2020

Obesity, Snoring, Sleep Apnea, and Coronary Heart Disease

Maryam Khalilah Muhammad
Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

Maryam K. Muhammad

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Diana Naser, Committee Chairperson, Public Health Faculty
Dr. Heidi Sato, Committee Member, Public Health Faculty
Dr. Simone Salandy, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2020

Abstract

Obesity, Snoring, Sleep Apnea, and Coronary Heart Disease

by

Maryam K. Muhammad

MPH, Walden University, 2005

BA, Georgia State University, 2003

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health Epidemiology

Walden University

November 2020

Abstract

Coronary heart disease (CHD) is a significant public health issue that affects communities across all socioeconomic and demographic groups. Risk factors for CHD include sleep apnea and snoring. Obesity with short sleep duration also places individuals at higher risk for CHD. Although limited research has been conducted on CHD and its relationship to obesity, sleep apnea, and snoring as individual risk factors for CHD, a gap exists as these factors had not been studied as paired in this study. The purpose of this quantitative, cross sectional study was to determine if a significant relationship existed between obesity, snoring, sleep apnea, and CHD while accounting for gender, race, age, and geographic location. The health belief model served as the theoretical framework for this research. The 2017 CDC Behavioral Risk Factor Surveillance System dataset was used to analyze data from 988 adults between 18 to 75 years of age. Binary logistic regression was used to analyze data. The key findings were that there was no significant relationship between sleep apnea, obesity, and snoring, when analyzed individually and combined against CHD. Positive social change implications are that the combined risk factors of sleep apnea, obesity, and snoring as assessed against CHD could encourage health specialists and medical professionals to provide multidisciplinary community-level support to monitor and manage follow-up care.

Obesity, Snoring, Sleep Apnea, and Coronary Heart Disease

by

Maryam K. Muhammad

MPH, Walden University, 2005

BA, Georgia State University, 2003

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health Epidemiology

Walden University

November 2020

Dedication

This dissertation is dedicated to my father, Sabir A. Muhammad, who taught me that "a body in motion is doing what the Creator intended and staying in motion keeps health issues at bay because they are out of sight and mind" while still fighting his serious health illness. This dissertation is also dedicated to my mother, Nadiyah S. Muhammad, who was my first teacher and main, daily encourager who never gave up on showing me how to dig in and cast out life's stressors to reach the finish line with my research despite her own battle with the issues inherent in this study. For the majority of the years of this study, I was a single parent of four and still managed to work, send them off to college for their own professional degrees, and take time each day to run at least a 5K. I dedicate this dissertation to all five of my children who have been my source of inspiration and drive to dare to complete my own lifetime goals as their example of one who does not quit and finishes strong.

Acknowledgments

All praise is due to God who provides me clarity, peace of mind, strength to drive on each day of research and study. I would like to first give thanks to Dr. Diana Naser, who has been there for me from start to finish of this dissertation process with genuine encouragement and support. Thank you, Dr. Heidi Sato, for your guidance and support in my dissertation process. I give thanks to my student success advisors and the entire Walden dissertation and academic professors who have guided me and imparted in me knowledge that I may continue to elevate the standards of public health epidemiology and positive social change!

I give thanks to all my family, colleagues, friends, Gullah Aunt Dorothy and the ancestors in South Carolina, my Sorors of Sigma Gamma Rho Sorority, Incorporated. I acknowledge all of the genuinely supportive staff from the Fulton County Police Department, Fulton County Health Department, Fulton County Sheriff's office, QuikTrip staff, Dekalb County Schools Police Department, Dekalb County Sheriff's office, Atlanta Police Department Staff, Northside Hospital, Northside Women's Specialists, Dr. Amos Obiefuna, Dr. Julius Sherwinter, MD, Dr. Lawrence Weinstein, MD, Dr. Zia Abdi, MD, Dr. Jordan Rush, MD, Members from the Centers for Disease Control and Prevention who assisted with our SWIFT program that was hosted by Jerry Kerce just before I started my Dissertation program who encouraged me to move forward into my doctorate upon completing my Master's program, and a host of friends from Madrid, Spain, Jamaica, Dubai, and Egypt! To my special classmates and Walden dissertation cohorts, thank you so much for constantly fueling and watering my spirit and drive to succeed!

Table of Contents

List of Tables

Chapter 1: Introduction to Study

Mortality and morbidity due to coronary heart disease (CHD) are impactful in communities regardless of socioeconomic and demographic backgrounds. The disparities in recommendations and access to services for CHD prevention and maintenance account for the varying outcomes as observed in socioeconomic, demographic, and across racial, age, and gender-specific backgrounds. Additionally, the risk factors attributed to CHD mortality and morbidity include sleep apnea (OSA), snoring, and obesity. The impact of these risk factors under study, except for snoring, on CHD account for the high prevalence of persons suffering mortality due to heart disease (Chen et al., 2016). This was evident in the study conducted by Zhang et al. (2018) whereby participants in the study were assessed over a 10-year period for the cause of their CHD mortality to which 86 of their participants who had OSA and high body mass index (BMI) suffered CHD mortality. This study needed to be conducted to evaluate the impact of OSA, snoring, and obesity risk factors on CHD. On a regional level, there have been disparities in recommendations for care and maintenance of prophylaxes used in the care of persons who sought help for OSA, obesity, and snoring, which could be addressed to reduce the negative impact of these individual risk factors. With previous literature showing how each risk factor impacts CHD individually and accounting for high rates of morbidity nationwide, this study was important to evaluate how combining these risk factors could account for extensive rates of morbidity and mortality regionally and nationwide.

Potential positive social change implications are that the combined risk factors of OSA, obesity, and sleep apnea as assessed against CHD, accounting for age, gender, race, and geographic location, could enable health specialists and medical professionals to provide multidisciplinary community-level support. The persons impacted by OSA and snoring who are in the obese category could benefit from this study with their medical doctors more closely monitoring and managing follow-up care that is linked to CHD prevention. In this chapter, I discuss the problem statement, background for this study, purpose, theoretical framework, nature of study, significance, assumptions, and limitations.

Background

This research was conducted to examine the association between risks for CHD as related to obesity, snoring, and OSA. Recent research conducted by Chen et al. (2016) focused on OSA, snoring, and high blood pressure but did not investigate obesity. Al-Zoughool et al. (2018) investigated how those with sedentary behavior had heightened levels of CHD by analyzing lifestyle and physical activity. However, Al-Zoughool et al. did not examine snoring or OSA in their study. Wang et al. (2018) also focused on CHD but only focused on those who were diagnosed with OSA but not obesity or snoring. In addition, Pleava et al. (2016) did a study on obesity and OSA's association with CHD but did not focus on snoring. Furthermore, Sharma et al. (2015) only focused on obesity in older adults and the association with CHD. Recent literature has only addressed some of the variables under study (OSA, obesity, and snoring), rather than the combination of these variables, and their association with CHD, which represents a gap in the literature. When there is an elevation of risk for CHD due to only one variable, OSA, for example, combining the additional variables in this study could be impactful to the risk for CHD in persons who are obese and snore.

Problem Statement

CHD is a serious public health issue that affects communities across all socioeconomic and demographic lines. Heart disease is the number one leading cause of death in the United States (Kochanek et al., 2019, p. 1) Out of the 2,813,502 resident deaths that were registered in the United States in 2017, the death rate was 731.9 deaths per 100,000 U.S. standard population (Kochanek et al., 2019, p. 3). The number of persons who suffered mortality due to heart disease amounted to 647,457 in 2017, accounting for 23% of the total deaths during that period (Kochanek et al., 2019, p. 6). The Centers for Disease Control and Prevention (CDC; 2019b) provided further depiction of the socioeconomic and demographic statistics whereby those with a family income less than $35,000 suffered mortality and morbidity due to heart disease at the rate of 12.5% in adults over 18 years of age as opposed to someone whose income was over $100,000 at the rate of 9.3%. Persons on Medicaid under 65 years of age were shown to have a 9.9% impact due to heart disease as opposed to those with private insurance at 6.1% (CDC, 2019b). Those individuals who were divorced or separated were at 12.5% compared to those who never married at 9.9% with those who married at 10.3% and those widowed at 11.6% (CDC, 2019b). This study was focused on the southern region of the United States, which accounts for the second leading percentage of deaths and morbidity due to heart disease at 10.8%; the CDC (2019b) showed the Midwest as accounting for the highest percentage at 12.1%.

CHD is sometimes referred to as coronary artery disease (CAD), which is caused by the narrowing of the large blood vessels that deliver oxygen to the heart (National Institutes of Health, 2017). The impact of CHD stems from one having an elevated risk of cardiovascular disease, which is a major public health concern in low-income families where socioeconomic and demographic disparities in healthcare access and use currently exist (Chen et al., 2016). OSA and snoring are some of the risks for CHD and warrant multidisciplinary assistance to patients, which include the physician and the dentists who aid in the necessary appliances for the treatment of OSA and snoring (Ramar et al., 2015, p. 774). OSA and snoring are related to social problems but are different. Snoring that is chronic and that a person cannot stop on their own is a sign of a serious health problem with factors that affect nighttime sleep and results in daytime sleepiness in older adults which may be due to medication side effects, environmental factors, and sleep disorders like OSA, which manifests itself as fatigue (Zhang et al., 2016). According to the Georgia ENT (n.d.) specialist, one in four persons has this problem with snoring. The prevalence of OSA in men and women is supported by Franklin and Lindberg’s (2015) study of respondents from 2008 to 2013, where the prevalence in men with OSA amounted to 37% of the study population and women amounted to 50% of the population. Additionally, a person who has OSA may be irritable and could have a compromised immune system, low energy, lack of productivity, and issues with their thought processes throughout the day (ENT, n.d.). Physical activity and exercise programs may be impacted due to the low energy one has as a result and could directly have a negative consequence related to obesity.

Obesity is important to study at a national level. There are regional differences, such as the findings in Georgia, where between 30% and 35% of adults were suffering from obesity in 2017 (CDC, 2018). In Alabama, greater than 35% of adults suffered from obesity in 2017 (CDC, 2018). Coupled with Alabama, other states like Oklahoma, Arkansas, Louisiana, Mississippi, Iowa, West Virginia, and Rhode Island all showed to report greater than 35% of the population as obese (CDC, 2018). Only DC, Hawaii, and Colorado showed findings where less than 20% of the population was reported as obese (CDC, 2018).

Additionally, the CDC (2018) reported that over 36.1% of adults in Alabama suffered from obesity with short sleep duration less than 7 hours as predicated with risk factors of sleep apnea. These individuals were Black (46%), American Indian (55%), White (37.6%), and Hispanic (34%; CDC, 2018). Adults in Georgia accounted for similar rates with 35.5% of adults suffering from obesity with short sleep duration less than 7 hours; however, there was no record for the American Indian population (CDC, 2018). In Georgia, the CDC (2018) noted that Blacks accounted for 48.4%, with the Georgia Hispanic population at 33.8%, and the White population at 35.6%. Georgia is one of the states that had the second-highest reported obesity rates coupled with Illinois, Kentucky, the Carolinas, and Virginia. Alabama holds the spot as having the highest rates of obesity in the United States along with Mississippi and the states previously mentioned. These national rates of obesity in adults over 18 years of age reveal short sleep duration, resulted in the lack of energy which impacts activity and productivity and a potential link to the increase in cardiovascular disease (Vaughan et al., 2017).

Although limited research has been conducted on CHD and its relationship to obesity, OSA, and snoring as individual risk factors for CHD, a gap existed as these factors were not studied as paired in this study. The literature includes recommendations through an article located in the CDC's special articles section to physicians on treatment options for OSA and snoring; however, even with the recommendation to the medical arena to use such tools as the continuous positive airway pressure (CPAP) machine and recommendations for weight loss, the recommendations are limited and showed a gap that required addressing the correlation between using a CPAP at night and obesity and how OSA, snoring, and obesity are risk factors for CHD (Ramar et al., 2015). There have been limited research studies conducted on how obesity combined with a OSA diagnosis is related to CHD along with limited research studies into how snoring combined with OSA is related to CHD. The gap in the literature was how this combination of factors within a person impacted CHD. Further research into how the combined risk factors work together to elevate the chances of CHD is still needed.

Purpose of the Study

In 2017, it was reported that 647,457 persons succumbed to CHD, which the CDC lists as the number one cause of death (CDC, 2019b). OSA and snoring are some of the risks for CHD (Ramar et al., 2015). Obesity with short sleep duration also places individuals at higher risk for cardiovascular disease (Vaughan et al., 2017). The purpose of this quantitative cross-sectional study was to explore if a significant relationship exists between obesity, snoring, OSA, and CHD while accounting for gender, race, age, and geographic location.

Research Questions

Research Question (RQ)1: Is there a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location?

$H_0$1: There is no significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

H_a1: There is a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

RQ2: Is there a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location?

$H_0$2: There is no significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

H_a2: There is a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

RQ3: Is there a significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location?

$H_0$3: There is no significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location.

H_a3: There is a significant relationship between apnea and CHD after controlling for gender, age, race, and geographic location.

RQ4: Is there a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location?

$H_0$4: There is no significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

H_a4: There is a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

Theoretical Framework for the Study

The health belief model (HBM) was used as the theoretical framework in this study. The HBM was developed as a means of showing that people were not using and participating in the preventative health behaviors necessary to aid in weight loss and smoking reduction (Whale Conley et al., 2016). There are two foci inherent in the HBM. The first states that researchers must investigate the value that the person places in the goal that is associated with the behavior that is affecting their declining health and presentation, such as obesity and OSA. The second focus of the HBM is that the person believes that their actions to change could result in the goal that they desire. Both foci were directly connected to this research study because of persons in each age group, gender group, and race that present with snoring and OSA formulates beliefs regarding their health and CHD. The theoretical framework is discussed in more detail in Chapter 2.

Nature of the Study

A quantitative methodology was appropriate to test if a relationship exists between the independent variables (obesity, snoring, OSA) and the dependent variable (CHD). I used a cross sectional design with the comparative approach while accounting for demographics such as age, gender, race, and the geographical region of the respondents. Additionally, because there was a binary dependent variable, I conducted binary logistic regression to observe the relationship between the variables. The CDC Behavioral Risk Factor Surveillance System (BRFSS) dataset was used in this study. This is a publicly available secondary dataset that was used to compare the data from 2015 to 2017. Participants were adults that responded to the BRFSS who were 18 to 75 years of age at the time of the survey.

Definitions

Coronary heart disease (CHD): CHD was the reference definition used in this study to describe the leading cause of heart failure worldwide due to elevated levels of morbidity and mortality by those impacted by it (Tian et al., 2019). Due to the link to stroke and the connection to the arterial disposition, CHD was found to be referenced or used interchangeably as coronary arterial disease (CAD). Wojtkowska et al. (2019) stated that CAD is the leading cause of heart failure, but heart failure then changes without mention from CAD to CHD when stating that CHD plays a major part in the development of heart failure. Throughout their research, Wojtkowska et al. continuously referred to CHD interchangeably with CAD, which is not uncommon. In this study, I specifically defined the condition as CHD consistently throughout.

Obesity: Obesity is characterized as one having a BMI that is higher than 30 kg/m (Kanna & Boutin-Foster, 2016, p. 1068). This could be attributed to diet, exercise, and heredity (Kanna & Boutin-Foster, 2016).

Sleep apnea (OSA): When a person has partial and complete airway obstructions while they are asleep, which results in continuous apneas and hypopneas, they are categorized as one who suffers from OSA (Franklin & Lindberg, 2015). Heavy and loud snoring, which is self-reported, is one of the characteristics of OSA (Franklin & Lindberg, 2015).

Snoring: Snoring is a condition caused by a large distribution of body fat around the nasal muscles in the upper airway (Franklin & Lindberg, 2015). The anatomy of the pharynx is also a characteristic of snoring (Franklin & Lindberg, 2015).

