Risk Factors Associated with Poor Sleep Quality Among Older Adults

by

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Abstract

Aim: The aim of this paper is to explore possible risk factors affecting the quality of sleep among older adults in the US. Factors to be explored include cognitive function, physical function, depression, anxiety, quality of life, visual impairment, and demographics.

Background: Sleep is a complex bodily function that is essential to the overall health and well-being of humans. Previous studies show that sleep patterns in adults often change with age. These changes may lead to sleep disorders, such as insomnia. Because of the rapid increase in age in the US, researchers have begun to look closely at changes in health with age. This has resulted in an exponential increase in awareness and understanding of the causes and consequences of poor sleep among older adults. Existing research has found possible relationships between poor sleep quality and poor cognitive and physical function, high levels of depression and anxiety, and low quality of life. Poor sleep quality has also been found to be more common in individuals who are visually impaired and of female gender. Previous studies have examined these factors independently without comparing these relationships simultaneously. Additionally, this study assessed how interest in sleep interventions, such as Brief Behavioral Treatment for Insomnia (BBTI), may be related to one's sleep quality along with these other factors.

Methods: An exploratory study was conducted among 66 adults aged 55 and older in Pittsburgh, Pennsylvania to analyze sleep quality and possible risk factors. In-person and telephonic surveys were performed. Using the Pittsburgh Sleep Quality Index (PSQI), Late-Life

Function and Disability Instrument (LLFDI), Patient Health Questionnaire (PHQ-8), Generalized Anxiety Disorder Assessment (GAD-7), Memory Impairment Screen (MIS), EuroQol-5D (EQ-5D), and questions assessing for visual impairment, we compared sleep quality among older adults.

Results: Among this population, results indicate that poor sleepers were more likely to be female and have higher levels of depression, anxiety, and disability limitations compared to good sleepers.

Conclusion: These results are significant to public health because they contribute to the existing literature of how sleep may play a role in "successful" aging.

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1.0 Introduction

Sleep is an essential daily function that allows our body to recharge physically and mentally. While it is true that our sleep patterns change with age, the need for sleep remains just as vital. However, it is common for aging adults to struggle receiving 7-9 hours nightly. Researchers estimate that 40-70% of older adults experience chronic sleep problems, and nearly half of those cases are undiagnosed (Miner and Kryger, 2016).

While it is often overlooked as part of maintaining overall health, sleep is just as important as eating a nutritious diet and exercising regularly. Sleep is closely linked to several brain functions, including concentration, productivity, and cognition (MediLexicon International, 2019). Studies have also found that dysregulated sleep duration (too short or too long) is correlated with glucose regulation, blood pressure, and BMI, leading to a number of negative health outcomes, including diabetes, cardiovascular disease, and obesity (Peltzer and Phaswana-Mafuya, 2017).

1.1 Cognitive Functioning

In addition to supporting mental and physical health, research shows that sleep is associated with daytime functioning (Pacheco and Wright, 2022). Thus, how you sleep during the night plays a significant role in how you function during the day. A lack of sleep, or sleep deprivation, can poorly affect how you think, react, and respond to others. Research also shows that poor sleep is associated with executive dysfunction, which inhibits memory, planning, organization, emotional control, and impulse control (Unsal et al., 2021). Sleep deprivation significantly increases amyloid-beta plaque formation, which is associated with decreased cognitive function (Unsal et al., 2021). Amyloid-beta is a peptide that accumulates in the brain of aging adults and is hypothesized to be a cause of Alzheimer’s (Kang et al., 2009). In a study performed by Unsal et al. (2021), adults who experience poor sleep were more likely to score lower on a three-word recall test than adults who receive adequate sleep, which may reflect short term deficits in attention. as well as longer term cognitive effects.

1.2 Physical Functioning

Sleep also affects mobility, balance, and energy levels. Sleep disturbances, short sleep duration, and daytime sleepiness were found to increase the risk of falls in older adults (Unsel et al., 2021). Additionally, according to Chien and Chen (2015), subjective poor sleep quality was found to be associated with physical disability, which include ADLs (activities of daily living), social activities, leisure activities, and physical function. However, the mechanism underlying this relationship is not entirely clear.

1.3 Changes in Circadian Rhythm

The cause of various sleep problems among older adults is often multifactorial. It is possible that age-related changes in medical, social, physical, and psychological health impact sleep in late life (Lo and Lee, 2012). Adults often experience changes in their circadian rhythm, or their body’s sleep-wake cycle (Pecheco and Rehman, 2022). The circadian rhythm is controlled by various signals to the brain, such as lightness and darkness and temperature (Gulia and Kumar, 2018). As temperatures rise, the body wakes. As temperatures decline, the body produces a hormone called melatonin that is responsible for promoting sleep (Gulia and Kumar, 2018). This daily pattern is managed by the suprachiasmatic nucleus (SCN), which is located in the hypothalamus of the brain (Gulia and Kumar, 2018). The SCN is highly influenced by light, as it resides closely to optic nerves (Peters, 2021). In addition to managing the circadian rhythm, the SCN controls core body temperature, metabolism, and the release of hormones, such as cortisol and melatonin (Peters, 2021). However, our circadian rhythm gradually shifts with advance age, often causing sleep problems (Pecheco and Rehman, 2022). This is known as a "phase advance" and typically occurs around ages 60-65 (Pecheco and Rehman, 2022). This phase advance is often responsible for older adults becoming fatigued earlier in the evening and waking up earlier in the morning (Gulia and Kumar, 2018). As the circadian rhythm becomes more delicate with age, older adults are particularly sensitive to changes in their sleep schedule (Pecheco and Rehman, 2022). Variability in sleep times and wake times is especially detrimental to their physical and emotional functioning (Pecheco and Rehman, 2022).

According to their circadian rhythm, many older adults will naturally go to sleep between 7-8 p.m. and wake up between 3-4 a.m. (Pecheco and Rehman, 2022). While this provides a healthy eight hours of sleep, many adults fight the natural urge to go to sleep early while the SCN insists on waking up at the same time. This often results in disturbed sleep, leading to daytime fatigue (Pecheco and Rehman, 2022). Daytime naps are often used as a coping strategy to combat this fatigue. However, this decreases their need for sleep in the evening and can make sleeping at night even more difficult, thus continuing the cycle (Pecheco and Rehman, 2022). Older adults additionally spend less time in the REM (rapid eye movement) stage, or the deepest level of sleep

(Gulia and Kumar, 2018). Because non-REM sleep is the lightest sleep and least restful, it is common for older adults to wake up three to four times a night (Pecheco and Rehman, 2022). Common sleep problems include snoring, coughing, urinary urgency, and pain.

1.4 Sleep Disorders

Insomnia is the most common sleep disorder among adults over the age of 60 (U.S. Department of Health and Human Services, 2020). Individuals with insomnia have trouble falling asleep or remaining asleep. The National Institutes of Health (NIH) estimates that 20-30% of adults in the US suffer from symptoms of insomnia, but only 6% have received a diagnosis (NIH State-of-the-Science Conference Statement on manifestations and management of chronic insomnia in adults, 2005). The most popular and widely accepted evidence-based treatment for insomnia is Brief Behavioral Treatment for Insomnia (BBTI). BBTI consists of four treatment sessions in a medical setting. Treatment involves modifying waking behaviors in order to facilitate sleep onset, promote restorative sleep, and improve daytime alertness (Troxel et al., 2012). Sleep apnea is another common sleep disorder among adults, which causes pauses in breathing while asleep (U.S. Department of Health and Human Services, 2020). Between 13 and 32% of adults over the age of 65 experience sleep apnea (Glasser et al., 2011). Other sleep disorders include restless leg syndrome (RLS, 10% - 35%), periodic limb movement disorder (PLMD, 45%), and rapid eye movement sleep behavior disorder (RBD, 0.4% - 0.5%) (U.S. Department of Health and Human Services, 2020; Milligan and Chesson, 2002; Leng et al., 2016; Trotti, 2010).

