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Relationships between hours of sleep and health-risk behaviors in US adolescent students

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ABSTRACT

Objective. To examine associations between insufficient sleep (<8 h on average school nights) and health-risk behaviors.

Methods. 2007 national Youth Risk Behavior Survey data of U.S. high school students (n = 12,154) were analyzed. Associations were examined on weighted data using multivariate logistic regression.

Results. Insufficient sleep on an average school night was reported by 68.9% of students. Insufficient sleep was associated with higher odds of current use of cigarettes (age-adjusted odds ratio [AOR], 1.67; 95% confidence interval [CI], 1.45–1.93), marijuana (AOR, 1.52; 95% CI, 1.31–1.76), and alcohol (AOR, 1.64; 95% CI, 1.46–1.84); current sexual activity (AOR, 1.41; 95% CI, 1.25–1.59); seriously considered attempting suicide (AOR, 1.86; 95% CI, 1.60–2.16); feeling sad or hopeless (AOR, 1.62; 95% CI, 1.43–1.84); physical fighting (AOR, 1.40; 95% CI, 1.24–1.60), not being physically active at least 60 min ≥ 5 days in the past 7 days (AOR, 1.16; 95% CI, 1.04–1.29), using the computer ≥ 3 h/day (AOR, 1.58; 95% CI, 1.38–1.80), and drinking soda/pop > 1 time/day (AOR, 1.14; 95% CI, 1.03–1.28).

Conclusion. Two-thirds of adolescent students reported insufficient sleep, which was associated with many health-risk behaviors. Greater awareness of the impact of sleep insufficiency is vital.

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Many adolescents are chronically sleep-deprived due to social, employment, recreational, and academic pressures as well as biological changes in the sleep/wake cycle (Carskadon et al., 2004; Dahl and Lewin, 2002; Institute of Medicine, 2006; Schuen and Millard, 2000). Insufficient sleep is also a symptom and corollary of several mental disorders, including major depression (American Psychiatric Association, 2000; Dahl and Lewin, 2002). The consequences of insufficient sleep may include a negative impact on the control of behavior, emotions, and attention that can be associated with health-risk behaviors (Dahl and Lewin, 2002). Short sleep duration and nightmares have been associated with suicide attempts in Chinese students (Liu, 2004). In a national sample of 10th–12th grade drivers, 15% reported driving drowsy at least once a week (National Sleep Foundation, 2006). O'Brien and Mindell (2005) examined sleep and risk behaviors among students from 4 high schools in Philadelphia; they reported an association between sleep problems and tobacco use, alcohol use, marijuana use, safety

behaviors, and sexual behaviors. These relationships need further examination in a nationally representative sample to inform public health and policy decisions that affect adolescent sleep. National surveillance data on sleep duration first became available in the 2007 Youth Risk Behavior Survey (YRBS) (CDC, 2008). We examined the associations between self-reported hours of sleep on an average school night and selected health-risk behaviors among adolescents using data from high school students in the 2007 national YRBS.

Methods

Survey

The national YRBS is a biennial, self-administered survey of US high school students. A three-stage cluster sample design was used to produce data representative of students in grades 9–12 in public and private schools in the 50 states and the District of Columbia. The 2007 school response rate was 81%; student response rate was 84%; and overall response rate was 68%. Each student record was weighted to adjust for school and student non-response and oversampling of black and Hispanic students. The study population included the 12154 students (87%) with responses to the sleep question (13% with missing data on the sleep question omitted). Additional information about the YRBS can be found elsewhere (CDC, 2008).

Abbreviations: YRBS, Youth Risk Behavior Survey; CI, confidence interval; AOR, adjusted odds ratio; IOM, Institute of Medicine.

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Measures

Hours of sleep was assessed by the question, “On an average school night, how many hours of sleep do you get?” Responses were dichotomized into <8 h of sleep (insufficient sleep¹) and ≥8 h of sleep (sufficient sleep).