Assumptions

In this study, much was believed but was not able to be demonstrated as truth. First, I assumed that participants were interviewed one time as the study data were extracted from secondary data. Additionally, because the data were secondary, I assumed that the participants answered each of the questions truthfully in the questionnaires provided about their socioeconomic status, gender, obesity, and BMI scores, and in response to all of the variables under study regarding their CHD, snoring, and OSA status. Third, the respondents' ability to read the level required of the survey was another assumption. Lastly, I assumed that the researchers who acquired the data were independent of the influence of the respondents and held no biases in retrieving the data regarding demographic responses. These assumptions were necessary to move forward with the study research inherent in using secondary data.

Scope and Delimitations

Participants were adults who responded to the BRFSS, who were 18 to 75 years of age at the time of the survey. These individuals were included if they identified as obese and snored or identified as obese and had been diagnosed with OSA. Individuals were included who received a diagnosis with CHD. Because the participants were anonymously selected and there was a large pool of selection due to the secondary database, this presented a large variation that enabled transferability and generalization of the findings of the study. Persons were excluded who did not reside in the United States or had arrived in the United States after 2016.

Several theories were considered for the theoretical framework of this study but were not used. The social cognitive theory was not selected for this study because although it addresses social determinants of a person's health and how their past experiences affect their behavior changes, it was not the best theory to show the perceptive reality of the continued use of tangible services and products to benefit the combined health-related issues as a means to combat CHD. The self-determination theory and motivation was not selected because although it addresses how people become self-determined based on fulfillment of the competence, connection, and autonomy needs that were fulfilled, it was not the best theory to show an egalitarian process to consistency in motivation while refuting barriers that may impact actions when the person is presented with one health issue over the other as in that with snoring coupled with OSA. The theory of reasoned action was not selected because although it addresses behavior and intentions based on outcomes, it was not the best theory to show the actual impact of a behavioral action when environmental and social disparities exist as barriers to consistency in use of tools and services available for those impacted with the four variables under study. The protection motivation theory was not selected because although it addresses perceived severity and efficacy when involving a potentially threatening event, it was not the best theory to show a practical application of continued use and maintenance of change in prevention models. The HBM is a theory that delves into the perceptions held by persons regarding their health problems and the benefit or impact to them taking action as well as any potential barriers to them taking action. None of the other theories provide a framework to develop the model that would address the relationship between the three combined variables and their relationship with CHD.

Limitations

In this study, the limitations included those that would have been inherent in using secondary data, which included a potential impact to the reliability of the responses due to study participant dropouts that may have impacted the actual number of persons who responded at the initial screening for those who presented with the three combined variables to review against CHD. Also, the answers provided may have been given based on what family or friends recommended and not necessarily the authentic answer from the respondent, thus producing a form of bias. However, the information was provided privately to reduce this element of bias. Additionally, the initial collection of the data did not advise of storage of the acquired information. Data could have been altered at some point in the collection and storage period, which could have had an impact on the actual data quantified. As an observational study, the exposure and the outcome were examined which limits the reliability of the relationship between the exposure and choices and the outcome of disease. The full scope of the potential frequency of the CHD with the independent variables was analyzed at one given period of time which is useful in looking at the potential plans for services and programs; however, cause for the disease and the incidence would limit the interpretation of the causal effects of the disease.

Despite these limitations, this study is one of the first to show the impact of how snoring, OSA, and obesity when combined, relate to CHD morbidity and mortality in the population.

Significance

This study could contribute to the identified gap in the literature as I examined the combined risk factors of OSA, obesity, and snoring and how they are related to CHD, taking into consideration certain demographic factors like age, gender, race, and geographic location. Obesity is on the rise due to diet choices, lack of physical activity, access to care and consistent services, and underlying health issues that have potentially subjected individuals to CHD (CDC, 2018). OSA is of major concern in public health due to the potential for mortality and morbidity as a result. Demonstrating that the combination of obesity, OSA, and snoring are linked to CHD was important in providing foundational, community support to the multidisciplinary, professional practice currently found in many of the major metropolitan states like Georgia and Alabama. Historical research such as that conducted by Gottlieb et al. (2010) focused on one variable's (OSA) relationship to CHD. In this study, I focused on the impact of three variables, which include OSA, snoring, obesity, and their relationship to CHD as a combined influence on morbidity and mortality as opposed to individual variable relationships to CHD. Unlike the study by Gottlieb et al., which only focused on older adult men in a specific cohort and community, I focused on the comparative analysis of three variables and their impact on CHD in adults 18 years of age and older and was not gender specific. The findings are not nationally representative and limits the focus to adults over 50 years of age without focus on those younger adults who have an even greater risk of OSA (see Gottlieb et al., 2010). The only and most recent reference to OSA and obesity that comes close to this topic relates to cardiovascular comorbidities but does not focus on the impact of these two variables coupled with snoring and CHD (Hudgel, 2018). What is important to note is that although clinicians and medical personnel have studied each individual variable, patients who are obese, snore, and have OSA could benefit from the outcome of this study by learning the gravity of impact of how having these combined factors are related to CHD. There is no known study that has specifically addressed the three variables combined. There could be more to a diagnosis when a person self-identified and medically listed as obese enters an office and informs the doctor that they snore and are diagnosed with OSA after a sleep study.

The literature on this topic is extremely limited; there are studies that link obesity to CHD. There are also studies that link SA to CHD. However, there are no studies that link all three of these variables together and show their combined association to CHD in adults. Because snoring, OSA, and obesity are combined risk factors of this study, the positive social change that could result from this study could be to aid dentists and physicians in working with sleep specialists and weight management organizations to address the combined issues of obesity, OSA, and snoring as a means to reduce the incidence and prevalence of CHD. This study is unique because it addressed an area of CHD research that has been understudied but necessary to bring about positive social change in fostering nondiscriminant multidisciplinary strategies to assist the specialists who focus on risk-specific issues that exist demographically and to the comorbidities connected to obesity, OSA, and the association with CHD.

Summary

Socioeconomic status, demographics, and geographic location are linked to quality and consistency in care and services for individuals who are diagnosed with OSA, snoring, obesity, and the potential for them to be further diagnosed with CHD. Georgia and Alabama hold the place of states with the highest rates of obesity and OSA (CDC, 2018). In this study, I focused on the southern region, which accounts for the second leading percentage of deaths and morbidity due to heart disease at 10.8%; the CDC (2019) showed the Midwest as accounting for the highest percentage at 12.1%. In this study, I addressed the relationship between the combined diagnoses of obesity, OSA, and snoring, and how they are risk factors for CHD (Ramar et al., 2015). In Chapter 2, I describe the theoretical framework for this study and provide the literature review related to obesity, OSA, snoring, and CHD.

Chapter 2: Literature Review

In 2017, over 640,000 persons succumbed to CHD, which the CDC (2019) lists as the number one cause of death. OSA and snoring are some of the risks for CHD (Ramar et al., 2015). Obesity with short sleep duration also places individuals at higher risk for cardiovascular disease (Vaughan et al., 2017). The purpose of this study was to determine if a significant relationship exists between obesity, snoring, OSA, and CHD while accounting for gender, race, age, and geographic location. In this chapter, I discuss the strategy used to obtain pertinent literature related to CHD, OSA, snoring, and obesity and provide a review of the literature. I also discuss the HBM, which served as the theoretical framework for this research.

Literature Search Strategy

The literature search for this study included publications that were from 2014 to 2019. The search was limited to the return of information that was in English. The literature search was conducted using the following databases: CDC, NIH, PubMed, Medline, and Walden University. The Walden University database provided relevant literature from PsycInfo, EBSCO host, and ProQuest. The searches were limited to only selecting peer-reviewed, full text scholarly journals.

During the search for literature, the following search terms were used: *obstructive sleep apnea* (89,342 results), *coronary heart disease* (286,346 results), *sleep apnea* (117,445 results), *coronary artery disease* (282,386 results), *obesity* (1,164,136 results), *snoring* (21,739 results), and *OSA* (91,619 results). In addition to using filters by subject, the search term groups to filter for CHD had to be classified and narrowed down. In narrowing down the search, the following results transpired for the terms used: *OSA* (68 results), *obstructive sleep apnea* (1,475 results), *sleep apnea* (3,262 results), *obesity* (21,543 results), and *snoring* (177 results).

The articles were selected by how well they related to the four variables under study: obesity, OSA, snoring, and CHD. Because there were no articles that reviewed all three variables under study against CHD as combined risk factors, articles that contained at least one or two of the variables were selected. Overall, I decided to use the articles based on the author's ability to show a relationship with the three variables to CAD or CHD.

Theoretical Foundation

The HBM was selected for this research because it lays the foundation for understanding why health impacting behaviors exist and further gives weight to providing the framework necessary to understand how the combination of obesity, OSA, and snoring have a direct impact on CHD relative to demographic disparities in care and services. There are four components of the HBM: perceived susceptibility, perceived seriousness, perceived benefits, and perceived barriers.

Perceived Susceptibility

The HBM concept focuses on how an individual perceives their susceptibility to getting a disease or the serious/severity of the diseases in Section 1 of the theoretical model (Rosenstock, 1974). Rosenstock (1974) noted that persons took action to keep from acquiring a disease if they believed that they would be susceptible to the disease or if the disease would have a severe impact to some part of their life and livelihood, and if they could not overcome barriers like cost, pain, and how they are viewed publicly.

Perceived Seriousness

Perceived seriousness focuses on the factors that modify the individuals' actions. These include the demographics, their societal placement, such as social class or peer group, or structural variables, such as how much they know about the disease and if they had any prior contact with someone with the disease, such as transmission or heredity (Rosenstock, 1974). The perception of the threat of disease by the individual stands centered with the demographics and perceptions along with those cues for the individual to act. In this case, cues to act, media, personal advice from others, physician/dental reminders, family ailments, and news articles would be the modifying actions.

Perceived Benefits and Barriers

The perceived benefits and barriers component of the HBM reflects on the likelihood that the person would act. This action would be due to their perception that there would be a benefit more than the barriers that could come about in complying with the prevention action. Additionally, this component of the HBM is the consolidation of the person's potential to adhere to taking the prevention action for their health and wellness (Rosenstock, 1974). If the individuals' modifying factors are linked with their cues to action, perceived susceptibility and severity of the potential for disease, then there would be a strong likelihood that person will take the recommended prevention, especially if there are elevated perceptions of benefits more than the barriers to the prevention action (Rosenstock, 1974).

Similar Studies That Used HBM

Jorvand, Sadeghirad, Mehrizi, Ghofranipour, and Tavousi (2019) applied the HBM to daily exercising among staff who were obese but did not focus on the additional variables of OSA and snoring and only focused on one group of individuals. In Jorvand et al.'s study, questionnaires were used to focus on the intention and amount of daily exercises. It was noted by Jorvand et al. that exercising in phases would benefit one in decreasing risk factors for obesity because around 70% of disease is due to lack of activity. The risk factors for cardiovascular disease (CVD) in the > 45-year-old bracket in the study were associated with smoking, lack of fruit and vegetable consumption, not being active, obesity, and having high blood pressure (Jorvand et al., 2019). There was a drive to find out the appropriate methodology to assist the individuals in reducing these risks by making small changes to their daily living for a better quality of life. Demographic data were acquired in the testing to compare gender along with the risk predictors between individuals who were overweight and obese for CVD (Jorvand et al., 2019). Once the information was collected from the study, the HBM was used as the foundation for recommending interventions as an effective means of reducing the risk of obesity as linked to CVD (Jorvand et al., 2019). The researchers' goal was to use the HBM and assess the determinants of daily activities in participants that were overweight/obese (Jorvand et al., 2019).

Jorvand et al. (2019) found that over 57% of the participants were men, over 86% were married, over 56% had bachelor degrees, over 81% were overweight, over 14% were obese, and over 63% did not conduct a daily exercise regimen (p. 389). The amount of exercise that was standard was 30 minutes a day for a week, but only 37 participants met this exercise standard (Jorvand et al., 2019, p. 390). In the study, the findings revealed that there was a significant relationship between the demographic, gender, and the number of daily exercises where men exercised more than women (Jorvand et al., 2019). Additionally, the relationships between the four elements of the HBM were assessed against the behavior of the individuals to daily exercises, such as perceived severity, self-efficacy, perceived benefits, and perceived barriers. It was found that self-efficacy was the main predictor of a person doing daily exercises, improving physical activity, and changing behavior (Jorvand et al., 2019). Most importantly, Jorvand et al. pointed out that one's perceived intensity due to the potential for acquiring CVD would start them exercising. Still, self-efficacy would be the reason they continue exercising throughout life.

Shahrabani, Tzischinsky, Givati, and Dagan (2014) focused solely on OSA and not obesity in their study regarding the intention and decisions for treatment using the CPAP. There was no mention of those who snore in their study regarding awareness and promotion of interventions and treatment. Shahrabani et al. looked into how the HBM impacted the intention to use the CPAP device and their decision to purchase the CPAP device based on sociodemographic variables, their physiological issues, and how long they would have to use the device. Shahrabani et al. showed how the beliefs that the patients have relative to OSA and how it is to be treated had an impact on whether they intend to purchase the CPAP device and use it. One of the most important barriers noticed in the study was income. Those persons with lower income did not have any plan to obtain the CPAP device as opposed to those within the higher income bracket (Shahrabani et al., 2014).

Sas-Nowosielski, Hadzik, Gorna, and Grabara (2016) conducted a study on how older adults went through phases in physical activity by applying the HBM to determine behavior. They found that women reported more benefits to physical activity than men and looked at the risk of diseases as a higher motivation to do the physical activity than men (Sas-Nowosielski et al., 2016). They were able to acknowledge why the HBM does not work for understanding why young and healthy adults show readiness for physical activity because they are not focused on disease avoidance (Sas-Nowosielski et al., 2016). Older adults were the focus of their study because of the concern with aging health issues currently relative to behavior. However, Sas-Nowosielski et al. recommended that interventions focus on elevating the belief that they can perform exercises and elevate their exercise behavior in addition to keeping any barrier to force inactivity at bay.

Tran et al. (2017) conducted a study that investigated cardiovascular disease risk factors regarding college students. They sought to look at how the students' knowledge and perception of risk for CVD impacted their lifestyle modification potential. The HBM was used in this study conducted by Tran et al. to assess perceived susceptibility and severity of CVD among college youth aged 19 to 39 while also screening for their CVD risk. They looked at the CVD risk factors and the ability to be modified against the knowledge, susceptibility, and perceived severity for 30 years to life (Tran et al., 2017). Age and gender are not able to be modified while carcinogen use, obesity, and hypertension are modifiable. In their study, Tran et al. conducted the CVD risk assessment profiles. They noted that the youth whose parents and families had some form of historical CHD had low results on the profiles, and their knowledge was positively associated with a lifetime CVD assessment. There was a discrepancy between that which is self-reported versus that which was measured due to not having a prescreening for blood pressure/hypertension and glucose levels/diabetes (Tran et al., 2017).

Kohler, Nilsson, Jaarsma, and Tingstrom (2016) conducted a study about how married couples' beliefs and lifestyle habits change 1 year after experiencing a heart issue. After a cardiac issue, individuals are provided with rehabilitation and given structured procedures for changes or modifications to their lifestyle and diet. Kohler et al. investigated the couple’s belief in what was to change with their lifestyle habits following the CHD event. Using the HBM to observe changes and maintenance of health behaviors to guide interventions, it was found that the spouse who experienced the CHD event focused on their ability alone with the recommendations from the health facility instead of working with their spouse (Kohler et al., 2016). Those recommendations led to issues with the spouses regarding family preferences versus the individual patient’s wishes (Kohler et al., 2016). Normally, with the perception of benefits and barriers, patients focused on how well they believed an activity would benefit them in the reduction of risk for CHD and what would be a barrier to medication use and obtaining it (Kohler et al., 2016). The severity of the CHD was not a question of thought in need for the dissolution of old, risk-taking habits. Overall, the need for family, medications, compromise, and tangible goals was equal between the spouses in the study (Kohler et al., 2016).

