

**THE EPIDEMIOLOGY AND HEALTH OUTCOMES ASSOCIATED WITH SLEEP: A
COMPARISON OF THE LITERATURE AND A SLEEP DISORDER SAMPLE**

by

Kelly L. Johnston

B.S., Pennsylvania State University, 2003

Submitted to the Graduate Faculty of
Behavioral and Community Health Sciences
the Graduate School of Public Health in partial fulfillment
of the requirements for the degree of
Master of Public Health

University of Pittsburgh

2009

UNIVERSITY OF PITTSBURGH
GRADUATE SCHOOL OF PUBLIC HEALTH

This thesis was presented

by

Kelly L. Johnston

It was defended on

July 22nd, 2009

and approved by

Paul A. Pilkonis, PhD, Professor of Psychiatry and Psychology, School of Medicine,

University of Pittsburgh

Christopher R. Keane, ScD, MPH, Assistant Professor, Behavioral and Community Health

Sciences, Graduate School of Public Health, University of Pittsburgh

Thesis Advisor: Martha Ann Terry, PhD, Senior Research Associate, Behavioral and
Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

**THE EPIDEMIOLOGY AND HEALTH OUTCOMES ASSOCIATED WITH SLEEP:
A COMPARISON OF THE LITERATURE AND A SLEEP DISORDER SAMPLE**

Kelly L. Johnston, MPH

University of Pittsburgh, 2009

The public health significance of sleep extends to both the impact of sleep on health outcomes and the demographic disparities of the experience of poor sleep. Sleep is often under-appreciated as a health factor. The purpose of this thesis is to provide a synthesis of the literature on the epidemiology of sleep and the health outcomes of poor sleep. **METHODS:** A literature review was conducted and compared to analysis of data from the Patient-Reported Outcomes Measurement Information System (PROMIS) sleep assessment study. The PROMIS sample is comprised of 258 individuals who self-reported symptoms of a sleep disorder. **RESULTS:** Literature revealed that gender, race, marital status, and socioeconomic status are factors that are associated with sleep. The literature also stresses the impact of sleep on several cardiovascular conditions. Among the PROMIS study sample of individuals with sleep disorders, marital status, and socioeconomic status were associated with sleep quality. Correlations were found between sleep disturbance and income, education, and body mass index. Wake disturbance (daytime functioning problems) was associated with diabetes and was correlated with age, income, and education. A diagnosis of insomnia was associated with the Caucasian race, depression, and low income. Obstructive sleep apnea diagnosis was associated with high blood pressure, being overweight or obese, being married or living with a partner, and having an income from \$50,000 - \$99,999. Restless legs syndrome was associated with having high blood pressure.

CONCLUSIONS: Though the literature and the PROMIS study analysis were generally in agreement, gaps and incongruities exist both within the literature and between PROMIS and the literature. Specifically, the PROMIS sample found no association between sleep and gender. It is important to note that the comparison is between a literature synthesis of sleep in the general population and a data analysis of sleep-disordered individuals. More research is needed to better understand the epidemiology of sleep and the health effects resulting from poor sleep. Suggestions for future research and interventions are provided.

TABLE OF CONTENTS

PREFACE.....	IX
1.0 INTRODUCTION.....	1
2.0 METHODS	7
2.1 LITERATURE REVIEW	7
3.0 LITERATURE REVIEW AND BACKGROUND.....	9
3.1 INITIAL THEMES OF LITERATURE REVIEW	9
3.2 LITERATURE REVIEW OF EPIDEMIOLOGY OF POOR SLEEP	12
3.3 LITERATURE REVIEW OF HEALTH OUTCOMES AND SLEEP.....	14
4.0 PROMIS SLEEP/WAKE STUDY	16
4.1 DESCRIPTION OF PROMIS STUDY	16
4.2 PROMIS STUDY ANALYSIS.....	18
4.3 PROMIS STUDY RESULTS.....	21
5.0 DISCUSSION	28
5.1 PROMIS SLEEP SAMPLE	29
5.2 LITERATURE REVIEW VS. PROMIS	36
5.3 STRENGTHS AND LIMITATIONS.....	40
5.3.1 Strengths.....	40

5.3.2	Limitations	41
6.0	CONCLUSIONS	44
6.1	SLEEP ASSESSMENT	44
6.2	FUTURE RESEARCH.....	45
6.3	SUGGESTIONS FOR INTERVENTIONS.....	46
6.4	FINAL CONCLUSIONS.....	48
	BIBLIOGRAPHY	50

LIST OF TABLES

Table 1: Sleep Epidemiology and Health Outcome Literature Review Keywords	8
Table 2: Sleep and Wake Disturbance Sample Items: PROMIS Study	19
Table 3: PROMIS Study Demographics	21
Table 4: Summary of ANOVA Results: Wave 1 PROMIS Study	23
Table 5: Correlations	24
Table 6: Regression Independent Variables	24
Table 7: Results of Regression for Health Outcomes	25
Table 8: Chi Square Analyses for Sleep Disorder Diagnoses	26
Table 9: Results of Regression of Sleep Disorder	27

LIST OF FIGURES

Figure 1: Centers for Disease Control Social-Ecological Model.....	28
--	----

PREFACE

I would like to thank the thesis committee for their time and effort. I would especially like to thank my thesis advisor, Martha Ann Terry, for her straightforward guidance. I would also like to thank Lan Yu, PhD, Research Assistant Professor, for providing her statistical expertise.

1.0 INTRODUCTION

Sleep is a universal part of life. Its naturally restorative properties allow many to feel refreshed and energized during the day, as a result of a good night's sleep. However, most people experience a problem with sleep at some point, due to stress, worry, physical illness, or the like. Unfortunately, many people experience sleep problems over a longer period of time and are then diagnosed with a sleep disorder. Such people fail to benefit from the recuperative effects of sleep. Poor sleep has under-appreciated impacts on health, as evidenced by the Institute of Medicine report "Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem." (Colten & Altevogt, 2006). Although poor sleep may not receive as much attention as other health problems, a wealth of literature exists on sleep. As initial examples, researchers have examined sleep throughout the lifespan. This research ranges from sleep during pregnancy (Gjerdingen & Chaloner, 1994; Lee, 1998; Lee & Gay, 2004), the sleeping position and environment of infants (Delzell, Phillips, Schnitzer, & Ewigman, 2001; Hunt, Lesko, Vezina, McCoy, Corwin, Mandell et al., 2003; Lam, Hiscock, & Wake, 2003; Trevillian, Ponsonby, Dwyer, Kemp, Cochrane, Lim et al., 2005; Wake, Morton-Allen, Poulakis, Hiscock, Gallagher, & Oberklaid, 2006; Willinger, Hoffman, & Hartford, 1994), the sleep of children and adolescents (Bonuck, Parikh, & Bassila, 2006; Chervin, Weatherly, Garetz, Ruzicka, Giordani, Hodges et al., 2007; Ebert & Drake, 2004; Hiscock, Canterford, Ukoumunne, & Wake, 2007; Lam & Yang, 2007; Lam, Hiscock, & Wake, 2003; Lopez-Garcia, Faubel, Leon-Munoz, Zuluaga, Banegas, & Rodriguez-Artalejo, 2008; Sohn & Rosenfeld, 2003; Spilsbury, Storfer-

Isser, Drotar, Rosen, Kirchner, & Redline, 2005), sleep in adulthood (Briones, Adams, Strauss, Rosenberg, Whalen, Carskadon et al., 1996; Finn, Young, Palta, & Fryback, 1998), and sleep among the elderly (Brassington, King, & Bliwise, 2000; Buysse, 2004; Byles, Mishra, & Harris, 2005; Byles, Mishra, Harris, & Nair, 2003).

Researchers have investigated the public health impact of poor sleep. It is estimated that approximately 40 million United States citizens have chronic sleep disorders, costing society roughly \$90 billion dollars (Dement & Pelayo, 1997). Many researchers examine sleep's contribution to all-cause mortality, cardiovascular disease, and diabetes (Sigurdson & Ayas, 2007; Walsh, 2006). Healthy People 2010 echoes the public health significance of poor sleep by including three objectives aimed to improve sleep in the general population (24-11a, 24-11b, and 24-12). The goals of these objectives range from improving the medical management of sleep problems to decreasing vehicular crashes that result from driver sleepiness. Unfortunately, poor sleep does not always receive as much consideration as other, perhaps more prominent, physical conditions. It is often difficult, if not impossible, to identify if poor sleep is a side effect of another condition or the cause of a particular health condition.

Little is understood about the many factors associated with poor sleep. While many scales exist to assess sleep, few contain complete and adequate information (Devine, Hakim, & Green, 2005). The National Sleep Disorders Research Plan put forth several recommendations for future research, including a need for more methods to measure sleep, as well as focuses on gender, racial, and ethnic disparities in sleep disorder outcomes (White, Balkin, Block, Buysse, Dinges, Gozal et al., 2003). The Institute of Medicine also insists upon a heightened need to examine the effect of sleep on health. Such examination of impact and health disparities is

necessary to increase awareness and knowledge of sleep problems among the public and health professionals.

For the purposes of this thesis, the main sleep diagnoses to be examined are insomnia, obstructive sleep apnea, and restless legs syndrome. Primary insomnia is defined in the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) as difficulty initiating and maintaining sleep and/or sleep that is not considered restorative or refreshing and is not due to the effects of a substance or a general medical condition. This causes clinically significant impairment. Insomnia affects approximately 15% of the population, tends to be reported more among women, and increases with age (Doghranji, 2006).

Obstructive sleep apnea is classified as recurring episodes of upper airway obstruction or a cessation in breathing during sleep (International Classification of Sleep Disorder, 1990). In other words, obstructive sleep apnea occurs when a person's airway is blocked during sleep, causing the person to stop breathing and to awaken to resume breathing throughout the night. Often, snoring and daytime sleepiness co-occur with this syndrome. Obstructive sleep apnea occurs in approximately 5% of the western populations (Young, Peppard, & Gottlieb, 2002).

Restless legs syndrome (RLS) is characterized by uncomfortable sensations in the legs and a persistent need to move them, usually just prior to sleep onset. These symptoms greatly impact a patient's sleep and daily functioning, due to tiredness and lack of energy. Roughly 10% of U.S. adults suffer from RLS (Allen & Mitler, 2009).

This thesis examined data from a cross-sectional assessment study known as PROMIS (Patient-Reported Outcomes Measurement Information System). The PROMIS sample included individuals with symptoms of a diagnosable sleep disorder who resided within the Pittsburgh, Pennsylvania area. The items included in the PROMIS sleep study made up two separate scales:

Sleep Disturbance and Wake Disturbance. Throughout this thesis, the following definitions will be used from www.nihpromis.org for these scales:

- **Sleep Disturbances**: The PROMIS Sleep Disturbances Scale focuses on perceptions of sleep quality, sleep depth, and restoration associated with sleep; perceived difficulties with getting to sleep or staying asleep; and perceptions of the adequacy of and satisfaction with sleep. The Sleep Disturbances Scale does not include symptoms of specific sleep disorders, nor does it provide subjective estimates of sleep quantities (e.g., the total amount of sleep, time to fall asleep, or amount of wakefulness during sleep).
- **Wake Disturbances**: The PROMIS Wake Disturbances Scale focuses on perceptions of alertness, sleepiness, and tiredness during usual waking hours; and on functional impairments during wakefulness that are associated with sleep problems or impaired alertness. The Wake Disturbances Scale does not directly assess cognitive, affective, or performance impairments. The Wake Disturbances scale measures the level of waking alertness, sleepiness, and function within the context of overall sleep-wake function.

Lastly, good sleep has been defined by the National Institutes of Health as having the ability to fall asleep without difficulty, sleep throughout the night, and feel refreshed and awake the following day. Generally, seven to eight hours of sleep is recommended for adults, and nine or more hours for school-aged children and adolescents. Needed hours vary between individuals, but the NIH suggest these ranges in order to perform adequately and avoid daytime sleepiness (Patlak, 2005).

This thesis does not aim to explore an exhaustive list of sleep disorders, but instead provides a focus on the most common sleep problems and complaints. By providing this emphasis, it is possible to carefully examine the public health burden of particular sleep issues.

