

The Association between Sleep Loss and Women's Wellness Decisions

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Abstract Sleep loss is an important determinant of health status owing to its relationships with molecular, immune, and neural changes; these changes, in turn, are important etiological mechanisms for the development of cardiovascular, metabolic diseases and increased risk of accident related injuries. While the association between sleep loss and risk of weight gain is established, studies on the association between sleep loss and nutrition and physical activity are limited. The purpose of this research was to determine if there are significant associations between reported sleep variations and nutrition and physical activity level while recognizing the association between body mass index (BMI) and sleep loss. Data from the 2011 sleep-related questions captured by the Centers for Disease Control and Prevention's (CDC) Behavioral Risk Factor Surveillance System (BRFSS) was used to identify possible behavioral indicators related to sleep loss in women. Multiple logistic regression was used to assess the hypothesized associations between sleep loss and fruit and vegetable consumption and physical activity levels. The odds ratios for the association between fruit/vegetable intake and sleep loss and that of BMI and sleep loss were ($OR = 0.761$, 95% $CI = 0.651, 0.889$) and ($OR = 1.108$, 95% $CI = 0.972, 1.262$), respectively. The odds ratio for the association between physical exercise and sleep loss was ($OR = 0.991$, 95% $CI = 0.864, 1.137$). Having adjusted for relevant covariates, consumption of fruits and vegetables was significantly associated with sleep loss; physical activity was not significantly associated with sleep loss.

Keywords BMI, Nutrition, Physical Activity, Sleep Loss, Women

1. Introduction

Sleep loss is a growing public health problem [1]. Sleep disorders are believed to affect between 50-70 million American adults and are associated with many chronic diseases such as diabetes, coronary vascular disease (CVD),

obesity, and depression [2]. McKnight-Eily [3] analyzed the data from the sleep module on the Behavioral Risk Factor Surveillance System (BRFSS) and reported that of the 74,571 respondents over the age of 18 years representing 12 states, 35.3% of the respondents slept less than 7 hours per night. These rates are an alarming public health issue because adults should get between 7 to 9 hours of sleep per night [1].

This study focused on the health/sleep-related questions captured by the BRFSS to determine if there were significant epidemiological patterns of reported sleep variations in women [4]. Because women tend to report higher sleep disturbances than men, we sought to study if these variations in sleep could be related to women's nutritional intake, physical activity level, and/or body mass index (BMI) [4]. Smoking was included as a covariate and considered a confounder [5].

Healthy People 2010 revealed that 25% of American adults are exposed to sleep discrepancies 15 days out of the month [3]. According to the Institute of Medicine U.S. Committee on Sleep Medicine and Research, the economic losses to sleep disorders in the U.S. are currently unknown; however, sleep disorders are believed to increase the use of healthcare systems by 11%. Those patients who self-report fatigue and sleepiness have been associated on average to use the healthcare system 18% to 20% more frequently than those not reporting sleeping problems [6,7].

The data used came from the 2011 BRFSS which is a cross-sectional, telephone survey, health tracking database coordinated by the CDC. The BRFSS, with its large sample size and its ability to capture data in specific geographical areas, was a fair representation of U.S. women's self-reported health related behaviors [8].

Sleep loss, defined as a state of sleep that is insufficient, can be prevented if it is identified and treated as a major symptom of many chronic diseases as opposed to a mere side effect of having a particular medical condition [9,10]. Improving nutritional uptake, increasing physical activity, and lowering BMI may be used as important public health interventions in reducing the problem of sleep loss [11].

2. Objectives

Women’s sleep associated with adverse health outcomes has not been sufficiently studied using representative national data by taking in to account the effects of amenable public interventions such as nutrition and physical activity. Therefore, this study was conducted with the objective of assessing if the prevalence of perceived insufficient rest is associated with nutrition, physical activity levels, and BMI.