Literature Review

CHD

CVD has been used interchangeably with heart disease when teaching within various demographic communities about health and wellness as is done in some law enforcement courses and when certifying officers for cardiopulmonary resuscitation (CPR). Unfortunately, CVD is only a part of the greater problem that exists with heart disease. CVD is a part of the group of diseases that fall under that which is considered CAD, which involves the arteries and is encompassed as is acute syndromes involving angina and myocardial infarction (Sanchis-Gomar et al., 2016). CAD is also dangerous in representation as atherosclerosis, which may have no symptoms, or it could have unstable angina (Sanchis-Gomar et al., 2016). The distinct difference between CAD and CHD is CAD involves pathology that stems from the coronary arteries. In contrast, CHD involves a person being diagnosed with angina pectoris, myocardial infarction, and silent myocardial ischemia (Sanchis-Gomar et al., 2016). According to Sanchis-Gomar et al. (2016), the resulting factor of having CAD is that the individuals would be subject to suffer CHD mortality, which is the major cause of death in the United States and across developed countries.

In developed countries, prevention of CVD should be available through persons maintaining a healthy diet, a physical activity regimen, and having non-disparate health services and options available and maintained. The most important factor is the maintenance of selected options in regimented care. Since there has been an increase in social inequalities, CVD mortalities in individuals over 35 years of age increased as well right alongside having negative lifestyle practices of limited to no physical activity based on environment (Sanchis-Gomar et al., 2016).

In 2016, the American Heart Association (AHA) updated their heart disease and stroke statistics, where 15.5 million people that were older than 20 years of age were diagnosed with CHD (Sanchis-Gomar et al., 2016, p4). There was no difference in the increase in heart disease and stroke statistics of those older than 20 years of age at diagnosis for men versus women. The statistics reported were from surveys and interviews conducted within this age group. As Sanchis-Gomar et al. (2016) pointed out, the use of the data from the National Health and Nutrition Examination Survey (NHANES) showed how the interview process might have underestimated the actual prevalence of advanced CHD since occlusive CHD may present with minimal or no symptoms. In this study, the use of data from postmortem results showed declines in the United States. This was due to the advancement of health care systems. However, there is the unfortunate issue with low and middle income persons as CHD mortality around the world and in the US with predictions of expected increases in men (48%) more than women (29%) from 1990 to the year 2020 (Sanchis-Gomar et al., 2016). Additionally, Sanchis-Gomar et al. (2016) pointed out that one-third of all the deaths in those 35 years of age and older are due to CHD. Unfortunately, this study did not incorporate any findings on snoring or OSA.

Physiological Impact of CHD in Adults

With men expected to live to 76.4 years of age and women 81.2, knowing the physiological impact of CHD is very important since it is the number one leading cause of mortality in the US, killing over 600,000 people each year, according to the CDC (Kochanek et al., 2016, p. 1). Angina pectoris, which is chest pain, is the main symptom of CHD (Singh et al., 2018). CHD is what leads to heart failure and eventual mortality. In 2013, Non-Hispanic Black males (1,083.3 per 100,000 standard population-sp) accounted for the largest rates of deaths in the total population followed by non-Hispanic white males (876.8 per 100,000 sp) than non-Hispanic Black females (740.6 per 100,00 sp) and lastly non-Hispanic White females (638.4 per 100,000 sp) with the actual Hispanic population of males and females not being significantly different (Kochanek et al., 2016, p. 2). In the Hispanic population, Males outnumbered females in their rates of death due to CHD per 100,000 standard population. Males accounted for 639.8 deaths per 100,000 sp in 2013 versus 448.6 in females (Kochanek et al., 2016, p. 2).

In adults studied by Ji et al. (2015), CHD was shown physiologically as directly associated with inflammation. Chronic inflammation of the blood vessels is impacted by monocytes and macrophages when inflamed. When this type of inflammation is sustained, and there is an issue with plaque build-up and instability, leading to the risk of coronary mortality in those that are healthy as well as those diagnosed with CHD (Ji et al., 2015). Macrophages migrate and have been categorized as a macrophage migration inhibitory factor (MIF), which is in macrophages, vascular smooth muscle cells, and cardiomyocytes, which is critical in the development of atherosclerosis (Ji et al., 2015). When there is an event, lesions are present which impacts the normal arterial expression. MIF is important when the immune-mediated inflammatory diseases prompt medical personnel to assess for the development of CHD (Ji et al., 2015). The presentation of

CHD is when there is a pain in the chest, behind the sternum. This description is also classified as angina pectoris. Medical personnel determine if the angina is stable angina pectoris (SAP) or unstable angina pectoris (UAP) when assessing diagnoses. An individual that states they have been under stress and may have overexerted themselves would have a primary diagnosis representative of SAP, and rest or taking nitrates relieves them of the sternal pain (Ji et al., 2015). However, one with UAP will find no relief because the angina is there more than three times a day, severe, and frequent, not caused by exercise, and happens during the person's rest period (Ji et al., 2015, p. 2).

CHD Prevention

Heart disease accounted for 170.5 deaths per 100,000 standard population in the United States (Kochanek et al., 2016, p. 3). Critical to understanding atherosclerosis, which is the primary factor that leads to CHD mortality, Ji et al. (2015) recommend focusing prevention on inflammation and immunity due to their association with atherogenesis and MIF (p. 4). In a study involving 17,113 adult men and women who were diagnosed with or at risk for CHD, medical treatment was also used to combat CHD mortality (Mondesir et al., 2018, p. 5). This was done by reducing the risk for hypertension due to high medication adherence thus reducing perceived stress (Mondesir et al., 2018, p. 5). The stress levels of the individuals diagnosed with CHD correlate with inflammation, as previously mentioned in the physiological depiction of those with CHD diagnoses.

Obesity

Obesity was found to be one of the most important risk factors for a person that snores and also have OSA to which once a person has bariatric surgery and been placed on a calorie-restrictive diet, the severity of OSA is reduced (Franklin & Lindberg, 2015). The lower the caloric intake, the lower the apnea-hypopnea index (AHI) based on the study. What was found to work better in Franklin and Lindberg's study is that when patients used the continuous positive airway pressure (CPAP) machine, coupled with the low caloric intake, they were much better off (Franklin & Lindberg, 2015). In their study, disease severity is measured at 95% confidence interval showing the mean (*M*) of the male participants (*M* = .22) exceeding that of the female participants (*M* = .17) in OSA. Overall, individuals subject themselves to OSA due to the increase in fat in the upper airway in men more so than women regardless of ethnicity. Obese patients and those that have enlarged necks were shown to have OSA, with one-third of this number of individuals not placing as obese (Franklin & Lindberg, 2015). The researchers pointed out that the observation of hypertension showed an *OR* = 2.03 (95% CI [1.29, 3.17]) for those with mild OSA whereas those with moderate to severe and *OR* = 2.89 (95% CI [1.46, 5.64]) for those with moderate to severe OSA (Franklin & Lindberg, 2015, p. 1316).

When looking at the disparities in race, gender, age and demographics, the Latino men accounted for 81.6% of the overweight or obese population in New York versus Latino women who accounted for 68.5% of the overweight or obese female population in New York as noted in the NHANES nationwide data (Kanna & Boutin-Foster, 2016, p.

1068). The researchers found that overweight or obese (*RR* 1.88, 95% CI [1.29, 2.73], p = .001) were generally men (Kanna, et al., 2016, p. 1064). This study focused solely on obesity in New York, where BMI was greater than 30 kg/m, and the researchers looked at the demographic setting and process of acculturation as the basis for explaining why the individuals felt their health behaviors influenced. Additionally, this study focused solely on the Latino population but pointed out that the survey used was community-based of minority adults in the inner-city which does not include data on the other races for complete comparative analysis. The researchers stated that they used bi-variate and multi-variate logistic regression to assess the associations between their variables with an odds ratio of 95% confidence interval and the consideration of significance at $p < .05$ with a power > 90% with $\alpha = .05$ (Kanna et al., 2016, p. 1063). In their study, most of the respondents agreed that their obesity classification was due to diet and exercise ($p < .001$), which would prove useful in a focus on diet and exercise (Kanna et al., 2016). Unfortunately, the buy into servicing in this classification toward the connection to such medical conditions as snoring, OSA, and CHD would not transpire since the study participants were uncertain as to the connection between their chronic conditions and obesity (Kanna et al., 2016). Many of them thought that their obesity was related to a family disease (59.2%) or a medical (68%) condition (Kanna et al., 2016, p. 1063). The age of the respondents was above 19 years of age, but the remaining demographic information was isolated solely to the Latino population. Hence, this verifies a gap in informational findings that could predict the use of non-disparate modules for assisting health care professionals when offering and maintaining monitored services relative to obesity across all demographics and states.

Snoring and OSA

OSA is observed as the times that a person has partial and complete airway obstructions while they are sleep as measured under the AHI where AHI is ≥ 5, which results in continuous apneas and hypopneas (Franklin & Lindberg, 2015). In the study conducted by Franklin and Lindberg (2015), coupled with the United States, eleven countries were studied between 1993 and 2013 for the prevalence of OSA**.** In their studies, the researchers pointed out an instrument used to determine if OSA exists in a patient. This instrument takes the mean number of apneas and hypopneas that occur during an hour of sleep (Franklin & Lindberg, 2015). If this is greater than or equal to 5, it meets the criteria for OSA (Franklin & Lindberg, 2015). Not only does this condition impair rest in individuals, but it also impacts the work environment. OSA is common and impairs work performance thus impacting financial income in businesses globally (Seyedmehdi et al., 2016). This is due to snoring and waking up early, getting less than 4 hours of sleep and impacting the overall sleep, and rest of individuals who self-report snoring and may have sleep-deprivation (OR = 2.803, 95% CI [1.460, 5.380], p = .001), because it causes one to be sleepy during the day (Seyedmehdi et al., 2016). The danger in this is that criteria subjects the patients to what Seyedmehdi et al. (2016) also researched regarding daytime sleepiness, according to Franklin and Lindberg (2015).

Additionally, Franklin and Lindberg's study pointed out how daytime sleepiness impacts a person's oxygen intake. Unfortunately, the findings in this study were limited but showed a gap that over time, the diagnostic equipment and changes in definitions of health issues such as apnea, OSA, daytime sleepiness had an impact on the prevalence of OSA and how it is treated. For example, in the study, only part of the individuals studied had snoring and sleepiness, which are requirements for the OSA investigation on clinical grounds. This partial study of the variables that the individual self-report as having limits any outcome that would be required for an effective, inclusive tool for OSA and snoring.

An additional tool that is used to focus on the prevalence of OSA is polysomnography, which is used to watch a person's output during sleep. This test requires the patient to be connected to leads that would monitor their nasal and mouth airflow, blood pressure, electrocardiographic activity, blood oxygen levels, the pattern of their brain waves, eye movement, and their respiratory muscle and limb movements (Seyedmehdi et al., 2016). This tool would provide a concrete document that is absent of disparities for the creation of modules and tools for continuous maintenance care of persons who present with obesity, OSA, snoring, and are with CHD. This is impactful since, when left untreated, OSA is found to increase persons' use of healthcare services and chronic diseases such as CHD (Seyedmehdi et al., 2016).

The researchers in the Franklin and Lindberg (2015) study used two methods to acquire their samples: Postal questionnaires for random sampling in stage one and oversampling of the subjects who said they snored and had daytime sleepiness in stage two. In their study, Franklin and Lindberg (2015) pointed out how medical personnel has been under-diagnosing patients by assessing them after they have an issue with CHD and later finding out that the patients have OSA. This delay has impacted association with relationships between OSA and CHD stemming from cross-sectional studies, although snoring and OSA have shown to have a positive association in case-control studies (Franklin & Lindberg, 2015). OSA increases after a person is 60 years of age which showed in their study that those with an AHI ≥ 30 were more likely (Adjusted *OR* = 3.0, 95% CI [1.4, 6.3]). to acquire mortality for all causes including CHD (Franklin & Lindberg, 2015).

Seyedmehdi et al. (2016) used the Berlin questionnaire and analyzed their variables under study with logistic regression to ascertain the risk of OSA and set their level of significance in their study to 0.05 to analyze the results of the respondents which showed that those over 35 years of age had a higher risk of OSA with a reported history of snoring (*OR* = 2.190, 95% CI [1.220, 3.933], *p* = .007). Additionally, they showed that men's risk was reported to be higher than that of women in the study (*OR* = 1.914, 95% CI [1.063, 3.449], *p* = .028). What was quite interesting is that married couple were found to have a higher risk than those that were single (*OR* = 2.545, 95% CI [1.249, 5.187], *p* = .008) in the study right alongside those that already had a history of chronic disease have a higher risk than those who did not (*OR* = 2.179, 95% CI [1.206, 3.940], *p* = .008) have the similar risk (Seyedmehdi et al., 2016).

Snoring is generally self-reported. Males who snore are evident in gender differences in the relationship of connection to OSA. In observing the men, the prevalence of snoring was higher, possibly due to the distribution of body fat, nasal muscles in their upper airway as well as the anatomy of the pharynx (Franklin & Lindberg, 2015). In women, obesity and hypertension coupled with age was associated with OSA in females but not noted as an issue in public health due to the different symptoms of OSA of that which males present with (Franklin & Lindberg, 2015). Overall, persons over 55 years of age with obesity and heart issues are shown to have issues with snoring (*OR* = 2.179, 95% CI [1.206, 3.940], *p* = .008) (Seyedmehdi et al., 2016). Franklin and Lindberg (2015) pointed out how snoring increases with age up until the person is 50 to 60 years of age. Then it decreases in both men and women. The impact of this change on the combination of all the other three variables wasn't in any of the studies relative to CHD. This lack of analysis of the combination of the variables adds to the gap in the literature.

Obesity and CHD

Obesity is directly associated with diet, lifestyle, and fitness. With this causal link between obesity and inactivity comes systemic inflammation where high levels of adiposity exist in individuals characterized as obese (Ahluwalia et al., 2018). Rodents are used in research to observe the association between obesity and CHD. However, human metabolism is not as understood, which limits the treatment options currently in place (Wang et al., 2014). Unfortunately, there has not been enough research into the outcome of CHD, and the connection obesity combined with snoring and OSA has with it.

A study by Sharma et al. (2015) conducted a multivariate logistic regression analysis on persons that were ≥ 65 years old (*n* = 7057) and examined CHD by looking into how the mortality from this disease related to BMI and coined it the "obesity paradox" (p. 476). This study revealed that obesity alone was subject to the highest rate in mortality but pointed out the study does not have evidence on the topic of obesity and

CHD in elderly men (*OR* = .63, 95% CI [.53, .76] or women (CI [.45, .75], $p < .001$). The purpose of the study was to look into how BMI, obesity, and mortality in the elderly who had CHD were within the limits of the "obesity paradox" and if there was an increase in the risk for mortality (Sharma et al., 2015). The tools used in the comparative analysis are the normal BMI based on the World Health Organization's classifications, and the normal weight-central obesity (NWCO) assessed the waist to hip ratio (WHR) as a means to observe the highest risk for obesity mortality. The waist to hip ratio is a method of assessing the measurement around the waist and base the classification on the National Cholesterol Education Program Adult Treatment Panel III classification (Sharma et al., 2015). The authors presented the definition of the obesity paradox where persons who have CHD have mortality that is related in reverse to their own BMI (Sharma et al., 2015). The independent variables were the normal BMI and central obesity. The researchers' aim and purpose of their study on these independent variable combinations was analyzed against the dependent variable, high CHD mortality risk. The covariates were age, gender, and the phases of weight. The research question was to study the relationship between BMI, central obesity, and CHD mortality in persons over 65 years of age. Their first research question sought to analyze the existence of the obesity paradox. The second research question sought to find out if NWCO is connected to persons having higher risks of CHD mortality (Sharma et al., 2015). In the study, the researchers conducted two points of assessment. The first assessed 5-year mortality in the elderly for those that were greater than 65 years of age (Sharma et al., 2015, p. 476). The individuals were categorized by normal weight, overweight, and obese in the study. Their study sample amounted to 7,057 persons (Sharma et al., 2015, p. 476). It was inferred that a convenience sample was used as the authors pointed out that the researchers obtained their sample from a database on persons diagnosed with CHD.