This thesis presents a synthesis of literature on sleep-related factors and health outcomes and compares this literature to analysis from PROMIS, a cross-sectional assessment study of sleep disorders. This will explore how the literature on epidemiology and health outcomes of sleep compares to an assessment of a sample of individuals with sleep problems.

An important distinction to preface the upcoming comparison is that the literature examines the epidemiology and health outcomes of the general population's sleep, whereas the PROMIS study assessed a clinical sleep sample. In other words, the PROMIS study included only those individuals who self-reported symptoms of a diagnosable sleep disorder. Since this is the case, the PROMIS study provides insight into the epidemiology and health effects of sleep among a sleep-disordered population only. In the literature it is possible to collect information on a fuller range of symptoms, epidemiology, and health outcomes. While the clinically sleep-disordered individuals are part of the general population, they represent a small portion of the possible epidemiology of sleep. This distinction allows for careful consideration of the differences between individuals with sleep disorders and others in the general population. This theme is threaded throughout the thesis in order to provide a better understanding of the PROMIS study versus the literature.

This thesis will first describe the methods used to perform the literature review, including the collection and selection of articles. Next, a synthesis of the literature on the epidemiology of poor sleep and health outcomes associated with poor sleep is presented. Following the literature synthesis, the results of the data analysis from the PROMIS study are outlined. The discussion section offers more interpretation and clarification of the results of the PROMIS study. Also within the discussion section, this thesis provides a comparison of the literature and the PROMIS study by identifying similar and conflicting results. Strengths and limitations of the thesis are

also provided. The conclusions begin with a discussion for the need to assess for sleep problems, followed by suggestions for future research and interventions.

2.0 METHODS

Methods on which this thesis is based include a literature review of the health outcomes of sleep and analysis of the PROMIS sleep/wake function testing. These reviews and analyses were compared. The comparison helps support findings of health outcome disparities in the literature and forms a foundation to further investigate risk factors for both developing sleep problems and exacerbating existing sleep disorders.

2.1 LITERATURE REVIEW

The literature review was mainly conducted through computer searches including the online databases Ovid, PubMed, PsychInfo, and Medline. The University of Pittsburgh library system was utilized for retrieval of full-text articles. General search words were used at the start of the search (i.e. “sleep,” “wake,” and “health outcome”). Through examination of the results of this first broad search, other more specific synonyms were added, including “insomnia,” “obstructive sleep apnea,” “restless legs syndrome,” and “cardiovascular disease,” “cancer,” and “diabetes.” A full list of search terms is included in Table 1.

Table 1: Sleep Epidemiology and Health Outcome Literature Review Keywords

First Phase	Second Phase		Third Phase
Health outcome	Insomnia	Gender	Diabetes
Sleep	Sleep Apnea	Race	Heart failure
Wake	Obstructive Sleep	Ethnicity	Cancer
Cardiovascular	Restless legs syndrome	Age	Myocardial infarction
Demographic	Health disparity	Income	Obesity
Sleep epidemiology	Shift work	Education	Body mass index
			Stroke

After these synonyms were included within the broad term search, a total of 5,443 articles references existed within an Endnote library. Duplicate, idiosyncratic, and non-English references were removed first. For example, articles related to bipolar disorder were removed since the lack of a need for sleep is an associated symptom of the disorder, and not the problem itself. Then, through reading abstracts, other references that discussed sleep only as a side effect of another condition were removed. These included articles which documented sleeping difficulty as a result of medications, for example. However, articles that appeared to closely examine sleep within a condition were kept, in order to provide more information about how sleep can play a role in health outcomes. Approximately 500 idiosyncratic and non-English articles were removed and roughly 4500 were removed in which sleep was merely seen as a side effect of another condition and did not provide a more substantial relationship to the health condition itself. After this trimming, a total of 344 references remained.

3.0 LITERATURE REVIEW AND BACKGROUND

The initial themes of the literature review were assessment, cardiovascular disease, cancer, general health behaviors, general health outcomes, epidemiology, and mental health. References were placed into at least one group, but several were placed in more than one group if the topics seemed to include other themes as well. After the initial theme categorization, the articles were further reviewed for demographics associated with sleep, including age, race, gender, marital status and socioeconomic status. Finally, health conditions associated with sleep were examined.

3.1 INITIAL THEMES OF LITERATURE REVIEW

Literature about assessment included articles about evaluation of sleep quality, classification of sleep disorders, and the various methods available to assess a person's sleep. For example, a review and evaluation of instruments assessing sleep dysfunction found six instruments that accounted for the full range of sleep classification and health-related quality of life factors. With only six instruments, the researchers felt that further research was necessary to assess sleep adequately (Devine, Hakim, & Green, 2005).

The health outcome themes, including cardiovascular disease, cancer, and general health outcomes, related mostly to physical health. This literature examined how poor sleep played a

role as either a risk factor for negative health outcomes, or the opposite, how good sleep can be a protective agent. Several studies examined how poor quality of sleep will effect a poorer outcome in previously diagnosed diseases (Brostrom, Stromberg, Dahlstrom, & Fridlund, 2004; Elder, Pisoni, Akizawa, Fissell, Andreucci, Fukuhara et al., 2008). Others discussed poor sleep as a risk factor for developing physical health problems (Bass & Turek, 2005; Lindberg, Berne, Franklin, Svensson, & Janson, 2007). Considering the impact of poor sleep on health, whether as a risk factor for disease development or as an exacerbating factor of an existing disease, further research is needed to better understand sleep's role in health.

General health outcomes research discusses the relationship of sleep and health more broadly. This literature examined several health outcomes within a particular study, as well as general health status, functional outcomes, and quality of life. It is fairly unanimously agreed that sleep and overall health are related, but the strength and direction of the relationship are arguable (Appling, 1997; Bradley, Yount, Strohl, Bliwise, Buysse, Carskadon et al., 1998; Gooneratne, Weaver, Cater, Pack, Arner, Greenberg et al., 2003; Reimer & Flemons, 2003).

The epidemiology of sleep included various demographics as they relate to sleep. Several studies and articles discussed sleep among the elderly, which emerged as a highly studied, vulnerable population. Overall consensus points to the need to focus on the sleep patterns of the elderly, as it appears to greatly affect their quality of life (Bliwise, Ansari, Straight, & Parker, 2005; Brassington, King, & Bliwise, 2000; Gooneratne, Weaver, Cater, Pack, Arner, Greenberg et al., 2003; Stepnowsky, Johnson, Dimsdale, & Ancoli-Israel, 2000). Women also appear to have a higher prevalence of sleep disorders than men, although they may be neglected in the research (Byles, Mishra, & Harris, 2005; Dursunoglu & Dursunoglu, 2007). These gender and

age differences, as well as race, ethnicity, and marital status, are further discussed in the literature review section below.

The literature discussing the complicated relationship between sleep and mental health presents conflicting views about whether the mental health or sleep problem came first. A bi-directional model has been proposed. For example, a sleep problem such as insomnia may be a risk factor for depression and vice versa (Buysse, 2004). Many studies have investigated the relationship between sleep and quality of life, especially among samples of individuals with other health conditions (Briones, Adams, Strauss, Rosenberg, Whalen, Carskadon et al., 1996; Phillips, Mock, Bopp, Dudgeon, & Hand, 2006; Redeker & Hilkert, 2005; Redeker, Ruggiero, & Hedges, 2004; Theadom, Cropley, & Humphrey, 2007). Still others have shown that positive affect is related to good sleep (Steptoe, O'Donnell, Marmot, & Wardle, 2008). Sleep and mental health are clearly interwoven throughout the literature.

Research articles about general health behaviors examined the relationship between healthy behaviors, such as exercising and eating a healthy diet, as they related to sleep. For example, long work hours and poor sleep were related to smoking and sedentary behaviors among women (Artazcoz, Cortes, Borrell, Escriba-Aguir, & Cascant, 2007). Others discussed the difficulty in examining such a relationship (Atkinson, Fullick, Grindey, & Maclaren, 2008). Lastly, others examined behavior treatment strategies, such as cognitive behavioral therapy (Page, Berger, & Johnson, 2006; Perlis, Sharpe, Smith, Greenblatt, & Giles, 2001; Sadeh, 2005; Wang, Wang, & Tsai, 2005).

3.2 LITERATURE REVIEW OF EPIDEMIOLOGY OF POOR SLEEP

While negative health outcomes occur as a result of poor sleep at any age, research has found that the elderly tend to experience the worst consequences of poor sleep (Brassington, King, & Bliwise, 2000; Doghramji, 2006; Gooneratne, Gehrman, Nkwuo, Bellamy, Schutte-Rodin, Dinges et al., 2006; Gooneratne, Weaver, Cater, Pack, Arner, Greenberg et al., 2003; Lopez-Garcia, Faubel, Leon-Munoz, Zuluaga, Banegas, & Rodriguez-Artalejo, 2008; Rao, Spiro, Samus, Rosenblatt, Steele, Baker et al., 2005; Stepnowsky, Johnson, Dimsdale, & Ancoli-Israel, 2000). These consequences are possibly linked with the changing circadian rhythms of aging. That is, as people age, the timing of sleep and awakenings during the night change significantly (Appling, 1997; Bliwise, Ansari, Straight, & Parker, 2005).

Sleep problems also appear to be associated with race. Some studies have found African Americans to be at higher risk for developing sleep problems (Unruh, Buysse, Dew, Evans, Wu, Fink et al., 2006). However, the opposite has also been witnessed (Blazer, Hays, & Foley, 1995; Phillips & Mannino, 2005). Sleep duration that is either too long or too short is seen among African Americans, Hispanics, and other racial minorities (Hale & Do, 2007). Some of the racial differences may be mediated by sleep medications, which may be used less often by African American women (Allen, Renner, Devellis, Helmick, & Jordan, 2008). Still other researchers look to physiological differences, such as cortisol levels, to explain the racial differences in sleep (DeSantis, Adam, Doane, Mineka, Zinbarg, & Craske, 2007).

Gender also appears to play a role in the risk for development of sleep problems. Many researchers identify older women as a higher-risk group for developing sleep problems. Older women with poor sleep report a poorer quality of life overall (Byles, Mishra, & Harris, 2005).

More specifically, sleep problems among older women increase the risk for falls and cognitive difficulty (Brassington, King, & Bliwise, 2000; Byles, Mishra, Harris, & Nair, 2003; Rao, Spiro, Samus, Rosenblatt, Steele, Baker et al., 2005). Lastly, women who suffer from a lack of sleep may have worse cardiovascular disease outcomes than men who sleep the same amount (Miller, Kandala, Kivimaki, Kumari, Brunner, Lowe et al., 2009).

Marital status also seems to affect sleep. Some literature identifies married individuals, especially happily married individuals, as having better sleep (Troxel, Buysse, Hall, & Matthews, 2009). In an abstract presented at the SLEEP 2009 conference, Troxel and colleagues found significantly less reporting of sleep disturbance among married individuals, compared to divorced, separated, widowed, and never married (Grandner, 2009). Another study found that if an individual has a sleep disorder, his/her significant other will also experience negative consequences, especially mental health issues (Strawbridge, Shema, & Roberts, 2004).

Other health disparities exist, as discussed in the literature. A cross-sectional study found that living in a low socioeconomic status (SES) area, in a disadvantaged neighborhood, increases the risk for childhood obstructive sleep apnea (Spilsbury, Storfer-Isser, Kirchner, Nelson, Rosen, Drotar et al., 2006). As a side effect of low income, perhaps these children receive less nutritious food and less exercise, and the resulting obesity leads to obstructive sleep apnea. Along the same lines, another found that low health literacy is associated with poor sleep, possibly due to a lack of understanding of clinician advice (Hackney, Weaver, & Pack, 2008).

3.3 LITERATURE REVIEW OF HEALTH OUTCOMES AND SLEEP

In terms of health outcomes, many researchers identified an association between sleep problems and poor cardiovascular health (Arzt, Young, Finn, Skatrud, Ryan, Newton et al., 2006; Brostrom, Stromberg, Dahlstrom, & Fridlund, 2004; Brown, 2006; Caples, Wolk, & Somers, 2005; Cassar, Morgenthaler, Lennon, Rihal, & Lerman, 2007; Haack, Sanchez, & Mullington, 2007; Meisinger, Heier, Lowel, Schneider, & Doring, 2007; Sinha, Skobel, & Breithardt, 2006). While generally the literature suggests a positive correlation between sleep problems and cardiovascular disease, the type of associations differ. Some researchers examined poor sleep as a risk factor for cardiovascular disease while others focused on how sleep contributed to health outcomes of cardiovascular patients. Given the difficulty of identifying a cause and effect relationship, the literature agrees on the need to critically assess sleep and relevant health outcomes.

