Sleep Duration and Association with Obesity: A Synthesis of Evidence

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Abstract

Obesity has become an epidemic in our world today. As healthcare providers, it is essential for us to both treat and prevent this condition in our patients. There is no one factor alone known to cause obesity. Therefore, it is crucial for us to be able to identify contributing risk factors in this disease. To look further into risk factors for obesity, we asked the clinical question—are adults with short sleep duration at higher risk for obesity? After an exhaustive review of the research literature, it is clear that the association between sleep duration and obesity has been validated through research. All studies reviewed report sleep duration less than or equal to seven hours nightly resulted in a statistically significant increased risk for obesity in the adult population. Despite the connection between short sleep and obesity, there has been no change in practice to identify those with altered sleep duration or a standard treatment plan to help short sleepers improve their sleep behaviors.

Obesity is one of the most significant health epidemics plaguing society today, costing the United States healthcare system roughly $149.4 billion annually (Kim & Basu, 2014). More importantly, obesity has been associated with many serious health consequences. According to the World Health Organization (WHO) (2018) these serious health consequences include diabetes, asthma, cardiovascular diseases, and cancer. Considering the physical and financial consequences, it is vital for healthcare providers to better understand the underlying factors influencing obesity.

An extensive survey of peer-reviewed scholarly articles yielded retrospective and prospective studies that addressed our population of interest,

short sleep duration, and obesity. Rapid critical appraisal tools were used to identify studies with the strongest evidence. Studies were selected for inclusion based on their strength of evidence, population size, consistency of methods used, and statistical significance. Results of this review revealed a statistically significant relationship between short sleep duration and increased risk for obesity. It is important for health care providers to be aware of these findings and proposed sleep assessment tools. By implementing these tools and increasing patient awareness of the importance of sleep duration, providers can assist their patients in achieving health and wellness goals to avoid the adverse health consequences associated with obesity. Ultimately—with a better understanding—we will be able to diminish the obesity epidemic, minimize negative health consequences, and reduce healthcare costs.

Significance of the Problem

Obesity is defined as individuals with a BMI ≥ 30 kg/m², and a BMI of 25 to 29.9 kg/m² is classified as overweight (Centers for Disease Control and Prevention, 2017a; World Health Organization, 2018). Obesity is a complex health condition influenced by many factors. One factor to consider is the impact of lifestyle. One modifiable lifestyle behavior shown to impact health is sleep duration. Therefore, we asked the clinically meaningful question—does an individual's sleep duration affect their risk for obesity? The purpose of this paper is to evaluate the evidence on sleep duration and its association with obesity.

We chose to explore the association between obesity and short sleep duration due to the high incidence of both conditions among adults. Authors McKnight-Eily et al. (2011) estimate that 35% of adults in the United States have a sleep duration less than the daily recommended amount. The Centers for Disease Control and Prevention (CDC) and National Sleep Foundation (NSF) both recommend optimal sleep duration for adults is between seven and nine hours nightly (Centers for Disease Control and Prevention, 2017b; Hirshkowitz et al., 2015). Therefore, short sleep duration would be defined as any amount less than the optimal range.

Obesity has become an epidemic across the world, but its prevalence in the United States is especially concerning. The Pan American Health Organization (n.d.) reports that the highest prevalence of obesity—for any WHO identified region—is in North and South America, with an estimated 62% of the population being obese. The consequences of short sleep duration include many of the same consequences of obesity. According to the CDC (2018), adults with short sleep duration have significantly higher risks for heart attack, coronary artery disease, stroke, asthma, chronic obstructive pulmonary disease, arthritis, depression, and diabetes.

PICOT

To evaluate the aforementioned relationship, we have chosen to use an etiology-based PICOT question. A PICOT question is a clinical question that can be answered by using available evidence. Our population of interest (P) is the adult population. The condition of interest (I) is short sleep duration, and the outcome (O) is the risk for obesity with no specified time frame established.

Population of Interest

The focus of this study is on the adult population. Adults are defined as individuals who are 18 years of age or older. We are excluding the pediatric population because pediatric recommendations for sleep duration vary widely depending on the age of the child (Centers for Disease Control and Prevention, 2017b; Hirshkowitz et al., 2015). In addition, pediatric sleep duration is often influenced by the lifestyle of the caregiver and not the child.

