke.

Research Question #3: Which demographic, co-morbid, and/or behavioral factors are significantly associated with myocardial infarction, coronary heart disease or angina, and stroke (cardiovascular condition variable)?

Hypothesis #1:

H_O= There are no demographic, co-morbid, and/or behavioral factors associated with myocardial infarction, coronary heart disease or angina, and stroke

H_A= There are is at least one demographic, co-morbid, and/or behavioral factors associated with myocardial infarction, coronary heart disease or angina, and stroke

Expected Outcome:

It is expected that one or more demographic, co-morbid, and/or behavioral factors will be significantly associated myocardial infarction, coronary heart disease or angina, and stroke.

Methodology

Study Design and Sample

This study is a cross sectional, population-based study, that utilizes the 2013 Nevada Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is a state-based, random-digit dialed telephone survey that collects descriptive and health-related data annually in the United States. The health-related data obtained from the BRFSS includes risk behaviors, chronic health conditions, and the use of preventive services. Throughout the year, a standardized core questionnaire, along with optional modules, and state-added questions, are administered to willing participants.

Administration of the standardized core questionnaire takes approximately 18 minutes, with an additional 5 to 10 minutes for additional modules and state-added questions. Management of the BRFSS by the state is achieved by way of a multi-faceted collaboration with various entities including the Centers for Disease Control (CDC), state health department agencies, telephone call centers, and participating universities. State health personnel or contractors conduct interviews by following specific rubric and guidelines given by the BRFSS. In-depth details on the data, collection, documentation, and methodology of the BRFSS survey may be found on the Centers for Disease Control website.

The study population asked to participate in the BRFSS are adults aged 18 years or older, are voluntary participants who have the option to refuse or elect to complete the telephone survey, and are not institutionalized or incarcerated in care homes, outpatient facilities, or prisons. The survey utilizes both landline telephones as well as cellular phone as of 2011. The BRFSS goal is to capture at least 4,000 interviews annually per each state. For the intended study year of 2013, the BRFSS obtained a total sample size of N=491,773 for all 50 states, in addition to British Columbia, and three U.S. territories. Completed interviews were estimated at N=433,220 whereas, N=58,553 were partial interviews. For this study, the state of Nevada in 2013 achieved a sample size of N=5,101; approximately 1.04% of the total sample size of the BRFSS.

Variables

To obtain the dependent variable for a cardiovascular disease (CVD) condition, three dichotomous variables were combined. These dependent variables (DV) include: heart attack, coronary heart disease or angina, and stroke (Appendix A). The three variables are defined as yes, or no, with the questions following the format "Has a doctor, nurse or other health professional ever told you that you had any of the following?", and "Ever told you had …a heart attack, coronary heart disease or angina, a stroke?" The dependent variables were transformed into one variable; if the survey participant said yes to having any of these three variables, they were considered having a cardiovascular disease condition.

The independent variables (IV) incorporated into the analysis were divided into three individual models for the purpose of running a multiple regression model. These three models include a demographic model, a co-morbid model, and a behavioral model.

Furthermore, a final significant variable model was ran with all of the significant variables determined from the previous models in order to reduce collinearity bias.

The independent variables (IV) in the demographic model include: sex, race/ethnicity, age, marital status, education, and health insurance coverage. The variable 'sex' is dichotomous and is defined as male or female. The variable 'race' is categorical and characterized as white, black, Hispanic, other race and multi-racial. Other race is defined as those of Asian or Native Hawaiian/ Pacific Islander, American Indian/Alaska Native, descent. 'Age' is categorical and was grouped by 18-34 years, 35-44 years, 45-64 years, and 65 years and older. 'Marital status' is categorical and characterized as married, divorced, widowed, separated, never married, and a member of an unmarried couple. Never married and a member of an unmarried couple were combined. 'Education' is categorical and grouped by did not graduate high school, graduated high school, attended college or technical school, and graduated college or technical school. 'Health insurance coverage' is dichotomous and is defined as yes or no for being currently covered by any health insurance or coverage plans.

The independent variables (IV) in the co-morbid model include: hypertension, high cholesterol, diabetes, depression, and BMI. The variable 'hypertension' or as having high blood pressure is dichotomous and is defined as yes or no with the question "Ever told you have high blood pressure". The variable 'high cholesterol' is dichotomous and is defined as yes or no with the question "Ever told you have high cholesterol". The variable 'diabetes' is dichotomous and is defined as yes or no with the question "Ever told you have diabetes". The variable 'depression' is dichotomous and is defined as yes or no with the question “Ever told you have a depressive disorder including depression, major depression, dysthymia, or minor depression”. The variable ‘BMI” was re-coded from a categorical variable to a dichotomous variable. BMI was then defined as adults who are obese or adults who are under, normal, or overweight.

The independent variables (IV) in the behavioral model include: inadequate sleep, cigarette smoking, heavy drinking, physical activity, and diet. The variable ‘inadequate sleep’ is continuous and is defined as number of hours with the question “On average, how many hours of sleep do you get in a 24 hour period”. Sleep duration was then re-coded as a categorical variable with four categories: 1-4 hours of sleep, 5-6 hours of sleep, 7-9 hours of sleep, and 10-18 hours of sleep. The cutoffs for sleep duration were decided based on the inconsistencies of sleep duration in the literature. The most effectual average amount of sleep per night is defined as 7-9 hours by the National Sleep Foundation, and therefore, it was intuitive to cutoff at 6 and 10 hours. The subgroup 1-4 hours and 10-18 hours are considered extreme sleep patterns, versus the subgroup 5-6 hours which has been unpredictably grouped with 7-9 hours in various literatures. Therefore, separating 5-6 hours of sleep, and 7-9 hours of sleep, follows the guidelines from the National Sleep Foundation, the leading educational and scientific non-profit organization for sleep education and advocacy.

The variable ‘cigarette smoking’ is dichotomous and is defined as yes or no with the question “Do you smoke every day and/or some days or not at all”. Cigarette smoking was re-coded by the BRFSS into a categorical variable with three categories: never smoked, former smoker, and current smoker. The variable ‘heavy drinking’ is dichotomous and asks how often men and women indulge in alcoholic drinks per day. If adult men answered two or more drinks per day and/or adult women answered one or more drinks per day, these participants were labeled as ‘yes’ to heavy drinking. If they did not meet the alcohol drink standard of two or more per day for men or one or more per day for women, they were labeled as ‘no’. The variable ‘physical activity’ is categorical and defined as meeting both aerobic and strength recommendations, meeting only aerobic recommendation only, meeting strength recommendation only, and did not meet either recommendation. The variable selected for diet was ‘dark green vegetable intake per day’. This variable is continuous and poses the question ‘ During the past month, how many times per day, week or month did you eat dark green vegetables for example broccoli or dark leafy greens including romaine, chard, collard green or spinach?”. A computed variable for the daily intake of dark green vegetables was derived.

Weighting the Sample

Beginning in 2011, cellular telephones were added to the sample to maintain generalizability, coverage, and validity in the BRFSS. Due to the inclusion of both cellular and landline telephones in the sample, the CDC changed from the statistical method of post stratification (utilized since the 1980’s) to a new weighting method called iterative proportional fitting, or raking. Post stratification allowed data to be weighted to known proportions of age, race, ethnicity, sex, and geographic region within a population. Raking, the new weighting technique utilized, is more advantageous by allowing the incorporation of more demographic variables into the weighting process such as education level, marital status, and home ownership; in addition, the weighting methodology may now incorporate landline and cellular telephone use, thus reducing bias and increasing generalizability in the sample. Ideally, groups that are underrepresented in the sample were more accurately represented after raking adjusted the data set.