In the same vein, the literature suggests an association with disorders and risk factors, such as diabetes (Cuellar & Ratcliffe, 2008a, 2008b; Knutson, Ryden, Mander, & Cauter, 2006; Williams, Hu, Patel, & Mantzoros, 2007) and obesity (Bass & Turek, 2005; Lam & Ip, 2007; Lopez-Garcia, Faubel, Leon-Munoz, Zuluaga, Banegas, & Rodriguez-Artalejo, 2008; Marshall, Glozier, & Grunstein, 2008; Stamatakis & Brownson, 2008; Trenell, Marshall, & Rogers, 2007). Sleep apnea appears to be highly associated with obesity (Budhiraja, Parthasarathy, & Quan, 2007; Lam & Ip, 2007).

Other noteworthy factors have been found to be associated with sleep. One of the most prominent is mental health, specifically anxiety and/or depression. In a study of the prevalence of mental illness among patients in a sleep clinic, researchers found that 22% of surveyed

patients had at least one mental disorder, and 10% had two (DeZee, Hatzigeorgiou, Kristo, & Jackson, 2005). Many studies agreed that while poor sleep tends to be associated with poor mental health, it appears that the reverse correlation is true: positive affect and good sleep are associated (Steptoe, O'Donnell, Marmot, & Wardle, 2008). Again, a causal relationship was not truly substantiated, but a general relationship was found.

Other factors related to sleep were shift work and overall quality of life and health status. Generally, researchers found that individuals with poor sleep were less likely to engage in healthy behaviors, such as exercising and maintaining a healthy diet. In a study utilizing the Behavioral Risk Factor Surveillance System, people with a short sleep duration were more likely to smoke, be physically inactive, obese, and drink heavily (among men) (Strine & Chapman, 2005). This study also found that individuals with less sleep were more likely to report poor general health, emotional distress, and pain. Working non-standard shifts also affected sleep quality, duration, and general health (Atkinson, Fullick, Grindey, & Maclaren, 2008). Lastly, several studies examined a more global health perspective. In other words, instead of focusing on a specific disease or disorder, researchers asked about general quality of life as it relates to sleep. Again, the correlation appeared that poor sleep tends to be associated with poor health (Reimer & Flemons, 2003; Strine & Chapman, 2005; Theadom, Cropley, & Humphrey, 2007; Yang, Hla, McHorney, Havighurst, Badr, & Weber, 2000).

In summary, the synthesis of the literature showed that aging, race, gender, marital status, and socioeconomic status are all factors associated with sleep among the general population. Being older, a minority, female, unmarried, and of low-income are all distinct risk factors for sleep problems. Sleep problems are also associated with cardiovascular disease, diabetes, and obesity, although the direction of the relationship (“which came first”) is still unclear.

4.0 PROMIS SLEEP/WAKE STUDY

4.1 DESCRIPTION OF PROMIS STUDY

This section describes the Patient-Reported Outcomes Measurement Information System (PROMIS) study, a part of an NIH roadmap initiative to create computerized adaptive tests for the assessment of health outcomes (Cella, Yount, Rothrock, Gershon, Cook, Reeve et al., 2007). Seven university sites are involved in data collection. The health outcomes include, but are not limited to, social role participation, pain, fatigue, emotional distress (e.g. depression, anxiety, and anger), sleep/wake function, and sexual functioning (see Appendix). At the University of Pittsburgh, the study is looking at sleep/wake functioning and emotional distress. The detailed process of item creation is out of the scope of this thesis, and has been published elsewhere (DeWalt, Rothrock, Yount, Stone, & Group, 2007). In general, the PROMIS study is innovative in its creation of items by incorporating patient-reported outcomes of health within academic conceptual models. In other words, through focus groups and cognitive interviews of patients with the researched problem, PROMIS has been able to create item banks by blending patient input with expert knowledge of the problem (www.nihpromis.org).

The data reviewed and analyzed for this thesis were drawn from Wave 1 testing of the sleep/wake item banks at the Pittsburgh site. Wave 1 testing is performed cross-sectionally, and all participants respond to the same items. The purpose of this phase of the study is to determine

which items perform best, provide the most information and which items are reported more often among a specific population, even at the same severity score (Differential Item Functioning; DIF). For example, in the depression item bank created by the Pittsburgh PROMIS site, the item “I felt like crying” was endorsed at a higher level by women even when the overall depression score was exactly the same between the genders. The PROMIS Computer Study was approved by the University of Pittsburgh Institutional Review Board (IRB #: IRB0602156, PI: Paul A. Pilkonis, PhD.)

The PROMIS study received a Waiver of Informed Consent to conduct a phone screen prior to written informed consent, due to the minimal-risk questions posed during the screen. Participants were eligible if they completed the phone screen with demographic questions and met cut-off criteria determined by a Co-Investigator, Daniel Buysse, MD. The cut-off criteria were measured via sleep surveys over the phone. These surveys included the Pittsburgh Sleep Quality Index, (PSQI), which assesses wake and sleep timing and sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Of the 342 who completed phone screens, 262 completed Wave 1 testing of the Sleep/Wake items. Of the 262 participants who completed study procedures, four were excluded from data analysis after a post-study review of psychiatric medical records for ineligible diagnoses, including presence of psychotic symptoms.

Prior to conducting any research procedures, informed consent was obtained (either in person or over the phone) and consents were signed by the participant. Participants were given the choice of either completing the survey at any computer with internet access or at Bellefield Towers in Oakland. Once informed consent was completed, participants were assigned a random four-digit PIN number in order to log into the computer and complete the survey. This

allowed for transmitting of information over the internet to the data coordinating center, Evanston Northwestern, without any identifiable information about the participant.

Participants completed the full Sleep/Wake item bank during Wave 1 testing. Questions included original PROMIS items and computerized versions of the PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), and Epworth Sleepiness Scale (Johns, 1991).

4.2 PROMIS STUDY ANALYSIS

Two phases of analyses were performed for the PROMIS data. First, demographic characteristics were compared to health outcomes via independent sample t-tests for 2-group comparisons (such as gender and ethnicity) and Analysis of Variance (ANOVA) for multiple group comparisons (such as race and income). The health outcomes analyzed included sleep severity, sleep diagnosis, cardiovascular disease (i.e. ever had high blood pressure, stroke, or heart attack), diabetes, and cancer. The health outcomes were drawn from yes/no self-reported items in the Sleep/Wake testing, such as “Has a doctor or health professional ever told you that you have diabetes?” Body Mass Index (BMI) will be derived from self-reported height and weight.

Sleep severity was derived from theta scores for sleep disturbance (SD) and wake disturbance (WD). Theta scores are a function of the Item Response Theory (IRT) method which PROMIS used. IRT is an increasingly popular method to develop, evaluate, and administer psychological measures. This method analyzes items’ difficulty, ability to differentiate between individuals and the quality of information it provides. By measuring

information item by item, researchers can place items in a scale and determine the full informational function of the scale. For more information regarding the methodology of IRT, see Reise, Ainsworth, and Haviland (Reise, Ainsworth, & Haviland, 2005). These items are also examined for invariance, or their ability to provide similar answers by participants with similar symptoms, regardless of age, race, ethnicity, gender, etc. Since we know the informational value of the sleep/wake items, a theta score can be calculated, which determines the severity of the sleep disturbance or wake disturbance. That is, the higher the theta score, the worse the sleep or wake problem.

The severity of the sleep problem is examined through two scores, one for Sleep Disturbance (SD) and one for Wake Disturbance (WD). SD is derived from an algorithm of items that assess sleep. These items measure concepts related to difficulties surrounding falling asleep, staying asleep, or waking too early. WD scores were derived from items assessing daytime functioning. These measure difficulties experienced during the day, or non-sleep time, especially sleepiness and fatigue. Each item asked about the “past seven days” and the response options were on a five-point Likert scale from Never to Always. Table 2 contains a few sample items used to derive sleep and wake disturbance. Each of these will be compared with the sample demographics, including age, gender, race, ethnicity, income, education, and relationship status.

Table 2: Sleep and Wake Disturbance Sample Items: PROMIS Study

Sleep Disturbance	Wake Disturbance
I had trouble sleeping.	I felt tired.
I woke up too early.	I made mistakes because I was sleepy.
I had difficulty falling asleep.	I had trouble concentrating because of poor sleep.
I had difficulty staying asleep.	I was sleepy during the daytime.

The second phase of data analysis included regression analyses to examine the relationship between sleep severity and health outcomes. During these analyses, step-wise comparisons were performed to determine the most meaningful associations. Logistic regression and chi square analyses were utilized to examine associations of binary variables (yes/no answers) and linear regression was used for continuous variables (e.g. age). The health outcomes include the same as listed above, and the covariates are the sample's demographics. Step-wise regression analyses were performed to determine which regression model provides the most information. In other words, the model began with all the covariates, and then variables that were not statistically significant were removed from the model until all the covariates were significant. This method provides a model that demonstrates which covariates predict, or help explain, the impact of a health outcome.

For this thesis, data from the PROMIS Sleep/Wake participants were compared with those from the literature review. First, the data were checked for matching themes and concepts. Second, the data were examined for discrepancies. Discrepancies include differences between the literature review and the PROMIS findings as well as interesting health outcome disparities between demographic groups.

Demographic variables were compared with health outcomes. Some demographic variables were re-coded into new variables to accommodate similar sample sizes per sub-group. First, the relationship variable consisted of "Never Married," "Married/Living with Partner," and "Separated/Divorced/Widowed." Next, the race variable was transformed into "Caucasian" and "African American." Other races (Asian, American Indian, Native Hawaiian/Other Pacific Islander, and participants who reported more than one race) were removed from analysis due to a

low sample size (n = 16). The education variable was changed to include “High school graduate or less,” “Some college/Technical Degree/AA,” and “College Graduate or more.”

The demographics of the PROMIS Wave 1 Sleep/Wake participants are presented in Table 3. Two hundred and fifty eight participants were enrolled. In general, the sample consisted of 62% female, 72% Caucasian, 21% African American, and 2% Hispanic. The mean age of the sample was 44 years.

Table 3: PROMIS Study Demographics

	n (%)		n (%)
Mean Age	44	High school grad or less	45 (17.4%)
Male	99 (38.3%)	Some college/Technical deg.	101 (39.1%)
Female	159(61.6%)	College graduate or more	112 (43.4)
Caucasian	187 (72.5%)	Married	84 (32.6%)
African American	55 (21.3%)	Never Married	96 (37.2%)
Other Races/2 or more races	16 (6.2%)	Divorced/Widowed/Separated	78 (30.2%)
Hispanic	6 (2.3%)		
Income < \$20,000	72 (27.9%)		
Income \$20,000 - \$49,999	75 (29.1%)		
Income \$50,000 - \$99,999	77 (29.8%)		
Income \$100,000 or more	30 (11.6%)		

4.3 PROMIS STUDY RESULTS

An alpha level of .05 was used for all statistical tests and Cohen’s d was calculated as the effect size (Cohen, 1988).

Independent t-tests were performed to examine relationships between gender and health outcomes. Due to the small sample size of Hispanics (n=6), no t-tests were performed with the ethnicity variable. The sample revealed no significant differences between males and females.

One-way ANOVA of SD ($p < .01$) and WD ($p < .01$) demonstrated a significant difference between the income groups. Via the post-hoc Tukey test, all 5 income groups were significantly different from each other, in terms of SD and WD.

Calculated ANOVA uncovered statistically significant differences among education groups on both sleep ($p < .01$) and wake disturbance. The post-hoc Tukey test found significant differences between all 3 groups of education for sleep disturbance (high school or less vs. some college ($p < .01$); high school or less vs. college degree or higher ($p < .01$); some college vs. college degree or greater ($p < .01$)). With wake disturbance, the significant difference existed between the high school or less group and the college graduate or higher group ($p < .01$).