Health-risk behaviors

The following health-risk behaviors were examined: drank soda or pop (not including diet soda or diet pop) at least one time/day during the 7 days before the survey; did not participate in at least 60 min of physical activity on ≥5 of 7 days before the survey; on an average school day: watched television ≥3 h/day and played video or computer games or used a computer for something that was not school work for ≥3 h/day; in a physical fight ≥1 time during the 12 months before the survey; during the 30 days before the survey: smoked cigarettes on ≥1 day (i.e., current cigarette use), had at least one drink of alcohol on ≥1 day (i.e., current alcohol use), used marijuana ≥1 time (i.e., current marijuana use); had sexual intercourse with ≥1 person during the 3 months before the survey (i.e., currently sexually active); felt so sad or hopeless almost every day for 2 weeks or more in a row that they stopped doing some usual activities; and seriously considered attempting suicide during the 12 months before the survey.

Statistical analysis

Descriptive analyses included the weighted percent and 95% confidence intervals (CI) of characteristics of the study population. Prevalence estimates and 95% CI of the health-risk behaviors were calculated by sleep status. The age-, sex-, and race/ethnicity-adjusted odds ratio (AOR) and 95% CI for the association of insufficient sleep with each dependent variable was calculated with separate multivariate logistic regression models for each health-risk behavior. We tested whether associations of sleep with each risk behavior varied by race or sex by adding sleep × sex and sleep × race interaction terms into multivariate logistic regression models that included age, sex, and race/ethnicity, and sleep as main effects.

Statistical significance of adjusted odds ratios was determined at $p < 0.05$. Stratified models were run when the interactions were significant (Wald $F p < 0.10$) and were adjusted by age and race/ethnicity (if stratified by sex), or age and sex (if stratified by race/ethnicity). All analyses were conducted on weighted data using SAS-callable SUDAAN 9.0.3 (Research Triangle Institute, 2007) to account for the complex sample design.

Results

Approximately half (49.7%) of the total sample ($N = 12,154$) was female. The majority of students were non-Hispanic white (62.7%) and reported sleeping 7 h (30.2%) on an average school night (Table 1). More than two-thirds (68.9%) reported insufficient sleep (<8 h) on an average school night. The prevalence of health-risk behaviors among study participants is indicated in Table 1 and similar to estimates for the overall 2007 national YRBS sample reported elsewhere (CDC, 2008).

Insufficient sleep was associated with 10 of 11 health-risk behaviors examined (Table 2). For all 10, students who reported insufficient sleep had higher odds of engaging in the risk behavior than did students who reported sufficient sleep. There was no association between insufficient sleep and watching television ≥3 h/day (Table 2).

The association of sleep with health-risk behaviors varied by race/ethnicity for 2 of 11 associations tested. Students who reported insufficient sleep (versus students who reported sufficient sleep) had higher odds of feeling sad or hopeless among white (AOR, 1.83; 95% CI, 1.50–2.22) and Hispanic (AOR, 1.47; 95% CI, 1.17–1.84) but not black students (AOR, 1.20; 95% CI, 0.98–1.48) or students of other race/ethnicity (AOR, 1.51; 95% CI, 0.99–2.31). The association of insufficient sleep with not being physically active at least

Table 1

Demographic, sleep, and health-risk characteristics of study sample ($N = 12,154$) – Youth Risk Behavior Survey, United States, 2007.