Sharma et al. (2015) addressed structural validity by using multivariate logistic regression to analyze mortality risk by assessing BMI with WHR and high waist circumference (WC) at two periods: 2-year and 5-year outcomes. The authors' results were that there were 53% women in the study and at the 2-year mark, there were 3532 deaths and that overall, women were three times and men two times as likely to suffer CHD mortality (OR = 1.0, 95% CI [2.26, 3.63], M = 2.86) based on WHR (Sharma et al., 2015, p. 478). For there to be CHD mortality, according to the results from the study conducted by Sharma et al. (2015), an older adult would have to have a normal BMI with a high WHR and not just with BMI alone. The authors pointed out a recommendation that future researchers would benefit from varying combinations of central obesity and risk in the elderly for social change implications (Sharma et al., 2015). As with the previous studies mentioned, this study, although current literature, only focused on the relationship between Obesity and CHD with no mention of OSA or snoring.

Wang et al. (2018) mentioned neck circumference in their retrospective study relative to OSA and conducted a Spearman’s rank correlation and Student’s t-test comparison to analyze the relationship neck circumference had relative to OSA and CHD. The Wang et al. (2018) study did not reference the power of the analysis, however that the significant findings was based upon the mean ± SD where ($p < .05$) to which those with heightened level of OSA had elevated levels of blood pressure due to higher serum matrix metalloproteinase-9 (MMP-9) and the neck circumference (NC) greater than 42.3 cm. The risk factor of CHD due to NC was not significant with *p* =.204 in the study (Wang et al., 2018, p. 6). Neck circumference is physiologically depicted as an increase in subcutaneous adipose tissue in the neck and associated directly with obesity and OSA, according to Zhang et al. (2018). The prospective study using Cox proportional hazards regression models was what Zhang et al. (2018) used to observe the association between NC and CHD morbidity or mortality (CI = 95%, $p < .05$ as statistically significant). Obesity has been noted as a condition of pathology where a person's BMI is measured over 30 kg/m_2 in this study conducted by Zhang et al. (2018). An interesting factor was presented regarding the distribution of body fat in determining risks such as the visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) of which a body with low SAT was noted as having less risk of CHD (95% CI [1.001, 1.284], *HR* = 1.134, *p* = .022). Zhang et al. (2018) immediately pointed out how VAT is related to atherosclerosis, and the SAT in the abdominal region is not a related risk factor for CHD. What makes the study conducted by Zhang et al. (2018) stand out concerning this research topic is how close it came to pointing out a comparison between the variables of obesity, OSA, CHD with the measurements of the laryngeal prominence as shown in the upper body SAT for NC. Their research did not delve into snoring as one of the variables but noted that the NC and its relationship with CHD had not been defined in recent research, which also verifies the gap in the literature (Zhang et al., 2018).

Al-Zoughool et al. (2018) researched how the risk for CHD is impacted by physical activity (PA). Physical activity has been linked to obesity by recommendations to increase it when a person is in the overweight category by health care professionals. The research in this article offered insight into the current study by the investigation of the variables where PA may show a significant relationship with CHD. Stemming from cardiovascular disease as referenced as CHD in this study, which has a global leader in the cause of morbidity and mortality, Al-Zoughool et al. (2018) highlights that over 17.2 million people worldwide suffer CHD mortality regardless of age (p.1).

With the increasing rates of CHD morbidity worldwide, Al-Zoughool et al., 2018) conducted a cross-sectional study to assess the existence and impact of PA and sedentary behavior on the risk of CVD in Saudi Arabia. The researchers addressed the manner PA and gender interplayed on the risk of CHD (Al-Zoughool et al., 2018). In the pilot study, the researchers used a questionnaire that was hosted by an interviewer who acquired the data on the participants' sociodemographics, how they live, and their medical history (Al-Zoughool et al., 2018). Additionally, they used the World Health Organization (WHO) lifestyle questionnaire, which provided the data on PA (Al-Zoughool et al., 2018). The resulting data from these questionnaires were analyzed using logistic regression, Chi-square, and paired *t*-tests, along with a semi-parametric regression (Al-Zoughool et al., 2018). By using this analysis process, results that showed 95% CI, $p \leq .05$, they were able to show how the gap in the literature fostered the need for their study to address the harm in socioeconomic and lifestyle issues that impact PA with elevations of sedentary living, thus elevating the risk for CHD mortality. They found that when individuals were vigorous with their occupational PA, there was a non-significant increased risk of CHD in men (Adjusted OR = 1.74, 95% CI [.73, 4.16], p =.16) and women (Adjusted OR =

1.14, 95% CI [.43, 3.04], p =.16) in their study. Their study population included 146 individuals. The participants had to live in Saudi Arabia and could not have been diagnosed with CHD for more than a year ago (Al-Zoughool et al., 2018). When the researchers used controls in the analyses, the controls could not have had any historical or current CVD diagnosis (Al-Zoughool et al., 2018). Since the participants were selected from the Prince Sultan Medical Center (Riyadh Armed Forces Hospital), the basis for their admissions was a part of the exclusion process. The participants could not be utilized if they were admitted for diabetes, hypertension, dyslipidemia, obesity, overweight, and respiratory issues (Al-Zoughool et al., 2018).

Al-Zoughool et al. (2018) acquired demographics on the participants in detail related to the study aims and proved beneficial in the standardized findings received. Their independent variable, physical activity (PA), was observed for its impact on the risk of CHD, the dependent variable. In this study, the demographics were the covariates that were examined, such as the participants' age, gender, socioeconomic status, history of CVD, and hypertension (Al-Zoughool et al., 2018). The mean (*m*) age of the participants was between 49 and 53 years of age (Al-Zoughool et al., 2018, p. 4). Additionally, there were approximately 45 females in this study, and most of the participants had a BMI greater than 30 (Al-Zoughool et al., 2018, p. 4).

Interpretation of the appropriate results of the effects of PA that addressed the hypothesis was provided by Al-Zoughool et al. (2018). With a close to equal distribution among the genders in the cases and controls with 146 CHD cases and 157 controls, there was equal representation amongst the participants in the study (Al-Zoughool et al., 2018,

p. 4). The researchers provided a further descriptive analysis of the participants in that the ones that were CHD cases were approximately 53 mean years of age, slightly older than the mean age of the controls who were approximately 49 years of age (Al-Zoughool et al., 2018, p. 4). The cases, unfortunately, were depicted as possibly being less educated (*m*=25) and suffering from morbidity issues like high cholesterol (*m*=72), hypertension (*m*=77), and diabetes (*m*=38) (Al-Zoughool et al., 2018). This depiction was supported where even the activity in degrees was observed in relationship to the participants' CHD risk. Odds ratio (*OR* = .31-3.88) and confidence intervals (CI = 95%) were used to lend support to the outcome of action displayed by the participants. A person who provided the least bit of effort was still able to benefit from a reduction in risk for CHD (adjusted *OR*= .31, 95% CI [.17, .56], whereby even walking (*OR* = .53, 95% CI [.31, .91] was negatively associated with CHD risk (Al-Zoughool et al., 2018). The researchers noted that they adjusted for confounding variables in the study for the age, gender, education, pattern of diet, and environment (Al-Zoughool et al., 2018). When a participant was moderate with their PA (adjusted *OR* = .38, 95% CI [.23, .64], the chart showed them to fit in the category with a significantly lower CHD risk in men with the same significance in women. (Al Zoughool et al., 2018). In total, the results showed that the more the PA, the lower the risk of CHD (Adjusted *OR* = .42, 95% CI [.22, .79], p <.001), which directly relates to the hypothesis and aims of the researchers governing this study (Al-Zoughool et al., 2018).

Al-Zoughool et al. (2018) looked at the basis for Saudi women having a large level of sedentary behavior, which was shown to have an elevated risk for CHD. These women's prevalence was 73%, where the sedentary behavior was cultural and considered very common (Al Zoughool et al., 2018). The sedentary behavior of the Saudi women in this Gulf region are the reason this location was selected by the researchers in fulfilling the gap in the literature to provide an informational assessment into tradition, diet, and lifestyle that discourages PA and elevates the prevalence of obesity (Al Zoughool et al., 2018). Future researchers who study the trends of tradition, diet, lifestyle, obesity and CHD in the United States and global countries and would benefit from this type of study for social change implications that involve programs and policy creation for health care management and servicing that is maintained and monitored to match the original aims of this study.

There were no provisions for protections for their workers, as was verified in the study conducted by Al Zoughool et al. (2018). When at work, heavy workloads made it difficult for individuals because they encompass heavy lifting and are accompanied by fatigue and exhaustion (OR = 1.0, 95%, p = .016), and are directly associated with an elevated CHD risk (Al-Zoughool et al., 2018). Additionally, Al-Zoughool et al. (2018) connected physiological concepts with PA activity by stating how, as women age, their blood pressure heightens faster than men regarding the gender-specific CHD. However, the researchers did point out that the variable specification in gender, menopausal women, was not in the study, and elements regarding women who are pre-, current, or post-menopausal could not have conclusions drawn on them regarding PA and CHD (Al-Zoughool et al., 2018).

The sedentary lifestyle behavior of the residents in the Gulf showed how the dose-response effect when participants exhibited sedentary behavior was assessed based on time and CHD risk (Al-Zoughool et al., 2018). With this, they looked at those who had more than 5 hours being sedentary as incurring an increased CHD risk and focused on diet and tobacco use as confounders in the study variables (Al-Zoughool et al., 2018, p.10). The authors showed how their results recommended at least moderate-intensity PA as protection from CHD due to sedentary behavioral risks for CHD (Al-Zoughool et al., 2018). Al-Zoughool et al., 2018 also recommended that future research work analyze the different types of PA, which specifically reduce the risk of CVD while similarly reducing CHD mortality (Al-Zoughool et al., 2018). One way to do this, they recommend, is to assess how much time they are spending being sedentary and to establish tools that would elevate occupational PA by giving notice to the health benefits through awareness (Al-Zoughool et al.,2018). This literature provided one of the closest assessments to the relationship between obesity and CHD mortality. This literature does not investigate how the factors of snoring and OSA predict CHD mortality. Still, it does provide extensive information on the covariates relative to age, gender, and geographic location. The findings in this research provide additional support for the factors that lead to obesity and its impact on higher risks for CHD, as hypothesized in this dissertation.

OSA and CHD

Wang et al. (2018) conducted a study depicting how individuals with untreated OSA had high levels of serum matrix metalloproteinase-9 (MMP-9) indicative of hypoxia and used vascular endothelial cells from rat aortas to determine such in their comparisons. In their study, they found those with elevated MMP-9 levels had heightened risks for OSA and thereby heightened the risk for CHD ($p<.001$). The purpose of their study was to find out how the serum MMP-9 that occurs in individuals with OSA triggers CHD risk (Wang et al., 2018). In their study, Wang et al. (2018) pointed out how individuals with 10 seconds of inhalation inhibition fit the description of those impacted by OSA and the issues with waking up after an event as impacting their restful sleep, physical and psychological issues as well (p. 1). For example, the researchers added to the OSA and CHD variables the following covariates: BMI, age, heart rate, and gender. Their original group amounted to 47 individual participants who had not been treated for OSA (Wang et al., 2018). Of this number, there were individuals that the authors pointed out that did not have CHD but presented with OSA within the original group of 47 which consisted of 11 women and 36 men who between 47 and 71 years of age (Wang et al., 2018, p. 2). There was no mention of race in the study or cultural background. The researchers took their sample size of 35 out of this original group of 47 due to their desire to look further into those who did not have CHD but had OSA, of which a longitudinal study was inferred as transpiring (Wang et al., 2018, p. 1). The authors stated they followed these participants for five years, and the outcome resulted in showing that MMP-9 was a risk for CHD in patients who were diagnosed with OSA (Wang et al., 2018).

Wang's et al. (2018) study addressed the counter element by noting that every individual diagnosed with OSA may not end up with CHD and deferred to addressing the risks that come with an OSA diagnosis and CHD. Additionally, the use of the Epworth

Sleepiness Scale and the hypopnea index in their classification process afforded Wang et al. (2018) the ability to show how other covariates were addressed against the dependent variable, CHD, such as the body mass index (BMI), neck and waist circumferences and blood. The researchers' approach to their problem involved a small selection of participants, which impacts the ability to generalize their findings. The researchers also noted an additional limitation which was that which resulted during the period of follow-up because the consistency in monitoring the participants was not there (Wang et al., 2018). Relative to this study, the therapy and provision of medication were not addressed to sanction the results of their study (Wang et al., 2018). There was limited information on how the sample participants were selected for the study. The only exclusion method that was noted in the study was those in the retrospective cohort study who had hypertension because the researchers wanted to determine if MMP-9 would determine if there was an occurrence of CHD with the value $p < .05$ as found to be statistically significant in the analysis (Wang et al., 2018).

When the individual has hypoxia because of OSA, there is an increased chance of inflammation, according to Wang et al. (2018). Wang et al. (2018) pointed out how there were 12 of their cases that had moderate OSA and 19 that had severe ODA within the 39-66 years of age range, which all had larger neck circumference than the 16 that had mild OSA (p. 3). The neck circumference is an indicator of OSA and associated with CHD.

The researchers in Wang's study utilized the Spearman correlation test. They pointed out how there was no statistically significant correlation observed between MMP-9 level and the ESS index ($p = 0.086$) in addition to there not being a significant correlation between MMP-9 and the other covariates when $p < 0.001$ (Wang et al., 2018). This could be due to the small number of participants and the 5-year follow-up for even smaller subgroups to check for risk and hypertension. After the follow-up, there were three individuals with the high MMP-9, with 12 of the patients having systematic hypertension at 34%, showing the high prevalence of hypertension in patients with OSA (Wang et al., 2018). The findings showed that an angiotensin-converting enzyme inhibitor (ACEI) would stop MMP-9 activity from helping in CHD that is a result of OSA (Wang et al., 2018). Additionally, by extracting cells for culture analysis, the results were used to show that MMP-9 is a risk determinant for CHD and OSA due to hypoxia (Wang et al., 2018). Unfortunately, this recent study does nothing but touch on the surface of obesity by addressing inflammation briefly. It never provides information on snoring. The gap in research, which is the basis for this study, is how Wang's study focused only on OSA and how it impacts CHD but not how OSA, when combined with obesity and snoring, is significant with CHD.

Zhang et al. (2018) conducted their research to analyze how the NC relates to the rates of CHD mortality by focusing their attention on sleep-disordered breathing (SDB), which will be referred to as OSA. In their study, the researchers used Sleep Heart Health Study (SHHS) as the basis for their study where they obtained their convenience sample participants in the study. The participants were clearly described relative to the inclusion requirements. They were persons that were 40 years of age, and older who answered were selected based on their responses to health and sleep habits from 1994 to the start of the survey in addition to taking polysomnography at home (Zhang et al., 2018). The resulting

5804 participants were followed from 1994 until 2020 for CHD. There were three main studies that the researchers used in their study. Atherosclerosis Risk in Communities, Cardiovascular Health Study, and Framingham Offspring Cohort along with additional studies were used in the study. Overall, the researchers looked to see how NC in those with or without SDB (OSA) relates to CHD mortality. Additional covariates were listed in the classification of status regarding smoking, educational level, diabetic, age, sex, race, BMI, and cholesterol levels in the study (Zhang et al., 2018). The methodology of obtaining the data from the participants included measurements. A participant engaged in a health interview before the observation in 1994, where their NC was measured (Zhang et al., 2018). Participants were classified based on the long axis neck measurements in three groups. The second method of measurement for NC and OSA was the use of the polysomnography which was conducted with a portable monitor. This is where apnea was provided the working definition as to when there is no airflow for at least 10s (Zhang et al., 2018, p. 2). If a participant had OSA, their AHI (the number of apneas and hypopneas averaged per hour of sleep) was greater than or equal to 5 (Zhang et al., 2018, p. 2). The participants received a follow-up assessment within the 2008 and 2011 years and CHD death would have been considered as fatal CHD between this time and the baseline polysomnogram conducted back in 1994 (Zhang et al., 2018).