1.5 Psychiatric Symptoms

In addition to the physical and emotional health outcomes of poor sleep, recent research has identified existing relationships between poor sleep and psychiatric symptoms, such as depression and anxiety. While research suggests that a relationship exists, its etiological relationship remains unclear but suggests a bi-directional relationship (Guan et al., 2020; Alvaro et al., 2013). According to Nutt et al. (2008), over three-quarters of depressed patients have sleep problems. This may be caused by the suppression of melatonin, which interferes with the body's circadian rhythm (Guan et al., 2020; Mahmood et al., 2016). Additionally, Guan et al. (2020) states that individuals who suffer from chronic insomnia are at higher risk for developing depression, as it disrupts the balance of the stress response system in our brain. However, other studies show conflicting results, suggesting that more research needs to be done on this relationship. Similarly, research suggests that anxiety can cause sleep problems, but sleep deprivation also puts individuals at higher risk of developing an anxiety disorder (Sleep Disorders, n.d.).

1.6 Visual Impairment

Another factor that deserves attention is the relationship between sleep and visual impairment. As previously mentioned, the SCN is very sensitive to light because of its location near the optic nerve (Peters, 2021). Thus, our body senses, through the signal of light, when to produce melatonin (Peters, 2021). Without this signal, the SCN will not release melatonin, the hormone that enables the body to sleep. Therefore, individuals without light perception often experience "continual circadian desynchrony," as a result of the light's inability to penetrate the

SCN (Lockley et al., 2013). Circadian desynchrony, or misalignment of the circadian clock, is often experienced through jet lag (Lockley et al., 2013). However, unlike jet lag, individuals without light perception can experience this continuously. This can result in excessive daytime sleepiness, insomnia, and fatigue (Lockley et al., 2013). While studies have shown that circadian desynchrony occurs most often in blind individuals without light perception, few studies have examined possible sleep problems among visually impaired individuals with light perception (Lockley et al., 2013).

1.7 Sex and Gender Differences

Multiple studies have also found that differences in sex and gender may be a cause of variations in sleep quality (Tang et al., 2017; Mong and Cusmano, 2016). According to Mong and Cusmano (2016), females are twice as likely to experience sleep problems and insomnia in their lifetime than males. In a population-based study conducted in China, females scored significantly higher on the Pittsburgh Sleep Quality Index than males, indicating poorer sleep (Tang et al., 2017). Clinical research suggests that variance in poor sleep quality may be due to sex steroids (Mong and Cusmano, 2016).

1.8 Purpose

With the US population rapidly increasing in age, so too will the prevalence of sleep problems. By 2030, 1 in 5 people living in the US will be over the age of 65 (Miner and Kryger, 2016). With this rapid demographic change, researchers and healthcare professionals have begun studying sleep disorders among older adults more closely. This has resulted in an exponential increase in awareness and understanding of the causes and consequences of poor sleep in older adults (Lo and Lee, 2012).

While there is an increasingly large number of studies on the topic of sleep among older adults, few have expanded its research to examine its relationship to depression, anxiety, function and disability, memory, visual impairment, and quality of life. Previous studies have examined these factors independently without comparing the relationships simultaneously. Additionally, no studies, to our knowledge, have examined how sleep quality, along with these other factors, affect interest in BBTI. Therefore, we conducted a study in Pittsburgh, Pennsylvania among adults aged 55 and older to explore these relationships. The purpose of this research is to determine how these factors interact with each other—most importantly, how does sleep play a role in psychiatric symptoms, function and disability, memory, visual impairment, and quality of life? Additionally, we will assess if participants are interested in BBTI. If there is a large number of participants interested, there is a possibility of being able to deliver the intervention in the future. We will also assess if participants who experience poor sleep quality are more likely to be interested in the intervention. We hypothesize that self-reported poor sleep quality is associated with 1) higher levels of depression and anxiety, 2) poorer memory, 3) visual impairment, and 4) greater disability and lower quality of life.

Note: Daniel J. Buysse (2014) defines "sleep health" as:

> A multidimensional pattern of sleep wakefulness, adapted to individual, social, and environmental demands, that promotes physical and mental well-being. Good sleep health is characterized

> by subjective satisfaction, appropriate timing, adequate duration, high efficiency, and sustained alertness during waking hours.

While this paper only measures one aspect of sleep health, subjective satisfaction, future studies should look into the other four components of sleep health.

2.0 Materials and Methods

2.1 Participants

A cross-sectional study was conducted in Pittsburgh, Pennsylvania involving 66 older adults. Inclusion criteria included individuals over the age of 55 who speak English. Exclusion criteria included those who had a hearing disability that precluded their ability to answer the survey questions or those with severe dementia. The University of Pittsburgh Human Research Protections Office approved the research protocol.

2.2 Sites and Procedure

Participants were recruited from two locations. The first sample was gathered from Moorhead Towers, a low-income independent living high-rise located in Pittsburgh, Pennsylvania with primarily senior and disabled residents. The research team had established a relationship with Beacon Communities, which include Moorhead Towers, and had agreed upon strategies for gathering participants for the study. Moorhead Towers was specifically chosen because late-night wakefulness among senior residents had previously been reported by those who observe the security cameras. Additionally, we were informed that Moorhead Towers had a large population of visually impaired residents.

An information session regarding the details of the study was presented to interested residents at Moorhead Towers on July 12, 2021. The information session included a short video detailing the importance of sleep, along with the purpose of the study and sign-up instructions. A short Q and A was provided after the presentation. In order to sign up for the study, residents were instructed to fill out a slip of paper, which asked for their name and phone number. Residents then inserted the sign-up slip in a one-way box, which was accessible only to the primary investigator. Attendees of the information session were provided with business cards including the primary investigator's contact information, as well as an informational brochure. These brochures were also delivered to each resident's apartment following the information session. Additional advertising of the study was done through verbal announcements in the residential building, posters, and an insert in the monthly newsletter. Finally, a copy of the study description printed in braille was provided onsite for those that were severely visually impaired.

The primary investigator was onsite approximately eight hours a week from July 12, 2021 to August 26, 2021. Interested residents provided verbal consent to participate in the survey after being read an introductory script describing the study. The survey was read by the primary investigator and lasted approximately 30 minutes. Of the 66 participants, 13 were from Moorhead Towers.

The remaining 53 participants were recruited from the Pittsburgh Claude D. Pepper Older Americans Independence Center research registry (known as the Pepper Registry hereafter). The Pepper Registry includes over 2,200 adults over the age of 60 that live independently in the Pittsburgh area. Individuals on this registry have agreed to participate in research studies regarding aging, balance, and mobility (Pittsburgh Pepper Center - University of Pittsburgh, n.d.). Between September 2, 2021 through October 19, 2021, 193 individuals were called. Voicemails were left to those that did not answer. Among the 193 individuals, 55 had agreed to participate in the survey, averaging approximately a 27.5% acceptance rate. Participants provided verbal consent to completing the survey over the phone after being read an introductory script, describing the study. The survey was read by the primary investigator and lasted approximately 30 minutes.