Relationship status also demonstrated significant differences for sleep and wake disturbance. Sleep disturbance was overall different $F(2, 256) = 7.07$, ($p = .01$). Specific differences were found between never married and married/living with partner ($p < .01$) and between married and separated/divorced/widowed ($p < .01$). Wake disturbance was significantly different among the relationship groups in general $F(2, 256) = 3.01$, ($p = .003$). The never married and married/living partner groups were statistically different ($p < .01$). See Table 4 for ANOVA results.

Table 4: Summary of ANOVA Results: Wave 1 PROMIS Study

Health Outcome	Demographic Variables		df	Sum of squares	Mean Square	F	
Sleep Disturbance	<i>Income</i>		3	23.39	7.78	14.69**	
		< \$20,000	1.22				
		\$20,000-\$49,999	.74				
		\$50,000-\$99,999	.52				
		\$100,000 or more	.38				
		<i>Education</i>		2	16.50	8.25	14.76**
		High school graduate or less	1.21				
		Some college	.82				
		College graduate or more	.54				
		<i>Relationship Status</i>		2	8.36	4.18	7.07**
	Never Married	.90					
	Married/Living with Partner	.55					
	Separated/Divorced/Widowed	.94					
Wake Disturbance	<i>Income</i>		3	15.87	5.29	10.08**	
		< \$20,000	1.27				
		\$20,000-\$49,999	.81				
		\$50,000-\$99,999	.68				
		\$100,000 or more	.63				
		<i>Education</i>		2	5.26	2.63	4.68**
		High school graduate or less	1.17				
		Some college	.88				
		College graduate or more	.76				
		<i>Relationship Status</i>		2	6.69	3.34	6.01**
	Never Married	1.06					
	Married/Living with Partner	.71					
	Separated/Divorced/Widowed	.90					

**** All variables were significant at the p<.01 level.**

In preparation for regression, correlations of the predicting variables were calculated. Predicting variables were age, sleep disturbance (SD), wake disturbance (WD), income, education, and body-mass index (BMI). Pearson correlations were calculated to determine any inter-correlations between the predicting variables, that is, if any were highly correlated. In a

multiple regression model, if highly correlated variables are present within the same regression model, the validity of its results on individual predictors may not be accurate. Perfect correlation (r) is -1 or 1. The correlations ranged from -.37 to .58, indicating moderate correlations among the correlated variables. The predictor variables are considered significantly different from one another and eligible to be used separately in regression analyses. Both sleep and wake disturbance were correlated with income ($r=-.371$; $r=-.300$) and education ($r=-.274$; $r=-.134$), respectively. In other words, the higher the sleep or wake disturbance score, the lower the income or education level. BMI was also mildly negatively correlated with sleep disturbance ($r=-.177$). Full correlation results are in Table 5.

Table 5: Correlations

	Age	Income	Education	BMI	SD	WD
Age	1	--	--	--	--	-.24
Income		1	.31	--	-.37	-.30
Education			1	--	-.27	-.13
BMI				1	-.18	--
SD					1	.58
WD						1

-- = Not a statistically significant correlation

Logistic regression analyses were performed to explore relationships between demographic variables and sleep/wake disturbance with health outcomes related to cardiovascular disease, diabetes, cancer, and sleep disorder diagnoses (see Table 6).

Table 6: Regression Independent Variables

Age	Sleep Disturbance	BMI
Gender	Wake Disturbance	Depression
Race	Income	Anxiety
Relationship Status	Education	

Logistic regression analyses were performed to explore which variables were associated with the presence of high blood pressure or diabetes. Positively reported health outcomes with

low sample sizes (n = 10 or less) were excluded from analysis. High blood pressure (37.2%) and diabetes (14.3%) represent the highest percentage of negative health outcomes within this sample. A summary of the results is presented in Table 7.

Table 7: Results of Regression for Health Outcomes

	n (%) Yes	β Age	β BMI	β Anx	β WD	R Square
High Blood Pressure	96 (37.2%)	.06	-1.19	-.99	---	.175**
Diabetes	37 (14.3%)	.03*	---	---	.60	.055**

WD = Wake Disturbance; Edu. = Education; Anx. = Anxiety; BMI = Body Mass Index; *p<.05; **p<.01

Age, BMI and anxiety were predictors of high blood pressure. In the final model, these 3 factors produced an R square of .175 (p<.001). In other words, age, BMI, and anxiety explain 17.5% of high blood pressure in this sample.

Age and Wake Disturbance significantly predicted diabetes in this sample. Within this final model, the R square was .055, so age and WD explained 5.5% of diabetes in this sample (p = .002).

Chi-square analyses were performed to determine associations between sleep disorder diagnoses and the independent variables and health outcomes (see Table 8). First, the presence of an insomnia diagnosis was associated with depression ($x^2 = 9.89$; p = .002), income, ($x^2 = 18.53$; p<.01), and race ($x^2 = 13.65$; p = .001). Among participants with an insomnia diagnosis, the majority were Caucasian (61.4%), reported depression (77.2%), and less than \$20,000 income (46.4%). Next, obstructive sleep apnea diagnosis was associated with high blood pressure ($x^2 = 21.23$; p < .01), body mass index ($x^2 = 17.65$; p < .01), diabetes ($x^2 = 4.21$; p = .04), relationship status, ($x^2 = 7.06$; p = .029), and income ($x^2 = 12.58$; p = .006). Participants who reported a sleep apnea diagnosis tended to have high blood pressure (55.2%), be overweight or obese (89.6%), be married or living with a partner (53.1%), and have an income between

\$50,000 - \$99,999 (42.7%). Lastly, restless legs syndrome was associated with high blood pressure ($\chi^2 = 6.69$; $p = .01$). Participants reporting a restless legs syndrome diagnosis tended to have high blood pressure (57.6%).

Table 8: Chi Square Analyses for Sleep Disorder Diagnoses

Sleep Disorder	Associated variable	χ^2	df	p
Insomnia	Depression	9.89	1	.002
	Income	18.53	3	.010
	Race	13.65	2	.001
Obstructive Sleep Apnea	High blood pressure	21.23	1	.000
	Body Mass Index	17.65	1	.000
	Relationship status	7.06	2	.029
	Income	12.58	3	.006
Restless Legs Syndrome	High blood pressure	6.69	1	.010

Logistic regression analyses were performed to determine predictors of the presence of a sleep disorder diagnosis (insomnia, obstructive sleep apnea, or restless legs syndrome). A summary of these results is displayed in Table 9. Sleep disturbance predicted the presence of insomnia. With an R square of .135, sleep disturbance explains 13.5% of the diagnosis of insomnia ($p < .001$). The predicting variables of obstructive sleep apnea were age and sleep disturbance. Within this final model, these two factors explained 17.9% of obstructive sleep apnea diagnosis ($R^2 = .179$; $p < .001$). Lastly, no predictors were statistically significant for restless legs syndrome.

Table 9: Results of Regression of Sleep Disorder

	n (%) Yes	β Age	β SD	R Square
Insomnia	70 (27.1%)	---	-1.22**	.135
Sleep apnea	96 (37.2%)	-.037**	.57**	.179
Restless Legs	33 (12.8%)	---	---	---

SD = Sleep Disturbance; *p<.05; **p<.01

5.0 DISCUSSION

The sleep literature and PROMIS data analysis present a complex relationship between sleep and health. Through examination of the literature of the general population, it is possible to draw out a wide range of epidemiological and health factors associated with poor sleep. The PROMIS study examined individuals with sleep disorders and can be utilized to determine what individuals are most affected by these sleep problems. With such a widespread impact in place, it is helpful to use the social ecological model throughout the discussion (Figure 1).



Figure 1: Centers for Disease Control Social-Ecological Model

Source: http://www.cdc.gov/ncipc/dvp/Social-Ecological-Model_DVP.htm

The social ecological model takes into account the complexity of factors that may have an effect on sleep and health. The model begins at the individual level, which considers a person's genetic history as well as demographic factors such as race, ethnicity, and age. This level also explores an individual's attitudes, knowledge, and beliefs. Next, the model extends out to relationships, or rather, how family members, peer groups, or partners affect health. Further still, the model looks into the community's influence on health. This level investigates the workplace, school,

and neighborhood as they play a role in health. Lastly, the model takes a broader view at the societal influence on health, which can include cultural, economic, and political factors. Given the layers of associations that exist between sleep and health, the use of such a model provides a framework for the discussion of literature review and data analysis results.

5.1 PROMIS SLEEP SAMPLE

The PROMIS clinical sample was purposefully drawn to include individuals who self-reported symptoms of a sleep disorder. As a result, this sample provides a truncated range of sleep-related factors. In other words, this sample represents a clinical population, and the scope of the information provided is limited to the epidemiology and health outcomes of a sleep-disordered population. Factors associated with health outcomes crossed levels of the social ecological model, including individual-level items such as body-mass index and relationship-level items including relationship status. Correlations, mean comparisons, and regression analyses show that several other factors were also associated with sleep among the PROMIS sample of individuals with sleep disorders.

Age was negatively correlated with wake disturbance scores. That is, among the PROMIS clinical sleep sample, the higher the age, the lower the wake disturbance. Since wake disturbance targets symptoms associated with daytime sleepiness, this suggests that the younger an individual is, the more likely he/she is to report daytime functioning problems. Conversely, the older an individual, the less likely he or she is are to report a problem in daytime functioning. Sleep disturbance was not significantly correlated with age. Although the literature suggests that

age is correlated with poor sleep, this finding from PROMIS suggests that younger people are more likely to report tiredness than older people. This conflict could represent a difference between the general population observed in the literature and the clinical population in the PROMIS study. Perhaps younger individuals with diagnosable sleep disorders report worse sleep. Since the data were collected on a computer, the reporting of symptoms may also be effected by age.

Next, income was correlated with education, sleep disturbance, and wake disturbance. First, income was positively correlated with education. This is a fairly common correlation in the general population (Day, 2002). However, the correlation was not high enough to cause concern that that the variables were too similar, or that only one should be included in analysis.

Income was negatively correlated with sleep disturbance, meaning that the lower the income, the higher the sleep disturbance. Through post hoc analyses, the “Less than \$20,000” group differed from each of the other income groups: \$20,000 - \$49,999; \$50,000 - \$99,999, and \$100,000 or more. However, the three higher income groups were not significantly different from each other. This suggests that the lowest income group (n = 73; 28.2%) is especially affected by sleep and wake disturbances, since the lowest income group was significantly different from all other income groups. Since correlations have shown that participants with lower incomes had higher sleep disturbance scores, it appears that even among participants who have self-reported a sleep problem, the lower income group reports the worst symptoms. Low income was also associated with the presence of an insomnia diagnosis. This health disparity coincides with many other social risk factors that disproportionably affect low income groups. For example, low-income neighborhoods tend to be high-crime areas, so sleep may be commonly disrupted due to neighborhood troubles. General daily stresses also affect the general

health and sleep of the low income population (Almeida, Neupert, Banks, & Serido, 2005; Grzywacz, Almeida, Neupert, & Ettner, 2004; McLeod & Kessler, 1990). In terms of the sleep environment, low-income individuals and families may have low quality bedding. Also, individuals with lower income tend to have more mental health problems (Berkman & Kawachi, 2000; Lorant, Deliege, Eaton, Robert, Philippot, & Anseau, 2003; Marmot & Wilkinson, 1999). The increased stress associated with having lower income can translate into increased difficulty falling and staying asleep as a result of anxious thinking. Also, while the PROMIS study did not collect data on childcare duties of the participants, the relationship between low income and poor sleep may also reflect the obligations of single, low-income mothers whose sleep is disrupted because of childcare responsibilities.

Income was negatively correlated with wake disturbance. That is, the PROMIS data illustrate that participants with lower incomes tended to have higher wake disturbance scores. In this case, the general stress of a low-income population may contribute to feelings of sleepiness and a decrease in the quality of daytime functioning. Occupational stress, childcare, and relationship difficulties may all play a role in the correlation between wake disturbance and income. However, it is important to not assume that only low-income individuals have such issues. Instead, these factors are suggestions of factors which may compound to produce problems with functioning throughout the day.

Individuals with a diagnosis of obstructive sleep apnea tended to have an income from \$50,000 - \$99,999. This finding could be a function of the participant's relationship status. In other words, individuals with a diagnosis of sleep apnea tended to be married, which could potentially mean two incomes, allowing them to fall into a higher income bracket. This could

also be reflecting the tendency of married individuals to seek a doctor's care, compared to non-married individuals (Joung, Van Der Meer, & Mackenbach, 1995).