Zhang et al (2018) provided results that gave demographic information on the study population with the relationship in the study showing CHD morbidity/mortality as a hazard ratio, *CI* 95%, and $p < .05$ as statistically significant. At the start of the study, 4433 participants, who were identified by the researchers as 86.6% White 63-year-old average age, did not have CHD and received a follow-up assessment approximately ten years later. At this follow up, the group that did not have OSA were described as follows: female (67.4%), under 61 years of age, much lower BMI and blood pressure thus lower cardiovascular risk than those who actually had OSA ($p < .05$) (Zhang et al., 2018, p. 3). Unfortunately, 58 participants suffered CHD mortality that was in the group that did not have OSA ($p = .027$) with 86 suffering CHD in the group that had OSA (Zhang et al., 2018, p. 3). Relative to those with NC quartiles and CHD mortality, there was a positive linear association ($p = .003$) observed in the group of individuals without OSA in the study (Zhang et al., 2018).

Zhang et al. (2018) stated that their community-based population was diverse, however since there was no validity to this depiction in the participant description and earlier in the study, approximately 87% of the participants were noted as White, the ethical diversity is misleading (p. 3). The researchers restated their intentions for this study and pointed out that this was the first of this type of research in the evaluation of NC and CHD mortality in a cohort of this size (Zhang et al., 2018). They restated their findings in the discussion section as well, where study participants without OSA with NC may suffer CHD mortality (adjusted *HR* of 1.134, 95% CI [1.001, 1.284], $p = .022$) with NC as an early risk factor and predictor for CHD mortality (Zhang et al., 2018).

Zhang et al. (2018) pointed out that when assessing the NC and incidence of cardiovascular disease in the study participants at their second assessment, there was no statistical significance. They further noted that a higher NC in persons without OSA with adjustment for BMI might be a contributing factor for CHD mortality (Zhang et al., 2018). The group studied who had NC were older than 60 years of age and had high BMIs, larger waist circumference, and presented with additional cardiovascular risk factors but had a stronger association with OSA (Zhang et al., 2018). Of similar interest is the finding that NC and those whose waist circumference was elevated varied regarding obesity relative to the participants' upper body. According to Zhang et al. (2018), when a person exercises or diets, for example, there will be an effect on waist circumference, not NC. This is why Zhang et al. (2018) made recommendations for future researchers that NC be used in a study with a larger cohort of persons with OSA and without it in observing persons with special conditions like those that are morbidly obese, on bed rest, and pregnant (p. 6). Additionally, Zhang et al. (2018) showed the simplicity of the tool of measurement for NC but noted that fat deposits are not only in the neck and that there is a small quantity of CHD mortalities occurring in persons without OSA.

Researchers who study CHD mortality by looking into how it is impacted by individuals with elevated NC and OSA would benefit from this type of study for social change implications involving the development of programs and policy creations for persons that may be obese. Unfortunately, even Zhang's study focused on NC, OSA, obesity, and CHD, each variable was assessed and weight against CHD when addressed with NC and OSA or NC and obesity. The results confirmed the researchers' recommendation for future investigations into the relationships between NC, obesity, and OSA that would bring about cardiovascular events such as those resulting in CHD mortality. The gap remains that none of this study provided a combination of OSA, obesity, or even addressed snoring as joint variables in relationship with CHD. Most importantly, the participant demographics were not addressed and shown as observed for relationships in this study, which would have been fascinating to observe as noted. This lack of address added to the gap that limits the generalizability of the findings.

Chen et al. (2016) conducted a study using Spearman correlation on OSA and its relationship with one having visceral adiposity (VA), which presents as obesity and the risk of one being diagnosed with metabolic syndrome (MetS). The closest to this study, having a connection to the variables is the obesity and OSA relative to cardiovascular disease which has previously been noted as directly associated with CHD. MetS was noted in this study to be related to a patient developing CVD (Chen et al., 2016). The researchers conducted a cross-sectional study to analyze the relationship between visceral adiposity (VA) and how it predicts upon OSA and MetS. In this study, the researchers retrospectively analyzed persons that used their sleep center who complained of issues with sleep with overnight polysomnography (PSG) and completion of a detailed questionnaire of their past tobacco use, illnesses, medical treatment and medications that were used for the treatment of hypertension (Chen et al., 2016).

The researchers showed how the gap in the literature regarding the clinical importance of using VA index in predicting MetS by focusing mostly on the VA index as opposed to OSA which elevated the need for their study to address the exploration of the way VA plays a role in MetS (Chen et al., 2016). If this is not done, the early degrees of MetS will be missed (Chen et al., 2016). Additionally, this research pointed out how the gap in literature depicted the role of inflammation and antioxidation in obesity whereby their study was needed to show how the VA index and uric acid (UA) were so connected that both inflammation and metabolism could be predicted upon by the VA index which is paramount in relation to obesity and CHD studies today (Chen et al., 2016).

Chen et al. (2016) clearly described the participants that were included in the study as having a total of 411 individuals selected from a convenience sampling selection process. The researchers provided inclusion and exclusion criteria appropriately by the participants completing the detailed questionnaire and self-reporting their medical history (Chen et al., 2016). In order not to be excluded, for example, they could not have been diagnosed or received treatment for OSA, and they had to answer affirmatively to having CHF, cerebrovascular disease, symptomatic ischemic heart disease, chronic renal failure, chronic obstructive pulmonary disease as a part of the 8 criterion for selection (Chen et al., 2016). The only demographics depicted were gender and age. Age and smoking status were listed as confounders in the study and were adjusted for. After adjusting for these, the OSA patients were shown to be at greater risk (OR = 10.237, 95% CI, $p < .001$) for incident MetS (Chen et al., 2016). The mean age of the participants was 48 years of age, with the majority of the participants being male (312) with 99 females with the total participant mean BMI totaling approximately 26 (Chen et al., 2016). The AHI that was greater than 5/h relative to OSA was classified as mild (67 patients), moderate (89 patients), and severe (205 patients), which was a gradual yet drastic increase (Chen et al., 2016). Demographically, there were no differences between the variables age, current smoking, or medical treatment; however, gender was significantly different among all the groups with significance accepted at $p < 0.001$, additionally, the researcher's effect size in the binary logistic regression was estimated through a two-tailed value of 95% CI, p <

0.05 as being significant with three levels consisting of all subjects, males, and females (Chen et al., 2016). This significance at $p < 0.05$ showed that AHI was significantly associated with an increasing measure on OSA, UA, MetS, the patient's metabolic score, and the VA index (Chen et al., 2016).

Chen et al. (2016) restated their intention for the study, which did show significance in variation regarding OSA, UA, MetS, the VA index, in which the Spearman correlation showed how gender did not alter the significant correlation between the variables. They also found that all the patients that had OSA were shown to have MetS with significance valued at $p = 0.000$, OR=10.237, OR = 13.556, and OR = 21.458 for each respective category (Chen et al., 2016, p. 3). Showing that OSA was closely related with MetS and the accumulation of visceral adipose tissue (VAT), is paramount to showing how obesity plays a role in showing that a person's VA is much greater than a person's BMI when both controls are matched in the study (Chen et al., 2016). Additionally, their finding in the study is that OSA is higher in males and shows that persons with excessive VA were shown with the study results (95% CI, OR 21.458, $p = .000$) to be associated with having severe OSA (Chen et al., 2016). These researchers recommended their findings that would aid in future research for therapeutic uses in cardiometabolic diseases by focusing on how the VA predicts what is under study by future therapists (Chen et al., 2016). They implied that there should be a focus on how a person's degree of deterioration, regardless of gender, with OSA may impact VA and MetS when insulin and cortisol heighten at night (Chen et al., 2016). Researchers who conduct sleep studies and aid persons with OSA would benefit from this type of study for social change implications that involve program and policy creation that would direct changes in health behaviors coupled with community health education programs. Chen et al. (2016) pointed out that their findings linked the VA index with hypertension significantly and recommended that future researchers would benefit from knowing that the calculation of the VA index would beneficial when used as an operative biomarker for observing hypertension.

When providing the results of their findings in addressing their hypothesis, the researchers showed that MetS was directly associated with those who experience CHD at 2.6 to 3.0 times more CHD Mortality (Chen et al., 2016, p. 8). In this case, their study showed that females had a greater risk of MetS than males (Chen et al., 2016). Similarly, these researchers recommended as well that the acknowledgment of the MetS and VA index be observed early in therapeutic care to prevent metabolism and growth in persons who have been diagnosed with OSA for benefits in the maintenance of the health issues (Chen et al., 2016).

They could not decide on the causal relationship that OSA and the metabolic issues had because of the cross-sectional design chosen in the study, which may lead to insufficiency in predictions on the VA index to the MetS in persons with OSA (Chen et al., 2016). There was a lack of measurement of the IR, which the researchers stated was connected to VA and inflammation, closely linked to obesity (Chen et al., 2016). Additionally, the researchers pointed out the biases that were present due to lack of inclusion of covariates such as stages of women's health, such as menopause, that could impact the VA index, OSA, and MetS in the study (Chen et al., 2016). Lastly, they pointed out how the lack of proper and inclusive use of gender and diversity, coupled with the geographic population included in the study, did not afford representativeness in the study's findings. The authors did recommend the use by therapists, medical personnel, and practitioners of the VA index as a beneficial tool when assisting and recognizing persons who are diagnosed with OSA and are at risk for MetS in the future (Chen et al., 2016).

Chen et al. (2016) focused their research on OSA and the VA index, coupled with a minimal discussion about inflammation. They also investigated hypertension, CVD and CHD mortality in their study. Their link to heart health was the MetS connection to CVD and CHD. Three of the variables in this study were addressed that relate to the current study. Although their study addressed the gap that existed regarding OSA, the VA index, CVD, and MetS, the gap still exists that combines OSA with obesity as possible predictors combined with snoring on CHD. Snoring was never addressed in this study as a variable. There are patterns of behavior that impact an individual's presentation with snoring, OSA, obesity and predisposes them to potential CHD mortality.

Summary and Conclusion

CHD is a major cause of death in the USA and across developed countries. In the literature to date, studies have been conducted to address how obesity and sedentary lifestyles along with diet impacts CHD. Although the current literature demonstrates a connection between obesity, NC, and potential CHD mortality or OSA and CHD mortality, it is not known how CHD mortality, based on the current literature, is impacted by the combined effect of obesity. Unfortunately, it is also not known how the impact of snoring while sleeping impacts OSA and obesity that may enlarge NC thus causing the CHD that is evident in the USA and developing countries. Strategies to prevent CHD and reduce the rates of incidence would entail maintaining a healthy diet, having an exercise regimen, having health services that are affordable, and available to all persons. With both men and women over 20 years of age being impacted by CHD and stroke, maintaining focus on prevention and adherence would start with examining how combined variables relate to CHD. Obesity linked with OSA and snoring, in combination, have been shown to impact individuals and these health issues have been shown to increase the risk for CHD when examined individually. This research would have shown the impact on CHD mortality which is missing in the current literature that only provides a relationship significance to the effects of obesity on CHD, or snoring and OSA, and OSA effects on CHD. The combination of these health issues could be impactful when examined in a combined relationship on CHD. In chapter 3, I discuss research methodology, data collection, and data analysis for this study.

Chapter 3: Research Method

The purpose of this study was to determine if a significant relationship existed between obesity, snoring, OSA, and CHD while accounting for gender, race, age, and geographic location. In this chapter, I explain the quantitative research design I used to examine the research questions in depth through comparative analyses of the variables. I also present the methodology of obtaining the research data on the target population and the description of the participants, the data collection, data operationalization, data analysis process, any threats to the research, and the ethical considerations that were allowed through informed consent by the Institutional Review Board (IRB).

Research Design and Rationale

The nature of this study was quantitative. A quantitative, cross sectional design was appropriate to test if a relationship existed between the independent variables and the dependent variable in my study. By using a cross sectional design, I used the comparative approach while accounting for demographics such as age, gender, race, and the geographical region of the respondents. The rationale and basis for this research design was shown as consistent with the style necessary to provide additional information to advance the knowledge of how the combined variables relate to CHD. The independent variables were obesity, snoring, and OSA. The dependent variable was CHD. Using the secondary data in this quantitative study methodology allowed for an examination of the variables from a large sample. Subject and participant bias were eliminated because there was no direct contact between the participants and me. Using the secondary data acquired from the CDC BRFSS minimized time and resource constraints.

Methodology

Population

The population selected for this study was adults who resided in the southern region of the United States that responded to the BRFSS who were 18 to 75 years of age at the time that they took the survey. The BRFSS has data from 2015 to 2019. The data were limited after the 2017 years for some of the target inquiries. Therefore, only the population from the years 2015 to 2017 was used for this study. In 2015, 441,456 people completed the questionnaire. There were 486,303 individuals who completed the questionnaire in 2016. In 2017, there were 440,016 individuals who completed the questionnaire. Individuals were only included if they identified as obese and snore. The individuals had to identify as obese and had been diagnosed with OSA as well. Additionally, the individuals included must have been diagnosed with CHD. The specific geographic location under study were those persons who resided in Georgia or Alabama during the years under study because these were the states with the highest incidence of mortality due to CHD.

Sampling and Sampling Procedures

The BRFSS survey had a population size of 441,456 respondents in 2015, 486,303 respondents in 2016, and 440,016 respondents in 2017. My study included a sample of these individuals that met my research question criteria. I used a probability sampling technique. The stratified random sampling technique that I used gave me a sample that was representative of the population with greater precision. This form of sampling aided in the prevention of a sample that would not have been representative of the population. This sampling technique aided in supporting a separate point of separate analysis of the subgroups of the variables under study. The sample size was determined using G* power Version 3.1.9.4. This procedure allowed a priori type of statistical power analysis that focused on a significance level of 0.05 and a power of 0.95 for the population effect size. Binary logistic regression was used for this study. The test family was *z* tests. The power analysis was A priori to compute the required sample size for each of the three years. The error of probability ($^{\alpha}$) was 0.05. The power (1-β err prob) was 0.95. The odds ratio used was 1.3. The similar selection in effect size that I chose for my study was also represented in the study conducted by Sharma et al. (2015), where they found that when individuals worked out strenuously, their varied types of PA provided no significant increase in CHD risk (adjusted *OR* 1.31, 95% CI[.70, 2.46]. Because the effect size is the measure of strength of association in the relationship of the variables, having this odds ratio is greater than zero where 0 will reflect no relationship between the variables. After performing the sample size calculations for each year in my study, the sample population amounted to 2,964 respondents consisting of 988 persons per year analyzed.

Data Collection

The BRFSS secondary data set is updated yearly by the CDC where the participation and data collection are through interviews and telephone call surveys retrieved from persons 18 years of age and older. The CDC uses the random digit dialing methodology to landlines and those that use cell phones to obtain the data (CDC, 2019a). Information for the public and researchers can be selected from the BRFSS data user guide, which gives a summary data quality report accompanied by the annual data release. These documents enable researchers and the public to compare data and conduct trends based on the data sets for each year accessed.

According to the policy of the CDC regarding the use of the BRFSS data, the websites are not under copyright, which allows the public use and reproduction without any permissions necessary (CDC, 2019c). Additionally, when using the information from the CDC websites, I needed to include a copyright statement and was afforded the contact point for the site (see CDC, 2019c). In Georgia, I reached out to the CDC BRFSS contact at the 1600 Clifton Road Atlanta, GA location.

Operationalization

The independent variables in this study were snoring, OSA, and obesity. The dependent variable was CHD. The covariates were gender, age, race, and geographic location. The gender of the respondents was nominal and represented by 0 for males and 1 for females. The race was coded as nominal where 0 represented those who identified as White, 1 represented those who identified as Black, and 2 represented those who identified as other. The White race percentage in 2015 amounted to 73.68%, Black race percentage amounted to 12.53%, American Indian/Alaskan Native race amounted to 1.91%, Asian race amounted to 5.17%, Native Hawaiian/Pacific Islander race amounted to .42%, and all other races amounted to 3.26%. To this effect, for each year, those in the American Indian/Alaskan Native, Asian, Native Hawaiian/Pacific Islander, and all other racial demographics for this study was coded as other. The age was ordinal/continuous and was grouped into categories where those 18 to 29 years of age were represented with

0. Those 30 to 39 were represented with 1. Those 40 to 49 were represented with 2. Those 50 to 59 were represented with 3. Finally, those 60 and older were represented with a 4. The respondent's geographic location was examined. Persons who resided in Georgia were represented with 0 while those who resided in Alabama were represented with 1. Those who resided outside of these two states were represented with a 2.

