

Sadly Awake: Short Sleep Duration and Depressive Symptoms among Adolescents

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Abstract

Background: Inappropriate sleep duration has been showed to be associated with increased suicidality among high school students in the United States. An association between inappropriate sleep duration and general depressive symptoms among this population has not been reported.

Methods: The biennial Youth Risk Behavior Surveillance System uses national and local school-based surveys to measure the prevalence of health-risk behaviors among youth and young adults. Students reported how many hours a night they get on an average school night and whether their daily routine was altered for two consecutive weeks due to sadness or hopelessness. We analyzed whether 8-10 hours of sleep was associated with depressive symptoms. Covariates included sex, race, BMI, bullying, abuse, smoking, alcohol use, and drug use.

Results: Students who reported <8 or ≥ 10 hours of sleep had an odds ratio of 1.66(1.49, 1.86) of concurrent depressive symptoms.

Conclusion: Routine adolescent depression surveillance may be enhanced by sleep duration assessments.

Keywords: Insomnia; Depression; Sleep medicine

Introduction

Insomnia is a risk factor for depression [1]. Meta-analysis demonstrates a two-fold increase in risk for depression among non-depressed individuals with insomnia [2], an association validated with as few as two weeks of sleep data [3]. Increased depression risk can persist for 30 years [4]. There is significant heterogeneity in how studies measure insomnia. Insomnia symptoms, insomnia symptoms with daytime consequences, insomnia diagnosis, and sleep dissatisfaction have been used to measure insomnia [5]. Current diagnostic criteria for insomnia include prolonged dissatisfaction with sleep quantity or quality coupled with difficulty initiating or maintaining sleep and functional impairments [6].

Insomnia implies poor sleep quantity or quality [7]. The definition of sleep quality may be subjective [8] and difficult to define [9]. Systematic deficiencies exist in the understanding and measurement of sleep quality [8-10]. Sleep quality-related complaints and diagnosis often are not correlated with objective sleep measurements, including electroencephalogram [11] and polysomnography [12]. Polysomnography is considered the “gold standard” of sleep measurement [13] but is expensive and impractical to use in large studies. The most commonly used standardized measurement of sleep quality is the Pittsburgh Sleep Quality Index (PSQI) [14], a survey-based measurement. PSQI is valid and reliable across heterogeneous populations [15]. PSQI incorporates sleep quantity and daily functioning into its measurement of sleep quality and cannot establish the validity or reliability of self-reported sleep quantity or quality alone.

In contrast to sleep quality, sleep quantity is essentially an objective measure. When measured subjectively through self-reporting, respondents tend to underestimate sleep duration [15]. A recent meta-analysis showed a moderate to strong correlation between self-reported and objectively measured sleep duration [16], consistent with previous studies [15,17-19]. Adolescents' estimates of sleep duration are strongly correlated with objective measurement in weekday sleep reports, and only moderately correlated in weekend sleep reports [15,16]. Self-report validity may be significantly enhanced by daily diary entries [20].

Multiple studies have reported associations between sleep duration and depression. A recent analysis of 22,281 adult participants in the US National Health and Nutrition Examination Surveys showed a significant association between sleep duration and depression [21]. Less than seven hours of sleep is associated with incident mood-related risks, including tension, depression, and dissatisfaction with life [22]. A longitudinal study of 2,259 students found that less than six hours of sleep per night predicts depressive symptoms and low self-esteem [23]. A recent cross-sectional study of 894 pairs of twins found an association between depressive symptoms and less than seven or greater than nine hours of sleep [24]. Insufficient sleep duration among adolescents is estimated at one-fourth to one-fifth of the population and predicts depressed mood and poor quality of life [7].

Despite conflicting evidence [25], sleep quality [4,22,26] seems to be more significantly correlated with poor emotional functioning than sleep quantity. Regardless of their relative importance, both sleep quantity and sleep quality are independently associated with depression [24] and poor depression outcomes [27,28]. Sleep duration data are simpler to define and tabulate than insomnia or sleep quantity data. Many large surveys routinely collect sleep duration data with a single question. If sleep duration is associated with depression, it can be an important mental health surveillance tool. We used a recent, large, representative study of US high school student to test the hypothesis that sleep duration predicts depression.