Along the same vein, education was negatively correlated with both sleep and wake disturbance. That is, lower educated participants tended to have higher sleep and wake disturbance scores. For sleep disturbance, the differences were for each of the education groups (high school or less vs. some college; high school or less vs. college degree or higher; some college vs. college degree or greater). Since correlations revealed that lower educated participants tended to have higher sleep and wake disturbance, the mean differences show that each group's sleep problems are actually different from one another. In other words, higher educated participants tend to report fewer symptoms of sleep problems and in turn, are reporting significantly better health outcomes. The highest education group (college degree or greater) also reports significantly fewer symptoms than even the next group (some college). This may reveal a difference in the awareness, knowledge, and implementation of healthy sleep behaviors. Such behaviors include restriction of the bedroom to sleep and intimacy. Sleep behavior therapists also suggest include avoiding work (e.g. occupational phone calls, laptop work), engaging in stressful conversations, and watching television in the bedroom, especially right before bedtime. From this sample, the highest educated participants seem to have the best sleep. Since this analysis is from a clinical sleep sample, this demonstrates that among people with sleep problems, higher education lessens the risk for sleep problems. In turn, this group may have had the greatest chance of an opportunity to learn about such behaviors. Along the same lines, the "some college" group would also have more of a chance of receiving health information than the "high school or less" group.

For wake disturbance, the only significant difference existed between the lowest educated group and the highest educated group. The lower education group had significantly more wake disturbance than the highest education group. This mirrors the above differences in sleep disturbances, and the psychosocial stressors of lower education and lower income may mediate such a difference. Also, in this case, while the “some college” group had a lower mean of wake disturbance scores, it was not statistically significant. Still, the lower education sample had the highest scores, and thus the worse sleep. Again, individuals with less education are less likely to be aware of healthy sleep behaviors.

Next, the PROMIS participants’ Body Mass Index (BMI) was negatively correlated with sleep disturbance. This suggests that among the sample, those with lower BMI had higher sleep disturbance scores. BMI was not significantly correlated with wake disturbance. On the other hand, being overweight or obese was associated with the presence of a diagnosis of obstructive sleep apnea. Given the conflict within the PROMIS sample, this finding may represent a discrepancy in the sample of individuals who would be identified as at risk for a sleep problem. Many researchers focus on obesity’s relationship with sleep, yet in some cases, the non-obese may self-report more sleep problems. Obesity was associated with a sleep apnea diagnosis in the sample, but not with wake disturbance, a common symptom of a sleep apnea diagnosis. Given obesity’s ties to poor overall health, perhaps obese individuals are more concerned with more prominent health problems, rather than the quality of their sleep.

Sleep disturbance was positively correlated with wake disturbance. This is a common, expected correlation. Individuals reporting poor sleep are also likely to report poor daytime functioning. However, the correlation is not strong enough to cause concern that the two

variables are assessing the same concepts. This allows for examination of both scores separately and their relation to demographics and health outcomes.

Relationship status also played a role in health outcomes. First, sleep disturbance was significantly different across relationship groups (Never Married, Married/Living with partner in committed relationship, Separated/Divorced/Widowed). Post hoc analyses revealed differences between the married/living with partner group and both the never married and separated/divorced/widowed group. By examining the means, the married/living with partner group had the lowest mean of sleep disturbance scores, indicating they had the “best” sleep of the three groups. Given the potentially positive effect of a committed relationship on mental health, this may also be associated with better sleep scores among this sample. The presence of a bed partner may also stimulate feelings of safety, calmness, and intimacy, all of which potentially aid in better sleep. Also, it is important to note the lack of difference between the never married and the separated/divorced/widowed group. This could lead to the assumption that the distinguishing factor for better sleep is the presence of a significant other. However, it is unknown whether individuals in these other groups have regular bed partners but do not consider themselves to be “living with a partner in a significant relationship.”

For wake disturbance, differences existed between the never married and the married/living with partner groups. No other significant differences existed among the other relationship groups. Here, the married/living with partner group had the lowest wake disturbance scores, or the fewest symptoms of a daytime functioning effect. The separated/divorced/widowed group’s mean was higher, but not statistically different. This difference suggest that those who were never married reported worse symptoms related to sleepiness, tiredness, and other sleep-related effects during the day. This significant difference

may be related to the companionship and social support received from a live-in partner, which contributes to better functioning throughout the day. Also, the never married group may be revealing more ego-centric symptom reporting. In other words, without the live-in committed relationship, they may be more prone to concentrating on their own symptoms, feelings, and worries. This differs from the person in a committed relationship, who receives ongoing support and spends time thinking about and caring for the significant other. Also, persons in a committed relationship may be more likely to have received care from a doctor, and in turn receive a diagnosis (Joung, Van Der Meer, & Mackenbach, 1995).

Age, body mass index, anxiety, and the presence of a diagnosis of either obstructive sleep apnea or restless legs syndrome was associated with high blood pressure. Age, BMI, and anxiety have been previously documented to be associated with high blood pressure (Must, Spadano, Coakley, Field, Colditz, & Dietz, 1999). Also, given obesity's tie with obstructive sleep apnea, the association with high blood pressure is expected. Next, diabetes was associated with age and wake disturbance. In other words, a higher wake disturbance score helped predict the presence of diabetes. Since wake disturbance is associated with tiredness and lack of energy, perhaps the association exists as a side effect of diabetes, or even the treatments involved.

Lastly, the presence of an insomnia diagnosis was associated with being Caucasian. Interestingly, however, sleep and wake disturbance scores did not significantly differ by race. Perhaps among a sample of individuals who have previously self-reported a sleep problem, the severity of symptom reporting is similar. Also, perhaps Caucasians are more likely to identify the insomnia diagnosis due to cultural differences in the definition of the disorder and social stigma of the diagnosis.

An insomnia diagnosis was associated with having depression. The tie between poor sleep and poor mental health has been established throughout the literature. Tiredness and a lack of energy are symptoms of both depression and insomnia, so the link is a natural fit. While it is still unclear whether one precedes the other, or they appear simultaneously, the association exists.

No gender differences were found in the PROMIS clinical sleep sample. That is, among those with sleep disorders, individuals of different genders report similar severity and outcomes. This lack of a difference may be due to the clinical aspect of the sample. Also, the PROMIS study was derived from a United States sample, specifically from Pittsburgh and surrounding areas. While the results were generalizable to the United States, it may not reflect the sleep of other countries.

5.2 LITERATURE REVIEW VS. PROMIS

The literature and data from the PROMIS Study clinical sleep sample generally corroborated one another, with some notable exceptions. Each comparison made, however, should be accompanied with the caveat that this thesis evaluated the literature of the general population and analysis of a clinical sleep sample. Disparities between the literature and PROMIS are potentially due to the truncated range of individuals and symptoms within the PROMIS sample. However, not only can this comparison be used to map how well the PROMIS

study relates to the general population, it can help identify which risk factors may be specific to a clinical population.

Age was strongly represented in both the literature and the PROMIS data as a significant factor in sleep and health. Increased age is a well-known risk factor for cardiovascular disease, including high blood pressure (National Institute on Aging, 2007). This was reflected in the PROMIS data in terms of the high blood pressure. While the goal of this thesis was not to reiterate such findings, the consistency of age as a predictor is encouraging. In terms of sleep, however, age was negatively correlated with wake disturbance. Rather, younger individuals tended to have greater difficulty with daytime functioning. While the literature does not negate the presence of sleep problems among the young, most literature identifies the middle-aged and elderly as having the worst sleep. This may be due to the measurement of sleep and wake problems across studies. In a review of sleep assessments, researchers found only six scales that covered the full range of sleep issues (falling asleep, staying asleep, getting adequate sleep, and drowsiness) (Devine, Hakim, & Green, 2005). Unless all research studies are choosing scales that assess each of these domains, it is likely that the definitions of sleep and wake problems are different from one study to the next. For example, one study may assess falling asleep and staying asleep while another examines daytime functioning.

Race and ethnicity did not show well-defined correlations with sleep either in the literature or in the PROMIS data. Lichstein et al. found few studies that documented racial differences in sleep (Lichstein, Durrence, Reidel, Taylor, & Bush, 2004). In studies they found in their review, it appears that African Americans tend to have a higher prevalence of insomnia and sleep apnea and tend to sleep lighter and longer. However, for this thesis, total sleep disturbance and wake disturbance were used for comparisons. The PROMIS sample found an

association between the presence of an insomnia diagnosis and the Caucasian race. Since this difference is only associated with a sleep disorder diagnosis and not the sleep or wake disturbance scores, it is difficult to determine what type of racial differences exist in sleep quality.

Disparities in socioeconomic status (SES) were evident in both the literature and the PROMIS data. The low-income population tended to experience the greatest impact of poor sleep. Given that the low-income population tend to suffer from comparatively worse health overall, this general similarity is not surprising, but unfortunate. Not only does this further demonstrate that low-income individuals are worse off in the general population, it also shows that even among a sample of sleep-disordered individuals, low income individuals experience the worst sleep.

A wealth of literature identifies the relationship between mental health and sleep. Specifically, poor mental health is associated with poor sleep and vice versa. The PROMIS analysis found an association between depression and the presence of an insomnia diagnosis. However, no association was found between depression and sleep or wake disturbance scores. However, the mental health variables used in this thesis were yes/no questions such as “Have you ever been told by a doctor or health professional that you have depression/anxiety?” This type of question is likely not sufficient to capture the wide variability of depressive symptoms that may affect sleep. Instead, these questions would only elicit a positive response among those who have experienced symptoms severe enough to warrant a conversation with a health professional. Also, while the literature shows such a strong association between mental health and sleep among the general population, the clinical sleep sample did not. This difference may be the result of more intense interviewing for mental health symptoms within the literature. Also,

individuals in the PROMIS study were recruited for sleep problems specifically, who either may not relate mental health and sleep, or were concentrating more intensely on sleep symptoms.

The literature strongly suggests a gender difference in sleep quality, suggesting women tend to have worse sleep and thus poorer health outcomes. However, the PROMIS clinical sleep sample did not find gender to be significantly associated with sleep or wake disturbance. This may be another issue of the measurement of sleep, as it is not standardized between research studies. Also, the PROMIS study consisted only of participants who reported a certain level of sleep problem symptoms. Or rather, PROMIS did not include non-symptomatic participants. Perhaps the lack of gender difference in PROMIS can be explained by the inclusion of only people with sleep problems. This may suggest that among individuals with sleep problems, the severity of the problem does not significantly differ between the genders. Since the literature shows that women tend to report more sleep problems, this may be more reflected in the percentage of women in the PROMIS sample (approximately 60%).

Relationship status emerged as an important factor for sleep and wake disturbance in both the literature and the PROMIS sample. Married individuals as well as those living with a partner in a committed relationship tended to have better sleep. The reverse also held true. Divorced, separated, widowed, and never married people had worse sleep than individuals who were married or living with a partner. Since the literature further examined the subjective status of the marriage as a predicting factor of sleep (i.e. happier marriages resulted in better sleep than unhappy marriages), it is important to not assume that all married individuals have good sleep. This reflects other literature linking positive affect and general happiness to better sleep as well.

Obesity/BMI also played key roles in cardiovascular conditions. For example, being overweight or obese was associated with a diagnosis of obstructive sleep apnea within the

PROMIS sample. The analysis also reflected previous extensive literature that documented obesity as a major risk factor for conditions such as heart disease and diabetes (Must, Spadano, Coakley, Field, Colditz, & Dietz, 1999). While this was not the focus of the thesis, it is important to note the consistency of such findings.

The literature supports the association between sleep and cardiovascular problems, diabetes, and cancer. Some research examined causal relationships, as in whether poor sleep caused a health condition or vice versa. Others explored poor sleep as a side effect that seemed to exacerbate an existing health condition. Within the PROMIS study, high blood pressure was associated with the presence of a diagnosis of obstructive sleep apnea or restless legs syndrome. Obesity may mediate this association, given its ties to high blood pressure and obstructive sleep apnea. Also, wake disturbance helped predict the presence of diabetes. However, as stated earlier, the PROMIS study had very few individuals who positively identified a health condition. This small sample size did not provide adequate information to make any inferences about associations.