To continue, unweighted data violates assumptions by assuming all individuals have an equal probability of being selected from the population and individuals who did not respond were the same to those who did respond. These violation of assumptions were found to greatly affect data sets, and therefore, weighting each individual record is needed to adjust for this. For a state population, such as Nevada, weighting adjusts for both non-response individuals, and individuals who were not covered. In addition, it makes the cases secured equal to the population estimates for each of the geographic regions. Without this, the data sample collected annually cannot be generalized to the main population.

For 2013, the weighted raking methodology is comprised of both design weight and raking; design weight reduces bias due to the unequal probability of selection by setting values to 1, and raking adjusts for demographic differences between persons who are sampled and the populations from which the samples came from. Design weight is calculated by using the weight of each geographic stratum, the number of landline phones within a household, and the number of adults who use those phones. Cell phone participants utilize the same equation except that the number of landline phones within a household and the number of adults who use the phones are set to 1. To further explain, cell phone participants are identified during the design weighting process as being a 1 adult and 1 phone household, whereas a landline participant could have more than 1 adult and more than 1 phone in a household.

Design weight takes into account the number of phones in a household, the number of adults in a household the number of available records, and the number of records selected within each geographic strata and density strata. Before the design weight can be calculated, the stratum weight (_STRWT) must be calculated within each geographic strata (_GEOSTR) and density strata (_DENSTR). Weighting variables and their complete definitions can be found in Appendix C.

STRWT= NRECSTR/NRECSEL

STRWT= Stratum weight

NRECSTR = number of available records

NRECSEL= number of records selected

Design weight = STRWT * (1/NUMPHON2) * NUMADULT

STRWT = Stratum weight

NUMPHON2 = Number of landline phones within a household

NUMADULT = Number of adults who use the landline phones within a household

_LLCPWT = the final weight assigned to each respondent

Statistical Analysis

Data from the 2013 BRFSS was analyzed using the statistical software SPSS version 20 with an add-on for complex samples. A sample plan was then created to use complex samples and three weighting variables from the data set were selected. These three weighting variables include: _STSTR, _PSU, and _LLCP_WGT and were placed into the categories of Strata, Cluster, and Weight, respectively.

Descriptive analysis of frequencies and cross tabs by Rao Scott χ^2 test were run. The Rao Scott χ^2 test is an adjusted chi-square that is utilized to compare weighted percentages and shows which independent variables have different distributions for the dependent variable. The Rao Scott χ^2 test statistics include: an adjusted Pearson chi-square, a Likelihood ratio, an adjusted F, degrees of freedom, and significance set at $p < 0.05$. Multiple logistic regression, similar to linear regression, was utilized to describe the relationship between the outcome variable and independent variables. Moreover, it's well-suited for models where the outcome variable, or dependent variable, is dichotomous. A stepwise or "block" approach was implemented during analysis; the models described earlier under 'Variables' were delineated as individual blocks. Each block will have the combined cardiovascular condition variable as its outcome variable, and the independent variables will be divided into a demographic block, a co-morbid block, a behavioral block, and a final significant variable block. The grouping of these factors into individual blocks is based on the perception of modifiable and non-modifiable risk factors for cardiovascular disease and its conditions. Applying the block approach to the multiple logistic regression analysis will also decrease the chance of flooding the models i.e. the kitchen sink effect, and reduce collinearity bias among variables. Furthermore, merging the cardiovascular conditions i.e. myocardial infarction, coronary heart disease or angina, and stroke, into one binary dependent variable allows for a more robust sample, and increases the power of the analyses. Odds ratios (OR) and confidence intervals (CI) are obtained from the multiple logistic regression model with significance set at $p < 0.05$, and 95% CI. Lastly, the cut off for variable inclusion in the final significant model was $p < 0.095$ in regression analyses.

Prior to this research, CITI Human Subjects: Social and Behavioral Research training, and Center for Online Medical Education and Training (COMET) through Cleveland Clinic was completed. Additionally, the BRFSS data were de-identified prior to analysis. For the BRFSS survey, informed consents were not collected during the telephone interview due to the de-identification process. For states with add-on modules regarding questions for children, informed consent is needed. This thesis did not analyze questions from these childhood add-on modules. The BRFSS data set is available for public use on the Centers for Disease Control website and is exempt from the UNLV Institutional Review Board (IRB).

Results

Demographics

The data set for the state of Nevada identified a total of N=5,102 individuals who participated in the 2013 BRFSS. Of the 5,102 individuals who participated, n=2,195 were reportedly male with a weighted percent of 50.2%, whereas n=2,907 were female with a weighted percent of 49.8% (Table 1). Those aged 45-64 years old consisted mostly of the sample with a weighted 33.9%, followed by those aged 18-34 years old with a weighted 30.4%. Both those aged 35-44 years, and 65 years or older, did not exceed one fifth of the sample (17.6%, 18.1% respectively). The majority of participants were white with a weighted 56.1%; Hispanics came in second with a weighted 24.4%. Over half of the participants of the survey were married (50.4%), whereas participants identifying as never married consisted of more than a quarter (26.8%). Approximately one-third of the sample attended college or technical school, closely followed by individuals graduated high school only (33.6%, and 29.5%). As for health insurance, an overwhelming majority of those whom participated in this study had some form of insurance, whether it was government or private, with a weighted 94.7%, while only 5.3% reported no health insurance (Table 1).

Table 1: Descriptive Statistics for the State of Nevada, BRFSS 2013 (N=5,102)			
Variable		Unweighted (n)	Weighted %
Gender			
	Male	2195	50.2%
	Female	2907	49.8%
Age			
	18-34 years old	895	30.4%
	35-44 years old	631	17.6%
	45-64 years old	1915	33.9%
	65 years and older	1607	18.1%
Race			
	White	3744	56.1%
	Black	187	7.7%
	Other race	259	9.9%
	Multi-racial	218	1.9%
	Hispanic	611	24.4%
Marital			
	Married	2480	50.4%
	Divorced	912	13.4%
	Widowed	618	6.6%
	Separated	129	2.8%
	Never Married	930	26.8%
Education			
	Did not graduate High School	356	17.1%
	Graduated High School	1375	29.5%
	Attended College/Tech School	1728	33.6%
	Graduated College/Tech School	1626	19.9%
Insurance			
	Yes Insurance	4727	94.7%
	No Insurance	327	5.3%

From the 2013 BRFSS sample, only 4.4% of participants reported having a myocardial infarction (MI) event, while the majority of participants (95.6%) did not. Less than 4% of the sample were diagnosed by a physician or health care provider with coronary heart disease or had angina; 96.6% had neither conditions (Table 2). Nearly 3% of the sample reported a stroke event, whilst the remaining did not (2.9% versus 97.1%).

These combined dependent variables to make the dichotomous ‘cardiovascular condition variable’ allowed for a more robust sample, with approximately 8.4% of the sample reporting as having one of the above conditions (n=499), and less than 92% as having none of these conditions (n=4463) (reported in Table 2).