3. Methodology

A retrospective, cross-sectional study design was used. The inclusion criteria were adult (18+), female, 2011 BRFSS participants who answered the questions pertaining to sleep, fruit and vegetable intake, physical fitness, and BMI. Missing data and “I don’t know/Not sure” and “Refused” responses were excluded from data analysis for the dependent variable of sleep along with the independent variables.

The first phase of the data analysis involved descriptive statistics of the dependent variable, independent variables, and covariates and covered percentages and frequencies of women as they had answered the questions. Multiple logistic regression was used to determine if there is an association between the sleep loss and the relevant independent variables such as vegetable fruit intake, physical activity and BMI. Odds ratios were calculated based on the results from the multiple logistic regression.

Statistical Package for the Social Sciences 21.0 (SPSS) was used in generating the descriptive statistics and logistic regression statistics.

In the 2011 BRFSS survey, 437,743 people participated via landline phones and 71,259 people participated via cell phone [12].

4. Results

Descriptive Statistics

From the adult women used in this sample pool, 51.1% were 55+ years of age ($M = 54.46$; $SD = 16.61$), had graduated or attended college or a technical school (65.9%), were currently employed (60.0%), married at the time the survey was taken (51.4%), and White (87.2%). A total of 56.5% of the adult women within the test sample population reported never to have smoked. Compared to the overall 2011 adult women population of the 2011 BRFSS, 55.9% was 55+ years of age ($M = 56.20$; $SD = 17.39$), had graduated or attended college or a technical school (60.6%), were currently employed (55.7%), unmarried at the time the survey was taken (50.5%), and White (82.5%). A total of 58.3% of the adult women within the test sample population reported never to have smoked.

Compared to the overall 2011 adult women population, the study population for this study was younger and more

educated, had a higher employment rate, had a greater percentage of being married, and was slightly less racially diverse. “Never smoked” rates were very similar between the two populations. Of the respondents within this study 11.1% reported moderate to high intake of fruits and vegetables, 42.6% reported low to none intake of fruits and vegetables. 45.7% of those surveyed answered a combination of moderate/high, low and no intake of fruits and vegetables. Table 1 shows the breakdown of fruit and vegetable according to the intake reported by the study sample. 49.3% reported moderate or high physical activity levels, 22.9% reported low physical activity. 27.2% reported no level of physical activity. 2.1% reported underweight < 18.50 BMI, 39.8% reported a normal BMI 18.50 - 24.99, and 57.6% reported overweight or obese > 24.99.

Table 1. Fruit and Vegetable Intake

| Variables | N | Frequency | % |
|------------------|--------|-----------|-------|
| Fruit Intake | 11,858 | | |
| Moderate/High | | 3,389 | 28.6% |
| Low | | 7,993 | 67.4% |
| None | | 288 | 2.4% |
| Missing | | 188 | 1.6% |
| Vegetable Intake | 11,858 | | |
| Moderate/High | | 2,434 | 20.5% |
| Low | | 6,347 | 53.5% |
| None | | 2,952 | 24.9% |
| Missing | | 125 | 1.1% |

To determine the simultaneous impact of the independent variables for the prediction of an adult woman reporting sleep three multiple regression models were computed to predict whether sleep would be between ≥ 6 and < 14 hours in duration or < 6 hours in duration based on the variables that were run.

Model 1 was run to predict how adult women from the BRFSS 2011 reported perceived sleep from how they responded to the variables concerning general health, fruit and vegetable intake, physical activity (exercise within past 30 days), BMI, and health access as predictors. A test of the full model against the independent variables was statistically significant, indicating that the predictors as a set reliably distinguished between adult women who reported ≥ 6 and < 14 hours in duration of sleep and women who reported < 6 hours in duration of sleep. Table 2 shows the results of the binary logistic regression analysis. Odds ratios are calculated with each respective variable level.