Nursing Theory

Nola Pender's Health Promotion Model (HPM) will assist in the evaluation of the question regarding the effect of sleep duration on obesity. The HPM includes several variables to consider when implementing health-behavior changes in individuals. According to Pender (2011), these factors include prior health behaviors and experiences, the influence of interpersonal or situational influences, perceptions of personal strengths and barriers to making health-related changes, self-efficacy, personal commitment to change, and competing demands for the desired outcome of behavior changes. Following the HPM, considerations must be made for individual characteristics such as prior sleep duration behavior, perceptions about benefits and costs related to changing sleep duration and how prepared individuals feel to commit to increasing sleep duration. The HPM also helps prepare individuals for potential barriers to behavior changes, including competing demands of their environment—such as demands of family, work, and personal values regarding taking the necessary actions to improve sleep duration (Pender, 2011). Pender's HPM can offer insight into root causes for short sleep duration that may lead to obesity which then can lead to identifying next steps toward reducing the impact of these factors.

Search for Evidence

Several electronic databases were used to locate the evidence: CINAHL Plus with Full Text, MEDLINE with Full Text, PubMed, ScienceDirect-Health & Life Sciences, Scopus, and Web of Science. We used key terms "obesity", "sleep duration", and "adults"—limiting results to scholarly peer-reviewed articles from academic journals from 2000 to 2018. This search resulted in 1,383 articles. To further refine the search, we reclassified sleep duration as "short

sleep duration", resulting in 348 articles. From these articles we identified 16 articles that most closely related to our concepts of short sleep duration and obesity among the adult population. After reviewing these articles, we narrowed the number down to eight articles. We chose these articles based on their level of evidence, sample size, the reliability of data collection, and criteria consistent with our PIO question. We chose articles with the highest level of evidence available for an etiology PIO—cohort studies and case control studies.

Critical analysis of evidence

Our research findings included four retrospective studies (Aziz et al., 2017; Buxton & Marcelli, 2010; Cai et al., 2018; Elder, Ammar, & Pile, 2015) and four prospective studies (Deng et al., 2017; Gutierrez-Repiso et al., 2014; Taheri, Lin, Austin, Young, & Mignot, 2004; Theorell-Haglow, Berglund, Berne, & Lindberg, 2014). While evaluating these studies, we used rapid critical appraisal tools for retrospective and prospective studies. The criteria we used to determine study validity included the study design, representation of the population, consistency of study variables used, how data were measured and analyzed, and the strength of association between outcome variables. In prospective studies, we also considered if the study had sufficient follow up intervals. After analysis of the evidence using these criteria, we concluded that these eight studies are trustworthy, even though cohort studies are considered a lower level of evidence than randomized controlled trials as mentioned by Deng et al. (2017).

The sample size was considered when choosing studies to include in this synthesis of evidence. In these eight studies, the number of participants per study ranged from 339 to 162,121 participants. One study—by Elder, Ammar, and Pile (2015)—included a population of 339 participants. Three studies had study populations between 1,000 and 5,000 participants (Gutierrez-Repiso et al., 2014; Taheri et al., 2004; Theorell-Haglow et al., 2014). Two studies had populations between 9,000 and 20,000 (Aziz et al., 2017; Cai et al., 2018). Another two studies included over 50,000 participants (Buxton & Marcelli, 2010; Deng et al., 2017). The large sample sizes included in these studies provide sufficient data representative of our population of interest.

Weaknesses that may affect implementation into clinical practice were found in all eight studies. Buxton and Marcelli (2010) mention that reverse causality should be considered when reviewing whether short sleep duration causes obesity or if obesity causes short sleep duration. One study discussed the effect of shift schedules and work stress on sleep duration (Aziz et al., 2017). Aziz et al., and Gutierrez-Repiso et al. (2014) also noted that psychiatric and medical conditions are not accounted for in their study. Theorell-Haglow, Berglund, Berne, and Lindberg (2014) only included women in their study, so it is uncertain if these results can be generalized to the entire population. Another weakness seen throughout these studies involves the data collection methods used.

Seven of the eight studies agree that data collection from self-reported questionnaires are subject to systematic error through recall bias (Aziz et al., 2017; Buxton & Marcelli, 2010; Cai et al., 2018; Deng et al., 2017; Elder et al., 2015; Taheri et al., 2004; Theorell-Haglow et al., 2014). Self-reported questionnaires are subjective measurements that can cause recall bias when participant answers do not necessarily reflect reality but instead, their perception of reality. Taheri, Lin, Austin, Young, and Mignot (2004) collected objective polysomnographic measurements for sleep duration and discussed that their results may be skewed because polysomnographic testing does not reflect the participant's natural sleep environment. They also used subjective interpretation of the data results.