The prevalence of selected co-morbid risk factors for the state of Nevada can be found in Table 3. Of the 5,102 individuals who participated, n=3,176 reported as having normal blood pressure (68.8%), versus n=1,1915 reported as having high blood pressure (31.2%). For high cholesterol, 38.6% responded yes, whereas a weighted 61.4% responded as having normal cholesterol levels. Ten percent of participants were diagnosed with diabetes, while the vast majority of the sample (89.7%) was non-diabetic. Similarly, those suffering from a depressive disorder accounted for less than one fifth of the population (17.6%) (Table 3). Participants identified as being under weight, normal weight, or over weight made up almost three fourths (73.8%), in conjunction with obese participants whom made up slightly more than a quarter (26.2%) of the sample.

The prevalence of selected behavioral risk factors for the state of Nevada can be found in Table 4. For physical activity, 38.5% of individuals did not reach either aerobic or strength recommendations, followed by 29.5% whom met aerobic recommendations only. Individuals who met both recommendations for aerobic and strength accounted for 22.8% of the sample, and lastly, 9.3% only met the strength recommendations (Table 4). For tobacco smoking, more than half of the sample reported never smoked (58.1%), and both former, and current smokers accounted for nearly a fourth each (22.5%, 19.4% respectively). As for heavy consumption of alcohol, 93.0% of the sample were purportedly not heavy drinkers, with the remaining 7.0% reporting consumption of more than two alcoholic beverages per day on average. Sleep duration, the variable of interest in this study, had a prevalence of 61.8% individuals who sleep 7-9 hours on average, followed by 31.5% who sleep 5-6 hours. Both outlying sleep duration hours e.g. 1-4 hours, and 10-18 hours, accounted for less than 7% of the sample (3.8%, and 2.8% respectively).

Table 2: Prevalence of Dependent Variables and Combined Outcome Variable for the State of Nevada, BRFSS 2013 (N=5,102)

Variable	Unweighted (n)	Weighted %
Myocardial infarction (MI)		
No MI event	4768	95.6%
Yes MI event	314	4.4%
Coronary heart disease (CHD) or angina		
No CHD or angina	4782	96.6%
Yes CHD or angina	281	3.4%
Stroke		
No stroke event	4865	97.1%
Yes stroke event	218	2.9%
Combined Cardiovascular (CVD) Condition variable		
No CVD condition	4463	91.6%
Yes CVD condition	599	8.4%

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke.

Table 3: Prevalence of Selected Co-morbid Factors for the State of Nevada, BRFSS 2013 (N=5,102)

Variable	Unweighted (n)	Weighted %
Blood Pressure		
No high blood pressure	3176	68.8%
Yes high blood pressure	1915	31.2%
Cholesterol		
No high cholesterol	2439	61.4%
Yes high cholesterol	1798	38.6%
Diabetes		
No diabetes	4537	89.7%
Yes diabetes	551	10.3%
Depression		
No depressive disorder	4129	82.4%
Yes depressive disorder	947	17.6%
BMI		
Under/normal/over weight	3633	73.8%
Obese	1239	26.2%

Table 4: Prevalence of Selected Behavioral Factors for the State of Nevada, BRFSS 2013 (N=5,102)		
Variable	Unweighted (n)	Weighted %
Physical Activity		
Met aerobic and strength rec.	970	22.8%
Met aerobic rec. only	1390	29.5%
Met strength rec. only	323	9.3%
Did not meet either rec.	1603	38.5%
Dark Green Vegetable intake per day		
Continuous variable	N/A	N/A
Sleep Duration		
1-4 hrs of sleep	185	3.8%
5-6 hrs of sleep	1478	31.5%
7-9 hrs of sleep	3183	61.8%
10-18 hrs of sleep	190	2.8%
Smoking		
Never smoked	2643	58.1%
Former smoker	1454	22.5%
Current smoker	888	19.4%
Heavy Drinking		
No heavy drinking	4509	93.0%
Yes heavy drinking	384	7.0%

Rao-Scott Adjusted χ^2

The Rao Scott adjusted chi-square examined the significance of relationships between the dependent cardiovascular condition variable e.g. myocardial infarction, coronary heart disease or angina, and stroke, and various independent variables. Table 5 highlights which independent variables show a statistically significant difference in the proportion of individuals who have had a cardiovascular condition. Of the demographic variables, age, race, marital status, and insurance had significantly different proportions; gender, and education were not statistically significant (p=0.286, and 0.336, respectively). Of the co-morbid variables, all variables except BMI (p=0.090), reached statistical significance including high blood pressure, high cholesterol, diabetes, and depression (p value < 0.05). Sleep duration, smoking, and physical activity are the behavioral variables that reached significance (Table 5). Heavy drinking was approaching statistical significance (p=0.065), as well as daily intake of dark green vegetables (p=0.088).

Table 5: The Rao-Scott adjusted χ^2 for Cardiovascular Conditions and Selected Factors including Demographic, Co-Morbid, and Behavior Variables

		χ^2		P
Demographic Variables	Age	49.23	G-statistic	0.0001
	Gender	1.140	χ^2	0.286
	Race	4.742	G-statistic	0.001
	Marital status	14.247	G-statistic	0.0001
	Education	1.122	G-statistic	0.336
	Insurance	18.476	χ^2	0.0001
Co-morbid Variables	High blood pressure	172.089	χ^2	0.0001
	High cholesterol	53.128	χ^2	0.0001
	Diabetes	69.72	χ^2	0.0001
	Depressive Disorder	25.128	χ^2	0.0001
	BMI	2.867	χ^2	0.090
Behavior Variables	Sleep duration	10.439	G-statistic	0.0001
	Smoking	15.367	G-statistic	0.0001
	Heavy drinking	3.395	χ^2	0.065
	Physical activity	5.009	G-statistic	0.002
	Dark green vegetables	1.375	G-statistic	0.088

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke.

Furthermore, the Rao-Scott adjusted chi-square gives additional information including the estimated sample size and percent of each variable for those that did or did not have a cardiovascular condition. For the variable ‘age’, of those that had a CVD condition, 3.7% were aged 18-34 years, 10.5% were aged 35-44 years, 37.7% were aged 45-64 years, and 48.1% were aged 65 years and older (Table 6). For the variable ‘gender’, of those that had a condition, 53.8% were male, and 46.2% were female. For the variable ‘race’, of those that had a condition, 67.2% are white, 10.6% are black, 5.8% are identified as other race, 2.1% are multi-racial, and 14.3% are Hispanic.

Continuing with co-morbid variables, of those who had a cardiovascular condition, 71.6% have high blood pressure, 63.3% have high cholesterol, 28.7% are diabetic, 30.9% suffer from a depressive disorder, and 31.4% are obese (Table 6). Additionally, of those participants who had reported a CVD condition, only 15.3% met the aerobic and strength recommendations, 28.5% met the aerobic recommendation only, 6.0% met the strength recommendation only, and 50.2% did not meet either recommendations for aerobics or strength training. As for those having a cardiovascular condition, and the variable ‘sleep duration’, 7.1% reported 1-4 hours of sleep, 27.1% reported 5-6 hours of sleep, 56.3% reported 7-9 hours of sleep, and 9.6% reported 10-18 hours of sleep a night. Moreover, of the participants whom had a CVD condition, 40.1% never smoked, 13.9% are former smokers, and 23.3% are currently smokers. Lastly, of those whom had a condition, 4.2% of these individuals answered yes to heavy drinking.

