The Relationship between Cognitive Decline with Sleep Trouble and Anxiety

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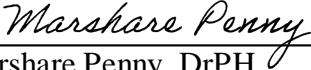
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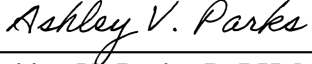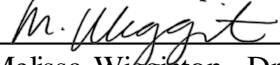California Baptist University

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Abstract

Cognitive decline is increasingly becoming an important focus of public health institutions throughout the United States. The population of American seniors over the age of 65 is projected to double in upcoming years. Cognitive decline can have a major impact on the daily life functioning of any adult, and multiple factors play an influence on the deterioration of an individual's cognitive functioning. Current literature has yet to definitively determine associations between cognitive decline, sleep trouble, and anxiety. This study aims to determine what relationship exists between cognitive decline, sleep trouble, and age as well as cognitive decline and anxiety. A cross-sectional study was conducted using the National Health and Nutrition Examination Survey standardized questions regarding cognitive decline, sleep trouble, and anxiety. The population sample consisted of 192 participants, 82 males and 110 females, living in the United States between the ages of 0 to 150. Two Chi-square tests of independence and a Cochran-Mantel-Haenszel test of independence were performed. Significant associations were found between cognitive decline and sleep, and cognitive decline and anxiety. Based on these results, a health coaching program and behavioral intervention program will be implemented in health clinics and hospitals around the United States to ensure adults manage their sleep trouble and anxiety early on in life to decrease the overall risk of cognitive decline.

Keywords: cognitive decline, anxiety, age

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Introduction

As the aging population begins to increase around the United States it is imperative we focus on decreasing the risks associated with any aging adult. Cognitive decline is among one of the greatest risks and more studies need to be done to understand what factors contribute to it.

The number of Americans over the age of 65 is projected to double in the next 40 years from 40.2 million to 88.5 million (Harada, Natelson, & Triebel, 2013). This drastic increase in older adults makes it imperative to understand the cognitive changes that accompany aging as they affect an elder's day-to-day functioning. Cognitive functioning includes processing speed, attention, memory, language, and executive functioning (Harada et al., 2013). Cognitive decline can be defined as memory loss or dementia that interferes with independent functioning (Mayo Clinic, 2019). In addition, cognitive decline, also known as cognitive impairment, is defined by an individual beginning to have a harder time learning new things, concentrating, or making decisions that affect everyday life (Centers for Disease Control and Prevention [CDC], 2019). Cognitive decline is known to be a representation of early or preclinical Alzheimer's disease and is associated with depression and anxiety in healthy elders (Lee, Kang, & Cho, 2017). The 65 and older age group percentage rising from 16% to 2% of the total population will bring about a wide range of issues for elders in the country, and cognitive decline is among one of those implications (Harada, 2014). Studies have shown normal cognitive aging may result in declines in key functional abilities of everyday life, such as driving a car (Harada, 2014). Memory complaints are usually associated with difficulties in daily living and poor

quality of life, which often lead to further health related health problems (Montejo, 2012).

Review of Literature

As cognitive decline becomes more prevalent in an aging adult, it is important to recognize the factors that can increase the chances of a deteriorating cognitive function. Lifestyle habits are important in any aging adult and can increase or decrease the chances of morbidity and mortality. The following literature will explain how lifestyle factors such as sleep trouble and anxiety can contribute to the likelihood of cognitive decline.

Cognitive Decline

According to the CDC (2019), cognitive decline is present in 11.7% of adults aged 65 and older and 10.8% of adults between the ages of 45 to 64 years. Although current research has suggested that cognitive decline targets the elderly population, there is contradictory research that reported that healthy adults experience memory decline regardless of age (Lee et al., 2017). In addition, many factors besides age effect cognitive functioning in adults (Lee et al., 2017). According to Tsapanou and colleagues (2018), increased sleep problems, such as trouble falling asleep or sleeping too much, were associated with increased subjective cognitive decline (SCD). Specially, sleep problems were found to be directly related to complaints regarding memory, naming, and calculations (Tsapanou et al., 2018). In research conducted by Mah, Binns, and Steffens (2015), older adults with anxiety were 135% more likely to develop cognitive decline, such as Alzheimer's disease.