Individuals who identified as obese were assessed based on their BMI reported in the questionnaires as weight and height. It was recorded as 0 for those who were in the obese category and no (1) for those who were not in the obese category/not diagnosed as obese. BRFSS results to the independent variable, snoring, were assessed based on whether they snore loudly, and 0 was representative of those who have been told that they snored loudly while 1 represented those who did not. In each year, OSA was not addressed directly as the specific variable under study in this dissertation. The only assessment within this category was an inquiry into whether someone observed the respondent stop breathing during their sleep (CDC, 2019b). Cessation of breathing while sleep was characterized in this study as OSA (see Sadeghi et al., 2017). If the respondent answered yes that they were observed experiencing a cessation in breathing during sleep, this was represented as 0. If not, their no response was represented as a 1. Lastly, the binary dependent variable, CHD answered yes (0) or no (1) to whether the respondents were told they had CHD. The representative values under study are shown in Table 1 on the next page.

Table 1

Variables Under Study With Questions and Responses Coded

Variable	Type	Question/Data point	Possible response(s)
Gender	Nominal	What was your gender at birth?	Male – 0 Female – 1
Age	Ordinal (Categorical)	What is your age?	18-29: 0 30-39: 1 40-49: 2 50-59: 3 60 and older: 4
Race	Nominal	What race do you identify as?	White: 0 Black: 1 Other: 3
Geographic location	Nominal	What state do you live in?	Georgia – 0 Alabama – 1 All other states – 2
Obese	Nominal	Are you in the obese category, or has your physician diagnosed you as obese?	Yes – 0 No – 1
Snore	Nominal	Have you been told that you snore loudly?	Yes – 0 No – 1
OSA	Nominal	Have you had a sleep study conducted that resulted in a diagnosis of OSA?	Yes – 0 No – 1
CHD	Nominal	Have you been diagnosed with heart disease?	Yes – 0 No – 1

Data Analysis Plan

The software used for analyses is the IBM statistical package for social sciences (SPSS) Grad Pack version 26. The data was obtained and input into SPSS for analysis. Incomplete records were not included in this study.

The following research questions guided the data analysis:

Research Question (RQ1)-Quantitative: Is there a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location?

$H_0$1: There is no significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

H_a1: There is a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

RQ2: Quantitative: Is there a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location?

$H_0$2: There is no significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

H_a2: There is a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

RQ3: Quantitative: Is there a significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location?

$H_0$3: There is no significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location.

H_a3: There is a significant relationship between apnea and CHD after controlling for gender, age, race, and geographic location.

RQ4: Quantitative: Is there a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location?

$H_0$4: There is no significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

H_a4: There is a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

The mean, median, and mode (central tendencies) were used to observe the demographic variation in gender, age, race, and geographic location as assessed against the independent and dependent variables under study. Additionally, the nominal variables were depicted in proportions such as race and gender.

I used logistic regression for both the bivariate and the multivariate data analyses. This analysis test was appropriate because it allowed me to evaluate my various explanatory variables against my dichotomous dependent variable. Since I wanted to explain the odds of each observation with a 95% confidence interval, the outcome from the logistic regression model provided the odds ratio for determining the probability of the outcome occurring or not. The logistic regression model has five assumptions that were met. The first assumption was that the dependent variable will be binary and coded as such (Diraj, 2019). Secondly, the independent variables must be7uy independent of each other (Diraj, 2019). Third, there must not be any multicollinearity amongst the independent variables (Diraj, 2019). Fourth, the independent variables must be linear in relationship to their log of odds (Diraj, 2019). This assured that the strength of the relationship was not underestimated. Lastly, there must be a large sample size (Diraj, 2019). These five assumptions were met in using the binary logistic regression mode. The level of significance of the logistic regression outputs were set to $p < 0.05$ (Frankfort-Nachmias et al., 2018). The *p* value was representative of the probability distribution where a one-tailed test was done in my analysis. It the outcome of my analysis showed in the table of variances output $p > .05$, I would have retained the null hypothesis. To the contrary, $p \leq .05$ will be significant and I would reject the null hypothesis.

Threats to Validity

There were potential threats to internal validity in this study. The history of the data used is itemized in each state by the year and posed minimal threat to attrition bias. This is because there is a count in the BRFSS site as to how many respondents were included in the final analysis. This alleviated the potential threat to internal bias in this area. However, detection bias was potentially inherent in the manner that each interviewer ascertained and confirmed their answers to the questions in each section from the respondents. The BRFSS did not elaborate on the status of the assessors when they ask the questions of over 400,000 individuals each year so it was unknown if the assessors are able to detect the race, gender, or any other demographic of the respondents when conducting the interviews. The calls are generated from call centers with live representatives to which the ability to sway an answer from a respondent could have led to potential performance and detection bias. This problem was inherent internally regarding the “experiences of the participants,” whereby my inferences may have been skewed (Creswell, 2009, p. 162).

Since this study was based on secondary data, there were minimal threats to external validity because it was not based on an experimental design and the sample size was representative of the target population. However, an external threat to validity was the unknown factor of percentage of how many respondents agreed or disagreed to participate in the original study. The original data was acquired through random, digit-dialing call sampling. This enabled me to reduce issues with reliability and validity in the results and data return. With random sampling, "everyone had an equal probability of being selected from the population which gave yield to that process which was called a true experiment (Creswell, 2009, p. 155). Each year there is a variation to the amount that were included in the study. Since I used a regression model, the results from the participants against the dependent variable posed a threat to external validity when observed against the means. However, this was addressed by using the BRFSS data, which was obtained by randomness so the results could not be due to chance which would have posed a threat to the external validity of the study.

Furthermore, in addressing external validity, the BRFSS states that their survey interviews were conducted randomly and without bias by use of the telephone calls to respondents. The random calls allowed each person in the greater population the opportunity to be selected thereby reducing the potential for selection biases that could threaten external validity. Additionally, the cross sectional questions in the interviews and questionnaires allowed me to obtain a greater understanding of the respondent's behaviors and lifestyles. The randomness and lack of experimentation elevated the external validity so that the results from my research study would have been able to be generalized to the greater population. However, the demographics of those who dropped out of the study are unknown. For those that participated in the study, the demographics were comparable from the sample to the target population in race, gender, and age.

Statistical conclusion validity (SCV) involves an understanding into how reasonable my research conclusion is. In this research I did threaten my research by conducting repeat tests or mining data to find a relationship. The dataset was input into SPSS and the logistic regression analysis was run. Since there is a binary dependent variable, the logistic regression was the correct statistical test for this research. The sample size was large which enhanced the validity of the statistical conclusion. This research followed the methods and standards that are held in place for a logistic regression model through SPSS.

Ethical Procedures

By using secondary, publicly available, data in this study, there were no agreements necessary to access the study participants or the data. The BRFSS allows anyone to obtain data from the site because it is operated from a public domain, and researchers can use the data without any permission. However, the states require that when a researcher publishes the data, they give credit to the state BRFSS data source through citation (CDC, 2019c). IRB approval to conduct this study was obtained from the Walden University IRB. My IRB approval number is 05-19-20-0018271. In managing the confidentiality of the data, the data will be stored on a password protected laptop for 5 years. At the end of the 5 years, the data will be destroyed by a two-tier deletion process. I am the only person who has access to my data.

Summary

The purpose of this chapter was to provide the research design and methodology that was used to answer the research questions. The quantitative research design was shown as the best design to address the research questions and hypotheses. In this chapter, I addressed the rationale for selecting this research design, the process of collecting and analyzing the data, and the population was addressed. Finally, I addressed the ethical considerations and potential threats to validity. Chapter four provided the results to the study.

Chapter 4: Results

Introduction

The purpose of this quantitative study was to examine the effects of obesity, snoring, and OSA on CHD while controlling for gender, race, age, and geographic location. The following research questions and hypotheses guided the study.

RQ1: Is there a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location?

$H_0$1: There is no significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

H_a1: There is a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

RQ2: Is there a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location?

$H_0$2: There is no significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

H_a2: There is a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

RQ3: Is there a significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location?

$H_0$3: There is no significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location.

H_a3: There is a significant relationship between apnea and CHD after controlling for gender, age, race, and geographic location.

RQ4: Is there a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location?

$H_0$4: There is no significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

H_a4: There is a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

In Chapter 4, I provide information about data collection and present the results of this study.

Data Collection

Data were collected from a secondary dataset from the CDC. Only, the 2017 BRFSS dataset, which is publicly available on the CDC website, was used to establish the relationships between the variables of interest in this study. Data were collected from adults between the ages of 18 to 75 at the time of the survey who responded to the BRFSS. Obesity, snoring, and OSA served as the independent variables. CHD was used as the dependent variable. The covariates were gender, age, race, and geographic location. Table 2 provides a detailed description of the 988 respondents who were used in the analysis.

In this study, the majority of the respondents (93.9%) did not have a CHD diagnosis. Most of the respondents were female (56%) and responded as not having an obesity classification (64.3%). Because obesity is a one of the main characteristics for persons who snore and have OSA, this study's outcome that showed no significance between the variables and CHD is consistent with previous studies (see Franklin & Lindberg, 2015). Additionally, snoring in previous studies was linked to women who were obese and not lean adult women (Franklin & Lindberg, 2015). This was also verified in my study because the majority of the respondents stated that they did not snore (51%) and did not have a diagnosis of OSA (51%). Although there is a narrow percentage who did not snore or have OSA in this study, future studies should be conducted to observe changes in response between the characteristics relative to OSA and snoring and the relationship to CHD and obesity.

The respondents in this study were mostly Alabama residents (53%) and self-identified as White (75%). The southern states are known to have lakes, rivers, forests, and nature and trails that individuals take advantage of for their lifestyle habits that entail exercise and gardening to enhance diets beneficial to lean body mass (Zhang et al., 2018). Traditional southern diets that are high in fat and refined, processed foods and no physical activity increases risk of CHD and the prevalence of obesity (Al-Zoughool et al., 2018). With the majority of the respondents to the BRFSS self-identified as White, an assessment into obesity risk due to diet and geographic location would be disproportionate because the other races were only of an extremely minimal number of respondents (25%) combined. Blacks accounted for only 9% of the sample amount, which is just below the total 16% of the other races who responded to the study (Hispanic, 8.8%, Alaskan/Indian, 2%; Asian, 2%; Hawaiian, .40%; and Non-Hispanic/multiracial, 2.7%).

Table 2

Frequency Table for Variables

Variable	Levels	Frequency	Percentage
Coronary heart disease	Yes	60	6.1
	No	928	93.9
Gender	Male	432	43.7
	Female	556	56.3
Obesity	Yes	353	35.7
	No	635	64.3
Race	White	738	74.7
	Black	89	9.0
	*Other	161	16.3
	*Alaskan/Indian	20	2.0
	*Asian	23	2.4
	*Hawaiian	4	.40
	*Non-Hispanic/Multi-racial	27	2.7
	*Hispanic	87	8.8
State of residence	GA	465	47.1
	AL	523	52.9
Apnea	Yes	487	49.3
	No	501	50.7
Snoring	Yes	483	48.9
	No	505	51.1

Note. *The respondents that fall under Alaskan/Indian, Asian, Hawaiian, Non-Hispanic multiracial, and Hispanic were analyzed under the third variable level in this study, accounting for 161 frequency and 16.3%.

One of the control variables, age, was initially recorded on an interval scale but was converted to a continuous scale by using the midpoint to represent each class. The population from the 2017 dataset was the only BRFSS dataset that contained all of the variables in this study. From this dataset, a stratified sample was taken, and then a random number was selected from each group category. The descriptive statistics for the age variable showed a median and mode age of 35 years. The mean age (M = 35.8) from the resulting sample of respondents is representative of the study analysis; however, it is difficult to tell if this is representative of the total population because the questions regarding OSA and snoring were not included for the second and third age categories analyzed in this study. These categories included respondents who were 40 to 59 years of age. Despite this issue of representativeness, the mean age could be representative of individuals who begin to take interest in their health and wellness relative to CHD. This is the working and career age of most individuals whereby cost and convenience (HBM perceived barriers) and severity susceptibility become the undergird that moves them to selective daily activities like jogging or weight-lifting and to taking proactive preventive measures with medical doctors and health professionals to address the factors that societally characterizes risk for CHD such as obesity. Additionally, Seyedmehdi et al. (2016) found that OSA was directly associated with the 35 and older age group, and their mean age was 33.51. However, the limitation in this study of the responding 40 to 59 year age group leads to an inability to determine whether the participants in the acceptable sample size were representative of the southern region population who were the respondents in Alabama and Georgia who accounted for 6,754 (AL) and 6,056 (GA) respondents, respectively. Future methods in acquisition of responses within all age groups would benefit continued studies into the relationships between OSA, snoring, and CHD with the current variables and covariates under study for better representativeness.

Results

Because the dependent variable in this study is binary containing two levels (Yes or No), logistic regression was deemed appropriate for analysis of each research question. For Research Questions 1, 2, and 3, a simple logistic regression was run for each of the independent variables to determine the individual effects while controlling for gender, race, age, and geographical location. A more complex model containing all three independent variables was used to determine the effect of each predictor variable on CHD in the presence of other independent variables.

Logistic Regression and Assumptions

Logistic regression was used to determine the effects of the independent variables (obesity, snoring, OSA) on CHD while controlling for gender, age, race, and geographic location. The logistic regression, in this instance, was used to determine the odds of having CHD as compared to not having the disease when a continuous independent variable is increased by 1. Similarly, for a categorical variable, the odds of having the disease versus not having the disease was determined for a level of the independent variable compared to a reference category of the variable. As an example, obesity, which is one of the independent variables, is binary (0 for those without the disease and 1 for those with the disease). The logistic regression analysis determined the odds of having CHD for those with obesity compared to those who are not obese.

All assumptions for logistic regressions were checked for violations. None of the assumptions were found to be violated. The major assumptions included having a binary dependent variable. In this case, the dependent variable, CHD is dichotomous whereas one diagnosed as having CHD is labeled *yes* and not having CHD as *no*. The other assumptions including independence of observations, linearity of the independence variables, and having a large sample were met.

As one of the major concerns when estimating linear or generalized linear models such as logistic regression, a collinearity test is usually performed to ascertain the level of the linear relationship between the predictor variables. However, multicollinearity was not considered a concern in this case. This is because three of the tests involved used single predictor variables. For the last analysis, a variance inflation factor showed the absence of multicollinearity.

Research Question 1

RQ1: Is there a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location?

$H_0$1- There is no significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

H_a1- There is a significant relationship between obesity and CHD after controlling for gender, age, race, and geographic location.

The first research question was tested if there was a significant relationship between obesity and CHD while controlling for gender, age, race, and geographic location. The dependent variable was CHD while obesity served as the predictor variable.

Gender, age, race, and geographical location served as covariates. Since some of the variables were controlled for, a hierarchical or block procedure was adopted to fully capture the effect of the predictor variable (obesity) on the response variable (CHD). Table 3 includes the results of the logistic regression analysis.