Table 6: Estimated Frequencies of Selected Factors Within a Cardiovascular Condition vs. Within No Cardiovascular Condition

Variable		n (%) No Condition	n(%) Yes Condition
Age	18-34 years old	880 (33%)	11 (3.7%)
	35-44 years old	595 (18.4%)	34 (10.5%)
	45-64 years old	1736 (33.6%)	170 (37.7%)
	65 years and older	1207 (15.1%)	377 (48.1%)
Gender	Male	1880 (49.8%)	297 (53.8%)
	Female	2583 (50.2%)	302 (46.2%)
Race	White	3251 (55.1%)	467 (67.2%)
	Black	156 (7.4%)	30 (10.6%)
	Other race	229 (10.3%)	27 (5.8%)
	Multi-racial	186 (1.9%)	28 (2.1%)
	Hispanic	565 (25.4%)	42 (14.3%)
Blood Pressure	Yes high blood pressure	1461 (27.2%)	427 (71.6%)
Cholesterol	Yes high cholesterol	1410 (35.7%)	371 (63.3%)
Diabetes	Yes diabetes	382 (8.5%)	164 (28.7%)
Depression	Yes depression	758 (16.2%)	170 (30.9%)
BMI	Yes obesity	1048 (25.7%)	181 (31.4%
Physical Activity	Met aerobic & strength rec.	893 (23.6%)	75 (15.3%)
	Met aerobic rec. only	1218 (29.6%)	158 (28.5%)
	Met strength rec. only	282 (9.6%)	38 (6.0%)
	Did not meet either rec.	1353 (37.2%)	235 (50.2%)
Sleep Duration	1-4 hrs of sleep	139 (3.5%)	44 (7.1%)
	5-6 hrs of sleep	1298 (31.9%)	168 (27.1%)
	7-9 hrs of sleep	2840 (62.3%)	323 (56.3%)
	10-18 hrs of sleep	132 (2.2%)	52 (9.6%)
Smoking	Never smoked	2411 (59.9%)	216 (40.1%)
	Former smoker	1189 (21.2%)	253 (13.9%)
	Current smoker	756 (18.9%)	122 (23.3%)
Heavy Drinking	Yes heavy drinking	351 (7.3%)	30 (4.2%)

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke.

Demographic Factors Associated with Cardiovascular Condition

For multiple logistic regression analysis, reference categories for the demographic variables were chosen based on the greatest number of cases for each variable with the exception of age. After adjusting for age, race, marital status, education, and insurance, males were found to be 1.34 times more likely to have myocardial infarction, coronary heart disease or angina, and stroke, compared to females, although this did not reach statistical significance (OR=1.343, CI=0.983, 1.835). However, the variable 'gender' approached significance with a p=0.064, and will be added to the final significant variable model with a liberal cutoff of p=0.095. For age, 65 years and older was chosen as the referent category for purposes of a cleaner odds ratio (OR). After adjusting for gender, age, race, marital status, education, and insurance, those aged 18-34 years were 95.8% less likely to have myocardial infarction, coronary heart disease or angina, and stroke compared to those aged 65 years and older (OR=0.042, CI= 0.017, 0.105). Those aged 35-44 years were 78% less likely to have a condition, whereas 45-64 year olds were 59.1% less likely than individuals 65 years and older, both with a significant p value less than 0.05 (Table 7).

For race/ethnicity, whites were used as the reference category. After adjustment, blacks were 1.2 times more likely than whites to have a condition, although this did not reach statistical significance (OR=1.237, CI=0.640, 2.394). The variable race and its subgroups were not statistically significant (p=0.492) and were not added in the final model. Marital status, education, nor insurance reached statistical significance and are therefore, excluded from the final model (p=0.722, p=0.439, and p=0.441 respectively).

This demographic regression model, according to Nagelkerke's R-square value, was able to explain 16.3% of the variability for a cardiovascular condition. R square values for the regression models can be seen in Appendix D, Table 1.

Table 7: Multiple Logistic Regression Analysis with Demographic Factors and Cardiovascular Conditions (N=5,102)

Variable		OR	CI	P
Gender				0.064
	Female (ref.)			
	Male	1.343	(0.983, 1.835)	
Age				0.0001
	18-34 years	0.042	(0.017, 0.105)	*
	35-44 years	0.22	(0.123, 0.396)	*
	45-64 years	0.409	(0.282, 0.593)	*
	65 years and older (ref.)			
Race				0.492
	White (ref.)			
	Black	1.237	(0.640, 2.394)	
	Other Race	0.64	(0.314, 1.304)	
	Multi-racial	0.793	(0.386, 1.630)	
	Hispanic	0.672	(0.357, 1.262)	
Marital				0.722
	Married (ref.)			
	Divorced	1.212	(0.813, 1.808)	
	Widowed	1.327	(0.846, 2.080)	
	Separated	1.268	(0.553, 2.909)	
	Never Married	1.194	(0.656, 2.175)	
Education				0.439
	Graduated High School (ref.)			
	Did not graduate High School	1.42	(0.799, 2.523)	
	Attended College/Tech School	1.235	(0.865, 1.763)	
	Graduated College/Tech School	1.001	(0.681, 1.471)	
Insurance				0.441
	Yes Insurance (ref.)			
	No Insurance	1.294	(0.671, 2.497)	

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke. * indicates p value < .05

Co-Morbid Factors Associated with a Cardiovascular Condition

For multiple logistic regression analysis, the referent category for the co-morbid variables are the subgroups delineated as 'without the disease or condition' (Table 8). After adjustment for all variables included in the block, individuals who said 'yes' to having high blood pressure are 3.67 times more likely to have had a myocardial infarction, coronary heart disease or angina, and stroke compared to those who have normal blood pressure ($p < .0001$). Furthermore, those with high cholesterol were 2.32 times more likely to have had a condition with a statistically significant p value < .0001 (OR=2.32, CI=1.645, 3.272). Diabetic persons were almost two fold times more likely to have a cardiovascular condition and was also statistically significant in the model (p=0.003). In addition, those suffering from a depressive disorder were 1.8 times more likely to have a cardiovascular condition compared to those who do not (OR=1.786, CI=1.228, 2.598).

Depressive disorders added significantly to the model with a p=0.002 (Table 8). In contrast, obese participants were protected against having a cardiovascular condition (OR=0.61, CI=0.416, 0.893) compared to those who are under weight, normal weight, or over weight (p=0.011). This co-morbid regression model, according to Nagelkerke's R-square value, was able to explain 17.3% of the variability for a cardiovascular condition. R square values for the regression models can be seen in Appendix D, Table 2. Lastly, all five co-morbid variables in this model met the liberal cutoff of p=0.095, and hence, are included in the final significant variable model.