Anxiety

Anxiety disorders, including feeling worried, nervous, or anxious, are recognized as one of the most prevalent mental disorders in late life (Villagrasa et al., 2018). According to a study on a community of older adults (55 and older), 17% of men and 21.5% of women in the sample self-reported higher, clinically significant levels of anxiety (Kogan, Edelstein & Mkcee, 2000). Anxiety negatively impacts quality of life and is associated with an increased risk of mortality and morbidity (Villagrasa et al., 2018). Numerous studies have determined that elderly individuals with anxiety demonstrate a decreased quality of life compared to those without anxiety (Wolitzky-Taylor, Castriotta, Lenze, Stanley, & Craske, 2010). In addition, among a sample of older adults aged 55-85, anxiety was associated with increased disability and reduced well-being (Wolitzky-Taylor et al., 2010).

Unfortunately, anxiety in elders is often missed or misdiagnosed because it presents differently than anxiety in younger adults (Wolitzky-Taylor et al., 2010). For example, anxiety among elders is often experienced as more somatic with complaints such as dizziness and shakiness (Wolitzky-Taylor et al., 2010). Anxiety in older adults has often been described as the "silent geriatric giant" due to its large prevalence among older people (Villagrasa et al., 2018).

A longitudinal research study by Wolitsky-Taylor and colleagues (2010) found that anxiety late in life may increase the risk of cognitive decline more than the risk associated with increasing age. Anxiety disorders and cognitive decline, such as dementia, among the elderly are often thought to be comorbid (Wolitzky-Taylor et al., 2010). In the same longitudinal study, those who were classified as experiencing

anxiety were four times more likely to experience cognitive impairment compared to those without anxiety (Wolitzky-Taylor et al., 2010). Lastly Wolitzky-Taylor et.al (2010) suggested that being in a constant state of anxiety over many years depletes cognitive reserves. It is evident, as explained in previous studies, that cognitive decline and anxiety symptoms commonly co-occur in later stages of life; although, whether cognitive decline leads to anxiety or anxiety leads to cognitive decline is still unknown (Petkus, Reynolds, Wetherell, Kremen, & Gatz, 2017). Sleep trouble is another factor related to the cognitive decline of an individual.

Sleep trouble

In a study sample of 2,391 young adults aged 20 to 39 years from the National Health and Nutrition Examination Survey, approximately 4.4% had a sleep disorder and 8.5% had sleep apnea (Chen, 2013). The American Sleep Association estimated that at least 40 million people in the United States suffer from chronic or long-term sleep disorders with an additional 20 million experiencing sleep-related problems (Farnsworth, Kim and Kang, 2015). According to the Mayo Clinic (2019), sleep trouble or difficulties can consist of trouble sleeping at night, finding it hard to fall asleep, or waking up several times throughout the night. These troubles may be due to various factors such as insomnia, sleep apnea, snoring, or night terrors (Mayo Clinic, 2019).

Among U.S. adults, sleep disturbances are common and associated with decreased quality of life (Chen, 2013). According to Miller (2015), sleep duration is directly associated with an increase in all-cause mortality. Likewise, sleep plays an important role in maintenance, disease prevention, repair, and restoration of the body

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and mind alike (Miller, 2015). As a result, sleep disturbances and disorders can disrupt neural pathways contributing to neurological diseases, which often lead to working memory impairment (Miller, 2015). According to Lim and colleagues (2013), sleep disruption in both animals and humans contributes to cognitive impairment and neurodegeneration. Sleep quality was determined to be associated with amnestic scores in the older adults (65+), while it was not associated with amnestic scores in younger adults (Miller, 2015). In conclusion, age-dependent adequate amount of quantity and quality of sleep is necessary for both memory and non-memory cognitive functioning (Miller, 2015).