Table 2. Multiple logistic results model 1

| Predictors | β^a | Exp (β) ^b | 95% CI |
|------------------------|-----------|------------------------------|--------------|
| Fruit/Vegetable Intake | -0.273 | 0.761* | 0.651, 0.889 |
| Physical Activity | -0.009 | 0.991 | 0.651, 0.889 |
| BMI | 0.102 | 1.108 | 0.972, 1.262 |

^a B represents the coefficient for the constant

^bExp(B) is the exponentiation of the B coefficient, or the odds ratio

*p < 0.05

A second model was run to predict how adult women from

the BRFSS 2011 reported perceived sleep based upon how they responded to the covariates concerning age, education level, employment status, marital status, race, and smoking status as predictors. A test of the model against only the covariates was statistically significant, indicating that the predictors as a set reliably distinguished between adult women who reported ≥ 6 and < 14 hours in duration of sleep and women who reported < 6 hours in duration of sleep. Table 3 shows the results of the binary logistic regression analysis. Odds ratios are calculated with each respective variable level.

Table 3. Multiple logistic results model 2

| Predictors | β^a | Exp (β) ^b | 95% CI |
|---------------------------|-----------|------------------------------|--------------|
| Age | | | |
| 18-24 | -0.731 | 0.481* | 0.374, 0.619 |
| 25-34 | -0.994 | 0.370* | 0.307, 0.447 |
| 35-44 | -0.896 | 0.408* | 0.342, 0.487 |
| 45-54 | -0.618 | 0.539* | 0.458, 0.634 |
| 55-64 | -0.425 | 0.654* | 0.564, 0.758 |
| 65+ (ref) | | | |
| Education | | | |
| Never attended | -0.996 | 0.369 | 0.118, 1.159 |
| 1-8 | -0.452 | 0.636* | 0.466, 0.867 |
| 9-11 | -0.381 | 0.683 | 0.558, 0.837 |
| 12 or GED | -0.112 | 0.894 | 0.811, 0.986 |
| College+ (ref) | | | |
| Employment | | | |
| Employed | -0.228 | 0.796* | 0.687, 0.922 |
| Not employed | -0.828 | 0.437* | 0.367, 0.520 |
| Student | -0.287 | 0.750 | 0.546, 1.030 |
| Retired (ref) | | | |
| Marital Status | | | |
| Married | 0.144 | 1.155* | 1.057, 1.262 |
| Not married | | | |
| Race | | | |
| White | 0.031 | 0.031 | 0.713, 1.492 |
| Black | 0.120 | 1.127 | 0.752, 1.688 |
| Asian | 0.377 | 1.458 | 0.862, 2.468 |
| Hawaiian/Pacific Islander | -0.260 | 0.771 | 0.314, 1.893 |
| Indian/Alaskan | 0.546 | 1.726* | 1.094, 2.723 |
| Other (ref) | | | |
| Smoking Status | | | |
| Never smoked | 0.575 | 1.777* | 1.586, 1.989 |
| Former smoker | 0.424 | 1.528* | 1.346, 1.735 |
| Current smoker (ref) | | | |

^a B represents the coefficient for the constant

^bExp(B) is the exponentiation of the B coefficient, or the odds ratio

*p < 0.05

Model 3 assessed the relationship between perceived sleep loss and the variables having controlled for the covariate's age, education level, employment status, marital status, race, and smoking status as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between adult women who reported ≥ 6 and < 14 hours in duration of sleep and women who reported < 6 hours in duration of sleep. Table 4 shows the results of the binary logistic regression analysis. Odds ratios are calculated with each respective variable level.

Table 4. Multiple logistic results model 3

| Predictors | β^a | Exp (β) ^b | 95% CI |
|------------------------|-----------|------------------------------|--------------|
| Fruit/Vegetable Intake | -0.259 | 0.772* | 0.654, 0.911 |
| Physical Activity | -0.047 | 0.954 | 0.826, 1.102 |
| BMI | 0.170 | 1.185* | 1.032, 1.361 |

^a B represents the coefficient for the constant

^bExp(B) is the exponentiation of the B coefficient, or the odds ratio

*p < 0.05

From the data analyzed there is sufficient evidence in which the prevalence of perceived insufficient rest or sleep in women is different in women self-reporting, fruit/vegetable intake, physical activity, and BMI. It also showed that the covariates do have a significant effect on the perceived reporting of sleep by adult women and controlling for the relevant covariates did not affect the observed significant association between perceived insufficient rest or sleep and each of the variables considered by each research question and when combined in logistic regression models can strengthen the prediction of perceived rest in adult women. BMI was not significant on the first regression model but found significant when computed in the third regression model which included the covariates.