Table 8: Multiple Logistic Regression Analysis with Co-Morbid Factors and Cardiovascular Conditions (N=5,102)

Variable	OR	CI	P
Blood Pressure			0.0001
No high blood pressure (ref.)			
Yes high blood pressure	3.677	(2.526, 5.353)	*
Cholesterol			0.0001
No high cholesterol (ref.)			
Yes high cholesterol	2.320	(1.645, 3.272)	*
Diabetes			0.003
No diabetes (ref.)			
Yes diabetes	1.971	(1.259, 3.085)	*
Depression			0.002
No depressive disorder (ref.)			
Yes depressive disorder	1.786	(1.228, 2.598)	*
BMI			0.011
Under/normal/over weight (ref.)			
Obese	0.61	(0.416, 0.893)	*

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke. * indicates p value < .05

Behavioral Factors Associated with a Cardiovascular Condition

For multiple logistic regression analysis, the referent category for the behavioral variables are the subgroups labeled ‘ref.’ found in Table 9. After adjustment, the variable ‘physical activity’ approached statistical significance with a p value of 0.067, yet only one subcategory among three was found to be significant. Physical activity subcategory ‘did not meet either recommendation’ for aerobics or strength activities was significant with an increased odds of having a cardiovascular condition compared to the referent

(OR=1.688, CI=1.053, 2.706). Dark green vegetable intake per day, a continuous variable, was approaching significance with p=0.095 (Table 9). Sleep duration, the principle variable of interest for this thesis, was found statistically significant ($p < .0001$), as well as two of its subgroups: deficient sleep and excessive sleep. Those who slept 1-4 hours a night were 2 times more likely to have myocardial infarction, coronary heart disease or angina, and stroke, compared to those who slept 7-9 hours a night (OR=2.013, CI=1.093, 3.707). In comparison, those who slept 10-18 hours a night were 6.2 times more likely to have had a condition, in contrast to the referent group who on average, had 7-9 hours of sleep at night (OR=6.242, CI=3.511, 11.09). The variable 'smoking' and both its subgroups were found statistically significant with a $p < .0001$ (Table 9).

Former smokers were 2.6 times more likely to have a cardiovascular condition, whereas current smokers were 1.7 times more likely than their 'never smoked' counterparts (OR=2.573, CI=1.766, 3.749; OR=1.728, CI=1.079, 2.719). The variable 'heavy drinking' was found to be protective with those who drank, on average, two drinks or more a night were 61.5% less likely to have a condition (OR=0.385, CI=0.202, 0.734). Moreover, heavy drinking added to the model significantly with p=0.004 (Table 9). According to Nagelkerke's R-square value, this behavioral regression model was able to explain only 9.0% of the variability for a cardiovascular condition and can be found in Appendix D, Table 3. Although only three behavioral variables were statistically significant ($p < 0.05$), both physical activity and dark green vegetable intake per day met the liberal cutoff (p=0.095) and will be included in the final significant variable model.

Table 9: Multiple Logistic Regression Analysis with Behavioral Factors and Cardiovascular Conditions (N=5,102)				
Variable		OR	CI	P
Physical Activity				0.067
	Met aerobic & strength rec. (ref.)			
	Met aerobic rec. only	1.322	(0.815, 2.144)	
	Met strength rec. only	0.897	(0.442, 1.820)	
	Did not meet either rec.	1.688	(1.053, 2.706)	*
Dark Green Vegetable intake per day				0.095
	Continuous variable			
Sleep Duration				0.000
	1-4 hours of sleep	2.013	(1.093, 3.707)	*
	5-6 hours of sleep	1.074	(0.720, 1.601)	
	7-9 hours of sleep (ref.)			
	10-18 hours of sleep	6.242	(3.511, 11.09)	*
Smoking				0.000
	Never smoked (ref.)			
	Former smoker	2.573	(1.766, 3.749)	*
	Current smoker	1.728	(1.097, 2.719)	*
Heavy Drinking				0.004
	No heavy drinking (ref.)			
	Yes heavy drinking	0.385	(0.202, 0.734)	*

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke. * indicates p value < .05

Final Significant Variable Model

For the final multiple logistic regression model, the referent subgroups from previous blocks will remain the same and will be labeled ‘ref.’ in Table 10. Twelve formerly significant variables have been included in this final model: gender, age, high blood pressure, high cholesterol, diabetes, depression, BMI, physical activity, sleep duration, smoking, heavy drinking, and dark green vegetable intake per day. After adjusting for all twelve variables added to the final model, a total of six variables reached statistical significance with a p <0.05. The significant variables found were age, high blood pressure, high cholesterol, depression, sleep duration, and heavy drinking (Table 10). For ‘age’, the subgroup 18-34 years old were 91.1% less likely to have a condition compared to 65 years and older (OR=0.089, CI=0.029, 0.272). Those aged 35-44 years were 80% less likely to have a condition, and those aged 45-64 years were 58% less likely versus the referent group (OR=0.201, CI=0.085, 0.477; OR=0.420, CI=0.280, 0.630). Individuals with high blood pressure were 2.4 times more likely to have a cardiovascular condition compared to those with normal blood pressure (p < .0001), whereas those with high cholesterol were 1.8 times more likely (p=0.002).

For the variable ‘depression’, those with a depressive disorder were 1.65 times more likely to have had a myocardial infarction, coronary heart disease or angina, and stroke (p=0.027). Participants who drank heavily on average were found to be protected again with a p value of 0.030 (Table 10). Based on the odds, this subgroup is 54.1% less likely to have a cardiovascular condition compared to those who do not heavily drink (OR=0.459, CI=0.227, 0.929). Sleep duration, the main focus of this study, was statistically significant with a p value < .0001, and the same two subgroups from the previous block have remained significant as well. Individuals who get a deficient amount of sleep e.g. 1-4 hours a night, are 2.4 times more likely to have a cardiovascular condition compared to the average of 7-9 hours of sleep a night (OR=2.412, CI=1.139, 5.107). As for individuals who sleep excessively e.g. 10-18 hours a night, they were nearly 7.2 times more likely to have a condition, versus the individuals who receive a normal night's sleep (OR=7.170, CI=3.284, 15.654).

Both diabetes and gender had approached significance with a p value less than 0.1, whereas BMI, physical activity, smoking, and dark green vegetable intake exceeded the liberal cutoff by at least 2-fold. Lastly, Nagelkerke's R-square value was calculated for this final model and was able to explain 26.4% of the variability for a cardiovascular condition i.e. for myocardial infarction, coronary heart disease or angina, and stroke (Appendix D, Table 4).

Table 10: Multiple Logistic Regression Analysis with Final Significant Factors and Cardiovascular Conditions (N=5,102)

Variable		OR	CI	P
Gender				0.099
	Female (ref.)			
	Male	1.391	(0.940, 2.059)	
Age				0.000
	18-34 years	0.089	(0.029, 0.272)	*
	35-44 years	0.201	(0.085, 0.477)	*
	45-64 years	0.420	(0.280, 0.630)	*
	65 years and older (ref.)			
Blood Pressure				0.000
	No high blood pressure (ref.)			
	Yes high blood pressure	2.407	(1.558, 3.717)	*
Cholesterol				0.002
	No high cholesterol (ref.)			
	Yes high cholesterol	1.855	(1.251, 2.751)	*
Diabetes				0.089
	No diabetes (ref.)			
	Yes diabetes	1.546	(0.936, 2.554)	
Depression				0.027
	No depressive disorder (ref.)			
	Yes depressive disorder	1.655	(1.060, 2.584)	*
BMI				0.252
	Under/normal/over weight (ref.)			
	Obese	0.785	(0.518, 1.188)	
Physical Activity				0.854
	Met aerobic & strength rec. (ref.)			
	Met aerobic rec. only	0.922	(0.538, 1.581)	
	Met strength rec. only	1.238	(0.618, 2.479)	
	Did not meet either rec.	0.939	(0.558, 1.580)	
Sleep Duration				0.000
	1-4 hours of sleep	2.412	(1.139, 5.107)	*
	5-6 hours of sleep	1.206	(0.784, 1.855)	
	7-9 hours of sleep (ref.)			
	10-18 hours of sleep	7.170	(3.284, 15.654)	*
Smoking				0.239
	Never smoked (ref.)			
	Former smoker	1.443	(0.943, 2.208)	
	Current smoker	1.180	(0.693, 2.007)	
Heavy Drinking				0.030
	No heavy drinking (ref.)			
	Yes heavy drinking	0.459	(0.227, 0.929)	*
Dark Green Vegetable intake per day				0.226
	Continuous variable			