Of further interest, more than half of the elder population have insomnia, and it is one of the top five most frequent reasons for visits in outpatient medical practices (Patel, Steinberg, & Patel, 2018). Many elderly individuals reported chronic problems with sleep onset, duration, and maintenance associated with functional disability (Amer, Hamza, Akkad, & Galeel, 2013).

Insufficient sleep is associated with significant morbidity and increased mortality, symptoms of depression, anxiety, and overall decreased quality of life (Amer et al., 2013). In addition, advancing age is commonly associated with greater likelihood of sleep disturbances and cognitive impairment (Otsuka et al., 2014). Researchers have considered sleep as a contributor to both qualitative and quantitative changes of memory representations (Suh et al., 2018). According to Spira, Chen-Edinboro, Wu, and Yaffe (2014), sleep loss was found to lead to neuronal damage in the hippocampus and thalamus, which is central to memory, and can ultimately lead to cognitive decline. Although the effect of cognitive function

impacting poor sleep has been studied in other literature, it is still unclear whether or not the two are related (Amer, 2013).

Purpose of the Study

Memory complaints, a result of cognitive decline, and their relationship with different aspects of health and quality of life are important to any aging adult. The purpose of this study is to examine if there is an association between cognitive decline and sleep trouble, specifically to determine if those experiencing sleep trouble are more likely to report cognitive decline compared to those not experiencing sleep trouble. Additionally, this study examines the effect age has on that relationship. Secondly, the relationship between anxiety and cognitive decline is examined to determine whether individuals experiencing anxiety are more likely to develop symptoms of cognitive decline compared to those not experiencing anxiety.

Research Questions

Questions this study will answer are:

1. Is there an association between cognitive decline and sleep trouble?

2. Does age influence the relationship between cognitive decline and sleep trouble?

3. Is anxiety related to cognitive decline?

Hypotheses

It is hypothesized that those experiencing sleep trouble, as measured by difficulty falling asleep, are more likely to report having cognitive decline compared to those without sleep trouble. Secondly, age is hypothesized to have an influence on the relationship between sleep trouble and cognitive decline. Lastly, it is hypothesized

that anxiety and cognitive decline are comorbid, more specifically those experiencing anxiety are more likely to develop cognitive decline compared to those who do not experience anxiety.

Method

Design

This study used a cross-sectional design to explore the relationship between cognitive decline and sleep trouble as well as anxiety and cognitive decline. This study used secondary data from the 2017-2018 National Health and Nutrition Examination Survey (NHANES). The NHANES dataset is a state-based survey that includes both interviews and physical examinations established by the CDC to collect information on medical, dental, and physiological measurements as well as laboratory tests administered by highly trained medical personnel to children and adults who live in the United States (CDC, 2017).

Participants

The 2017-2018 NHANES original dataset consists of a nationally representative sample of 9,254 participants. The target population selected for this study included all adults who responded to the cognitive decline, sleep trouble, and anxiety questions on the survey while excluding missing responses from the dataset. A total of 3,617 participants responded to all three questions in the survey and so met the criteria. The minimum required sample size was calculated using G* Power Software Version 3.1 for three statistical tests, including two Chi-square test of independence and a Mantel-Haenszel test. It was determined that the Mantel-Haensel sample size required the greatest number of participants with a statistical power of 0.80, an alpha coefficient of 0.05, and a moderate effect size, which produced a necessary sample size of 192.

Procedures

        The 2017-2018 NHANES data is collected from health interviews that are conducted in respondents' homes and follow-up health measurements are performed in specially-designed and equipped mobile centers that travel to several locations throughout the country (CDC, 2017). The interviews are administered each year by a study team consisting of a physician, medical and health technicians, and dietary and health interviewers with bilingual staff (CDC, 2017). The interview includes demographic, socioeconomic, dietary, and health-related questions for adults and children living in the U.S. Each participant is ensured that his or her answers to the interviews are strictly confidential.