2.3 Measures

Data collected through the survey was inputted in Qualtrics XM. The survey assessed eight criteria: sleep quality, vision, function and disability, depression, anxiety, memory, quality of life, and demographic information.

2.3.1 Sleep Quality

Sleep quality was measured through the Pittsburgh Sleep Quality Index (PSQI). The PSQI contains 19 self-rated questions and five questions rated by a bed partner or roommate if applicable. However, only questions one through five were gathered for data, and only question five was used to calculate overall sleep score. This is because question five is applicable to everyone, multidimensional, and a tractable data reduction strategy for the PSQI. Question five includes 10 parts, which assesses sleep latency and sleep disturbances. Possible answers include, “Not during the past month,” “Less than once a week,” “Once or twice a week,” or “Three or more times a week.” Our scale ranges from 0 to 30 points with each answer valuing 0, 1, 2, or 3 points, respectively. High scores indicate poor sleep quality. Table 1 shows our modified PSQI scale.

We additionally measured if participants were interested in a future intervention that may help improve their sleep quality, such as BBTI. This was assessed through the question, “People may improve the quality of their sleep by altering their behavior, for example, by changing the time for going to sleep and getting up. Would you be interested in trying such a program if it were offered to you?"

Table 1 Modified PSQI Scoring

Overall Score	Response
0	"Very good"
1-10	"Fairly good"
11-20	"Fairy bad"
21-30	"Very bad"

2.3.2 Vision

Vision was measured through three questions: "Do you wear glasses or contacts to see things close up?", "In the last month, did you use other vision aids such as a magnifying glass to help you see things close up?" and "If you use glasses or contacts, do you see well enough to read newspaper print?" These questions were taken from the National Health and Aging Trends Survey. The last question was used to assess if visual impairment was present.

2.3.3 Function and Disability

Function and disability were measured using the Late-Life Function and Disability Instrument (LLFDI). Functional limitations include a person's inability to do certain actions or activities, while disability refers to "a person's performance of socially defined life tasks expected of an individual within a typical sociocultural and physical environment" (Jette et al., n.d.). This part of the survey is split into two sections: one which assesses frequency of an activity and another which assesses limitation while performing this activity. Each section asks 16 questions, making a total of 32 questions for the LLFDI. The frequency section offers the options: “very often,” “often,” “once in a while,” “almost never,” or “never,” each scored 5, 4, 3, 2, and 1 point, respectively. The limitation section offers the options, “not at all,” “a little,” “somewhat,” “a lot,” or “completely,” each again scored 5, 4, 3, 2, and 1 point, respectively. Therefore, the lowest score for each section is 16 points, while the highest score is 80 points. Low scores indicate low functionality, while high scores indicate high functionality.

2.3.4 Depression

Depression was measured using the Patient Health Questionnaire Depression Scale (PHQ-8). This eight-item instrument is used to assess the presence of depression in the last two weeks. Options include, “not at all,” “several days,” “more than half the days,” or “nearly every day,” each scored 0, 1, 2, and 3 points, respectively. The highest possible score is 24, and the lowest possible score is 0. A score of 10 or greater indicates major depressive disorder, while 20 or greater indicates severe major depressive disorder (Kroenke et al., 2009). These scores were analyzed as continuous variables.

2.3.5 Anxiety

Anxiety was measured using the Generalized Anxiety Disorder Assessment (GAD-7). This seven-item instrument is used to assess the presence of anxiety in the last two weeks. Similar to the PHQ-8, options include, “not at all,” “several days,” “more than half the days,” or “nearly every day,” each scored 0, 1, 2, and 3 points, respectively. The highest possible score is 21, and the lowest possible score is 0. Scores 0-4 indicate minimal anxiety, 5-9 indicate mild anxiety, 10-

14 indicate moderate anxiety, and 15-21 indicate severe anxiety (GAD-7 Anxiety, n.d.). These scores were analyzed as continuous variables.

2.3.6 Memory

Memory was assessed using the Memory Impairment Screen (MIS). Each participant is given four words to repeat. With each word, they are additionally given a categorical clue to remember the given word. For instance, they are asked to repeat two words: checkers and toothbrush. Then, they are asked, “Which of those is a game?” and “Which of those is a personal hygiene product?” The process is repeated. The participant is told to keep the four given words in mind while they move on to the next survey section. Approximately two minutes later, they are asked to repeat the four words. Two points are given for recalling each word alone, one point if they can recall given the categorical clue, and zero points if they cannot recall the word alone or with the clue. A score of 5-8 points indicate no cognitive impairment, while a score of 4 and below indicates possible cognitive impairment.

2.3.7 Quality of Life

Quality of life was assessed using the EQ-5D-3L, or EuroQOL. This assessment is divided into two parts: the EQ-5D description system and the EQ Visual Analogue Scale (EQ VAS). The description system evaluates five criteria: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has three levels: “no problems,” “some problems,” or “extreme problems,” which are scored 1, 2, and 3 points, respectively. The final score is produced by combining the values to create a 5-digit profile. For example, the best possible score is “11111,” while the worst possible score is "33333." This 5-digit profile represents the participant's health and quality of life. The second part of EQ-5D, the Visual Analogue Scale (VAS), includes a self-rated scale that represents the individual's perceived health state. The scale ranges from 0 to 100 with 0 being the worst imaginable health state and 100 being the best possible health state (EQ-5D, n.d.).

2.3.8 Demographics

The final section of the survey asks nine demographic questions, including age, gender, race, ethnicity, disability status, work status, marriage status, roommate status, and education level.

2.4 Sample Size Calculation

The original purpose of this research was to compare sleep quality between visually impaired seniors and non-visually impaired seniors. However, because of the small sample, we were unable to collect a significant number of visually impaired participants. Thus, we instead conducted an exploratory analysis of sleep quality and how it relates to the aforementioned factors, where 66 participants were gathered.

3.0 Data Analysis

After data was collected in Qualtrics XM, it was inputted to Excel (version 2111). Data management and analysis were carried out in STATA/SE 16.0. Analytic tests include Pearson's Correlation Coefficient, one-way ANOVA, T-tests, and Chi-squared tests. Pearson's Correlation Coefficient was used in order to calculate the strength and direction of association between two continuous variables—including scores from the PSQI, MIS, GAD-7, LLFDI, and PHQ-8. One-way ANOVA was used to calculate the means of continuous variables among groups with three or more categories. For example, the means of the PSQI, MIS, GAD-7, LLFDI (frequency), LLFDI (limitation), PHQ-8, and age were calculated among the groups that 1) are interested in the intervention, 2) are not interested in the intervention, and 3) feel they do not need the intervention. T-tests were used to calculate the means of continuous variables among two categorical groups. The two categorical groups that were compared describe sleep quality: "good" and "poor." To define sleep quality, we dichotomized the distribution at the mean. "Good" sleep was defined as a score of 0 to 6 points on the PSQI, while "poor" sleep was defined as scoring 7 or more points. Chi-squared tests were used to compare the relationships between two categorical variables, such as race and interest in BBTI. A 95% confidence interval was used for all tests. Therefore, all results with a p-value less than 0.05 were considered significant.