Additional drawbacks to the questionnaire format were discussed by Buxton and Marcelli (2010) and Gutierrez-Repiso et al. (2014). First, limited numbers of sleep duration categories were used, leading to reduced study sensitivity because participants must choose a category that may not reflect their perceived sleep duration. The terms "short sleep duration" and "long sleep duration" do not have consistent definitions throughout different studies, and results do not account for the variation in individual sleep needs. Finally, questionnaires may only ask about hours slept during the night without consideration for hours of sleep during the day (Gutierrez-Repiso et al., 2014).

We believe there are other important weaknesses that were not addressed in these studies. First, the issue of sleep quality and its possible contribution to both sleep duration and obesity is not addressed. In addition, no standardized data collection method—such as an existing tool or questionnaire—was used throughout these studies.

Data analysis

The reviewed studies used appropriate statistical methods when calculating study results. Throughout these studies, both one and two-sided test statistics all used an appropriate significance level of $p \leq 0.05$—with some study results showing a higher statistical significance with results at $p \leq 0.01$, and $p \leq 0.0001$. The studies that used Confidence Intervals (CI) and Odds Ratios (OR) used the appropriate minimal statistically significant value of 95%—with some studies even using 99% to show greater confidence in the estimated parameters.

As seen in Table 1, all the reviewed studies used a BMI value to correlate sleep duration and obesity—which is the most widely accepted measurement of obesity in the absence of a gold standard (Ortega, Sui, Lavie, & Blair, 2016). These studies also represented their population through adequate study size and addressed the possibility of bias due to data collection methods and prospective study design. All prospective studies had sufficiently long follow-up intervals—ranging from four to eighteen years—and addressed the reduced number of participants in follow-up intervals along with how the change in the number of participants influenced data results.

Synthesis of Findings

Table 1
Short Sleep Duration and Risk of Obesity in Adults: Synthesis of Evidence of Population and Study Characteristics

Citation	Gender	Short Sleep Duration	Long Sleep Duration	Obesity		Outcome Obesity
				BMI	Waist Circumference (central obesity)	
Aziz, M., Osendu, C. U., Yournas, A., Malik, R., Rouseff, M., Das, S., . . . Nasir, K. (2017).	M 25% F 75%	< 6 hours/ night	≥ 8 hours/ night	Non-obese: < 30 kg/m² Obese: 30-34.9 kg/m² Morbid obese: ≥ 35 kg/m²	n/a	- Short sleep duration was associated with 24% prevalence of obesity. ($p < 0.001$) - Short sleep duration increased the risk of morbid obesity 2-fold compared with optimal sleep duration (OR = 1.8; 1.5-2.2) - Adjusted for gender and age
Buxton, O. M., & Marcelli, E. (2010).	M 48.8% W 51.2%	< 7 hours/ night	> 8 hours/ night	> 30 kg/m²	n/a	- Short sleep duration (6%) - Long Sleep duration (3%) is associated with obesity with a 99% CI.
Cai, G., Theorell-Haglow, J., Janson, C., Svartengren, M., Elmstahl, S., Lind, L., & Lindberg, E. (2018).	M 43.3% W 56.7%	< 6 hours/ night	≥ 9 hours/ night	≥ 30 kg/m²	Obese: ≥ 88 cm F ≥ 102 cm M	- Short sleep alone and when combined with insomnia symptoms resulted in increased risk of obesity (95% CI). - Adjusted for gender and age
Deng, H., Tam, T., Zee, B. C., Chang, R. Y., Su, X., Jin, L., . . . Lao, X. Q. (2017).	M 47.4% W 52.6%	< 6 hours/ night	> 8 hours/ night	Overweight/Obese: ≥ 25 kg/m²	Obese: ≥ 80 cm F ≥ 90 cm M	- < 6 hours sleep duration significantly increased the risk of central obesity by 12%, and risk of being overweight or obese by 18% when compared with 6-8 hours of sleep duration (HR 1.12[1.07-1.17]) - Adjusted for gender and age
Elder, B. L., Ammar, E. M., & Pile, D. (2015).	M 47% W 53%	n/a	n/a	Overweight: BMI: ≥ 25 kg/m²	Obese: ≥ 88 cm F ≥ 102 cm M	- Sleep duration ranged from 2 hours per night to 12 hours per night - Sleep duration has an inverse correlation with waist circumference: $r(319) = -0.113$, $p = 0.043$
Gutierrez-Repiso, C., Soriguer, F., Rubio-Martin, E., Antonio, I. E., Adana, M. S., Almaraz, M. C., ... Rojo-Martinez, G. (2014).	M 39% W 61%	≤ 7 hours/ night	≥ 8 hours/ night	BMI >30 kg/m²	n/a	- Risk for obesity was higher with ≤ 7 hours per night. - Follow up at 6-years: OR = 1.99 95% CI (1.12-3.55) - Follow up at 11-years: OR = 2.73 95% CI (1.47-5.04) - Adjusted for gender and age
Taheri, S., Lin, L., Austin, D., Young, T., & Mignot, E. (2004).	M 53.8% W 46.2 %	n/a	n/a	Standard BMI formula used for correlation	n/a	- U- shape relationship between hours sleep and BMI ($p = 0.008$) - Adjusted for gender and age
Theorell-Haglow, J., Berglund, L., Berne, C., & Lindberg, E. (2014).	W 100%	< 6 hours/ night	> 9 hours/ night	≥ 30 kg/m²	> 88 cm	- In W, continuous short sleep duration is a risk for obesity OR = 1.71 (95% CI, 1.01-2.87) - W under 40 - short & long sleep have risk factor for: General obesity - Short sleep OR, 6.78 and 95% CI, 2.71–17.0 - Long sleep aOR, 4.64 and 95% CI, 4.64–19.8 Central Obesity - Short sleep n/s - Long sleep aOR, 6.05; 95% CI, 1.19–30.7