Cardiovascular conditions include myocardial infarction, coronary heart disease or angina, and stroke. * indicates p value < .05

Discussion

The primary goals of this study were to determine: 1) if deficient sleep is associated with a cardiovascular condition, 2) if excessive sleep duration is associated with a cardiovascular condition, and 3) which demographic, co-morbid, and/or behavioral factors are associated with a cardiovascular condition. The null hypotheses for all three research questions were rejected when analyzed with multiple logistic regression. Demographic variables age and gender were significantly associated with cardiovascular disease, but gender became insignificant after all eleven variables were entered into the final model. All co-morbid variables were significant in the initial analysis i.e. high blood pressure, high cholesterol, diabetes, BMI, and depression. After addition to the final model, only high blood pressure, high cholesterol, and depressive disorder remained significant. Sleep duration, smoking and alcohol consumption were significant in the initial analysis; physical activity, and dark green vegetable daily intake approached significance. Once all the behavioral models were added to the final model, only sleep duration and alcohol consumption remained statistically significant.

Sleep duration, the intended variable of interest, remained significant in both the behavioral block analysis and the final block analysis. Both subgroups 1-4 hours and 10-18 hours of sleep remained statistically significant with both odds ratios increasing and a steady p value. In contrast, sleep subgroup '5-6 hours' never reached significance in either analysis and both confidence intervals crossed 1 in the analyses. This may be due to different sample sizes among each subgroup. Both extreme subgroups e.g. 1-4 hours, and 10-18 hours, had sample sizes of less than 4% each, compared to 5-6 hours with a weighted sample size of 31.5%. However, many studies still showed the extreme subgroups of deficient and excessive sleep are significant, and associated with cardiovascular disease and its various conditions. Altman et al. (2012) found those with the highest risk for heart attack and stroke were among individuals who slept less than 5 hours or more than 9 hours. Additionally, Kronholm et al. (2011) found the highest risk of CVD mortality was among those on the extreme ends of sleep duration distribution. In conjunction, Suzuki et al.'s similar study identified an association with excessive sleep duration and a higher risk of cardiovascular mortality (2009). These studies are consistent with this study and have observed similar findings, therefore, giving validity to the results found despite the smaller weighted percentage for the extreme sleep subgroups.

Epidemiologic studies also support the associations found in the results between age, high blood pressure, high cholesterol, and depression, with sleep duration, and cardiovascular disease conditions. Huang et al. (2013) found a greatly increased risk for stroke in the elderly with a non-apnea sleep disorder, as well as the study by Sabanayagam & Shankar (2010) whom had positive associations with CVD, age subgroups, and sleep duration. Both short and long sleep, similar to this study, were positively associated with cardiovascular disease, and other health risks like high blood pressure, obesity, and diabetes (Buxton & Marcelli, 2010). Although obesity and diabetes did not remain significant in the final model, this may be due to the interactive effects between confounders. Regardless, a review paper from Grander et al. (2013) confirmed that "there is strong evidence for sleep duration, both short and long, as a risk factor for CVD, even though the mechanisms are not understood". Grander et al. (2013) also suggests that high cholesterol causes inflammation and is a potential pro-inflammatory biomarker for the development of CVD. Similarly to this study, the significant variable ‘depression’, has also been found to be associated or related with both sleep insufficiency, and cardiovascular risk (MMWR, 2011; Sabanayagam & Shankar, 2010).

Lastly, heavy drinking was shown to be protective against myocardial infarction, coronary heart disease or angina, and stroke. Probable explanations for this protective association may be due to the wording of the question in the BRFSS. The survey question for heavy drinking classifies men consuming ‘two or more drinks per day’ or women consuming ‘one or more drinks per day’ as heavy drinkers. One or two drinks per day on average may be considered light to moderate alcohol consumption, not heavy or binge drinking (Berger et al., 1999). Another explanation may perhaps be alcohol has been found to be protective against various brain diseases such as mild cognitive impairment, and vascular dementia (Panza et al., 2012). Moreover, light to moderate alcohol consumption has also been found to reduce the overall risk of stroke, and the risk of ischemic stroke in men according to a study published in the New England Journal of Medicine (Berger et al., 1999). Generally known as a vasodilator, alcohol relaxes the smooth muscles in the arteries allowing for widening and improved blood flow. This may be indicative as to why the findings from this study show one or more drinks per night may be protective against cardiovascular conditions. Based on these explanations, the results of this study shows consistency with others mentioned and makes a compelling case for an association between sleep duration, various variables, and cardiovascular conditions.

Strengths and Limitations

The major strengths of this study include the large data set with over 5,000 participants and its population-based study design. Population-based studies allow for a more honest representation of the state and are deemed valid. This study is generalizable due to the BRFSS weighting and inclusion of individuals who rely on cellular phones, not landlines. This may also eliminate selection biases based on characteristics of persons who don't own a cell phone versus those who do. In addition, the BRFSS accurately measures prevalence based on matching other prevalent rates from other national studies. Its large data set also allows for the study of multiple outcomes and exposures. Although the sample sizes for the cardiovascular conditions are small, the combining of the three variables e.g. myocardial infarction, coronary heart disease or angina, and stroke, allows for a more robust sample, and thus, increases the power of the study. Lastly, the Nagelkerke's R-square value calculated for the final model accounted for 26.4% of the variability for a cardiovascular condition. This strengthens the findings of the study because the variables in the final model were able to explain over a quarter of the variability for the cardiovascular condition, thus giving additional explanatory power to the multiple logistic regression model.

Limitations of this study may include the cross sectional nature of the BRFSS as well as its self-reported measures. Self-reported measures can be susceptible to misclassification due to recall bias. Recall bias is characteristic of participants recalling past exposures based on memory alone and can be a threat to the internal validity of a study. The BRFSS survey also only includes non-institutionalized and non-incarcerated persons. Individuals in nursing or caregiver homes are unable to complete this survey and may cause an underestimation of the dependent variable. In addition to this selection bias, the BRFSS survey does not permit proxy interviews. For this study, a proxy interview may be needed for individuals who had suffered a stroke. Stroke victims commonly have paralysis of the facial muscles and have difficulty with speech and hearing. The stroke sample for this study is small with only three percent reporting the condition, yet when compared to the national average, Nevada has a higher prevalence of stroke. Thus, stroke victims may be underrepresented in the dependent variable and sample.