4.0 Results

Table 2 shows the descriptive characteristics of the sample population. Among 66 total participants, 13 (19.7%) were recruited from Moorhead Towers, while 53 (80.3%) were recruited from the Pepper Registry. The mean age of the participants was 70.8 (+/-7.1) years. Most participants were female (74.2%), White (81.8%), non-Hispanic or Latino (98.4%), not disabled (74.2%), unemployed or retired (74.2%), non-visually impaired (94.0%), and received a high school education (94.0%).

Table 2 Total Sample Demographics

Total Sample	N = 66		
Location		**Marriage Status**	
Pepper Registry	80.3%	Married	40.9%
Moorhead Towers	19.7%	Never Married	22.7%
Age		Divorced	22.7%
Mean (sd)	70.8 (7.1)	Separated	1.5%
Gender		Widowed	12.1%
Female	74.2%	**Roommates**	
Male	25.8%	Yes	44.0%
Race		No	56.0%
White	81.8%	**Education**	
Black	16.7%	High School or Above	94.0%
Asian	1.5%	Less than High School	6.0%
Ethnicity		**Been to hospital in last 6 months**	
Hispanic or Latino	1.6%	Yes	71.2%
Non-Hispanic or Latino	98.4%	No	28.8%
Disability Status		**Visual impairment even with corrective lenses**	
Disabled	25.8%	Yes	6.0%
Not Disabled	74.2%	No	94.0%
Employment Status		**Interested in sleep intervention**	
Full-time	6.0%	Yes	31.8%
Part-time	19.7%	No	68.2%
Unemployed or Retired	74.2%		

Table 3 shows the characteristics of the 13 participants from Moorhead Towers. Of these 13 participants, the mean age was 67.7 (+/-10.6) years. The majority of the participants were female (69.2%), non-Hispanic or Latino (100.0%), disabled (92.3%), unemployed or retired (92.3%), non-visually impaired (76.9%), and received a high school education (76.9%). Approximately half of the sample was White, and half of the sample was Black.

Table 3 Moorhead Towers Demographics

Moorhead Towers	n = 13	**Marriage Status**	
Age		Married	7.7%
Mean (sd)	67.7 (10.6)	Never Married	53.8%
Gender		Divorced	15.4%
Female	69.2%	Separated	7.7%
Male	30.8%	Widowed	15.4%
Race		**Roommates**	
White	46.2%	Yes	0.0%
Black	46.2%	No	100.0%
Asian	7.7%	**Education**	
Ethnicity		High School or Above	76.9%
Hispanic or Latino	0.0%	Less than High School	23.1%
Non-Hispanic or Latino	100.0%	**Been to hospital in last 6 months**	
Disability Status		Yes	46.2%
Disabled	92.3%	No	53.8%
Not Disabled	7.7%	**Visual impairment even with corrective lenses**	
Employment Status		Yes	23.1%
Full-time	0.0%	No	76.9%
Part-time	7.7%	**Interested in sleep intervention**	
Unemployed or Retired	92.3%	Yes	46.1%
		No	53.8%

Table 4 shows the characteristics of the 53 participants from the Pepper Registry. Of these 53 participants, the mean age was 71.6 (+/-5.9) years. The majority of the participants were female (75.5%), White (90.6%), non-Hispanic or Latino (98.1%), not disabled (90.6%), unemployed or retired (69.8%), non-visually impaired (98.1), and received a high school education (100.0%).

Table 4 Pepper Registry Demographics

Pepper Registry	n = 53	**Marriage Status**	
Age		Married	49.1%
Mean (sd)	71.6 (5.9)	Never Married	15.1%
Gender		Divorced	24.5%
Female	75.5%	Separated	0.0%
Male	24.5%	Widowed	11.3%
Race		**Roommates**	
White	90.6%	Yes	54.7%
Black	9.4%	No	45.3%
Ethnicity		**Education**	
Hispanic or Latino	1.9%	High School or Above	100.0%
Non-Hispanic or Latino	98.1%	Less than High School	0.0%
Disability Status		**Been to hospital in last 6 months**	
Disabled	9.4%	Yes	24.5%
Not Disabled	90.6%	No	75.5%
Employment Status		**Visual impairment even with corrective lenses**	
Full-time	7.5%	Yes	1.9%
Part-time	22.6%	No	98.1%
Unemployed or Retired	69.8%	**Interested in sleep intervention**	
		Yes	28.3%
		No	71.7%

Table 5 shows the mean and standard deviation for each continuous variable, including sleep quality (PSQI), function and disability (LLFDI), depression (PHQ-8), anxiety (GAD-7), memory (MIS), and quality of life (EQ-5D). The scale we used for the PSQI ranges from 0 to 30. The mean among the total population is 7.5 +/- 4.4. According to our modified PSQI scale, this average fits in the "fairly good" group. The mean score of the LLFDI-Frequency is 56.9 +/- 8.8, and the mean score of the LLFDI-Limitation is 67.4 +/- 11.2. Therefore, both scores fall above the 50th percentile. The mean score for the PHQ-8 is 4.1 +/- 3.2, which indicates low levels of depression in the sample. The mean score for the GAD-7 is 2.6 +/- 2.9, which indicates the overall sample expresses minimal anxiety. The mean MIS score from our sample is 7.2 +/- 1.6. This score indicates that our overall sample population shows minimal cognitive impairment. Because the EQ-5D's final score is produced by combining digits to create a 5-digit number, we calculated the percentage of individuals with a "perfect" score and the percentage of individuals reporting "extreme problems" at least once. Among the sample, 19.7% have a perfect score and indicate zero problems, while 6.1% indicate extreme problems in at least one area. Finally, the VAS, which is self-ranked 0 to 100, has a mean of 79.3 +/- 15.7.

Table 5 Continuous Variables

Total Sample	**Mean (sd)** **N = 66**
PSQI	7.5 (4.4)
Disability (LLFDI)	
Frequency	56.9 (8.8)
Limitation	67.4 (11.2)
PHQ-8	4.1 (3.2)
GAD-7	2.6 (2.9)
MIS	7.2 (1.6)
EQ-5D	
% w/ perfect 11111	19.7%
% w/ at least one "3"	6.1%
VAS	70.85

Table 6 shows the correlations between two continuous variables. There are small positive correlations between GAD-7 and PSQI, LLFDI-Frequency and MIS, PHQ-8 and PSQI, PHQ-8 and GAD-7, LLFDI-Limitation and LLFDI-Frequency, EQ-5D (VAS) and MIS, EQ-5D (VAS) and LLFDI-Frequency, and EQ-5D (VAS) and LLFDI-Limitation. There are small negative correlations between the LLFDI-Limitation and PSQI, LLFDI-Limitation and GAD-7, PHQ-8 and LLFDI-Limitation, EQ-5D (VAS) and GAD-7, and EQ-5D (VAS) and PHQ-8. All other relationships were found to be non-significant.