Legend: BMI = body mass index, n/a = no information provided in this study, kg = kilograms, m = meters, cm = centimeters, OR = Odds ratio, CI = confidence interval, W = women, M = men

Evidence across the studies

Across the studies, we found variations in the definitions used for each concept within the PIO question. Gender was divided into male and female categories. Gender was included in Table 1 due to variations in gender between the studies. Theorell-Haglow et al. (2014) included only female participants. Aziz et al. (2017) had 75% female representation in their study population. The remaining six studies had approximately equal gender representation.

The term adult had the most variation among study definitions. Deng et al. (2017) and Theorell-Haglow et al. (2014) defined adults as those ≥ 20 years of age—although Deng et al. (2017) only included subjects less than 80 years of age. Buxton and Marcelli (2010), Elder et al. (2015), and Gutierrez-Repiso et al. (2014) all defined adults as those over the age of 18 years. However, Buxton and Marcelli limited the oldest age of participants to 85 years old, while Elder et al. and Gutierrez-Repiso et al. limited the oldest age of participants to 65 years old. Two studies limited the age ranges even further. Cai et al. (2018) only included participants aged 45 to 78 years of age and Taheri et al. (2004) limited participants to 30 to 60 years of age. One study used a mean age to represent their population data with a result of 42.8 + 12.1 years old (Aziz et al., 2017).

As seen in Table 1, five of the eight studies defined obesity as BMI > 30 kg/m2 (Aziz et al., 2017; Buxton & Marcelli, 2010; Cai et al., 2018; Gutierrez-Repiso et al., 2014; Theorell-Haglow et al., 2014). Deng et al. (2017) and Elder et al. (2015) included results for both overweight and obese individuals (BMI > 25 kg/m2). Results reported in one study were not based on a definition of obesity but instead correlated changes in BMI with hours of sleep (Taheri et al., 2004). While there is no gold standard to measure obesity, each of the reviewed studies used BMI as the primary measurement of obesity.

Four of our eight studies in Table 1 looked at waist circumference as a secondary tool to define obesity (Cai et al., 2018; Deng et al., 2017; Elder et al., 2015; Theorell-Haglow et al., 2014). Three out of these four studies stated female waist circumference > 88 cm indicated obesity (Cai et al., 2018; Elder et al., 2015; Theorell-Haglow et al., 2014). Only one study stated female waist circumference > 80 cm indicated obesity (Deng et al., 2017). Male waist circumference indicative of obesity was set at > 102 cm (Cai et al., 2018; Elder et al., 2015; Theorell-Haglow et al., 2014) Deng et al. (2017) set male waist circumference > 90 cm as an indicator of obesity. Elder et al. (2015) recommend using waist circumference in addition to BMI to include patients with increased central obesity who have BMI within the optimal range.