Independent Variables

        The independent variables in this study include cognitive decline, anxiety, and age. Cognitive decline was measured by question PFQ057-experience confusion/memory problems, *"Are you limited in any way because of difficulty remembering or because you experience periods of confusion?"* Cognitive decline was recorded as categorical with four options "1 -Yes," "2-No," "7-Refused," and "9-Don't know." Response options "7" and "9" were recoded as "Missing."

        Anxiety was measured by question DLQ100, *"How often do you feel worried, nervous, anxious? Would you say daily, weekly, monthly, a few times a year, or never?"* Anxiety was measured using the following seven responses: "1-Daily," "2-Weekly," "3-Monthly," "4-A few times a year," "5-Never," "7-Refused," and "9-Don't Know." The anxiety variable was collapsed and recoded into a dichotomous variable with two categories "1-Yes Anxiety" and "2-No Anxiety." The options "1-

Daily" and "2-Weekly" were recoded into "1-Yes Anxiety," while "3-Monthly" and "4-A few times a year" were recoded into "2-No Anxiety." Response options "5," "7," and "9" were recoded as "Missing." The final independent variable, age from research question number two, was measured by survey variable RIDAGEYR, "Age in years at screening." Age was a continuous variable measured in years. The age variable was recoded into two categories, the 64 and under age group and the 65 and older age group.

Dependent Variables

The dependent variables in the study include cognitive decline and sleep trouble. Cognitive decline was used as both an independent and dependent variable in this study for separate research questions. Cognitive decline was measured once again by question PFQ057-Experience confusion/memory problems, *"Are you limited in any way because of difficulty remembering or because you experience periods of confusion?"* Cognitive decline was recorded as a categorical with four levels "1-Yes," "2-No," and "7-Refused" and "9-Don't know" were recorded as "Missing."

Sleep trouble was measured by question DPQ030, *"Over the last 2 weeks, how often have you been bothered by the following problems: trouble falling or staying asleep, or sleeping too much?"* Sleep trouble was measured in the dataset using six options "0-Not at all," "1-Several days," "2-More than half the days," "3-Nearly every day," "7-Refused," and "9-Don't know." The sleep trouble variable was recoded into a dichotomous variable with two categories; "0-Not all" were recoded into "1-No sleep trouble" and "1-Several days," "2-More than half the days," "3-

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Nearly every day" were recoded into "2-Yes sleep trouble." Response options "5,"

"7," and "9" were recorded as missing.

Data Analysis

In order to answer research question one, a Chi-square test of independence was performed to determine whether there is a relationship between cognitive decline and sleep trouble. A Mantel-Haenszel test was conducted to analyze research question two concerning whether age influences that relationship. Lastly, to determine if there is a relationship between anxiety and cognitive decline, a Chi-square test of independence was performed to answer research question three.

<center>**Results**</center>

Demographics

The sample from this study included data from the 2017-2018 National Health and Nutrition Examination Survey (NHANES). The purpose of the study was to determine if there was an association between cognitive decline and sleep trouble as well as anxiety and cognitive decline. Among the study participants *(n* = 192), most were female (57.3%). A majority of the NHANES participants classified themselves as Non-Hispanic White (34.4%) followed by Non-Hispanic Black (20.3%). Participants were categorized into two age groups; 80.2% were under 65 years of age and 19.8% were 65 and older. Most of the participants reported being married (45.8%) and most had completed some college or an AA degree (31.3%). Lastly, among the 192 participants, most respondents reported an income of $45,000 or greater (44.1%) (see Table 1).