Table 3

Logistic Regression of Obesity on Coronary Heart Disease

					95% CI			
Variable	β	SE	OR	Wald	LL	UL	*p*	R^2
Block 1								.013
Race Black	1.078	.733	2.939	2.166	.699	12.355	.141	
Race Other	.048	.360	1.049	.018	.518	2.125	.894	
Age	-.003	.013	.997	.042	.973	1.023	.837	
Gender (F)	.193	.499	1.213	.149	.456	3.226	.699	
Location (AL)	-.095	.508	.910	.035	.336	2.460	.852	
Block 2								.016
Obesity	.334	.297	1.396	1.260	.780	2.499	.262	

Note. $*p < .05$; OR = odds ratio; CI = confidence interval; LL = lower limit; UL = upper limit. Statistically significant values are indicated by p-values < .05, Nonsignificant values: p >.05, Dependent variable = Coronary heart disease; SE = standard error

It can be seen from the results of the analysis that the odds ratio for obesity is *OR* 1.396, 95% CI [.78, 2.50]. This will mean that those with obesity are 1.4 times more likely to have CHD than those without obesity. However, since the associated *p*-value for obesity is greater than the chosen alpha level of 0.05 ($p = .262$), the result is not deemed statistically significant and the null hypothesis cannot be rejected. I can therefore conclude the obesity is not a significant predictor of having a CHD. The R^2 column shows the values of the Nagelkerke R^2 which is analogous to the coefficient of determination that measures the percentage of the variation in the dependent variable explained by the model. The addition of obesity into the model increased this measure from 1.13% to 1.16%, a small increase of about of .3%. The Hosmer and Lemeshow test was also run to determine if the model was a good fit. With a Chi-square value of 9.79 and a *p*-value of .201, the logistic regression model was a good fit.

Research Question 2

RQ2: Is there a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location?

$H_0$2: There is no significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

H_a2: There is a significant relationship between snoring and CHD after controlling for gender, age, race, and geographic location.

The second research question was used to examine the relationship between snoring and CHD while controlling for gender, age, race, and geographic location. Since the dependent variable (CHD) did not change and remained binary, another logistic regression was run to examine such relationships. Snoring was the independent variable while gender, age, race, and geographical location still served as covariates. A hierarchical or block procedure was used to perform the logistic regression since some of the variables were being controlled for. This was done to clearly capture the unique contributions of the variables in the blocks or models. The covariates were first introduced into the model followed by the main independent variable. The results of the analysis are presented in Table 4. A Hosmer and Lemeshow goodness of fit test was run to determine the goodness of fit of the logistic model. A Chi-square value of 11.10 was obtained with a *p*-value of 0.085. With this *p*-value ($p > .05$), there is an indication that the logistic regression model is a good fit. However, the model explains little of the variation in CHD—predicting whether a person has CHD or not. With a Nagelkerke R^2 value of 0.013 for block 1 and 0.023 for block 2, the addition of snoring increased the percentage of variation in CHD by only 0.01 (1%).

Table 4

Logistic Regression of Snoring on Coronary Heart Disease

					95% CI			
Variable	β	SE	OR	Wald	LL	UL	*P*	R^2
Block 1								.013
Race Black	1.092	.733	2.981	2.218	.708	12.549	.136	
Race Other	.037	.360	1.038	.011	.512	2.104	.918	
Age	-.003	.013	.997	.044	.973	1.022	.833	
Gender (F)	.188	.500	1.207	.142	.453	3.214	.707	
Location (AL)	-.122	.508	.885	.058	.327	2.395	.810	
Block 2								.023
Snoring	.536	.717	1.709	3.751	.994	2.941	.053	

Note. *$p < .05$; OR = odds ratio; CI = confidence interval; LL=lower limit; UL = upper limit. Statistically significant values are indicated by p-values < .05, Non-significant values: $p > .05$, Dependent variable = Coronary heart disease; SE = standard error

From the regression results table above, I observed from that snoring is not a significant predictor of the odds that a person has CHD (p=0.053) at 95% confidence level ($\alpha = 0.05$). Therefore, I cannot conclude, due to insufficient evidence, that snoring can predict the odds of having CHD at the 0.05 alpha level. However, increasing the alpha level to 0.1 will lead to the rejection of the hypothesis. In this analysis, with an alpha level of > 0.05 (95% confidence level), the null hypothesis cannot be rejected.

Research Question 3

RQ3: Is there a significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location?

$H_0$3: There is no significant relationship between OSA and CHD after controlling for gender, age, race, and geographic location.

H_a3: There is a significant relationship between apnea and CHD after controlling for gender, age, race, and geographic location.

The third research question investigated the effect of OSA on CHD while controlling for gender, age, race, and geographic location. Again, since the dependent variable (CHD) was binary, logistic regression was used investigate the relationships. OSA is the independent variable while gender, age, race, and geographical location were the covariates. A hierarchical logistic regression procedure was used to produce the desired effect due to the presence of covariates. The goal was to capture the unique contributions of the independent variables in a stepwise manner. The covariates were entered into the model first followed by the main independent variable, apnea. Table 5 provides details of the analysis. To test for the goodness of fit of the model, a Hosmer and Lemeshow test was run to determine if logistic model was a good fit. A Chi-square value of 7.762 and a *p*-value of 0.354 were obtained. The high *p*-value ($p > .05$) indicates that the logistic regression model is a good fit. With a Nagelkerke R^2 value of 0.013 for block 1 and 0.014 for block 2, the addition of OSA increased the percentage of variation in CHD by only 0.001 (.1%).

Table 5

Logistic Regression of Sleep Apnea on Coronary Heart Disease

					95% CI			
Variable	β	SE	OR	Wald	LL	UL	*P*	R^2
Block 1								.013
Race Black	1.072	.732	2.925	2.148	.696	12.290	.143	
Race Other	.062	.360	1.064	.030	.526	2.154	.863	
Age	-.002	.013	.998	.021	.974	1.023	.884	
Gender (F)	.237	.499	1.267	.226	.477	3.368	.635	
Location (AL)	-.081	.508	.992	.026	.341	2.496	.873	
Block 2								.014
OSA	-.162	.268	.851	.365	.503	1.438	.546	

Note. *$p < .05$; OR = odds ratio; CI = confidence interval; LL=lower limit; UL = upper limit. Statistically significant values are indicated by p values < .05, Non-significant values: $p > .05$, Dependent variable = Coronary heart disease; SE = standard error

At 95% confidence (α = 0.05), I observed that OSA is not a significant predictor of for CHD ($p = 0.546$). Therefore, the null hypothesis cannot be rejected. This indicates that I did not have enough evidence to conclude that there is a significant relationship between apnea and CHD after controlling for gender, age, race, and geographic location at an alpha level of 0.05.

Research Question 4

RQ4: Is there a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location?

$H_0$4: There is no significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

H_a4: There is a significant relationship between snoring, OSA, obesity, and CHD after controlling for gender, age, race, and geographic location.

The fourth research question investigated the effect of obesity, OSA, and snoring on CHD while controlling for gender, age, race, and geographic location. Logistic regression was used to investigate the relationships between the variables. Obesity, OSA, and snoring were used as the independent variables while gender, age, race, and geographical location were covariates. A two-step logistic regression procedure was used. The covariates were entered in the first step followed by the three main independent variables. The stepwise procedure was done to capture the exact effects of the independent variables while controlling for the effects of the covariates. The results of the analysis are presented in Table 6.

Before running the logistic regression, a collinearity test was conducted since multicollinearity is considered a major concern when estimating logistic regression with multiple independent variables. Since there are three independent variables for this research question, this test was deemed necessary. A variance inflation factor (VIF) of one for all three variables was obtained and it was concluded that multicollinearity was not a problem in this case. I ran a Hosmer and Lemeshow test to determine if the logistic model was a good fit. With a Chi-square value of 12.346 and a *p*-value of 0.136, there is an indication the model is a good fit. With a Nagelkerke R^2 value of 0.013 for block 1 and 0.028 for block 2, the addition of obesity, snoring, and OSA increased the percentage of variation in CHD by 0.015 (1.5%)

Table 6

Logistic Regression of Obesity, Snoring, and Sleep Apnea on Coronary Heart Disease

					95% CI			
Variable	β	SE	OR	Wald	LL	UL	*P*	R^2
Block 1								.013
Race Black	1.096	.734	2.991	2.230	.710	12.600	.135	
Race Other	.030	.361	1.031	.007	.508	2.090	.933	
Age	-.003	.013	.997	.062	.972	1.022	.804	
Gender (F)	.180	.502	1.198	.129	.448	3.201	.719	
Location (AL)	-.085	.510	.919	.028	.338	2.498	.868	
Block 2								.028
Obesity	.339	.298	1.404	1.298	.783	2.518	.255	
Snoring	.540	.277	1.715	3.793	.997	2.957	.051	
OSA	-.181	.269	.835	.450	.492	1.415	.502	

Note. **p* < .05; OR = odds ratio; CI = confidence interval; LL=lower limit; UL = upper limit. Statistically significant values are indicated by *p* values < .05, Nonsignificant values: *p* >.05, Dependent variable = Coronary heart disease; SE = standard error

I observed from Table 6 that none of the independent variables is a significant predictor of the odds of a person having CHD. The *p*-values for obesity (.255), snoring (.051) and OSA (.502) are all greater than the chosen alpha level of 0.05. This indicates that given this model with three independent variables, I cannot reject the null hypothesis. I did not have enough evidence to conclude that all three independent variables have significant relationship or effects on CHD after controlling for gender, age, race, and geographic location at the 0.05 alpha level.

Summary

Logistic regression was used to examine the effects of obesity, snoring, and OSA on CHD. CHD was used as the dependent or response variable while gender, age, race, and geographic location served as covariates. The results of the analysis showed that none of the independent variables had a significant relationship with CHD at the 0.05 alpha level. The results of the analysis were consistent when variables were tested individually as a single predictor or with multiple predictors. Based on the findings, I do not have enough evidence to conclude that these predictor variables can significantly predict the odds of having CHD at the 0.05 alpha level. In chapter 5, I will provide a discussion about interpretation of findings, study limitations, implications, and recommendations for future research.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quantitative, cross sectional study was to examine the effects of obesity, snoring, and OSA on CHD while controlling for gender, race, age, and geographic location. The CDC BRFSS dataset was used to compare data from 2015 to 2017. Results of this study showed that obesity, snoring, and OSA were not statistically significant predictors of CHD either individually or collectively.

Interpretation of the Findings

To address the research questions, four different logistic regression analyses were run to determine the effects of obesity, snoring, and OSA while controlling for the effects of gender, race, age, and geographic location. The first analysis tested the odds of having CHD for those who were obese compared to those who were not obese. Obesity was not found to be a significant predictor of CHD. The result indicated that there was not enough evidence to show that those with obesity were more likely to have CHD. It is important to note that this lack of effect is consistent with some of the past studies that did not find a conclusive and definitive significant influence of obesity on CHD. In one of such similar studies, Sharma et al. (2015) found that obesity alone was one of the highest contributors to mortality but did not find any direct link between obesity and CHD.

The second research question focused on the effects of snoring on CHD. Specifically, the analysis tested for the odds of having CHD versus not having it for those who snore compared to those who did not snore. The effect was not statistically significant, and I could not conclude that the odds of having CHD was higher for those who snored. A review of related literature revealed that the search for a significant effect of snoring on CHD will continue as most of the past studies found no direct link between snoring and CHD. Ramar et al. (2015) found in an indirect link or association between CHD and snoring. They revealed that snoring is one of the risk factors for CHD but fell short of concluding that snoring had a direct significant effect on CHD (Ramar et al., 2015).

The third research question tested the effect of OSA on CHD. Specifically, the analysis focused on whether the odds of a diagnosis of CHD could be determined by whether a person had OSA or not. The goal was to find out if those with OSA were more likely to have CHD than those without OSA. The logistic regression analysis performed with race, age, gender, and location as covariates revealed that the effect of OSA was not statistically significant. This led to the conclusion that there is insufficient evidence to support the alternative hypothesis that those with OSA were more likely to have CHD. Like the literature, I have failed to prove any direct relationship between OSA and CHD. Some of the past studies with such an indirect link included the work by Wang et al. (2018), whose study established that MMP-9 was a risk for CHD in patients who were diagnosed with OSA. Ramar et al. (2015), in a similar study, found that OSA and snoring are some of the risks for CHD but were unable to establish any direct linkage.

The last research question tested the effect of a combination of obesity, snoring, and OSA on CHD while controlling for race, age, gender, and geographic location. The overall objective, in this case, was to determine if any effect on CHD could occur when all three of the independent variables (obesity, snoring, and OSA) were simultaneously included in the system while controlling for the covariates (race, age, gender, and geographic location). Like previous analyses, the results were not statistically significant. I observed that snoring was found to be the closest to being statistically significant (p = .051) and should therefore be considered to have the strongest effect on CHD. There was insufficient evidence to conclude that when combined, a level of each variable had a higher chance of having CHD than the other level. It was also observed that the result of this analysis did not significantly deviate from previous results. Therefore, it did not matter if the effects were tested individually or collectively. This is consistent with the findings in the literature. Chen et al. (2016) examined a person's therapeutic care relative to OSA, obesity, inflammation, and metabolic issues to which they were unable to note a causal relationship due to insufficiencies relative to gender, snoring, and geographic diversity. Their study did lead to further investigation of patterns of behavior relative to a person who would be impacted by OSA, obesity, and their potential diagnosis with CHD although they never addressed snoring as relative to CHD (Chen et al., 2016).

Patterns of behavior could also have played a role in the findings, whereby awareness coupled with how respondents value causative risk for CHD impacted the effects. When individuals were advised of relapses in their CHD factors, it is possible that they provided causative risks such as things that created physical and emotional stress like diet and smoking (Kohler et al., 2017). With snoring as the one variable in my study closest to being significant with CHD, this variable could have been the one behavior that outwardly impacted relationships and the health and wellness of additional members in a household, warranting immediate acknowledgement by the respondents in each of the categories regardless of age, race, gender, and geographic location. Additionally, obesity and OSA are health related behaviors that individuals diagnosed tend to gain advantages in rehabilitative and supportive assistance, whether supervised or not. Because the study into OSA and snoring was recently undertaken and listed in the BRFSS, it would be presumed that the findings showed no substantial relationship to CHD because there are limited recent studies into compliance and adherence to treatment with the tools currently available such as the CPAP machine. As Rezaeetalab et al. (2016) pointed out, the treatment of choice is the CPAP, whereby oxygen therapy is also added to treat OSA because of the potential for combinations of variables in existence for which patients would require screening. The issue is the belief that the patients hold and buy into accepting that they have a sleep disorder and that their CHD is related to the overlap syndromes of OSA, snoring, and obesity (Rezaeetalab et al., 2016).

Limitations of the Study

Upon execution of the study analysis, there were a minimal number of limitations of the study. Although there was a large sample size to enhance the generalizability of the findings, the reliability of the study responses was impacted due to the novelty of the study on OSA and snoring, resulting in a single year questionnaire of all of independent and dependent variables. The last and most recent year showed the desire to analyze the potential impact on CHD by obesity, OSA, and snoring; however, there were limited responses to OSA and snoring, which could have an impact on the reliability of the associated findings against CHD when combined. The results of the study were from the respondents in the southern region of the US whereby the two specific states, Alabama and Georgia showed a much lower response to the BRFSS questionnaire thus impacting the ability to generalize the findings. With a combined total of over 12,000 respondents in Alabama and Georgia compared to the total of 119,700 from the southern states, representativeness of my sample was slightly impacted. Having a total of 450,016 respondents in 2017 from all states whereby only over 130,000 persons responded in the southern states and of this amount only just over 12,000 responded in Alabama and Georgia combined. Lastly, the persons who dropped out of the study was higher compared to those that participated in the study which can lower the representativeness of participant involvement in the study outcome.

The original intention of the research design was to use a combination of the 2015-2017 datasets from the CDC BRFSS. However, it was discovered that the 2015 and 2016 datasets did not include some of the key variables for the study. A decision was then made to use only the 2017 datasets that came complete with all the needed variables. Another problem that arose while exploring the dataset was the discovery that most of the values for the key variables were missing. An action had to be taken to either replace the missing values by imputation or to exclude them. Excluding the missing values would lead to significant reduction in sample size. This idea was jettisoned in favor of imputation of values. This action could lead to reliability issues as the values imputed may not reflect the true values and may also lead to skewness and unreliability of the data results.

Another main limitation of this study was the issue of age. Age was one of the control variables, but it was observed that there were no records for the 40 to 49 and 50 to

49 age categories in the CDC dataset. This meant that all analyses were performed without these critical age groups, which might cast doubt on the generalizability of the results to the entire population. Any future similar study must make efforts to include these important age groups to avoid a potential reliability or generalizability issue encountered with the present study.