The definition for sleep duration varied slightly between the studies as noted in Table 1. Four studies defined short deep duration as less than six hours (Aziz et al., 2017; Cai et al., 2018; Deng et al., 2017; Theorell-Haglow et al., 2014). Buxton and Marcelli (2010) defined short sleep as less than seven hours and Gutierrez-Repiso et al. (2014) defined short sleep as less than or

equal to seven hours. Four of the eight studies defined long sleep duration as greater than or equal to eight hours per night (Aziz et al., 2017; Buxton & Marcelli, 2010; Deng et al., 2017; Gutierrez-Repiso et al., 2014). However, Cai et al. and Theorell-Haglow et al. defined long sleep duration as greater than or equal to nine hours. Elder et al. (2015) and Taheri et al. (2004) did not provide definitions for short and long sleep but rather measured their results based on an hourly amount of sleep deficit or gain and its association with increased BMI or waist circumference.

Despite variations among concept definitions, all studies found statistically significant results showing an association between short sleep duration and obesity. Across all studies, a general consensus is that short sleep duration is equal to, or less than seven hours nightly. All studies using BMI as an obesity measurement showed a statistically significant association between short sleep duration and BMI > 30 kg/m2, except for Elder et al. (2015). Three of the four studies in Table 1 associated short sleep duration with a waist circumference greater than the threshold for obesity (Cai et al., 2018; Deng et al., 2017; Elder et al., 2015).

An incidental finding noted when reviewing Table 1 showed a statistically significant association between long sleep duration—greater than or equal to eight hours nightly—and obesity. Additionally, studies in Table 1 show the outcome of obesity was found with short sleep duration despite differences in gender of the participants. Further, Taheri et al. (2014) identified the risk of obesity with long sleep duration was only found in women under 40 years of age.

The evidence in Table 1 supports the association between short sleep duration and obesity in adults. The collective wisdom among these studies is that sleep duration is an important variable to consider when working with patients to reduce the health risks associated with obesity. Our research identified only a few—and varied—recommendations related to these findings.

Action needed

Theorell et al. (2014) recommend efforts to improve sleep duration begin early in life as the benefits of improving sleep duration—with regard to its relationship with obesity—decreases with increasing age. Deng et al. (2017) and Elder et al. (2015) recommend that hours of sleep should be collected during health screenings to identify those with short sleep duration and provide education and support toward the promotion of optimal sleep duration. Elder et al. (2015) go on to encourage the collection of waist circumference data—along with BMI—to determine obesity risk factors due to an increased risk of morbidity associated with central obesity. Aziz et al. (2017) give a recommendation specific to employers to develop work strategies and education opportunities promoting optimal sleep for employees. Multiple studies made recommendations for screening and identification of patients for whom healthy sleep hygiene education would have the

greatest impact on reducing their risk of obesity, with consideration of age and social or environmental risk factors for obesity (Deng et al., 2017; Elder et al., 2015; Theorell-Haglow et al., 2014).

Further research was a common recommendation among several of the studies. Aziz et al. (2017), recommend additional research to evaluate work supported wellness initiatives and their impact on sleep hygiene among employees. Two studies, Buxton and Marcelli (2010) and Deng et al. (2017) call for more longitudinal studies to access the effects of short sleep duration on obesity. Recommendations for objective measurements for sleep duration, health status, and sleep quality, along with information about existing sleep disorders, was made by Buxton and Marcelli. Likewise, Deng et al. recommend an investigation into the effect of sleep apnea on sleep duration. The impact of environmental or social factors related to short sleep duration and obesity was recommended by Elder et al. (2015). Taheri et al. (2004) supported future research into the effect of chronic short sleep duration on dietary intake and activity levels. Specifically, future research should consider the hormonal influences—such as leptin and ghrelin—on increases in BMI in the setting of short sleep duration.

Expert opinion

Sleep experts at the National Sleep Foundation published a paper in 2015 with recommendations for optimal sleep duration according to age groups. For adults ages 18 years to 64 years, the NSF recommends sleep duration of seven to nine hours nightly (Hirshkowitz et al., 2015). For adults over the age of 65 years, the recommended sleep duration only differed by one hour less, at seven to eight hours of sleep nightly. Hirshkowitz et al. goes on to state that sleep durations outside of the recommended ranges per age group are not advised and can lead to detrimental health consequences.

Therefore, we conclude there is a link between short sleep duration and obesity. All studies reviewed recommend sleep duration greater than six hours nightly to lower the risk of obesity. This recommendation for sleep greater than six hours nightly is in agreement with the NSF recommendations. For these reasons, we believe there is sufficient evidence to support the implementation of interventions into clinical practice.