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Methods

The biennial Youth Risk Behavior Surveillance System (YRBS) uses national and local school-based surveys to measure the prevalence of health-risk behaviors among youth and young adults [29]. The survey is directed by the Centers for Disease Control and Prevention. In 2013, the response rate was 77% among schools and 88% among students, with an overall response rate of 68%. Weighted adjustments were used to adjust for non-response rates and oversampling. The survey collected data on 99 questions related to individual characteristics and health-risk behaviors. A total of 13,583 usable questionnaires were completed by students in grades 9–12.

Our exposure variable of sleep duration is assessed by the survey question, “On an average school night, how many hours of sleep do you get?” Fixed-choice responses are, in hours, ≤ 4 , 5, 6, 7, 8, 9, and ≥ 10 . The American Academy of Sleep Medicine (AASM) recommends 8–10 hours of sleep for adolescents [30]. To best match these recommendations, students who reported <8 hours or ≥ 10 of sleep on school nights are compared with those who reported 8 or 9 hours of sleep. Combining appropriate ($=10$) and inappropriate (>10) durations

Variables	1	2	3	4
Intercept	-1.267*** (0.041)	-1.835*** (0.143)	-2.376*** (0.157)	-2.401*** (0.168)
<8 or ≥ 10 Hours of sleep	0.592*** (0.047)	0.597*** (0.050)	0.517*** (0.054)	0.507*** (0.057)
Female		0.872*** (0.043)	0.704*** (0.046)	0.793*** (0.050)
Age		-0.000561	0.002 (0.019)	-0.026 (0.020)
BMI		0.013*** (0.004)	0.010** (0.004)	0.010** (0.005)
Black		-0.240*** (0.079)	-0.133 (0.085)	-0.078 (0.090)
Hispanic		0.203*** (0.075)	0.283*** (0.081)	0.281*** (0.086)
White		-0.008307	-0.164** (0.077)	-0.242*** (0.081)
Bullied in school			0.808*** (0.060)	0.834*** (0.064)
Bullied online			0.763*** (0.067)	0.775*** (0.072)
Physically assaulted			0.285*** (0.080)	0.238*** (0.099)
Sexually assaulted			0.215*** (0.030)	0.191*** (0.032)
Rape victim			0.732*** (0.089)	0.666*** (0.098)
Smoking				0.461*** (0.094)
Alcohol use				0.046*** (0.013)
Recreational Injectable drug use				-0.079 (0.144)
Recreational Prescription drug use				0.156*** (0.025)
N	12,264	11,277	10,839	9,901
Log Likelihood	-7,452.611	-6,610.11	-5,901.61	-5,257.017
Akaike Inf. Crit.	14,909.220	13,236.22	11,829.22	10,548.030

Table 1: Summary of logistic regression analysis for variables predicting depressive symptoms.

***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.

Models	Odds Ratio	Lower Limit	Upper Limit
Model 1	1.81	1.65	1.98
Model 2	1.82	1.65	2.01
Model 3	1.68	1.51	1.86
Model 4	1.66	1.49	1.86

Table 2: Odds ratio and 95% CI of depressive symptoms with <8 hours of sleep.

Variables	Odds Ratio	Lower Limit	Upper Limit	p-value
<8 or ≥ 10 Hours of sleep	1.66	1.49	1.86	5.67E-19
Age	0.97	0.94	1.01	
Female	2.21	2.01	2.45	1.12E-56
BMI	1.01	1	1.02	3.50E-02
Black	0.93	0.76	1.1	
Hispanic	1.32	1.12	1.57	1.09E-03
White	0.78	0.67	0.92	2.90E-03
Bullied in school	2.3	2.03	2.61	1.50E-38
Bullied online	2.17	1.89	2.5	3.19E-27
Physically assaulted	1.27	1.05	1.54	1.66E-02
Sexually assaulted	1.21	1.14	1.29	3.67E-09
Rape victim	1.94	1.61	2.36	1.26E-11
Smoking	1.59	1.32	1.9	1.07E-06
Alcohol use	1.05	1.02	1.07	3.23E-04
Injectable drug abuse	0.92	0.7	1.23	
Prescription drug abuse	1.17	1.11	1.23	2.98E-10

Table 3: Odds ratio and 95% CI of depression (Model 4).

of sleep into a single level was unavoidable, but thought to be important to report upon.