5. Discussion

Perceived sleep indicated by the BRFSS 2011 participants in this study group suggested that reported behavior indicators can be utilized to predict sleep responses in adult women. Sleep questions on the BRFSS are subjective in nature, but responses as to how a person is sleeping have been associated with a variety of physical and mental health issues [2]. By understanding perceived sleep as it can be influenced by particular behaviors, it could be possible to encourage better health behavioral practices to reduce insufficient rest and to promote better quality of sleep

The study outcomes confirm a significant relationship with the independent variables and an adult woman's perception of her sleep. Compared to the overall adult women 2011 BRFSS participant population, the study population for this research was younger, more educated, had a higher employment rate, had a greater percentage of married women, and was slightly less racially diverse. The module concerning sleep loss questions used for this

research asked participants in the following states: Alaska, Minnesota, and Tennessee. Due to the limited regional areas sampled, the sample population is not representative of the general BRFSS 2011 adult female population.

There are discrepancies within the sample population used for this study and the general BRFSS 2011 participant population for adult women. Concerning employment, 60.0% of the study sample reported being currently employed while 55.7% of the BRFSS participants reported being employed; regarding, education 65.9% of the study sample reported having attended college while 60.6% of the BRFSS participants reported having college. This could have possibly skewed the data for it to be compared with the general population as studies have shown that such factors which can influence health outcomes in a given population include such demographics as education, employment, personal health behaviors, access to healthcare, and culture [13].

The total 2011 BRFSS women's responses was $N = 304,132$ and the sample for this research was $n = 11,858$. Given the large sample size it is possible that even though the populations are not representative of each other between the study population and the BRFSS population the results of this study could still imply practical significance that positive and negative behaviors can predict sleep duration between the two populations; although this cannot be shown under the parameters of this research given the differences of demographics between the two populations

The study sample seems to have a greater economic advantage over the general BRFSS participants so it is unclear if the study would reveal an association of the independent variables in states that are more diverse, report a higher unemployment rate, and are less educated. For this particular study group, employment played a much bigger role in predicting sleep outcomes. This could perhaps be that for the BRFSS 2011 question on income, it asks the participant to report income from all sources; the response could be skewed from women who are married compared to women who are not married as the married women would report their combined income which could increase their reported income considerably considering 60% of the women were employed and 51.4% were married

The multiple logistic regression models indicated that when the variables are factored in together, fruit and vegetable intake is weakly able to predict sleep differences (Models 1 and 3). It is unclear as to why physical activity level and BMI (only significant in Model 3) are not significant in the ability to predict sleep outcomes in this model as there is substantial peer reviewed literature that correlates better sleep quality with increased physical activity and a normal BMI [8,14,15]. It must be noted that there were only two categories of sleep quality, ≥ 6 and < 14 hours in duration or < 6 hours. This study did not capture the description of adult women reporting sleep times above eight hours of sleep thus making three categories of short sleep, normal and oversleep durations. If this distinction was made it could be possible that physical activity and BMI may have

the ability to predict; but was not within the scope of this study

Fruit/vegetable intake was a complex question and the coding for this question came from many individual questions asked within the survey. The questions themselves could be complex as those participants may, for example, perceive fruit drinks as fruit intake when it is not under the constraints of the BRFSS. Same goes with vegetables. Potatoes and other starches were not considered vegetable intake, only green leafy, orange vegetables were considered for the purpose of this study. This could skew the data as the whole picture of her nutrition was not taken into account nor was a comparison done between those women who reported a higher intake of overall healthy foods compared to women reporting foods high in fat and salt. This particular research question does not address the many facets of the human diet and does not take into account age differences and nutrient needs as a woman progresses through her lifecycle. As the results show a weak ability to predict for this research question, it does not factor in all the parameters of nutrition availability that an adult woman chooses to eat. Additional investigation to break down this research question further and compare other intakes of foods as well as to include type of diet (i.e., vegan, vegetarian, all inclusive diet) would be an interesting follow-on study to examine the relationship of diet and reported sleep and would be a more accurate reflection as to how nutritional intake influences sleep in adult women