Table 1.
Demographic description of 2017-2018 NHANES sample (n=192)

Variable	n	%
Gender		
Male	82	42.7%
Female	110	57.3%
Race/Ethnicity		
Non-Hispanic White	66	34.4%
Non-Hispanic Black	39	20.3%
Mexican American	39	20.3%
Non-Hispanic Asian	21	10.9%
Other Hispanic	15	7.8%
Other Race-Including Multi-Racial	12	6.3%
Age		
0-64	154	80.2%
65 and older	38	19.8%
Annual Family Income		
$0 to $4,999	9	5.1%

$5,000 to $9,999	10	5.6%
$10,000 to $14,000	12	6.8%
$15,000 to $19,999	11	6.2%
$20,000 to $24,999	11	6.2%
$25,000 to $34,999	26	14.7%
$35,000 to $44,999	19	10.7%
$45,000 to $54,999	13	7.3%
$55,000 to $64,999	17	9.6%
$65,000 to $74,999	8	4.5%
$20,000 and Over	1	.6%
Under $20,000	3	1.7%
$75,000 to $99,999	13	7.3%
$100,000 and Over	23	13.0%

Marital Status		
Married	88	45.8%
Widowed	17	8.9%
Divorced	28	14.6%
Separated	11	5.7%
Never Married	27	14.1%
Living with Partner	21	10.9%
Education Level		
Less than 9th grade	17	8.9%
9-11th grade (Includes 12th grade no diploma)	24	12.5%
High School Graduate/GED or Equivalent	53	27.6%
Some College or AA degree	60	31.3%
College graduate or above	38	19.8%

Major Findings

To answer research question one, a Chi-square test of independence was performed comparing the relationship between cognitive decline and sleep trouble. A significant association was found ($X^2(1) = 4.21$, $p = .040$). Cognitive decline was associated with sleep trouble (see Table 2). Those who reported sleep trouble were 66% less likely to also report cognitive decline compared to those who reported no sleep trouble.

Table 2.
Association between Cognitive Decline and Sleep Trouble (n = 192)

Variable	Sleep Trouble		Adjusted OR
	Yes N(%)	No N(%)	(95% CI)
Cognitive Decline			
Yes	12 (6.3%)	5 (2.6%)	
			*.335
No	78 (40.6%)	97 (50.5%)	(.113 - .992)

Note. N = Total Number, % = Valid Percent; OR, odd ratio; CI, confidence interval. Chi-square test was used to assess the relationship between cognitive decline and sleep trouble *p=.04

Table 3 illustrates the results of a Cochran-Mantel-Haenszel test of

independence used to answer the second research question, which explored whether

age had an influence on the relationship between sleep trouble and cognitive decline.

Age appears to influence the relationship between sleep trouble and cognitive decline.

Table 3.
Bivariate Association between Sleep Trouble and Cognitive Decline with the influence of Age (n = 192)

Sleep Trouble		Yes N (%)	No N (%)	Adjusted OR (95% CI)
Under 65	Cognitive Decline	11 (78.6%)	3 (21.4%)	
				*.233
(0-64)				(.060 - .835)
	No Cognitive Decline	63 (45.0%)	77 (55.0%)	
65 and Older	Cognitive Decline	1 (33.3%)	2 (66.7%)	
				1.50
(65 -100)				(.124 – 18.13)
	No Cognitive Decline	15 (42.9%)	20 (57.1%)	

Note. N = Total Number, % = valid percent, OR, odds ratio; CI, confidence interval. Chi-square test was used to assess the influence of age on the relationship between sleep trouble and cognitive decline. *p=.023 & p=.75

After adjusting for age, a statistically significant association was found among

those under 65 years of age ($X^2(1)$ =5.75, p = .023). However, among those 65 years

and older, there was no association found between sleep trouble and cognitive decline

$(X^2(1) = .103,\ p = .75)$. Among those under 65 years of age, the odds of cognitive

decline were 72% lower for those with sleep trouble compared to those without sleep

trouble.