Table 6 Correlations Between Continuous Variables

	PSQI		MIS		GAD-7		LLFDI (Frequency)		LLFDI (Limitation)		PHQ-8	
	r	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
MIS	0.05	0.70										
GAD-7	**0.42****	**0.00**	0.02	0.89								
LLFDI (Frequency)	-0.18	0.16	**0.27***	**0.03**	-0.12	0.36						
LLFDI (Limitation)	**-0.33****	**0.00**	0.11	0.38	**-0.36****	**0.00**	**0.40****	**0.00**				
PHQ-8	**0.50****	**0.00**	0.05	0.67	**0.59****	**0.00**	-0.21	0.10	**-0.34****	**0.01**		
EQ-5D (VAS)	-0.22	0.07	**0.50****	**0.00**	**-0.26***	**0.04**	**0.43****	**0.00**	**0.42****	**0.00**	**-0.26***	**0.04**

*** </= 0.05   ** </= 0.01**

We also asked if participants were interested in a sleep intervention, such as BBTI. Table 7 describes the various test scores and demographic characteristics among those who 1.) do not have sleep problems, and therefore do not need the intervention, 2.) are not interested in the intervention, and 3.) are interested in the intervention. According to the data, those who are interested in intervention include 46.2% of participants from Moorhead Towers, 28.3% from the Pepper registry, 47.1% of males, 26.5% of females, 32.7% of unemployed, 29.4% of employed, 42.1% of those who have been to hospital in past 6 months, 27.7% of those who have not been to the hospital in the past 6 months, 100% of those who did not graduate high school, 28.6% who did graduate high school, 41.2% who are disabled, and 28.6% who are not disabled. Therefore, those who are interested in the intervention are more likely to be from Moorhead Towers, male, unemployed, been to the hospital in the last 6 months, not graduated from high school, and disabled. However, among these characteristics, only high school graduation and disability status falls into our 95% confidence interval. Additionally, the PSQI, GAD-7, and PHQ-8 scores are significantly correlated with interest in intervention. Individuals who are not interested in the sleep intervention reported worse sleep compared to individuals who are interested in the intervention. Both groups have significantly worse sleep scores than individuals who perceived no sleep problems and therefore do not need the intervention. Additionally, those not interested in the intervention have significantly higher levels of anxiety in the GAD-7 than the other two groups. Finally, individuals indicating lower levels of depression were significantly more likely to say they do not have a sleep problem and do not need the intervention.

Table 7 Test Scores and Demographics According to Interest in Intervention

	Interested in Sleep Intervention		
	Don’t have sleep problems/ Don’t need it (n = 28)	**No (n = 17)**	**Yes (n = 21)**
PSQI, mean (sd)**	5.04 (3.73)	9.65 (4.30)	8.90 (3.96)
MIS, mean (sd)	7.29 (1.21)	7.41 (0.94)	6.81 (2.42)
GAD-7, mean (sd)*	1.75 (2.50)	4.06 (3.34)	2.70 (2.68)
LLFDI (frequency), mean (sd)	58.63 (8.16)	55.06 (10.93)	56.21 (7.61)
LLFDI (limitation), mean (sd)	70.71 (11.04)	64.81 (11.01)	64.58 (10.85)
PHQ-8, mean (sd)**	2.36 (1.91)	5.75 (2.86)	5.05 (3.85)
Age (years), mean (sd)	70.07 (5.15)	71.29 (9.57)	71.52 (7.38)
% Non-White	33.3	33.3	33.3
% from Moorhead Towers	15.4	38.5	46.2
% from Pepper Registry	49.1	22.6	28.3
% Male	41.2	11.8	47.1
% Female	42.9	30.6	26.5
% Employed (Full-time or Part-time)	52.9	17.6	29.4
% Unemployed	38.8	28.6	32.7
% Been to hospital in last 6 months	31.6	26.3	42.1
% NOT been to hospital in last 6 months	46.8	25.5	27.7
% Graduated High School*	44.4	27.0	28.6
% NOT Graduated High School*	0	0	100.0
% Disabled**	11.8	47.1	41.2
% Not Disabled**	53.1	18.4	28.6
% Visually Impaired (even with corrective lenses)	25.0	25.0	50.0
% w/ Perfect EQ5D score	64.29	7.14	28.57
% w/ at least one “3” in EQ5D score	40.0	40.0	20.0

*** </= 0.05   ** </= 0.01**

Table 8 shows the test scores and demographic characteristics among the total population split into two categories: “good” sleepers and “poor” sleepers. As previously described, “good” sleepers are defined as having a PSQI score 0 to 6, and “poor” sleepers are defined as having a PSQI score 7 and above. While slight differences between the groups exist in the table below, the only significant factor to note of is gender. According to our data, 70.6% of males and 38.8% of females qualify as “good” sleepers. Conversely, 29.4% of males and 61.2% of females qualify as “poor” sleepers. Therefore, the data suggests that females are nearly twice as likely to report a sleep score of 7 and above, indicating females have poorer sleep.

Table 8 Test Scores and Demographics According to Sleep Quality

	Sleep Quality	
	Good (0-6) (n = 31)	**Poor (7+) (n = 35)**
MIS, mean (sd)	7.23 (1.28)	7.11 (1.92)
GAD-7, mean (sd)	2.07 (2.42)	3.14 (3.22)
LLFDI (frequency), mean (sd)	56.37 (8.39)	57.45 (9.30)
LLFDI (limitation), mean (sd)	68.69 (11.17)	66.24 (11.29)
PHQ-8, mean (sd)	3.39 (3.12)	4.68 (3.24)
Age (years), mean (sd)	71.77 (5.63)	70.03 (8.22)
% Non-White	58.3	41.7
% from Moorhead Towers	38.5	61.5
% from Pepper Registry	49.1	50.9
% Male*	70.6	29.4
% Female*	38.8	61.2
% Employed (Full-time or Part-time)	47.1	52.9
% Unemployed	46.9	53.1
% Been to hospital in last 6 months	47.4	52.6
% NOT been to hospital in last 6 months	46.8	53.2
% Graduated High School	46.0	54.0
% NOT Graduated High School	50.0	50.0
% Disabled	41.2	58.8
% NOT Disabled	49.0	51.0
% Visually Disabled (even with corrective lenses)	25.0	75.0
% w/ Perfect EQ5D score*	71.43	28.57
% w/ at least one "3" in EQ5D score	40.0	60.0

*** </= 0.05 ** </= 0.01**

Table 9 and Figure 1 compare the characteristics of “good” versus “poor” sleepers in order to assess clinical difference in sleep quality. Among the full sample of 66 participants, 31 (47.0%) reported “good” sleep (PSQI score of 0-6) and 35 (53.0%) reported “poor” sleep (PSQI score 7+). In the group of 31 participants that reported “good” sleep, 19 (61.3%) reported no sleep problem/no need for intervention, 5 (16.1%) reported no interest in intervention, and 7 (22.5%) reported interest in intervention. In the group of 35 participants that reported “poor” sleep, 9 (25.7%) reported no sleep problem/no need for intervention, 12 (34.3%) reported no interest in intervention, and 14 (40.0%) reported interest in intervention. From these figures, we can see that there are slightly more participants reporting “poor” sleep than “good” sleep. “Good” sleepers are more likely to report that they do not have any sleep issues and do not need the intervention (61.3%), and “poor” sleepers are more likely to report a sleep problem (74.3%). For both groups that report a sleep problem, participants are more likely to be interested in intervention.