5.3 STRENGTHS AND LIMITATIONS

5.3.1 Strengths

When comparing the PROMIS study with the literature synthesis, it was possible to identify demographics that are related to a high-risk of sleep problems. By using the PROMIS study, which studied a clinical sleep-disordered sample, the risk factors identified will help tailor

sleep treatments. By analyzing which individuals have the worst sleep among this sample, it is possible to find the “worst of the worst” and potentially have a greater public health impact in sleep treatment.

The PROMIS study was based on self-report on a computerized survey, which allowed for easy collection of information. The data were instantly sent to a statistical coordinating center, so data loss was minimal. Since the data were already stored, this allowed for easy access and analysis. Also, since the survey could be completed on any computer with internet access, this allowed for a relatively easy mode of administration and little participant burden.

5.3.2 Limitations

However, many limitations exist in this comparison. First, the PROMIS study was done cross-sectionally and the questions assessed the “past seven days” for the participant. Within such a limited one-time assessment, there lies potential to “miss” some of the symptoms the person has experienced, since they did not occur in the past week. Also, within a week’s time there is a chance of experiencing more situational sleep problems that may or may not be exacerbated by an underlying sleep disorder.

The PROMIS sample consisted of individuals from the United States, primarily from Pittsburgh areas. Since the literature extended to outside the U.S., comparability is also somewhat limited. The definition of poor sleep may vary both within and outside the U.S. with cultural differences. For example, in a survey of 10 countries, the types of sleep disturbances reported differed. Austrian, Portuguese, and Chinese individuals reported more trouble falling asleep, whereas individuals in Belgium, Germany, Slovakia, Spain, and South Africa reported

more awakenings throughout the night. Brazilian and Japanese participants reported too little sleep (Soldatos, Allaert, Ohta, & Dikeos, 2005). In another national study using sleep diaries, the definition of daytime sleepiness differed between countries, especially among Asian cultures. Given the varying definitions for sleep disturbances, these researchers noted the need for a standardized cross-nationally validated sleep instruments (Adam, Snell, & Pendry, 2007).

As mentioned within the discussion, another limitation is the comparability of the assessment of sleep between research studies. In other words, the definition of a sleep problem may substantially differ between studies in terms of professional opinion, scale choice, cultural background, or diagnostic criteria. PROMIS used a sophisticated method to allow for an overall sleep severity score. However, other research studies based their sleep assessment on scales that may or may not reflect the various symptoms of sleep problems. Others may use physical measurements. The need for standardization of sleep assessment becomes apparent.

The diagnoses reported in the PROMIS study were not supported by physical assessment, but instead on self-report. For example, obstructive sleep apnea and restless legs syndrome could be examined via polysomnography, or a sleep study, which can record breathing cessations and other biophysiological changes associated with sleep disorders. Insomnia could be further diagnosed through extensive interviews with a specialist.

This sample included only individuals who reported a sleep problem. While they were from Pittsburgh and surrounding communities, they may not be representative of the entire sleep disorder population. Also, by examining the PROMIS sleep sample, only a small section of the potential demographics and health outcomes associated with sleep are seen. When looking at the correlation between demographics of sleep problems and health, only a small section of the continuum is represented.

The number of individuals in the sample who identified negative health outcomes was very small for some disorders, and several were removed from PROMIS data analysis. Only high blood pressure and diabetes were examined within the PROMIS sample, which may not reflect the health outcome of cardiovascular disease fully.

6.0 CONCLUSIONS

This thesis reflects the abundance of literature and research on sleep and its effects on health. The PROMIS study echoed many of the previous literature's findings regarding high-risk populations and significant health outcomes of poor sleep. Given the discrepancies identified both within the literature and between the literature and PROMIS, more research is needed to better understand the multi-faceted impact of sleep on health. As a result of this literature synthesis and analysis of PROMIS data, it is possible to argue for the importance of sleep assessment and future sleep research, as well as offer suggestions for future interventions.

6.1 SLEEP ASSESSMENT

Sleep problems are often overlooked within the primary care setting, and as a result, have under-appreciated and sometimes undocumented effects on health. By using the Social Ecological Model and especially utilizing a societal perspective, it is necessary to encourage the integration of sleep assessment at many levels. It is important to examine individual level factors, such as race, age, and SES, as they affect sleep. Since marital status plays a role, the relationship status of an individual should also be taken into account. Within the community, neighborhood problems, such as crime and safety considerations, will need to be examined with regards to

sleep problems. Lastly, at the societal level, increased awareness and knowledge of the sleep's impact on health is required both by the general population and health care workers. If sleep is assessed and thereby treated regularly, a large public health impact is possible (Colten & Altevogt, 2006).

With the need for assessment established, the next step is the creation and implementation of sleep assessment instruments. Many validated self-reports are available, such as the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), which can be included in patient paperwork. Also, the PROMIS study created a quick computerized assessment which can be easily integrated into a primary care or other public health setting. Since the assessments are within the public domain, free, and readily accessible over the internet, PROMIS provides a simple method to quickly assess a patient's sleep or wake disturbance score in minutes. This does not provide a diagnosis for a sleep disorder, but instead provides a health care worker with a patient's "temperature" on a "thermometer" of sleep and wake disturbance, which can open up further discussion.

6.2 FUTURE RESEARCH

Several types of studies are still needed to increase the public's attention towards sleep's impact on health. The PROMIS study was a cross-sectional study with a purposefully recruited sample of participants with sleep problems. With that being the case, more prospective, longitudinal studies of sleep assessment are necessary to provide a lifespan perspective of the factors which affect sleep and the impact of sleep on public health. Since only a small

percentage of the sample reported cardiovascular conditions, case-control studies that compare sleep's impact on individuals with and without cardiovascular conditions would provide meaningful evidence of sleep's contribution to health.

Since several contradictions existed within the literature regarding the demographic risk factors for poor sleep, more research is needed to have a better understanding of the higher risk groups for poor sleep. Multi-faceted research that examines several demographics would be useful since it appears that no one demographic is at the highest risk. Rather, a combination of factors is likely to contribute to the resulting poor sleep.

6.3 SUGGESTIONS FOR INTERVENTIONS

As a preface to the suggestions for future interventions, it is important to identify existing effective treatments that can be utilized to both target at-risk individuals and continue to tease out the confounding variables which affect sleep. First, cognitive behavioral therapy (CBT) has shown to be extremely effective in treating symptoms of insomnia. CBT is effective among children and adolescents (Owens, France, & Wiggs, 1999; Sadeh, 2005), adults (Irwin, Cole, & Nicassio, 2006; Riemann & Perlis, 2009) and the elderly (Montgomery & Dennis, 2004). Pharmacological treatments, such as benzodiazepine receptor agonists, are also available, but some research has shown that these are effective only in the short-term, compared to longer term effects of behavioral treatments (Riemann & Perlis, 2009). For sleep apnea, the standard treatment is with a Continuous Positive Airway Pressure (CPAP) machine (McDaid, Durée, Griffin, Weatherly, Stradling, Davies et al., ; Pusalavidyasagar, Olson, Gay, & Morgenthaler,

2006). Since these interventions have been documented as effective, they can be used as potential starting points for future interventions.

Despite the apparent discrepancies in the literature, several high-risk groups emerged which could be target populations for interventionists. Since this thesis compared a literature synthesis and a PROMIS sleep sample, two different types of groups can emerge. First, it is possible to identify groups at risk for developing sleep problems among the general population. Next, using the PROMIS study, researchers can identify individuals in a sleep-disordered population who may be at risk for other health problems associated with poor sleep.

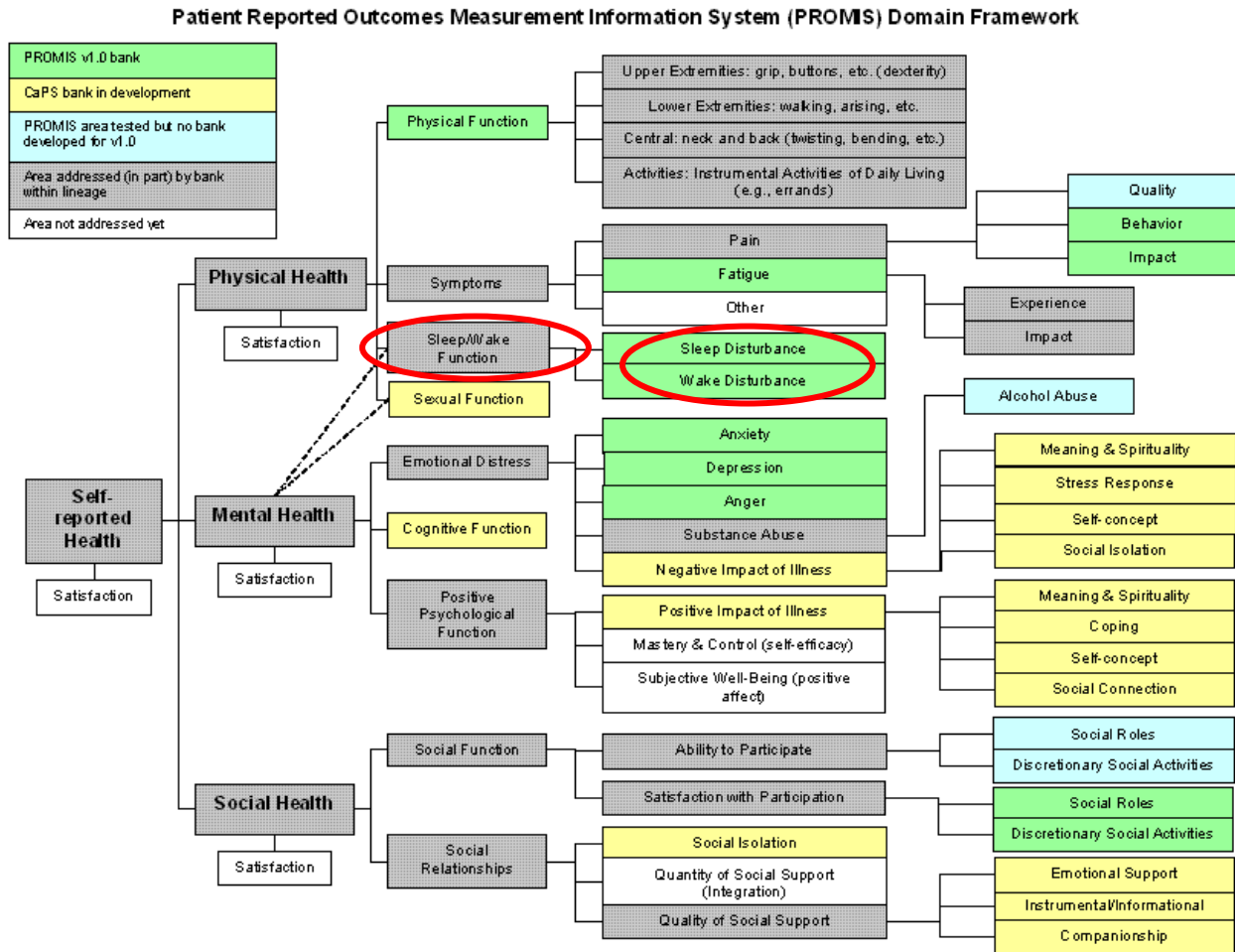
First, older women are well-studied and have been repeatedly identified as having poor sleep. Since age seems to be a factor overall, interventions including all elderly would provide a public health impact. However, given that the PROMIS study found that younger people identified more disturbances during the day as a result of poor sleep, it is important to not neglect other age ranges. Also, in a clinical sleep sample, younger individuals may tend to report worse sleep, and treatment-related interventions may need to tailor therapy and medications according to age. Obesity was also a factor in poor sleep and should be taken into account as a part of sleep interventions.

Researchers who specialize in other physical health conditions would increase the strength of their intervention by assessing participant's sleep. The additional sleep data, a possible mediating factor to the studied health condition, could help explain at least some of the factors involved in the health of the participants.