To answer research question three, a Chi-square test of independence was performed

comparing the relationship between anxiety and cognitive decline. A significant

association was found $(X^2(1) = 8.40,\ p=.004)$. Anxiety was associated with cognitive

decline (see Table 4). Those individuals with cognitive decline were 4.49 times more

likely to report anxiety compared to those without cognitive decline.

Table 4.
Association between Cognitive Decline and Anxiety (n = 192)

Variable	Cognitive Decline		Adjusted OR (95% CI)
	Yes N(%)	No N(%)	
Anxiety			
Yes	12 (6.3%)	61(31.8%)	
			*4.49
No			(1.51 – 13.32)
	5 (2.6%)	114(59.4%)	

Note. N = Total Number, % = Valid Percent; OR, odd ratio; CI, confidence interval. Chi-square test was used to assess the relationship between cognitive decline and anxiety *$p=.004$

Discussion

The studies analysis results revealed three major findings. Despite a few study limitations and inconsistencies, significant associations were found in all three research questions that led to public health implications.

Summary of Major Findings

The findings for the first research question reveal a significant association between cognitive decline and sleep trouble. More specifically, those who reported sleep trouble were 66% less likely to report cognitive decline compared to individuals who reported no sleep trouble. These findings are inconsistent with Lim's (2013) findings that sleep disruption is attributed to cognitive impairment and neurodegeneration. It is also inconsistent with research that finds that sleep loss leads to neuronal damage in the hippocampus and thalamus, which is central to memory, ultimately leading to cognitive decline (Spira et al., 2014). This inconsistency could be due to the fact that in previous studies, the participants were over the age of 65. Eighty percent of the participants in this research study were under the age of 65. Although it has become evident in previous research that cognitive decline targets the elderly population, this study samples both the 65 and older age group and the 65 and under age group. Reasons for including both age groups are to determine the validity of the contradictory research by Lee and colleagues (2017) that reports healthy adults experience memory decline regardless of age.

The findings for the second research question demonstrate that age influences the relationship between sleep trouble and cognitive decline. Essentially, those individuals under the age of 65 who reported having sleep trouble were less likely to

experience cognitive decline. Among the participants under 65 years of age, cognitive decline was 72% lower for those reporting sleep trouble. These findings are inconsistent with the Otuska (2014) study, which found that aging was associated with a greater likelihood of sleep disturbances and cognitive impairment. These conflicting results can also be attributed to the fact that a majority of the participants in this study were under the age of 65, thus not representing a true aging population among the participants.

The results from the third research question found that anxiety was associated with cognitive decline with individuals who reported cognitive decline more likely to report experiencing anxiety. These findings are congruent with the longitudinal study conducted by Wolitsky-Taylor and colleagues (2010) in which individuals experiencing anxiety were four times more likely to experience cognitive impairment compared to those without anxiety. A constant state of anxiety over many years can deplete cognitive reserves (Wolitzky-Taylor et al., 2010). The depletion of cognitive reserves results in the interference of independent functioning, such as memory trouble, learning, concentrating, or making decisions (CDC, 2019). Cognitive decline is also known to be an early representation of preclinical Alzheimer's and dementia (Lee et al., 2017). It has become evident from this study and previous studies that anxiety and cognitive decline are related. More studies must be conducted to determine if the association is bidirectional; do individuals with chronic anxiety develop cognitive decline or is cognitive decline an effect of anxiety (Wolitzky-Taylor et al., 2010).

Public Health Implications

There are two important public health implications that identified from this study's results. Previous studies on cognitive decline have prioritized studying the elderly because it is well-known that as age increases the severity in deterioration of cognitive functioning increases (Harada, 2014). A greater focus must be placed on adults before they reach older age in an effort to promote better habits early on in life. Better lifestyle habits can help to decrease sleep trouble patterns which in turn can have a positive effect on cognitive decline. According to the International Consortium of Health and Wellness Coaches (ICHWC) lifestyle health coaching program, preventable lifestyle diseases are increasingly becoming major contributors in the rise of healthcare costs (Budzowski, Parkinson, & Silfee, 2019). An important implication that will help place a greater focus on the lifestyle habits of adults before they reach an older age would be implementing Budzowski's evidenced-based curricula in the lifestyle health coaching program. The lifestyle program is based on the ICHWC standards, which focus on weight, substance abuse, physical fitness, stress reduction, and healthy eating. Sleep health is also an important factor in the lifestyle of any adult. Adding sleep help to the curricula will ensure that adults are receiving an adequate amount of sleep. Reducing sleep disturbances early on in life can lead to better cognitive functioning once individuals reach later stages in life (Miller, 2015).