Table 9 Sleep Quality According to Interest in Intervention

	Interested in Sleep Intervention			
	Don’t have sleep problems / Don’t need it	**No**	**Yes**	**Total**
Good (0-6)	19	5	7	31
Poor (7+)	9	12	14	35
				66

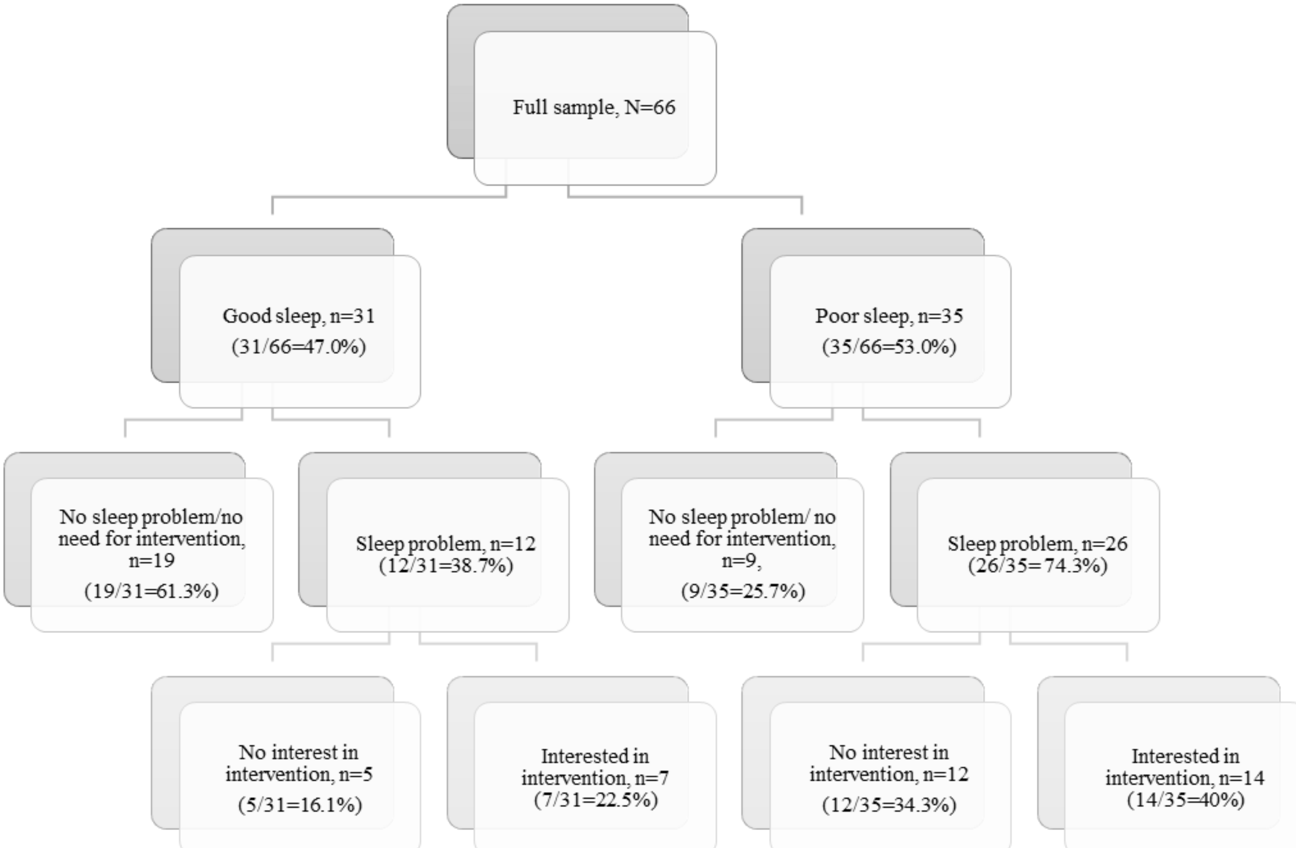

Figure 1 Interest in Sleep Intervention According to Sleep Quality

Table 10 looks exclusively at the "poor" sleepers (PSQI score of 7+) that admit a sleep problem. Among this group of 26 individuals, 12 participants are not interested in intervention, and 14 participants are interested in intervention. After comparing the characteristics of both groups, the only significant factor is gender. Among the males that qualified as having "poor" sleep, 100% of them were interested in intervention. Among the females that qualified as having "poor" sleep, 45.45% of them were not interested in intervention and 54.55% were interested in intervention. Therefore, the data shows that females are more likely than males to experience poor sleep, but less likely to be interested in intervention.

Table 10 Test Scores and Demographics Among "Poor" Sleepers that Admit a Sleep Problem

	Interested in Intervention	
	No (n = 12)	**Yes (n = 14)**
PSQI, mean (sd)	11.33 (4.03)	10.79 (3.47)
MIS, mean (sd)	7.33 (0.98)	6.57 (2.85)
GAD-7, mean (sd)	4.08 (3.73)	2.93 (2.95)
LLFDI (frequency), mean (sd)	54.92 (12.75)	56.67 (6.41)
LLFDI (limitation), mean (sd)	63.42 (12.39)	65.15 (12.08)
PHQ-8, mean (sd)	5.85 (2.94)	4.71 (3.77)
Age (years), mean (sd)	69.42 (9.72)	71.71 (8.83)
% Non-White	40.0	60.0
% from Moorhead Towers	50.0	50.0
% from Pepper Registry	44.44	55.56
% Male*	0	100.0
% Female*	54.55	45.45
% Employed (Full-time or Part-time)	50.0	50.0
% Unemployed	45.0	55.0
% Been to hospital in last 6 months	37.50	62.50
% NOT been to hospital in last 6 months	50.0	50.0
% Graduated High School	48.0	52.0
% NOT Graduated High School	0	100.0
% Disabled	50.0	50.0
% Not Disabled	43.75	56.25
% Visually Impaired (even with corrective lenses)	50.0	50.0
% w/ Perfect EQ5D score	50.0	50.0
% w/ at least one “3” in EQ5D	66.67	33.33

*** </= 0.05 **</= 0.01**

Figure 2 is a scatterplot to show the relationship between sleep quality (PSQI sum) and depression (PHQ-8 sum). As shown in Table 6, there is a significant positive relationship of 0.50 between sleep and depression. Therefore, as PSQI scores increase, PHQ-8 scores increase. However, the same results were not illustrated in Table 8 when the group was dichotomized by "good" sleepers and "poor" sleepers. By examining the scatterplot, we can see a general positive correlation between these two factors. However, we also see some extreme results, indicating that our calculations were likely skewed by outliers. As the graph shows, those with very high PSQI scores also report very high levels of depression. On the contrary, those with very low PSQI scores also report very low levels of depression. Most participants, however, fall somewhere in the middle, where we can see a slight positive trend.

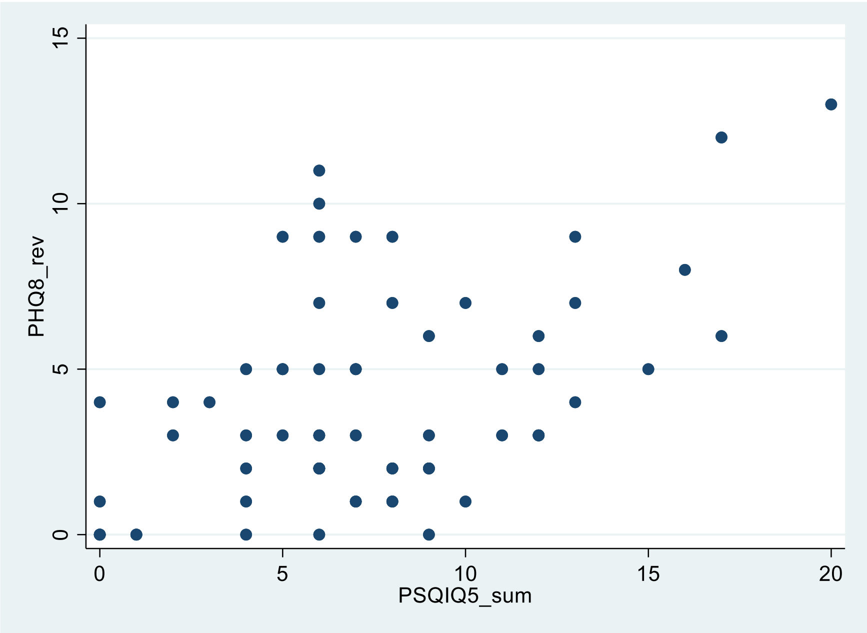

Figure 2 Correlation Between Sleep Quality and Depression

Figure 3 is a scatterplot to show the relationship between sleep quality (PSQI sum) and anxiety (GAD-7 sum). Similar to the relationship explained above, these two measures show a significant positive relationship of 0.42 in Table 6. As anxiety scores increase, PSQI scores increase—indicating that higher anxiety is related to poorer sleep quality. However, when we dichotomize the participants into "good" sleepers and "poor" sleepers, we no longer have a significant relationship between sleep quality and anxiety. The scatterplot shows a slight positive trend between these two factors. Individuals with very low PSQI scores tend to report low anxiety levels, while individuals with very high PSQI scores tend to report high anxiety levels. This positive relationship, however, is likely impacted by the outliers, as mentioned in Figure 2.