6.4 FINAL CONCLUSIONS

Sleep has a great significance in public health, even though its impact is sometimes under-appreciated. By reviewing the literature and the PROMIS clinical sleep sample, it is possible to determine which individuals should be targeted more closely for interventions within the general population and among participants with sleep disorders. From this examination, certain demographics seem to have a higher risk for developing sleep problems, such as the female gender, the elderly, African Americans, and the overweight and obese. Unmarried and low income individuals are especially affected by sleep and should be targeted among both the general population and among individuals with sleep problems. Among the general population, interventions should be directed towards lower income individuals, women, the elderly, and the overweight/obese. Among those with sleep disorders, younger, Caucasian individuals should receive special attention. In the end, sleep is a universally experienced state which should provide restorative effects. With such a potentially beneficial impact on quality of life and health, sleep demands greater attention from health professionals and the general population.

APPENDIX: PROMIS DOMAIN FRAMEWORK



Retrieved from <http://www.nihpromis.org/Web%20Pages/Domain%20Framework.aspx>.

BIBLIOGRAPHY

- Adam, E. K., Snell, E. K., & Pendry, P. (2007). Sleep Timing and Quantity in Ecological and Family Context: A Nationally Representative Time-Diary Study. *Journal of Family Psychology, 21*(1), 4.
- Allen, K. D., Renner, J. B., Devellis, B., Helmick, C. G., & Jordan, J. M. (2008). Racial Differences in Sleep Medication Use: A Cross-Sectional Study of the Johnston County Osteoarthritis Project (September). *Ann Pharmacother.*
- Allen, R. P., & Mitler, M. M. (2009). Restless Legs Syndrome (RLS) and sleep. Retrieved July 12, 2009, from <http://www.sleepfoundation.org/article/sleep-related-problems/restless-legs-syndrome-rls-and-sleep>
- Almeida, D. M., Neupert, S. D., Banks, S. R., & Serido, J. (2005). Do daily stress processes account for socioeconomic health disparities? *Journal of Gerontology Series B: Psychological Sciences and Social Sciences, 2*(Special No. 60), 34-39.
- Appling, S. E. (1997). Sleep: linking research to improved outcomes. *Medsurg Nurs, 6*(3), 159-161.
- Artazcoz, L., Cortes, I., Borrell, C., Escriba-Aguir, V., & Cascant, L. (2007). Gender perspective in the analysis of the relationship between long workhours, health and health-related behavior. *Scand J Work Environ Health, 33*(5), 344-350.
- Arzt, M., Young, T., Finn, L., Skatrud, J. B., Ryan, C. M., Newton, G. E., Mak, S., Parker, J. D., Floras, J. S., & Bradley, T. D. (2006). Sleepiness and sleep in patients with both systolic heart failure and obstructive sleep apnea. *166*(16), 1716-1722.
- Atkinson, G., Fullick, S., Grindey, C., & Maclaren, D. (2008). Exercise, energy balance and the shift worker. *Sports Med, 38*(8), 671-685.
- Bass, J., & Turek, F. W. (2005). Sleepless in America: a pathway to obesity and the metabolic syndrome? *Arch Intern Med, 165*(1), 15-16.
- Berkman, L. F., & Kawachi, I. (2000). *Social epidemiology*. New York: Oxford University Press.
- Blazer, D. G., Hays, J. C., & Foley, D. J. (1995). Sleep complaints in older adults: A racial comparison. *Journal of Gerontology, 50A*(5), M280-M284.
- Bliwise, D. L., Ansari, F. P., Straight, L. B., & Parker, K. P. (2005). Age changes in timing and 24-hour distribution of self-reported sleep. *Am J Geriatr Psychiatry, 13*(12), 1077-1082.
- Bonuck, K., Parikh, S., & Bassila, M. (2006). Growth failure and sleep disordered breathing: a review of the literature. *Int J Pediatr Otorhinolaryngol, 70*(5), 769-778.
- Bradley, T. D., Yount, T. B., Strohl, K. P., Bliwise, D., Buysse, D. J., Carskadon, M., Dinges, D. F., Flemmons, W., Fowler, F. J., George, C., Hla, M., Lowe, A., McHorney, C., Pack, A., Palta, M., Powell, N., Rapaport, D., Redline, S., Sandblom, R., Schmidt-Nowara, W.,

- Sher, A., Terrin, M., Tosselli, R., Weaver, T., Weiss, J. W., & White, D. B. (1998). Statement on health outcomes research in sleep apnea. *Am J Respir Crit Care Med*, *157*(1), 335-341.
- Brassington, G. S., King, A. C., & Bliwise, D. L. (2000). Sleep problems as a risk factor for falls in a sample of community-dwelling adults aged 64-99 years. *J Am Geriatr Soc*, *48*(10), 1234-1240.
- Briones, B., Adams, N., Strauss, M., Rosenberg, C., Whalen, C., Carskadon, M., Roebuck, T., Winters, M., & Redline, S. (1996). Relationship between sleepiness and general health status. *Sleep*, *19*(7), 583-588.
- Brostrom, A., Stromberg, A., Dahlstrom, U., & Fridlund, B. (2004). Sleep difficulties, daytime sleepiness, and health-related quality of life in patients with chronic heart failure. *J Cardiovasc Nurs*, *19*(4), 234-242.
- Brown, D. L. (2006). Sleep disorders and stroke. *Semin Neurol*, *26*(1), 117-122.
- Budhiraja, R., Parthasarathy, S., & Quan, S. F. (2007). Endothelial dysfunction in obstructive sleep apnea. *J Clin Sleep Med*, *3*(4), 409-415.
- Buysse, D. J. (2004). Insomnia, depression and aging. Assessing sleep and mood interactions in older adults. *Geriatrics*, *59*(2), 47-51; quiz 52.
- Buysse, D. J., Reynolds, C. F. r., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213.
- Byles, J. E., Mishra, G. D., & Harris, M. A. (2005). The experience of insomnia among older women. *Sleep*, *28*(8), 972-979.
- Byles, J. E., Mishra, G. D., Harris, M. A., & Nair, K. (2003). The problems of sleep for older women: changes in health outcomes. *Age Ageing*, *32*(2), 154-163.
- Caples, S. M., Wolk, R., & Somers, V. K. (2005). Influence of cardiac function and failure on sleep-disordered breathing: evidence for a causative role. *J Appl Physiol*, *99*(6), 2433-2439.
- Cassar, A., Morgenthaler, T. I., Lennon, R. J., Rihal, C. S., & Lerman, A. (2007). Treatment of obstructive sleep apnea is associated with decreased cardiac death after percutaneous coronary intervention. *J Am Coll Cardiol*, *50*(14), 1310-1314.
- Cella, D., Yount, S., Rothrock, N., Gershon, R., Cook, K., Reeve, B., Ader, D., Fries, J. F., Bruce, B., Rose, M., & Group, P. C. (2007). The Patient-Reported Outcomes Measurement Information System (PROMIS): Progress of an NIH roadmap cooperative group during its first two years. *Medical Care*, *45*(5 Suppl 1), S3-S11.
- Chervin, R. D., Weatherly, R. A., Garetz, S. L., Ruzicka, D. L., Giordani, B. J., Hodges, E. K., Dillon, J. E., & Guire, K. E. (2007). Pediatric sleep questionnaire: prediction of sleep apnea and outcomes. *Arch Otolaryngol Head Neck Surg*, *133*(3), 216-222.
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Orlando: Academic Press.
- Colten, H. R., & Altevogt, B. M. (2006). *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*. Washington, D.C.: The National Academies Press.
- Cuellar, N. G., & Ratcliffe, S. J. (2008a). A comparison of glycemic control, sleep, fatigue, and depression in type 2 diabetes with and without restless legs syndrome. *J Clin Sleep Med*, *4*(1), 50-56.

- Cuellar, N. G., & Ratcliffe, S. J. (2008b). Restless legs syndrome in type 2 diabetes: implications to diabetes educators. *Diabetes Educ*, 34(2), 218-234.
- Day, J. C. (2002). The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings. Retrieved June 12, 2009, from <http://www.census.gov/prod/2002pubs/p23-210.pdf>
- Delzell, J. E., Jr., Phillips, R. L., Jr., Schnitzer, P. G., & Ewigman, B. (2001). Sleeping position: change in practice, advice, and opinion in the newborn nursery. *J Fam Pract*, 50(5), 448.
- Dement, W. C., & Pelayo, R. (1997). Public health impact and treatment of insomnia. *European Psychiatry*, 12(Supplement 1), 31.
- DeSantis, A. S., Adam, E. K., Doane, L. D., Mineka, S., Zinbarg, R. E., & Craske, M. G. (2007). Racial/ethnic differences in cortisol diurnal rhythms in a community sample of adolescents. *J Adolesc Health*, 41(1), 3-13.
- Devine, E. B., Hakim, Z., & Green, J. (2005). A systematic review of patient-reported outcome instruments measuring sleep dysfunction in adults. *Pharmacoeconomics*, 23(9), 889-912.
- DeWalt, D. A., Rothrock, N., Yount, S., Stone, A. A., & Group, P. C. (2007). Evaluation of item candidates: the PROMIS qualitative item review. *Medical Care*, 45(5 Suppl 1), S12-21.
- DeZee, K. J., Hatzigeorgiou, C., Kristo, D., & Jackson, J. L. (2005). Prevalence of and screening for mental disorders in a sleep clinic. *J Clin Sleep Med*, 1(2), 136-142.
- Doghramji, K. (2006). The epidemiology and diagnosis of insomnia. *Am J Manag Care*, 12(8 Suppl), S214-220.
- Dursunoglu, N., & Dursunoglu, D. (2007). Do we neglect women with sleep apnea? *Maturitas*, 56(3), 332-334.
- Ebert, C. S., Jr., & Drake, A. F. (2004). The impact of sleep-disordered breathing on cognition and behavior in children: a review and meta-synthesis of the literature. *Otolaryngol Head Neck Surg*, 131(6), 814-826.
- Elder, S. J., Pisoni, R. L., Akizawa, T., Fissell, R., Andreucci, V. E., Fukuhara, S., Kurokawa, K., Rayner, H. C., Furniss, A. L., Port, F. K., & Saran, R. (2008). Sleep quality predicts quality of life and mortality risk in haemodialysis patients: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). *Nephrol Dial Transplant*, 23(3), 998-1004.
- Finn, L., Young, T., Palta, M., & Fryback, D. G. (1998). Sleep-disordered breathing and self-reported general health status in the Wisconsin Sleep Cohort Study. *Sleep*, 21(7), 701-706.
- Gjerdengen, D. K., & Chaloner, K. M. (1994). The relationship of women's postpartum mental health to employment, childbirth, and social support. *J Fam Pract*, 38(5), 465-472.
- Gooneratne, N. S., Gehrman, P. R., Nkwuo, J. E., Bellamy, S. L., Schutte-Rodin, S., Dinges, D. F., & Pack, A. I. (2006). Consequences of comorbid insomnia symptoms and sleep-related breathing disorder in elderly subjects. *Arch Intern Med*, 166(16), 1732-1738.
- Gooneratne, N. S., Weaver, T. E., Cater, J. R., Pack, F. M., Arner, H. M., Greenberg, A. S., & Pack, A. I. (2003). Functional outcomes of excessive daytime sleepiness in older adults. *J Am Geriatr Soc*, 51(5), 642-649.
- Grandner, M. (2009). *Who sleeps better? Socioeconomic differences in reports of sleep disturbance* Paper presented at the 23rd Annual Meeting of the Associated Professional Sleep Societies.