Our outcome variable of depression is assessed by the yes/no question, “During the past 12 months, did you ever feel so sad and hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?” Depressed mood or loss of interest in activities for two weeks or more are the cardinal criteria for major depressive disorder (MDD) [31] and are necessary but not sufficient conditions for diagnosis [32]. The YRBS also contains data on suicidality, another major depressive disorder symptom. Our analyses do not include suicidality because it is a restrictive criterion for depression; half or more of those with MDD do not consider suicide [33,34], while a study of patients with MDD found the prevalence of depressed mood and loss of interest in activities to be 93.7% and 82.2%, respectively [34]. Fitzgerald et al. [35] previously found inappropriate sleep duration to be associated with suicide ideation in YRBS survey data. This study analyzes whether that finding can be extended to depressive symptoms.

Logistic regression was used to measure the association between sleep duration and depressive symptoms, adjusting for possible confounders including age, sex, race, body mass index (BMI), physical assault victim, sexual assault victim, rape victim, smoking, alcohol use, recreational injectable drug use and recreational prescription drug use (survey items listed in Appendix A). Four logistic regression models were used. The first contained no covariates. The second model added gender, race, and BMI. The third model added bullying- and abuse-related covariates. The fourth model added smoking, alcohol use, and drug use.

Results

Logistic regression revealed a strong and consistent correlation between <8 or ≥ 10 hours of sleep and depressive symptoms across all models (Table 1).

In our initial model, <8 or ≥ 10 hours of sleep had an odds ratio

of 1.71 for depressive symptoms. The correlation remained significant through all our models with odds ratios ranging from 1.66 to 2.01 (Table 2).

Female sex (OR=2.21 in model 4), physical bullying (2.30), online bullying (2.17), and rape (1.95) were the strongest correlates of depressive symptoms across our models. The level of correlation with depressive symptoms was similar for smoking (1.59) and ≤ 8 or ≥ 10 hours of sleep (1.66). Physical assault (1.27) and sexual assault (1.21) were associated to a lesser degree. The individual associations of physical and online bullying, as well as rape and sexual assault, may be underestimated due to collinearity. Hispanics had greater odds of depressive symptoms (OR=1.32) while Whites had lower odds (OR=0.78). Alcohol use (1.05) showed only a small association with depressive symptoms (Table 3).

Discussion

Analysis of survey data from a nationally representative sample of high school students shows a significant association between ≤ 8 or ≥ 10 hours of sleep and depressive symptoms. This association remains statistically and practically significant after controlling for confounders. The results suggest that sleep duration may be an important indicator of depression. Fitzgerald et al. [35] found, using YRBS survey data, that sleep duration predicts suicide ideation, and should be a routine component of suicide surveillance efforts in adolescents. Our findings suggest that sleep duration should be used routinely in general depression surveillance efforts as well.

Our results suggest that Hispanic adolescents may have greater odds of depression than other racial groups, a finding consistent with previous studies [36,37]. The stress of immigrant acculturation may cause increased risk of depression and suicide ideation [38]. These findings suggest that identifying effective school interventions for adolescent Hispanics may be of particular importance [39].

Many covariates had the expected positive correlation with depressive symptoms predicted by previous research. Female sex has been widely shown to be a risk factor for depression [40]. Bullying has been associated with depression and suicidality [41]. Physical assault [42], sexual assault [43], smoking [44], and alcohol and drug abuse [45] have also been associated with depression. The YRBS data additionally supports the need to focus intervention efforts on these at-risk populations.

This study has several limitations. First, YRBS data is cross-sectional and can only establish associations, not longitudinal risk. Second, the discrete, 7-level classification of sleep duration can hide important intragroup differences, as each level contains individuals with different sleep durations. In addition, the variable level of ≥ 10 hours of sleep combines appropriate and inappropriate 30 levels of sleep. Third, the survey contains numerous data, and can be analyzed using many different groups of covariates. We did not perform stepwise analysis of possible confounders, but rather decided on a set of confounders prior to data analysis. Nevertheless, there are other survey data that can be reasonably included in the analysis. Thus our results can be due to an unknown confounder or group of confounders. Fourth, the survey data are subjective, and not corroborated with objective measurement. The possibility remains that depression is correlated with self-reported but not objective sleep durations.

Conclusion

In conclusion, Data from the 2013 YRBS survey of high school students indicates that sleep durations of ≤ 8 or ≥ 10 hours of sleep is

associated with a significantly increased odds of depression. Routine adolescent depression surveillance may be enhanced by sleep duration assessment. Future studies should look for causal associations between sleep duration and depressive symptoms.

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