Due to the many factors that can affect sleep time and sleep quality, the second model evaluated the covariates only. It was recognized that the covariates tested were not an exhaustive list of possible influences but were readily available for use on the 2011 BRFSS. Age and smoking status were shown to be significant predictors at all age ranges tested while the other covariates revealed significance only at some or one level. Age is extremely important as it represents women who are in their reproductive age, perimenopause, and postmenopausal stages of life and thus is not unexpected that it has an influence on sleep prediction [16]. Smoking status was mentioned as a confounder at the beginning of this study and can influence other diseases such as asthma and obstructive sleep apnea syndrome (OSAS). These were not considered within the parameters of this study but are important factors to consider when looking for factors that may inhibit a healthy sleep pattern

When all the variables were factored with the covariates within the third regression model, fruit/vegetable intake and BMI were determined to predict sleep differences within the study population. The covariates of age and smoking show significance of all levels as was the case in Model 2. BMI was shown to be significant in the Model 3, but this could be due to the influence of age as a covariate. The mean age for this study population was 54.46 ($SD = 16.61$). Far more study participants surveyed indicated they were overweight or obese. Age relating to BMI indicates that, in general, total percent body mass increases as a person ages. While this is occurring, bone mineral density and lean muscle mass

decreases yet body weight does not necessarily change [17]. This in itself did not explain why age could influence BMI in such a way to determine sleep outcomes, but it does indicate there are metabolic changes occurring in the aging process that can influence changes in the endocrine system which can chemically influence sleep patterns. This may indicate that BMI, when age is considered, may be able to predict sleep outcome dependent of the age range of the woman; providing confounders such as a woman reporting asthma or OSAS are not included

Physical activity was not shown to be significant in either of the logistic regression models. The research question only inquired about reporting moderate to high levels of physical activity and reporting low physical activity. The analysis did not consider reporting no physical activity. It would be difficult to determine if those people who reported no physical activity were all bed bound or if they did not feel the questions related to what they considered physical activity was within their own environment.

6. Limitations

The study population was compared to the adult women population of the 2011 BRFSS. The results were generated from self-reported content concerning demographics and health related behaviors, thus recall bias may be a factor and is a limitation of this effort. Also, participants were chosen from those with a listed phone line or cell phone. Smoking was considered a delimitation and was treated as a potential confounder that can adversely affect sleep quality but was controlled. The covariates of age, education level, employment status, marital status, and race were also controlled. Since the models compared < 6 and 6- to 14-hours of sleep reported, it was not determined within the scope of this study if differences in sleep reporting > 8 hours would have shown an ability to predict in the populations reporting over what is considered normal sleep range for adults. It is recognized that oversleep can also signal health issues but was not included within the scope of this study [18,19].

Because the BRFSS in 2011 changed to raking, a system that combines design weight and raking to represent underrepresented populations, no attempts were made to weight the data collected in SPSS during the analysis [20]. The nine criteria used by the CDC included race/ethnicity, age range, marital status, gender, age range by race/ethnicity, gender by race/ethnicity, own or rent property, educational background, and phone ownership [21].

7. Conclusions

The results of the current study indicated that, among adult women, there is significant association between sleep loss and vegetable/fruit intake. Moreover, BMI was significantly associated with sleep loss having accounted for several

covariates. Physical activity was not significant with sleep loss. A follow-up study that examines the variations in physical activity levels with respect to the various ranges of recommended sleep durations is warranted. This proposed investigation would look if there is an association of physical activity and sleep adequacy by carefully pinpointing potential confounding factors that may have skewed the data within the research parameters set for this study model.

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