We propose that resources should be developed to help with the identification and treatment of short sleep. First, an objective and universally recognized screening tool should be developed for practitioners to evaluate patients' sleep duration. Next, a home sleep log should be created so patients can monitor their sleep duration patterns. Finally, educational materials—for both providers and patients—on the effects and management of short sleep duration should be developed and distributed.

Nursing clinical expertise brings a holistic approach to the care and support of patients when discussing sensitive topics like obesity. Using this holistic approach, practitioners will need to consider many factors before implementation of interventions recommended in the study findings. Using Nola Pender's HPM, practitioners should consider the values and beliefs of patients and their families about sleep and the health risks of obesity. According to Pender (2011), patient perceptions about benefits and costs related to making lifestyle changes will drive how committed they are to the intervention. Additionally, Theorell et al. (2014) found the impact of increasing sleep duration on obesity was greater when implementations were initiated with patients younger than 40 years of age. This finding highlights the importance of early screening and early intervention in at-risk populations.

Practitioners also need to consider medical reasons for short sleep duration prior to attempting lifestyle interventions. These medical causes include conditions such as sleep apnea, mental health issues, endocrine disorders, and differences in personal and cultural preferences. Also, it is important for practitioners to assess for existing obesity, risk for obesity, and family history of obesity. In the unpublished paper, "Short Sleep Duration and Obesity: A Proposal for Implementation of Evidence," (Holmes & Pribble, 2018), recommendations are made for screening all patients for sleep duration through use of the Holmes Pribble Sleep Duration Questionnaire (HPSDQ) and the associated Holmes Pribble Sleep Duration Questionnaire Algorithm (HPSDQ-A) to identify possible root causes for short sleep (see Appendix A for the HPSDQ and Appendix B for the HPSDQ-A).

Using Pender's HPM, identifying possible issues for implementation is important to the success of the intervention (Pender, 2011). Common issues can be found in the treatment of other major health conditions. We believe these common issues will be similar to those that influence the proposed interventions.

We believe obstacles that could affect patients include time management, socioeconomic status, and patients' understanding and beliefs about the condition. These include the demands of family, work, and the corresponding time management issues. Low socioeconomic status may lead to inadequate housing, bedding, and conditions not conducive to sleeping. Finally, patient beliefs about obesity—and its associated health risks—are important to assess to determine how committed they will be to the intervention.

CONCLUSION

In conclusion—based on our synthesis of evidence—there is an association between short sleep duration and increased risk of obesity. We believe the continuation of research into this association will further our understanding of this topic and should continue to be explored. However, we believe

there is sufficient evidence to implement screenings, develop educational material, and implement protocols on sleep duration that will assist in the efforts to decrease obesity. We propose the screening and assessment of short sleep duration with the HPSDQ and the HPSDQ-A, further assessment and follow-up for those identified by the HPSDQ with short sleep duration, and education about the association between short sleep duration and obesity to all patients. We believe that implementing these recommendations will result in improved sleep duration, decreased risk for obesity, financial benefits, and improved health status of all patients.

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Appendix A
HPSDQ: Holmes Pribble Sleep Duration Questionnaire

HPSDQ: Holmes Pribble Sleep Duration Questionnaire		
Part One:		
1. On average, how many hours of sleep do you get a night? (circle one number) 1 2 3 4 5 6 7 8 9 10 11 12		
If Part One is less than 7 hours a night, continue questionnaire to Part Two:		
Part Two:		
1. Has anyone ever told you that you snore?	Yes	No
2. Do you fall asleep while driving or while stopped at a stop sign?	Yes	No
3. Do you wake up in the morning with a headache?	Yes	No
4. Do you have problems falling asleep?	Yes	No
5. Do you have problems staying asleep?	Yes	No
6. Do you feel like your mind won't shut off?	Yes	No
7. Any history of anxiety or depression?	Yes	No
8. Do you feel that your heart races at night?	Yes	No
9. Do you drink or urinate excessively, or are you excessively thirsty?	Yes	No
10. Have you had unintentional weight loss or gain?	Yes	No
11. Do you get up more than once a night to go to the bathroom?	Yes	No
12. Have you been diagnosed with restless leg syndrome?	Yes	No
13. Do you have a history of Congestive Heart Failure or any other cardiac issues?	Yes	No
14. Do you have a history of chronic pain?	Yes	No

Appendix B
HPSDQ-A: Holmes Pribble Sleep Duration Questionnaire Algorithm