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The Association of Insufficient Sleep with Smoking, Obesity, Physical Inactivity, and Poor Quality of Life: Results from the 2008 North Carolina Behavioral Risk Factor Surveillance System (BRFSS) Survey

by
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Introduction

It is estimated that sleep related problems, such as chronic sleep-loss, affect 50 to 70 million Americans of all ages.¹ For public health, the extent and repercussion of this problem has largely been under-recognized, and the public remains relatively un-informed of the health consequences associated with prolonged and insufficient sleep. Research has found that insufficient sleep is associated with a wide range of adverse health conditions including hypertension, diabetes, obesity, depression, heart attack, and stroke, as well as various health risk behaviors, such as smoking.²⁻⁴

It is only within the last decade that on-going, population-based surveillance and research in sleep disorders has gained national attention and commitment. Recommendation 5.3 from the 2006 Institute of Medicine report, entitled, "Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem,"⁵ called upon the Centers for Disease Control and Prevention (CDC) and the National Center on Sleep Disorders Research to

support and expand surveillance of sleep patterns in the U.S. population. In response, the CDC introduced a question on insufficient sleep in the 2008 BRFSS Core Questionnaire, which consists of CDC-sponsored questions asked by all 50 states participating in the BRFSS Survey.

This study builds upon a previous study conducted by researchers at the CDC. Using 2002 BRFSS survey data from an 18-state pilot study of the insufficient sleep question, the authors (Strine and Chapman) examined the association of frequent sleep insufficiency with poor quality of life and selected health risk behaviors.⁶ Frequent sleep insufficiency (high risk) was defined as a dichotomous measure, i.e., respondent report of 14 or more days in the past 30 days of insufficient sleep, versus the report of less than 14 or no days of insufficient sleep (low risk). The results from the Strine and Chapman study revealed that frequent sleep insufficiency was strongly associated with poor quality of life, including smoking, physical inactivity, and heavy drinking among males.

In this study, we examine the association among three levels of insufficient sleep (low, medium, and high) with several of the same adverse health outcomes examined in the Strine and Chapman study. We test the assumption that those who report *all* 30 days of insufficient sleep will have significantly higher risk of poor quality of life or engagement in health risk behaviors, than those who report 14 to 29 days. Furthermore, we can likely assume that those who report less than 14 or no days of insufficient sleep will have significantly lower risk than those reporting 14 to 29 days of insufficient sleep.

Methods

Survey data

The BRFSS survey is a state-based, random-digit-dialed telephone survey of non-institutionalized adults with landline telephones. The survey is administered in all 50 states and three U.S. territories on a calendar-year basis; funding from the CDC helps support the on-going operations of this national survey. In 2008, the North Carolina BRFSS Survey completed 15,835 interviews.

BRFSS data are weighted to represent North Carolina's total adult resident population, ages 18 and older. The weighting procedure adjusts for unequal probabilities of selection due to disproportionate sampling of listed and unlisted phone numbers, number of phone lines in the household, and unequal non-response rates among different demographic groups. In this study, only weighted prevalence estimates are reported.

Study variables

Insufficient sleep was assessed by the survey item: "During the past 30 days, for about how many days have you felt you did not get enough rest or sleep?" Responses to the question were categorized as *low* (0–13 days), *medium* (14–29 days) and *high* (all 30 days) sleep-loss.

The decision to treat those with all 30 days of insufficient sleep as a separate risk group was based, in part, on the large number of respondents (N=1,877) who met this definition. Furthermore, a sample of this

size affords sufficient statistical power for detecting small differences in risk prevalence among groups.

The health risk behaviors we examined included current smoking, consisting of daily or occasional smokers; physical inactivity, consisting of no exercise or leisure time activity in the past 30 days; and obesity, consisting of a body mass index (BMI) greater than 30.0.

Quality of life was assessed by three measures from the Health Related Quality of Life Module of the BRFSS: frequent physical distress, frequent mental distress, and frequent activity limitations. These measures were treated as dichotomous outcomes. Following the Strine and Chapman definition, poor quality of life was based on respondent report of 14 or more days in past 30 days when physical or mental health was not good, or when usual activities were restricted.

Analysis

Demographic characteristics, by low, medium and high sleep-loss, are shown in Table 1. These characteristics include sex, age, race, ethnicity, education, employment, and disability status.

Given the difference in age distributions, the fact that younger respondents tended to be over-represented in the high and medium sleep-loss groups (see Table 1), age-adjusted prevalence rates were calculated for all study outcomes. In addition, all analyses were conducted separately for males and females to discern possible differences associated with gender.