- Grzywacz, J. G., Almeida, D. M., Neupert, S. D., & Ettner, S. L. (2004). Socioeconomic status and health: a micro-level analysis of exposure and vulnerability to daily stressors. *Journal of Health and Social Behavior, 45*, 1-16.
- Haack, M., Sanchez, E., & Mullington, J. M. (2007). Elevated inflammatory markers in response to prolonged sleep restriction are associated with increased pain experience in healthy volunteers. *Sleep, 30*(9), 1145-1152.
- Hackney, J. E., Weaver, T. E., & Pack, A. I. (2008). Health literacy and sleep disorders: a review. *Sleep Med Rev, 12*(2), 143-151.
- Hale, L., & Do, D. P. (2007). Racial differences in self-reports of sleep duration in a population-based study. *Sleep, 30*(9), 1096-1103.
- Hiscock, H., Canterford, L., Ukoumunne, O. C., & Wake, M. (2007). Adverse associations of sleep problems in Australian preschoolers: national population study. *Pediatrics, 119*(1), 86-93.
- Hunt, C. E., Lesko, S. M., Vezina, R. M., McCoy, R., Corwin, M. J., Mandell, F., Willinger, M., Hoffman, H. J., & Mitchell, A. A. (2003). Infant sleep position and associated health outcomes. *Arch Pediatr Adolesc Med, 157*(5), 469-474.
- Irwin, M. R., Cole, J. C., & Nicassio, P. M. (2006). Comparative Meta-Analysis of Behavioral Interventions for Insomnia and Their Efficacy in Middle-Aged Adults and in Older Adults 55+ Years of Age. *Health Psychology, 25*(1), 3.
- Johns, M. W. (1991). A new method for measuring daytime sleepiness: The Epworth sleepiness scale. *Sleep, 14*(6), 540-545.
- Joung, I. M. A., Van Der Meer, J. B. W., & Mackenbach, J. P. (1995). Marital status and health care utilization. *International Journal of Epidemiology, 24*(3), 569-575.
- Knutson, K. L., Ryden, A. M., Mander, B. A., & Cauter, E. V. (2006). Role of sleep duration and quality in the risk and severity of Type 2 diabetes mellitus. *Arch Intern Med, 166*(16), 1768-1774.
- Lam, J. C., & Ip, M. S. (2007). An update on obstructive sleep apnea and the metabolic syndrome. *Curr Opin Pulm Med, 13*(6), 484-489.
- Lam, L. T., & Yang, L. (2007). Short duration of sleep and unintentional injuries among adolescents in China. *Am J Epidemiol, 166*(9), 1053-1058.
- Lam, P., Hiscock, H., & Wake, M. (2003). Outcomes of infant sleep problems: a longitudinal study of sleep, behavior, and maternal well-being. *Pediatrics, 111*(3), e203-207.
- Lee, K. A. (1998). Alterations in sleep during pregnancy and postpartum: a review of 30 years of research. *Sleep Med Rev, 2*(4), 231-242.
- Lee, K. A., & Gay, C. L. (2004). Sleep in late pregnancy predicts length of labor and type of delivery. *Am J Obstet Gynecol, 191*(6), 2041-2046.
- Lichstein, K. L., Durrence, H. H., Reidel, B. W., Taylor, D. J., & Bush, A. J. (2004). *Epidemiology of Sleep: Age, Gender, and Ethnicity*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Lindberg, E., Berne, C., Franklin, K. A., Svensson, M., & Janson, C. (2007). Snoring and daytime sleepiness as risk factors for hypertension and diabetes in women--a population-based study. *Respir Med, 101*(6), 1283-1290.
- Lopez-Garcia, E., Faubel, R., Leon-Munoz, L., Zuluaga, M. C., Banegas, J. R., & Rodriguez-Artalejo, F. (2008). Sleep duration, general and abdominal obesity, and weight change among the older adult population of Spain. *Am J Clin Nutr, 87*(2), 310-316.

- Trevillian, L. F., Ponsonby, A. L., Dwyer, T., Kemp, A., Cochrane, J., Lim, L. L., & Carmichael, A. (2005). Infant sleeping environment and asthma at 7 years: a prospective cohort study. *Am J Public Health, 95*(12), 2238-2245.
- Troxel, W. M., Buysse, D. J., Hall, M., & Matthews, K. A. (2009). Marital happiness and sleep disturbances in a multi-ethnic sample of middle-aged women. *Behavioral Sleep Medicine, 7*(1), 2-19.
- Unruh, M. L., Buysse, D. J., Dew, M. A., Evans, I. V., Wu, A. W., Fink, N. E., Powe, N. R., & Meyer, K. B. (2006). Sleep quality and its correlates in the first year of dialysis. *Clin J Am Soc Nephrol, 1*(4), 802-810.
- Wake, M., Morton-Allen, E., Poulakis, Z., Hiscock, H., Gallagher, S., & Oberklaid, F. (2006). Prevalence, stability, and outcomes of cry-fuss and sleep problems in the first 2 years of life: prospective community-based study. *Pediatrics, 117*(3), 836-842.
- Walsh, J. K. (2006). Insights into the public health burden of insomnia. *Sleep, 29*(2), 142-143.
- Wang, M. Y., Wang, S. Y., & Tsai, P. S. (2005). Cognitive behavioural therapy for primary insomnia: a systematic review. *J Adv Nurs, 50*(5), 553-564.
- White, D. B., Balkin, T., Block, G., Buysse, D. J., Dinges, D. F., Gozal, D., Henrikson, S., Kinney, H. C., Landis, C. A., Mignot, E., Owens, J. A., Siegel, J. M., Sternberg, E., & Weese-Mayer, D. F. (2003). 2003 National Sleep Disorders Research Plan. Retrieved July 10, 2009, from http://www.nhlbi.nih.gov/health/prof/sleep/res_plan/index.html
- Williams, C. J., Hu, F. B., Patel, S. R., & Mantzoros, C. S. (2007). Sleep duration and snoring in relation to biomarkers of cardiovascular disease risk among women with type 2 diabetes. *Diabetes Care, 30*(5), 1233-1240.
- Willinger, M., Hoffman, H. J., & Hartford, R. B. (1994). Infant sleep position and risk for sudden infant death syndrome: report of meeting held January 13 and 14, 1994, National Institutes of Health, Bethesda, MD. *Pediatrics, 93*(5), 814-819.
- Yang, E. H., Hla, K. M., McHorney, C. A., Havighurst, T., Badr, M. S., & Weber, S. (2000). Sleep apnea and quality of life. *Sleep, 23*(4), 535-541.
- Young, T., Peppard, P. E., & Gottlieb, D. J. (2002). Epidemiology of obstructive sleep apnea: a population health perspective. *JAMA, 289*, 2230-2237.

- residing in assisted living: findings from the Maryland Assisted Living Study. *Int J Geriatr Psychiatry*, 20(10), 956-966.
- Redeker, N. S., & Hilkert, R. (2005). Sleep and quality of life in stable heart failure. *J Card Fail*, 11(9), 700-704.
- Redeker, N. S., Ruggiero, J. S., & Hedges, C. (2004). Sleep is related to physical function and emotional well-being after cardiac surgery. *Nurs Res*, 53(3), 154-162.
- Reimer, M. A., & Flemons, W. W. (2003). Quality of life in sleep disorders. *Sleep Med Rev*, 7(4), 335-349.
- Reise, S. P., Ainsworth, A. T., & Haviland, M. G. (2005). Item Response Theory. *Current Directions in Psychological Science*, 14(2), 95-101.
- Riemann, D., & Perlis, M. L. (2009). The treatments of chronic insomnia: A review of benzodiazepine receptor agonists and psychological and behavioral therapies. *Sleep Medicine Reviews*, 13(3), 205.
- Sadeh, A. (2005). Cognitive-behavioral treatment for childhood sleep disorders. *Clinical Psychology Review*, 25(5), 612.
- Sigurdson, K., & Ayas, N. T. (2007). The public health and safety consequences of sleep disorders. *Can J Physiol Pharmacol*, 85(1), 179-183.
- Sinha, A. M., Skobel, E. C., & Breithardt, O. A. (2006). Sleep apnea and heart disease. *N Engl J Med*, 354(10), 1086-1089; author reply 1086-1089.
- Sohn, H., & Rosenfeld, R. M. (2003). Evaluation of sleep-disordered breathing in children. *Otolaryngol Head Neck Surg*, 128(3), 344-352.
- Soldatos, C. R., Allaert, F. A., Ohta, T., & Dikeos, D. G. (2005). How do individuals sleep around the world? Results from a single-day survey in ten countries. *Sleep Medicine*, 6(1), 5.
- Spilisbury, J. C., Storfer-Isser, A., Drotar, D., Rosen, C. L., Kirchner, H. L., & Redline, S. (2005). Effects of the home environment on school-aged children's sleep. *Sleep*, 28(11), 1419-1427.
- Spilisbury, J. C., Storfer-Isser, A., Kirchner, H. L., Nelson, L., Rosen, C. L., Drotar, D., & Redline, S. (2006). Neighborhood disadvantage as a risk factor for pediatric obstructive sleep apnea. *J Pediatr*, 149(3), 342-347.
- Stamatakis, K. A., & Brownson, R. C. (2008). Sleep duration and obesity-related risk factors in the rural Midwest. *Prev Med*, 46(5), 439-444.
- Stepnowsky, C., Johnson, S., Dimsdale, J., & Ancoli-Israel, S. (2000). Sleep apnea and health-related quality of life in African-American elderly. *Ann Behav Med*, 22(2), 116-120.
- Steptoe, A., O'Donnell, K., Marmot, M., & Wardle, J. (2008). Positive affect, psychological well-being, and good sleep. *J Psychosom Res*, 64(4), 409-415.
- Strawbridge, W. J., Shema, S. J., & Roberts, R. E. (2004). Impact of spouses' sleep problems on partners. *Sleep*, 27(3), 527-531.
- Strine, T. W., & Chapman, D. P. (2005). Associations of frequent sleep insufficiency with health-related quality of life and health behaviors. *Sleep Med*, 6(1), 23-27.
- Theadom, A., Croyley, M., & Humphrey, K. L. (2007). Exploring the role of sleep and coping in quality of life in fibromyalgia. *J Psychosom Res*, 62(2), 145-151.
- Trenell, M. I., Marshall, N. S., & Rogers, N. L. (2007). Sleep and metabolic control: waking to a problem? *Clin Exp Pharmacol Physiol*, 34(1-2), 1-9.

- Trevillian, L. F., Ponsonby, A. L., Dwyer, T., Kemp, A., Cochrane, J., Lim, L. L., & Carmichael, A. (2005). Infant sleeping environment and asthma at 7 years: a prospective cohort study. *Am J Public Health, 95*(12), 2238-2245.
- Troxel, W. M., Buysse, D. J., Hall, M., & Matthews, K. A. (2009). Marital happiness and sleep disturbances in a multi-ethnic sample of middle-aged women. *Behavioral Sleep Medicine, 7*(1), 2-19.
- Unruh, M. L., Buysse, D. J., Dew, M. A., Evans, I. V., Wu, A. W., Fink, N. E., Powe, N. R., & Meyer, K. B. (2006). Sleep quality and its correlates in the first year of dialysis. *Clin J Am Soc Nephrol, 1*(4), 802-810.
- Wake, M., Morton-Allen, E., Poulakis, Z., Hiscock, H., Gallagher, S., & Oberklaid, F. (2006). Prevalence, stability, and outcomes of cry-fuss and sleep problems in the first 2 years of life: prospective community-based study. *Pediatrics, 117*(3), 836-842.
- Walsh, J. K. (2006). Insights into the public health burden of insomnia. *Sleep, 29*(2), 142-143.
- Wang, M. Y., Wang, S. Y., & Tsai, P. S. (2005). Cognitive behavioural therapy for primary insomnia: a systematic review. *J Adv Nurs, 50*(5), 553-564.
- White, D. B., Balkin, T., Block, G., Buysse, D. J., Dinges, D. F., Gozal, D., Henrikson, S., Kinney, H. C., Landis, C. A., Mignot, E., Owens, J. A., Siegel, J. M., Sternberg, E., & Weese-Mayer, D. F. (2003). 2003 National Sleep Disorders Research Plan. Retrieved July 10, 2009, from http://www.nhlbi.nih.gov/health/prof/sleep/res_plan/index.html
- Williams, C. J., Hu, F. B., Patel, S. R., & Mantzoros, C. S. (2007). Sleep duration and snoring in relation to biomarkers of cardiovascular disease risk among women with type 2 diabetes. *Diabetes Care, 30*(5), 1233-1240.
- Willinger, M., Hoffman, H. J., & Hartford, R. B. (1994). Infant sleep position and risk for sudden infant death syndrome: report of meeting held January 13 and 14, 1994, National Institutes of Health, Bethesda, MD. *Pediatrics, 93*(5), 814-819.
- Yang, E. H., Hla, K. M., McHorney, C. A., Havighurst, T., Badr, M. S., & Weber, S. (2000). Sleep apnea and quality of life. *Sleep, 23*(4), 535-541.
- Young, T., Peppard, P. E., & Gottlieb, D. J. (2002). Epidemiology of obstructive sleep apnea: a population health perspective. *JAMA, 289*, 2230-2237.