Another public health implication is addressing anxiety in adults to help them manage their symptoms as they age. Learning to manage anxiety early on in life can possibly reduce the likelihood of cognitive decline later in life. A low-intensity cognitive behavioral intervention based on the Oregon Research Behavioral

Intervention Strategies is designed for anxiety in older adults, and this evidenced-based practice has potential to impact older adults with signs of improvement and involvement from the participants (Seeley, Manitsas, & Gau, 2017). Altering this cognitive behavioral intervention to cater young adults so that they are taught to manage their anxiety before they become older can be a way to ensure that their anxiety does not cause greater health issues in the future. Each young adult would be assigned a peer mentor to assist in completing the five areas workbook intervention on anxiety that teaches skills on how to tackle and manage anxiety, face fears, and understand and use anxiety medication (Seeley et al., 2017). Managing anxiety as a young adult will reduce the depletion of cognitive reserves in the future, which is vital for an individual's cognitive functioning (Wolitzky-Taylor et al., 2010).

Study Limitations

There are several limitations of this research study. The first limitation in this study is recall bias. Recall bias is an error that occurs when participants do not remember previous events; therefore, the accuracy of their answer may be flawed (Wolitzky-Taylor et al., 2010). In this study, participants were asked to remember their sleeping patterns or if they had any sleep trouble over the past two weeks. Participants may not have been able to recall their exact sleep history during two weeks prior to the survey, causing their responses to the questionnaire to be false or flawed. In addition participants could have had a self-report bias, where they answer the questions on the survey untruthfully because of social pressure to give answers that are socially acceptable (Huppert, Pasupuleti, Foa, & Mathews, 2007). When answering the questions related to anxiety and cognitive decline participants may

have underreported their true anxiety symptoms for fear of stigma as well as possibly underreporting symptoms of cognitive decline for fear of possibly losing their independence, this can result in self-report bias.

Another limitation is the cross-sectional design of the study. Cross-sectional studies are used to examine snapshots in time with the outcome and exposures of the participants observed at the same point in time. With this study design, it is not possible to determine causality. According to Crosby (2015), taking data from the same time period limits the understanding of the temporal relationship between exposure and outcome. Using a longitudinal study design to measure sleep trouble and cognitive decline over a period of time would have allowed for several observations on the same participants. We surmise that overtime it is possible to see new developments, or changes to the observations taken, which may occur to establish causality.

Subsequently, the underrepresentation of elders may have been a study limitation. It is evident in the literature that cognitive decline and sleep trouble is much more prevalent among individuals 65 and older; however, in this study only 20% of participants were age 65 and older. In order to truly understand the relationship between sleep trouble and cognitive decline, as well as the effect age has on the relationship, future studies must have a greater representation of participants 65 and older.

Lastly, outside factors could have also influenced the results of the study and internal validity because these factors were not controlled for or held constant.

Extraneous variables not controlled for include chronic medical conditions, lower education, stressful life events, and neuroticism (Wolitzky-Taylor et al., 2010).

Future Directions

Future studies should continue to examine the relationship between sleep trouble and cognitive decline. Studies should ensure the sample has an even distribution of both age groups to better examine the distribution of the population under study and ensure the elder population is better represented. In addition, a longitudinal study may be needed to record the participants' sleeping patterns over an extended period of time and examine these patterns' relationship with cognitive functioning.

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