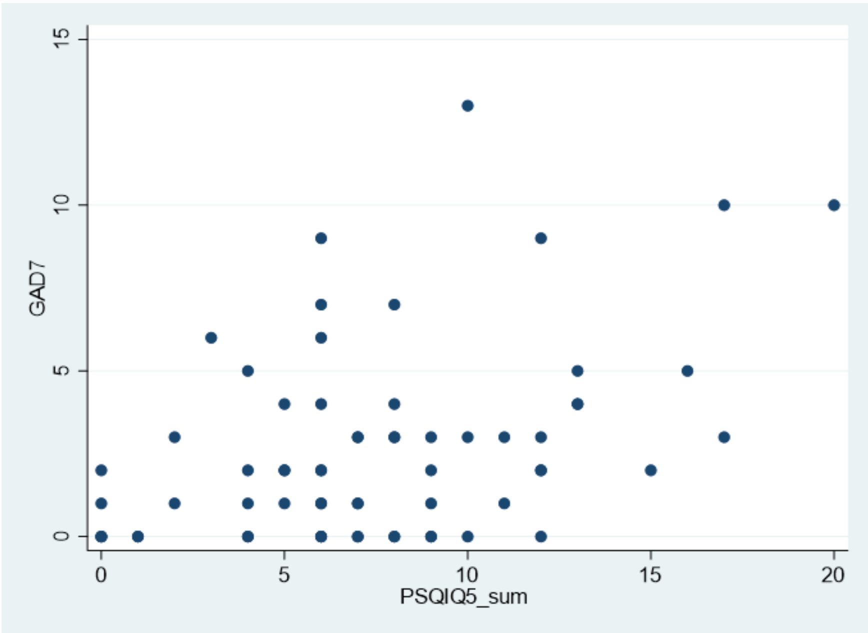

Figure 3 Correlation Between Sleep Quality and Anxiety

Figure 4 is a scatterplot to show the relationship between sleep quality (PSQI sum) and disability limitations (LLFDI limitation sum). Table 6 indicates a significant negative relationship between these two factors. Therefore, as PSQI scores increase, disability limitation scores decrease—indicating that poorer sleep quality is related to greater disability limitations. When the sample is dichotomized into “good” sleepers and “poor” sleepers, we no longer see a significant relationship between sleep quality and disability limitations. Unlike Figure 2 and Figure 3, the scatterplot shows a slight negative trend between these two factors. Participants with very low PSQI scores report very high levels of disability limitations, while participants with very high PSQI scores report lower levels of disability limitations. The significant relationship indicated in Table 6 is likely explained by these outliers. However, most participants fall somewhere in the middle.

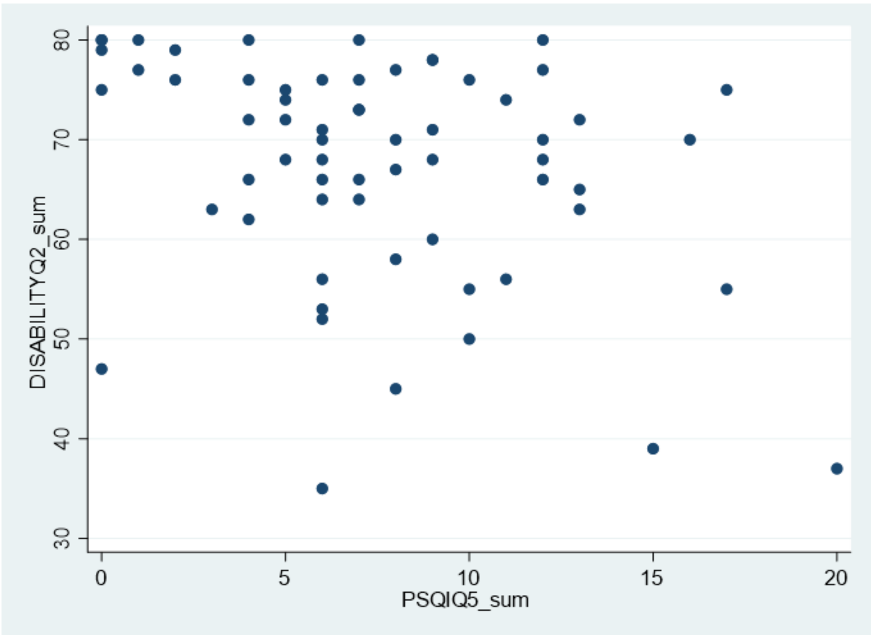

Figure 4 Correlation Between Sleep Quality and Disability Limitations

As mentioned earlier, Table 6 shows correlations between sleep and depression, anxiety, and disability limitation scores. Figure 5 shows a regression model, indicating the relationship between sleep (PSQI score) and depression (PHQ-8 score) while controlling for gender and location of residence. These covariates were chosen because they are important social determinants. When these two factors are accounted for, we can still see a significant relationship of 0.34 between sleep and depression scores. The same regression analysis is performed in Figure 6 for anxiety scores and Figure 7 for disability limitation scores. Sleep and anxiety scores are still significantly positively correlated at 0.25, and sleep and disability limitation scores are significantly negatively correlated at -0.79. Therefore, as depression, anxiety, and limitations in disability increase, sleep quality decreases.

```
. regress PHQ8_rev PSQIQ5_sum  DEMQ2_r Location_r
```

Source	SS	df	MS			
				Number of obs	=	65
				F(3, 61)	=	7.95
Model	187.10829	3	62.36943	Prob > F	=	0.0001
Residual	478.645556	61	7.84664846	R-squared	=	0.2810
				Adj R-squared	=	0.2457
Total	665.753846	64	10.4024038	Root MSE	=	2.8012

PHQ8_rev	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PSQIQ5_sum	.3383196	.0833688	4.06	0.000	.1716133	.5050258
DEMQ2_r	.4195026	.814357	0.52	0.608	-1.208905	2.04791
Location_r	-1.404873	.9002859	-1.56	0.124	-3.205106	.3953599
_cons	3.552321	2.316123	1.53	0.130	-1.079053	8.183696