The data used for the analysis were collected from only two states. A randomly selected sample will only lead to generalization to the two states and not to the entire country. An expanded or more tailored data collection technique could be used to generalize to the entire country more realistic. However, a more narrowed population will make sampling and data collection more effective.

One of the potential fallouts of analyzing data without certain key segments of a variable is to cause Type 1 or Type II errors. The exclusion of the 40 to 49 and 50 to 59 age groups could potentially cause these errors. For instance, snoring was found to have a p value of 0.051, which is close to the alpha level of 0.050. It is possible that the presence of the missing values could have pushed this value up to 0.05 or less. That possibility could be further addressed with future similar studies.

Recommendations

Future recommendations and ideas for specific types of research studies on this topic include a qualitative study design because the respondents would be able to provide a range of subjective responses to semi structured interviews. A subjective, qualitative design could give researchers more knowledge about how adults perceive their sedentary behavior as related specifically, for example, to their obesity and OSA status while also addressing their use of tools and current treatments available. In addition to being able to obtain this type of information from a qualitative design study, researchers may be able to gain information about how individuals in the community recognize their own potential susceptibility to a diagnosis of OSA and CHD.

A mixed methods approach could also be beneficial as it will provide an opportunity for respondents to answer subjectively as well as objectively as to how they communicate their perception of risk of CHD coupled with their trust in the medical personnel who conduct their examinations at the healthcare facility level. The outcome of the study would be rooted in the experiences and voices of the persons who respond, which would aid public health specialists, social change experts, and multidisciplinary professionals in constructing case-specific and diagnosis-specific services that could specifically address the variables under study, individually and combined, in an effort to address the morbidity from OSA, snoring, obesity, and mortality from CHD.

Implications

The findings of this study could launch an awareness factor that could enhance positive social change within an individual, community, and nationwide approach. Despite not showing the desired significant effects of obesity, snoring, and OSA on CHD in this study, efforts could continue to be made by public health practitioners to sensitize the public, as well as the public health specialists who conduct community interventions, on the health hazards associated with these variables. This process would include public health workers continuing to address the challenges encountered in this study by seeking to find significant effects of these variables on public health in future studies. Public health practitioners can be better guided by past studies, most of which pointed to obesity, snoring, and OSA as risk factors for CHD. Chen et al. (2016) pointed out the impact of these risk factors on the community and individuals whereby the prevalence of those suffering mortality and morbidity due to heart disease was high in their study. Having a high BMI, an individual elevates their risk for CHD mortality as well for this was one of the findings in the recent study conducted by Zhang et al. (2018). Unfortunately, disparities in regional locations within the community in which an individual resides, also impact their ability to receive care and access to assessment of adherence to care provided. This geographic challenge should be addressed in future studies to aid in accounting for morbidity and mortality resulting from elevation of combined and individual risk factors within the community for CHD due to the direct effects of these variables.

With multidisciplinary community-level support as a necessary component to effective whole care of individuals impacted by snoring, OSA, obesity, and/or CHD, the similar style in multidisciplinary community-level studies on the variables' impact on the community and the organizations that provide services to the individual within society must transpire. This could be done through cluster and map-tracing of adherence to protocols, recommendations for care, use of tools like the CPAP, dietary recommendations, even sleep and wellness home assessments would aid individuals and the community in combatting the limiting issues of address in this study that would have a positive social change impact as a whole.

Lastly, the overall health impact to an individual's family members who lose sleep due to the snoring of one of its members could be a negative outcome resulting in daytime sleepiness as found in respondents to the study conducted by Zhang et al. (2016). They found that daytime sleepiness alone was a risk factor in many individuals with CHD and noted that OSA and snoring were strongly associated with daytime sleepiness and CHD (Zhang et al., 2016). This impact to the individual's rest that results in sleepiness, would directly impact the community when the individual and/or their family members are entrusted to manage a vehicle, perform medical tasks with patients, or even have the entrustment of the standards of law enforcement. In my study, noting that the national rates in obesity in persons over 18 years of age had short sleep durations was important to show how the resulting lack of energy due to missed sleep would negatively impact activity and productivity in society at large (Vaughan et al., 2017). Adhering to evidence-based practice can lead to improvement in the overall health and well-being of the people with early diagnoses and proper diagnosis-specific treatments for the risk factors addressed in this study. The resulting positive social change would result in an enhanced relationship of trust from the individuals that are served by health practitioners that put in practice possible adherence and service tools that were acquired from seeking and innovating new ways of studying the combined relationship between the health variables that were addressed in this study.

Conclusion

CHD accounts for nationwide morbidity and mortality at alarming rates irrespective of socioeconomic, demographic, or geographic background. The results of the analysis in this study showed that obesity, snoring, and OSA were not significant predictors of CHD. Future researchers should continue to analyze the combination of obesity, snoring, and OSA on CHD to be able to provide services, products, risk-specific, and age-specific health and wellness services and tools to address CHD. Multidisciplinary services, as well as adherence protocols and standards, could bring about the necessary positive social change inherent in observed perceptive beliefs of individuals nationwide to do what is necessary to reduce their obesity, OSA, snoring, and CHD risk.

References

Ahluwalia, A., Misto, A., Vozzi, F., Magliaro, C., Mattei, G., Marescotti, M. C., ...Iori, E. (2018). Systemic and vascular inflammation in an in-vitro model of central obesity. *PLoS ONE, 13*(2), 1-15. doi:10.1371/journal.pone.0192824

Al-Zoughool, M., Al-Ahmari, H., & Khan, A. (2018). Patterns of physical activity and the risk of coronary heart disease: A pilot study. *International Journal of Environmental Research and Public Health*, *15*(4), 1-13. doi:10.3390/ijerph15040778

Centers for Disease Control and Prevention. (2018). Overweight and obesity: Adult obesity prevalence maps. Retrieved from https://www.cdc.gov/obesity/data/prevalence-maps.html

Centers for Disease Control and Prevention. (2019a). Behavioral risk factor surveillance system. Retrieved from https://www.cdc.gov/brfss/

Centers for Disease Control and Prevention. (2019b). *Summary health statistics: National health interview survey, 2017. Table A-1a. pp 1-9.* Retrieved from https://ftp.cdc.gov/pub/Health_Statistics/NCHS/NHIS/SHS/2017_SHS_Table_A-1.pdf

Centers for Disease Control and Prevention. (2019c). Use of agency materials. Retrieved from https://www.cdc.gov/other/agencymaterials.html

Chen, G., Qi, J., Wang, B., Lin, X., Zhang, X., Zhao, J., … Lin, Q. (2016). Applicability of visceral adiposity index in predicting metabolic syndrome in adults with obstructive sleep apnea: A cross-sectional study. *BMC Pulmonary Medicine*, *16*, 1–10. doi:10.1186/s12890-016-0198-0

Creswell, J. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: SAGE Publications, Inc.

Diraj, K. (2019). Top 5 assumptions for logistic regression. Retrieved from https://medium.com/@dhiraj8899/top-5-assumptions-for-logistic-regression-96b11d24d357

Ear, Nose, and Throat of North Georgia. (n.d.). Snoring and sleep apnea. Retrieved from http://www.entofga.com/snoring-and-sleep-apnea/

Frankfort-Nachmias, C., & Leon-Guerrero, A. (2018). *Social statistics for a diverse society* (8th ed.). Thousand Oaks, CA: Sage Publications.

Franklin, K., & Lindberg, E. (2015). Obstructive sleep apnea is a common disorder in the population-a review on the epidemiology of sleep apnea. *Journal of Thoracic Disease*, *7*(8), 1311-1322. doi:10.3978/j.issn.2072-1439.2015.06.11

Gottlieb, D. J., Yenokyan, G., Newman, A. B., O'Connor, G. T., Punjabi, N. M., Quan, S. F., … Shahar, E. (2010). Prospective study of obstructive sleep apnea and incident coronary heart disease and heart failure: The sleep heart health study. *Circulation*, *122*(4), 352–360. doi:10.1161/CIRCULATIONAHA.109.901801

Hudgel, D. W. (2018). Critical review: CPAP and weight management of obstructive sleep apnea cardiovascular co-morbidities. *Sleep Medicine Reviews*, *37*, 14-23. doi:10.1016/j.smrv.2016.12.001

Ji, K., Wang, X., Li, J., Lu, Q., Wang, G., Zue, Y., ...Tang, J. (2015). Macrophage migration inhibitory factor polymorphism is associated with susceptibility to inflammatory coronary heart disease. *BioMed Research International, 2015, 1-6.* doi:10.1155/2015/315174

Jorvand, R., Sadeghirad, K., Haeri Mehrizi, A. A., Ghofranipour, F., & Tavousi, M. (2019). Determinants of daily exercises among employees with overweight or obesity: The application of health belief model. *Journal of Research & Health, 9*(5), 387–393. doi:10.29252/jrh.9.5.387

Kanna, B., & Boutin-Foster, C. (2016). Demographic and behavioral factors linked to obesity among inner-city Latino New Yorkers in the Bronx community. *Journal of Community Health, 41(*5), 1062–1068. doi:10.1007/s10900-016-0190-x

Kochanek, K., Murphy, S., Xu, J., & Arias, E. (2016). *Mortality in the United States. NCHS data brief, no 293 Hyattsville, MD.* National Center for Health Statistics, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services; 2104. Retrieved from https://www.cdc.gov/nchs/data/databriefs/db293.pdf

Kohler, A. K., Nilsson, S., Jaarsma, T., & Tingstrom, P. (2017). Health beliefs about lifestyle habits differ between patients and spouses 1 year after a cardiac event – A qualitative analysis based on the health belief model. *Scandinavian Journal of Caring Sciences, 31*(2), 332-341. doi:10.1111/scs.12351

Mondesir, F., Carson, A., Durant, R, Lewis, M., Safford, M., & Levitan, E. (2018). Association of functional and structural social support with medication adherence among individuals treated for coronary heart disease risk factors: Findings from the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study. *PLoS ONE*, *13*(6), 1–13. doi:10.1371/journal.pone.0198578

National Institutes of Health. (2017). Coronary artery disease: Overview. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK355313/

Pleavă, R., Gaiţă, D., Ardeleanu, C., Frentz, S., Udrescu, M., Udrescu, L., … Mihăicuţă, S. (2016). Obesity in association with sleep apnea syndrome as a predictor for coronary-vascular comorbidities. *Pneumologia (Bucharest, Romania), 65*(1), 14–18. www.pneumologia.eu/en/all-articles

Ramar, K., Dort, L., Katz, S., Lettieri, C., Harrod, C., Thomas, S., & Chervin, R. (2015). Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: An update for 2015. *Journal of Clinical Sleep Medicine*, *11*(7), 773-827. doi:10.5664/jcsm.4858

Rezaeetalab, F., Ahmadhosseini, S., Akbarirad, M., Akbarirad, M., Akbarirad, F., & Azami, G. (2016). Sleep overlap syndrome: A narrative review. *Journal of Cardiothorac Medicine,4*(4), 497-504. http://jctm.mums.ac.ir

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs*, *2*(4), 328-335. doi.org/10.1177/109019817400200403

Sadeghi, A., Soltaninejad, F., & Amra, B. (2017). Compliance with continuous positive airway pressure in Persian patients with obstructive sleep apnea. *Journal of Research in Medical Sciences*, *22*(1), 114-121. doi:10.4103/jrms.jrms_108_17

Sanchis-Gomar, F., Perez-Quilis, C., Leischik, R., & Lucia, A. (2016). Epidemiology of coronary heart disease and acute coronary syndrome. *Annals of Translational Medicine, 4*(13), 256-268. doi:10.21037/atm.2016.06.33

Sas-Nowosielski, K., Hadzik, A., Gorna, J., & Grabara, M. (2016). Applying the health belief model in explaining the stages of exercise change in older adults. *Polish Journal of Sport and Tourism,* (4) 23, 221-225. doi:10.1515/pjst-2016-0029

Seyedmehdi, S. M., Rahnama, N., Yazdanparast, T., Jamaati, H., Attarchi, M., Naghan, P. A., & Hassani, S. (2016). Prevalence of snoring and the risk of sleep apnea in hospital staff. *Work*, *55*(4), 765-772. Retrieved from https://search-ebscohost-com.ezp.waldenulibrary.org/login.aspx?direct=true&db=edb&AN=120560904&site=eds-live&scope=site

Shahrabani, S., Tzischinsky, O., Givati, G., & Dagan, Y. (2014). Factors affecting the intention and decision to be treated for obstructive sleep apnea disorder. *Sleep and Breathing, 18*(4), 857-868. doi:10.1007/s11325-014-0957-1

Sharma, S., Batsis, J., Coutinho, T., Somers, V., Kragelund, C., Kanaya, A., & Lopez-Jimenez, F. (2015). Normal weight-central obesity is associated with the highest mortality risk in older adults with coronary artery disease. *Journal of Clinical Lipidology, 9(*3), 476–478. doi:10.1016/j.mayocp.2015.12.007

Singh, V., Kumari, G., Chhajer, B., Jhingan, A. K., & Dahiya, S. (2018). Effectiveness of enhanced external counter pulsation on clinical profile and health-related quality of life in patients with coronary heart disease: A systematic review. *Acta Angiologica, 24*(4), 105-122. doi: 10.5603/AA.2018.0021

Tian, J., Yan, J., Zhang, Q., Yang, H., Chen, X., Han, Q., ...Han, Q. (2019). Analysis of re-hospitalizations for patients with heart failure caused by coronary heart disease: Data of first event and recurrent event. *Therapeutics & Clinical Risk Management, 15,* 1333-1341. doi: 10.2147/TCRM.S218694

Tran, D. M., Zimmerman, L. M., Kupzyk, K. A., Shurmur, S. W., Pullen, C. H., & Yates, B. C. (2017). Cardiovascular risk factors among college students: Knowledge, perception, and risk assessment. *Journal of American College Health, 65*(3), 158-167. doi: 10.1080/07448481.2016.1266638

Vaughan, A. S., Ritchey, M. D., Hannan, J., Kramer, M. R., & Casper, M. (2017). Widespread recent increases in county-level heart disease mortality across age groups. *Annals of Epidemiology, 27*(12), 796–800. doi:10.1016/j.annepidem.2017.10.012

Wang B., Chandrasekera P & Pippin J. (2014). Leptin- and leptin receptor-deficient rodent models: Relevance for human type 2 diabetes. *Current Diabetes Reviews, (10)* 131-145. https://doi.org/10.2174/ 1573399810666140508121012

Wang, S., Li, S., Wang, B., Liu, J., & Tang, Q. (2018). Matrix metalloproteinase-9 is a predictive factor for systematic hypertension and heart dysfunction in patients with obstructive sleep apnea syndrome. *BioMed Research International*, 1–10. doi: 0.1155/2018/1569701

Whale Conley, C. E., Olson, A. D., Howard, J. S., Dressler, E. V., Lattermann, C., & Mattacola, C. G. (2018). Use of an adaption to the health belief model to influence rehabilitation adherence in athletic training. *Athletic Training & Sports Health Care, 10*(1), 10-19. doi: 10:3928/19425864-20170811-01

Wojtkowska, I., Bonda, T. A., Tysarowski, A., Seliga, K., Siedlecki, J. A., Winnicka, M. M., & Stepinska, J. (2019). PPARG2 Pro12Ala and TNF^{a}-30^{a}8G>A Polymorphisms are not associated with heart failure development in patients with ischemic heart disease after coronary artery bypass grafting. *PPAR Research,* 1-7. doi: 10.1155/2019/1932036

Zhang, J., Guo, Q., Peng, L., Li, J., Gao, Y., Yan, B, Fang, B., & Wang, G. (2018). The association of neck circumference with incident congestive heart failure and coronary heart disease mortality in a community-based population with or without sleep-disordered breathing. *BMC Cardiovascular Disorders, 18*(1), 108-128. doi: 10.1186/s12872-018-0846-9

Zhang, N., Chen, S., Chen, Y., Guo, X., Sun, G., Qian, H., & Sun, Y. (2016). Daytime sleepiness is associated with hyperhomocysteinemia in rural area of China: A cross-sectional study. *European Journal of Internal Medicine, 35*, 73–77. doi: https://doi.org/10.1016/j.ejim.2016.05.029