A difference in proportions test, or two-tailed t-test, was used to evaluate changes in the age-adjusted prevalence of risk behaviors and poor quality of life associated with high to medium levels of sleep-loss (all 30 days vs. 14–29 days), and medium to low levels of sleep-loss (14–29 days vs. 0–13 days). The t-test can be used to determine if there is a statistically significant difference between two percentages. The results from these t-tests (*p* values) are shown in Tables 2 and 3. All estimates and statistical calculations were generated using the SUDAAN software (Research Triangle Institute, Cary, North Carolina).

Table 1.
Demographic Characteristics of Adults
by High, Medium, and Low Levels of Sleep-loss Days:
2008 North Carolina BRFSS Survey

Demographics	Sleep-loss Days					
	All 30 days (high)		14 to 29 days (medium)		0 to 13 days (low)	
Sex	N	%	N	%	N	%
Males	663	45.0	797	44.1	4,432	50.0
Females	1,214	55.0	1,466	55.9	6,962	50.0
<i>total</i>	1,877	100.0	2,263	100.0	11,394	100.0
Age						
18–24	72	14.7	82	12.7	320	11.7
25–34	247	22.3	288	21.7	948	16.7
35–44	359	21.7	486	23.5	1,591	18.4
45–54	397	17.3	573	22.2	2,075	18.4
55–64	385	13.0	449	12.2	2,504	15.6
65+	406	10.9	375	7.7	3,869	19.2
<i>total</i>	1,866	100.0	2,253	100.0	11,307	100.0
Race						
White, non-Hispanic	1,349	72.3	1,790	79.3	8,789	75.9
Black, non-Hispanic	334	22.8	301	15.3	1,667	19.5
Other, non-Hispanic	95	4.9	99	5.4	386	4.6
<i>total</i>	1,778	100.0	2,190	100.0	10,842	100.0
Ethnicity						
Hispanic	83	7.9	61	4.1	487	9.0
non-Hispanic	1,785	92.1	2,196	95.9	10,875	91.0
<i>total</i>	1,868	100.0	2,257	100.0	11,362	100.0
Education						
Less than high school	372	18.3	248	9.7	1,540	14.5
High school / G.E.D	589	31.9	626	29.1	3,357	29.4
Post H.S. / technical school	512	29.2	642	28.5	2,892	24.6
College or more	399	20.6	743	32.7	3,575	31.4
<i>total</i>	1,872	100.0	2,259	100.0	11,364	100.0
Employment						
Employed	780	46.8	1,168	59.8	4,830	52.2
Self-employed	122	7.0	145	6.3	880	8.1
Unemployed	119	9.1	122	5.7	465	5.7
Unable to work	353	13.6	284	9.2	604	4.1
All other	496	23.6	541	19.0	4,601	29.9
<i>total</i>	1,870	100.0	2,260	100.0	11,380	100.0
Disability						
Yes	1,063	48.4	1,044	38.3	3,618	26.7
No	772	51.6	1,171	61.7	7,428	73.3
<i>total</i>	1,835	100.0	2,215	100.0	11,046	100.0
Sample Total by Group	1,877	13.0	2,263	15.9	11,394	71.1

Results

Thirteen percent reported 30 days of insufficient sleep (N = 1,877), while 15.9 percent (N=2,263) reported 14 to 29 days of insufficient sleep, and 71.1 percent (N=11,394) reported 0 to 13 days of insufficient sleep (Table 1). Insufficient sleep was found to vary by both age and sex. Females

were more likely than males to report medium and high sleep-loss. Additionally, younger respondents (25–44 yrs.) were more likely than older respondents (age 65+), to be represented in the high and medium sleep-loss groups. Among the unemployed sample population, the highest percentage was found in the high sleep-loss group.

Most pronounced was the difference in prevalence of disability across the three levels of sleep-loss. Nearly half (48.4%) of adults in the high sleep-loss group reported having a disability, compared to 38.3 and 26.7 percent, respectively, for those in the medium and low sleep-loss groups.

Table 2 presents the age-adjusted prevalence rates for selected health risk behaviors by level of sleep-loss. Findings showed that the difference in age-adjusted smoking rates for males changed significantly from medium to high sleep-loss (p<0.01). Among females,

the change in smoking rates was statistically significant from low to medium *and* medium to high levels of sleep-loss. With respect to obesity, the prevalence for both males and females was significantly higher in the medium sleep-loss group, compared to the low sleep-loss group; however,

Table 2.
Age-adjusted Prevalence of Selected Risk Behaviors by Sex and Sleep-loss Days:
2008 North Carolina BRFSS Survey