Continuing, causal inferences cannot be made from this study because of its cross sectional design. A cross sectional study design cannot accurately determine whether the outcome followed the exposure in time or the exposure resulted from the outcome. Essentially, this study is unable to say if deficient or excessive sleep caused cardiovascular conditions or vice versa. It can only be said that a negative association exists between the variables and any assumptions made should be cautious. Furthermore, the hypotheses created for this study may be susceptible to Neyman bias, commonly known as selective survival bias. Selective survival bias is when an outcome such a myocardial infarction or stroke may result in death, and thus, the individual whom could have participated in the study was unable because they died of the condition. This could affect the study by underestimating the findings since the dependent variable isn’t a true reflection of those with the disease or condition. Additionally, those who may have died from the disease or condition may be different than the population of the study. These deceased individuals could have more co-morbidities and may have different sleep patterns than those who survived the condition or disease. This selective survival bias has the potential to underestimate the associations between the dependent and independent variables.

Public Health and Clinical Application

To reduce cardiovascular conditions, public health officials may benefit from targeting sleep duration by developing sleep recommendations and treatment strategies. The National Sleep Foundation has recommended for those to practice sleep hygiene, a technique to help promote the quality and duration of sleep. Some sleep hygiene tips include not napping during the day, avoiding stimulants such as caffeine and nicotine many hours before bed, avoiding alcohol before bed, not consuming large meals before bed, and practicing relaxing exercises such as yoga. For individuals diagnosed with apnea-related sleep disorders, continuous positive airway pressure (CPAP) has been shown to be an effective treatment. For individuals with non-apnea sleep disorders, over the counter medications such as acetaminophen PM pills and night syrups can be used and is non-habit forming. Prescribed medications from a physician can also be used to treat chronic sleep problems. Natural remedies, a common suggestion by doctors of osteopathic medicine, suggest supplements such as melatonin and/or chamomile or mint tea. Cognitive behavioral therapy has also been proposed as an effective treatment (National Sleep Foundation, 2014).

Treatment of the modifiable risk factors identified in this study is important as well to reduce cardiovascular conditions. Blood pressure and cholesterol should be monitored by health care professionals and treated by prescribing medications along with encouraging healthy diet and activity modifications. Monitoring and treating both high blood pressure and high cholesterol is easily done by primary care physicians, physician assistants, and registered nurses. Less healthcare resources are utilized by treating these risk factors with behavioral modifications as well as medications such as diuretics, beta-blockers, ACE inhibitors and statins. Treating a cardiovascular condition in a hospital setting including ambulatory services, emergency department usage, and urgent care is extremely costly and critical interventions could help reduce the financial and global impact of this condition. Antidepressants are also more easily treatable through medications such as SSRIs or SNRIs, therapy, and social support. Overall, there is less economic burden to the system when preventive strategies handled through the primary care setting is utilized compared to hospital emergency care settings.

Federal funding will be needed to help develop, and promote sleep recommendations, and treatment strategies like the techniques recommended by the National Sleep Foundation. Public health policy is based on current literature and therefore, more definitive studies are needed to identify the true relationship between sleep and the development of cardiovascular diseases and its various conditions. It is highly recommended that a prospective cohort be funded and endorsed; only then can a true relationship between deficient or excessive sleep and cardiovascular disease development be found. The future study will determine whether the outcome (cardiovascular condition) precedes the exposure (sleep duration), or the exposure precedes out the outcome. Prospective cohorts, similar to the Framingham Heart study, are capable of making important scientific contributions and identify common risk factors or characteristics that contribute to diseases. Moreover, determining these risk factors or characteristics inevitably leads to the development of new and effective treatments and preventive strategies in both public health policy and clinical practice.

Conclusion

In conclusion, this study shows that both deficient, and excessive sleep duration, are associated with cardiovascular conditions i.e. myocardial infarction, coronary heart disease or angina, and stroke. Future prospective cohort studies are needed to determine the true relationship between sleep and cardiovascular conditions. Primary prevention and guidelines for the treatment of high blood pressure, high cholesterol, and depression, will also be necessary to reduce risk. If future studies support the results in this study, sleep recommendations and treatment strategies can be constructed. Although sleep recommendations by organizations such as The National Sleep Foundation exist, further research and funding on improving and treating ineffectual sleep will be needed to lower the risk and economic burden of cardiovascular disease, and its conditions.

Appendix A

Relevant Health Condition Questions from BRFSS

Section 4: Inadequate Sleep

I would like to ask you about your sleep pattern.

4.1 On average, how many hours of sleep do you get in a 24-hour period?

INTERVIEWER NOTE: Enter hours of sleep in whole numbers, rounding 30 minutes (1/2 hour) or more up to the next whole hour and dropping 29 or fewer minutes.

(91-92)

_ _	Number of hours [01-24]
7 7	Don't know / Not sure
9 9	Refused

Section 5: Hypertension Awareness

5.1 Have you EVER been told by a doctor, nurse, or other health professional that you have high blood pressure?

(93)

Read only if necessary: By "other health professional" we mean a nurse practitioner, a physician's assistant, or some other licensed health professional.
If "Yes" and respondent is female, ask: "Was this only when you were pregnant?"

1	Yes	
2	Yes, but female told only during pregnancy	**[Go to next section]**
3	No	**[Go to next section]**
4	Told borderline high or pre-hypertensive	**[Go to next section]**
7	Don't know / Not sure	**[Go to next section]**
9	Refused	**[Go to next section]**

Section 6: Cholesterol Awareness

6.3 Have you EVER been told by a doctor, nurse or other health professional that your blood cholesterol is high?

(97)

1	Yes
2	No
7	Don't know / Not sure
9	Refused

Section 7: Chronic Health Conditions

Now I would like to ask you some questions about general health conditions. Has a doctor, nurse, or other health professional EVER told you that you had any of the following? For each, tell me "Yes," "No," or you're "Not sure."

7.1 (Ever told) you that you had a heart attack also called a myocardial infarction?

(98)

1	Yes
2	No
7	Don't know / Not sure
9	Refused

7.2 (Ever told) you had angina or coronary heart disease?

(99)

1 Yes
2 No
7 Don't know / Not sure
9 Refused

7.3 (Ever told) you had a stroke?

(100)

1 Yes
2 No
7 Don't know / Not sure
9 Refused

7.10 (Ever told) you have a depressive disorder, including depression, major depression, dysthymia, or minor depression?

(107)

1 Yes
2 No
7 Don't know / Not sure
9 Refused

7.12 (Ever told) you have diabetes?

(109)

If "Yes" and respondent is female, ask: "Was this only when you were pregnant?"
If respondent says pre-diabetes or borderline diabetes, use response code 4.

1 Yes
2 Yes, but female told only during pregnancy
3 No
4 No, pre-diabetes or borderline diabetes
7 Don't know / Not sure
9 Refused

CATI note: If Q7.12 = 1 (Yes), go to Diabetes Optional Module (if used). If any other response to Q7.12, go to Pre-Diabetes Optional Module (if used), otherwise, go to next section.