Figure 5 Correlation Between Sleep Quality and Depression, Controlling for Gender and Location

```
. regress GAD7 PSQIQ5_sum  DEMQ2_r Location_r

      Source |       SS           df       MS      Number of obs   =        65
-------------+----------------------------------   F(3, 61)        =      5.12
       Model |  108.745679         3  36.2485596   Prob > F        =    0.0032
    Residual |   432.11586        61  7.08386655   R-squared       =    0.2011
-------------+----------------------------------   Adj R-squared   =    0.1618
       Total |  540.861538        64  8.45096154   Root MSE        =    2.6616

------------------------------------------------------------------------------
        GAD7 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  PSQIQ5_sum |   .2510664   .0791377     3.17   0.002     .0928208    .4093119
     DEMQ2_r |   .0244625   .7862308     0.03   0.975    -1.547703    1.596628
  Location_r |  -1.139098   .8812932    -1.29   0.201    -2.901353    .6231562
       _cons |   2.806368   2.219383     1.26   0.211    -1.631563    7.244299
```

Figure 6 Correlation Between Sleep Quality and Anxiety, Controlling for Gender and Location

```
regress DISABILITYQ2_sum PSQIQ5_sum  DEMQ2_r Location_r

      Source |       SS           df       MS      Number of obs   =        63
-------------+----------------------------------   F(3, 59)        =      4.87
       Model |  1546.07264         3  515.357545   Prob > F        =    0.0043
    Residual |  6248.53054        59  105.907297   R-squared       =    0.1984
-------------+----------------------------------   Adj R-squared   =    0.1576
       Total |  7794.60317        62  125.719406   Root MSE        =    10.291

------------------------------------------------------------------------------
ISABI~2_sum |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  PSQIQ5_sum |  -.7925442   .3061061    -2.59   0.012    -1.405061   -.1800274
     DEMQ2_r |  -5.053022   3.014037    -1.68   0.099     -11.0841    .9780514
  Location_r |   6.026234   3.311135     1.82   0.074    -.5993312     12.6518
       _cons |   68.91045   8.515424     8.09   0.000     51.87112    85.94977
```

Figure 7 Correlation Between Sleep Quality and Disability Limitations, Controlling for Gender and Location

5.0 Discussion

This study examined sleep quality in adults over the age of 55 and how it relates to depression, anxiety, function and disability, memory, visual impairment, and quality of life. Previous studies have examined these factors independently without comparing these relationships simultaneously. Additionally, this study assessed how interest in a sleep intervention, such as BBTI, may be related to one's perceived sleep quality along with these other factors.

Existing literature has found depression, anxiety, disability, and visual impairment to be negatively associated with sleep quality, while memory and quality of life have been found to be positively associated. A number of previous studies have also found significant relationships to exist among sleep quality and gender.

Consistent with aforementioned literature, we found relationships to exist between sleep and depression, anxiety, and disability limitations. However, when sleep scores were dichotomized into two groups ("good" sleepers and "poor" sleepers), these relationships were no longer significant. This is because only those with very poor sleep scores were more likely to experience higher levels of depression, anxiety, and disability limitations. These extremes are illustrated in the scatter plots above. However, when we performed regression analyses, we can see that depression, anxiety, and disability limitations are significantly correlated with sleep when controlling for gender and location as covariates.

High levels of depression and anxiety are associated with poor sleep, consistent with relevant research (Alvaro et al., 2013; Mahmood et al., 2016). Further research is necessary to determine its etiology, though clinical studies suggest that melatonin levels and inflammation may play a role in this relationship (Alvaro et al., 2013; Mahmood et al., 2016; Alexopoulos and

Morimoto, 2011). This research could be critical to finding another possible treatment for depression and anxiety, while also aiding in improving sleep.

Additionally, we found poor function and disability to be associated with poor sleep, as narrated in Chien and Chen's research (2015). As with similar literature, we are unable to assume a causal or temporal relationship. However, research suggests there are several mechanisms that may link physical disability to poor sleep. This includes through sleep disturbance, which can cause impaired attention and fatigue, predisposition to illness, such as diabetes and depression, or through maladaptive behaviors, such as daytime napping (Chien and Chen, 2015).

This regression analyses shows that gender plays a significant role in sleep quality, which is consistent with Tang et al. (2017), along with other studies. In fact, our data shows that females are nearly twice as likely than males to report a sleep score of 7 or above, indicating poor sleep. Although it is not entirely understood, researchers suggest that differences in sex hormones, stress responses, and social behavioral patterns may contribute to the gap in sleep quality (Tang et al., 2017).

Participants interested in sleep intervention are more likely to be disabled and not a high school graduate. Those who admit sleep problems but are not interested in the intervention actually report worse sleep scores than those who are interested in the intervention. Individuals who admit sleep problems, regardless of interest in intervention, have significantly worse sleep scores than those who do not believe they have sleep problems and do not need the intervention. Participants not interested in the intervention (and admit sleep problems) additionally have higher levels of depression and anxiety compared to those who report interest in the intervention and those who report no sleep problems. Among the participants who qualified as having "poor" sleep, over 25% of them believe they do not have a sleep problem and therefore do not need the intervention. Less than half of those who qualified as having "poor" sleep showed interest in the intervention. Interestingly, over 22% of those who qualify as having "good sleep" actually believe they have a sleep problem and are interested in the intervention. By looking exclusively at the "poor" sleepers who admit sleep problems, we can see that females are less likely than males to show interest in intervention. However, as discovered earlier, females are nearly twice as likely to experience poor sleep.

In contrast to our hypotheses, we found that sleep had no impact on memory scores, quality of life, or visual impairment. We did, however, find that sleep correlated with depression, anxiety, and disability limitations when controlling for gender and location. Gender appears to be the strongest factor in our dataset associated with sleep quality.

The present research helps us understand the correlates of sleep quality in older adults. Through this research, we have verified that depression, anxiety, disability limitations, and gender are all factors affecting sleep, as is narrated in previous studies. While more research is needed to build upon the mechanisms behind these relationships, this information can be used when considering treatment options to better improve sleep. Sleep quality is not just the absence of sleep disorders and deficits. It refers to a combination of factors, telling us how well we are sleeping. Thus, measuring sleep quality is important because it provides us a point of reference to understand what is considered "normal" and "healthy" sleep. This scale also encourages a target goal for health promotion and prevention programs. Those that do not fall into this "good" sleeper range may want to look into interventions, such as BBTI. Through interventions, we are able to aid individuals in improving their behaviors, which may ultimately improve their overall physical and mental health. This is especially vital for older adults, as it has the power to restore energy and heal physical and cognitive damage. This research additionally contributes to the growing literature suggesting that sleep does not “naturally” worsen with age but is affected by a number of underlying factors. These results, along with similar studies, may inform us on how sleep plays a role in “successful” aging.

6.0 Limitations

While this research observes results consistent with similar studies, we must consider the limitations present. This study contained a very small sample of participants. While similar studies included many more participants, this was a small project only including older adults from Pittsburgh. Males were not proportionally represented, as nearly 75% of the sample was female. We additionally did not obtain an equal sample from Moorhead Towers and the Pepper Registry, as Moorhead Towers represented less than 20%. Furthermore, time restraints were present, as participants were only collected for a three-month period. Because sampling took place in 2021, we must consider how Covid-19 may have affected the responses of the participants. Social distancing restrictions likely had an impact on responses to social activities and stress levels. It is possible that the stress and anxiety caused by COVID-19 impacted sleep as well. Finally, we had limited information on medical conditions and prescription drug use and relied exclusively on self-reports.

7.0 Conclusion

This study showed that high levels of depression, anxiety, and disability limitations are associated with poor sleep quality. Additionally, individuals of the female gender are nearly twice as likely to experience poor sleep.

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