Risk Factors by Gender	Sleep-loss Days			T-test for Difference in Proportion	
	All 30 days (high)	14–29 days (medium)	0–13 days (low)	30 days vs. 14–29 days P value	14–29 days vs. 0–13 days P value
Males					
Current smoking daily or occasional	32.1%	21.7%	21.9%	<0.01	0.91
Obesity BMI ≥ 30 kg/m ²	35.7%	34.7%	27.5%	0.77	<0.01
Physical inactivity no exercise past 30 days	34.4%	26.0%	18.3%	<0.01	<0.01
Females					
Current smoking daily or occasional	28.8%	21.6%	15.2%	<0.01	<0.01
Obesity BMI ≥ 30 kg/m ²	35.6%	33.3%	27.4%	0.39	<0.01
Physical inactivity no exercise past 30 days	39.6%	31.1%	24.6%	<0.01	<0.01

among females: for mental distress and frequent activity limitations, the associated *p* values for the change in prevalence from medium to high sleep-loss were 0.06 for both measures. Overall, these results suggest that poor quality of life and sleep-loss are highly correlated.

Regarding the risk factors we examined, the

there was no statistical difference in the prevalence of obesity between the medium and high sleep-loss groups. By contrast, for both sexes, the prevalence of physical inactivity changed by a substantial margin from low to medium sleep-loss ($p < 0.01$) and from medium to high sleep-loss ($p < 0.01$).

Table 3 presents the age-adjusted prevalence rates for poor quality of life by level of sleep-loss. The most noticeable difference was observed in the very sharp increase in the age-adjusted prevalence of frequent physical distress, and frequent mental distress, and frequent activity limitation, from low to medium levels of sleep-loss; and, this large difference in rates was comparable for both males and females.

Discussion

This study provides some support for our hypothesis that those reporting all 30 days of insufficient sleep would have a significantly higher risk of poor quality of life than those reporting 14 to 29 days. This effect was particularly evident among males; in this case, the reported prevalence of poor physical or mental health, and restricted activity, changed significantly from low to medium and medium to high levels of sleep-loss. This effect was also close to statistical significance

report of all 30 days of insufficient sleep (for males and females) was not associated with a significant change, or independent risk, in the prevalence of obesity, but was associated with an independent risk for physical inactivity. Also noteworthy, among females high sleep-loss was, in fact, associated with an independent risk of smoking—a finding that warrants further study. Here, the results suggest higher levels of insufficient sleep tend to be associated with an increase in the prevalence in health risk behaviors, such as smoking and particularly physical inactivity.

Furthermore, the trends we observed in this study support those found in the Strine and Chapman study. For example, the authors report that 18.8 percent of those in the high risk sleep group (≥ 14 days of insufficient sleep) had frequent physical distress, as compared to 6.7 percent in the low risk sleep group (< 14 days of insufficient sleep); regarding frequent mental distress, the rates were 24.7 percent and 5.7 percent, respectively, for these two groups. Moreover, after adjusting for sex, age, race/ethnicity, marital status, education and employment status, the odds of smoking, physical inactivity, and obesity were all significantly higher in the high risk sleep group, compared to the odds in the low risk sleep group.

In conclusion, the study of sleep disorders at the population level is in its early stages. It is likely that the assessment of sleep in surveys, such as the BRFSS, will continue to evolve, and that the resulting research will continue to enhance our understanding of how sleep is associated with various health outcomes and health risk-behaviors. It is also evident that sleep is a powerful correlate of overall health, and, to that extent, improving the quality of sleep in the U.S. child and adult population should be considered an emerging and important public health objective.

Table 3.
Age-adjusted Prevalence of Self-reported Poor Quality of Life by Sex and Sleep-loss Days:
2008 North Carolina BRFSS Survey

Poor Quality of Life	Sleep-loss Days			T-test for Difference in Proportion	
	All 30 days (high)	14–29 days (medium)	0–13 days (low)	30 days vs. 14–29 days P value	14–29 days vs. 0–13 days P value
Males					
Frequent physical distress 14+ days in the past 30 of poor physical health	27.1%	20.0%	5.8%	0.010	<0.001
Frequent mental distress 14+ days in the past 30 of poor mental health	23.2%	16.9%	4.7%	0.026	<0.001
Frequent activity limitations 14+ days in the past 30 of poor health limiting activities	20.5%	13.2%	3.2%	0.002	<0.001
Females					
Frequent physical distress 14+ days in the past 30 of poor physical health	27.6%	19.7%	8.5%	<0.001	<0.001
Frequent mental distress 14+ days in the past 30 of poor mental health	27.9%	23.3%	6.3%	0.058	<0.001
Frequent activity limitations 14+ days in the past 30 of poor health limiting activities	18.3%	14.7%	3.7%	0.057	<0.001

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