Section 9: Tobacco Use

9.2 Do you now smoke cigarettes every day, some days, or not at all?

(188)

1	Every day	
2	Some days	
3	Not at all	**[Go to Q9.4]**
7	Don't know / Not sure	**[Go to Q9.5]**
9	Refused	**[Go to Q9.5]**

9.4 How long has it been since you last smoked a cigarette, even one or two puffs?

(190-191)

0 1 Within the past month (less than 1 month ago)
0 2 Within the past 3 months (1 month but less than 3 months ago)
0 3 Within the past 6 months (3 months but less than 6 months ago)

0 4	Within the past year (6 months but less than 1 year ago)
0 5	Within the past 5 years (1 year but less than 5 years ago)
0 6	Within the past 10 years (5 years but less than 10 years ago)
0 7	10 years or more
0 8	Never smoked regularly
7 7	Don’t know / Not sure
9 9	Refused

Section 10: Alcohol Consumption

10.1 During the past 30 days, how many days per week or per month did you have at least one drink of any alcoholic beverage such as beer, wine, a malt beverage or liquor?

(193-195)

1 _ _	Days per week
2 _ _	Days in past 30 days
8 8 8	No drinks in past 30 days **[Go to next section]**
7 7 7	Don’t know / Not sure **[Go to next section]**
9 9 9	Refused **[Go to next section]**

10.2 One drink is equivalent to a 12-ounce beer, a 5-ounce glass of wine, or a drink with one shot of liquor. During the past 30 days, on the days when you drank, about how many drinks did you drink on the average?

(196-197)

NOTE: A 40 ounce beer would count as 3 drinks, or a cocktail drink with 2 shots would count as 2 drinks.

_ _	Number of drinks
7 7	Don’t know / Not sure
9 9	Refused

10.3 Considering all types of alcoholic beverages, how many times during the past 30 days did you have **X [CATI X = 5 for men, X = 4 for women]** or more drinks on an occasion?

(198-199)

_ _	Number of times
8 8	None
7 7	Don’t know / Not sure
9 9	Refused

Section 11: Fruits and Vegetables

These next questions are about the fruits and vegetables **you** ate or drank during the past 30 days. Please think about all forms of fruits and vegetables including cooked or raw, fresh, frozen or canned. Please think about all meals, snacks, and food consumed at home and away from home.

I will be asking how often **you** ate or drank each one: for example, once a day, twice a week, three times a month, and so forth.

11.4 During the past month, how many times per day, week, or month did you eat dark green vegetables for example broccoli or dark leafy greens including romaine, chard, collard greens or spinach?

(211-213)

1 _ _	Per day

2 _ _ Per week
3 _ _ Per month
5 5 5 Never
7 7 7 Don't know / Not sure
9 9 9 Refused

INTERVIEWER NOTE: Each time a vegetable is eaten it counts as one time.
INTERVIEWER NOTE: Include all raw leafy green salads including spinach, mesclun, romaine lettuce, bok choy, dark green leafy lettuce, dandelions, komatsuna, watercress, and arugula.

Do not include iceberg (head) lettuce if specifically told type of lettuce. Include all cooked greens including kale, collard greens, choys, turnip greens, mustard greens.

Section 12: Exercise (Physical Activity)

The next few questions are about exercise, recreation, or physical activities other than your regular job duties.

INTERVIEWER INSTRUCTION: If respondent does not have a "regular job duty" or is retired, they may count the physical activity or exercise they spend the most time doing in a regular month.

12.2. What type of physical activity or exercise did you spend the most time doing during the past month?

(221-222)

_ _	(Specify)	**[See Physical Activity Coding List]**
7 7	Don't know / Not Sure	**[Go to Q12.8]**
9 9	Refused	**[Go to Q12.8]**

INTERVIEWER INSTRUCTION: If the respondent's activity is not included in the Physical Activity Coding List, choose the option listed as "Other ".

12.3 How many times per week or per month did you take part in this activity during the past month?

(223-225)

1_ _ Times per week
2_ _ Times per month
7 7 7 Don't know / Not sure
9 9 9 Refused

12.4 And when you took part in this activity, for how many minutes or hours did you usually keep at it?

(226-228)

_:_ _ Hours and minutes
7 7 7 Don't know / Not sure
9 9 9 Refused

12.5 What other type of physical activity gave you the next most exercise during the past month?

(229-230)

_ _	(Specify)	**[See Physical Activity Coding List]**
8 8	No other activity	**[Go to Q12.8]**
7 7	Don't know / Not Sure	**[Go to Q12.8]**
9 9	Refused	**[Go to Q12.8]**

INTERVIEWER INSTRUCTION: If the respondent's activity is not included in the Coding Physical Activity List, choose the option listed as "Other".

12.6 How many times per week or per month did you take part in this activity during the past month?

(231-233)

1_ _ Times per week
2_ _ Times per month
7 7 7 Don't know / Not sure
9 9 9 Refused

12.7 And when you took part in this activity, for how many minutes or hours did you usually keep at it?

(234-236)

_:_ _ Hours and minutes
7 7 7 Don't know / Not sure
9 9 9 Refused

12.8 During the past month, how many times per week or per month did you do physical activities or exercises to STRENGTHEN your muscles? Do NOT count aerobic activities like walking, running, or bicycling. Count activities using your own body weight like yoga, sit-ups or push-ups and those using weight machines, free weights, or elastic bands.

(237-239)

1_ _ Times per week
2_ _ Times per month
8 8 8 Never
7 7 7 Don't know / Not sure
9 9 9 Refused

Appendix B

List of Acronyms

BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control
CHD	Coronary Heart Disease
CI	Confidence Interval
CVD	Cardiovascular Disease
DV	Dependent Variable
IV	Independent Variable
MI	Myocardial Infarction
OR	Odds Ratio
SPSS	Statistical Package for the Social Sciences
UNLV	University of Nevada, Las Vegas

Appendix C

BRFSS Description of Weights Table

The final BRFSS data set includes several variables that are used in the weighting process. The following table explains data weighting variables:

Weighting Variables Included in the BRFSS Dataset	
Variable Name	Description
_LLCP_WGT	The final weight assigned to each respondent for the landline telephone and cellular telephone combined data. This weight should be used when landline telephone and cellular telephone data are included in analyses.
_LANDWT	The weight assigned to each respondent for the landline telephone sample only. This weight should be used in analyses of landline telephone data when cellular telephone data are not included.
_STRWT	Stratum weight accounts for differences in the basic probability of selection among strata (subsets of area code/prefix combinations). It is the inverse of the sampling fraction of each stratum. There almost never is a complete correspondence between strata, which are defined by subsets of area code/prefix combinations, and regions, which are defined by the boundaries of government entities.
NUMPHON2	The number of residential telephone numbers in the respondent's house.
NUMADULT	The number of adults in the respondent household.
NRECSEL	Number of records selected to be included in the sample.
NRECSTR	Number of records available in the strata.

Appendix D

Regression Statistic Tables

Table 1: Regression Statistics for Demographic Factors (Block 1)	
Cox and Snell	0.071
Nagelkerke	0.163
McFadden	0.128

Table 2: Regression Statistics for Co-Morbid Factors (Block 2)	
Cox and Snell	0.083
Nagelkerke	0.173
McFadden	0.133

Table 3: Regression Statistics for Behavioral Factors (Block 3)	
Cox and Snell	0.040
Nagelkerke	0.090
McFadden	0.690

Table 4: Regression Statistics for Final Model (Block 4)	
Cox and Snell	0.126
Nagelkerke	0.264
McFadden	0.207

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