Characteristic	%	95% CI
Sex		
Female	49.7	(48.5–50.9)
Male	50.3	(49.1–51.5)
Race/ethnicity		
White (non-Hispanic)	62.7	(56.1–68.8)
Black or African American (non-Hispanic)	14.7	(11.6–18.5)
Hispanic/Latino	15.8	(12.5–19.7)
Other (American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander students and students who specified multiple races)	6.8	(4.9–9.4)
Age (years)		
≤14	10.8	(9.9–11.8)
15	25.4	(24.4–26.5)
16	26.3	(25.1–27.5)
17	23.8	(22.5–25.1)
≥18	13.7	(12.8–14.7)
Number of hours of sleep on an average school night		
≤4	5.9	(5.3–6.5)
5	10.0	(9.2–10.9)
6	22.8	(21.5–24.1)
7	30.2	(29.3–31.2)
8	23.5	(21.8–25.3)
9	5.9	(5.2–6.6)
≥10	1.7	(1.3–2.2)
Insufficient sleep (<8 h on an average school night)	68.9	(66.9–70.9)
Health-risk behaviors		
Drank soda or pop ≥1 time/day ^a	35.0	(32.2–37.9)
Did not participate in 60 min of physical activity on ≥5 of 7 days ^b	65.7	(63.9–67.5)
Watched television ≥3 h/day ^c	35.7	(33.5–37.8)
Used computers ≥3 h/day ^{c,d}	24.8	(23.3–26.4)
In a physical fight ≥1 time ^e	35.4	(33.5–36.2)
Current cigarette use ^f	21.2	(18.8–23.9)
Current alcohol use ^g	46.1	(44.2–48.0)
Current marijuana use ^h	20.9	(19.2–22.8)
Currently sexually active ⁱ	35.6	(33.3–38.0)
Felt sad or hopeless ^j	28.1	(27.0–29.3)
Seriously considered attempting suicide ^e	14.6	(13.6–15.7)

^a Not including diet soda or diet pop, during the 7 days before the survey.

^b Were not physically active doing any kind of physical activity that increased their heart rate and made them breathe hard some of the time for a total of at least 60 min/day on ≥5 days during the 7 days before the survey.

^c On an average school day.

^d For something that was not school work.

^e During the 12 months before the survey.

^f Smoked cigarettes on ≥1 day during the 30 days before the survey.

^g Had at least one drink of alcohol on ≥1 day during the 30 days before the survey.

^h Used marijuana ≥1 time during the 30 days before the survey.

ⁱ Had sexual intercourse with ≥1 person during the 3 months before the survey.

^j Almost every day for at least 2 or more weeks in a row so that they stopped doing some usual activities.

60 min ≥5 days in the past 7 days was significant among black (AOR, 1.41; 95% CI, 1.06–1.88), Hispanic (AOR, 1.38; 95% CI, 1.15–1.66) and other race/ethnicity students (AOR, 1.61; 95% CI, 1.09–2.37), but not among white students (AOR, 1.04; 95% CI, 0.92–1.17).

The association of sleep and health-risk behaviors varied by sex for 1 of the 11 associations tested. The association of insufficient sleep with watching television ≥3 h/day was significant among male (AOR, 1.16; 95% CI, 1.00–1.35), but not among female (AOR, 0.88; 95% CI, 0.73–1.06) students.

Discussion

To our knowledge, this is the first large sample, nationally representative study of adolescents to examine associations between self-reported insufficient sleep on an average school night and selected health-risk behaviors and to examine if those associations varied by sex and race. These associations may be due to the impact of

¹ To correspond with a suggested definition of insufficient sleep by the National Sleep Foundation in its 2006 Sleep in America poll of adolescents (National Sleep Foundation, 2006).

Table 2

Prevalence and adjusted likelihood of selected health-risk behaviors by sleep status on an average school night –Youth Risk Behavior Survey, United States 2007.

Health-risk behavior	<8 h sleep on an average school night [N = 8370]		≥ 8 h on an average school night [N = 3784]		Adjusted OR ^a (≥ 8 h is the referent)	(95% CI)	p value
	%	(95% CI)	%	(95% CI)			
Drank soda or pop ≥ 1 time/day ^b	35.7	(33.0–38.6)	33.5	(30.1–37.0)	1.14	(1.03–1.28)	0.02
Did not participate in 60 min of physical activity on ≥ 5 of 7 days ^c	67.3	(65.2–69.3)	62.2	(59.9–64.4)	1.16	(1.04–1.29)	0.01
Watched television ≥ 3 h /day ^d	35.6	(33.3–37.9)	35.9	(32.8–39.1)	1.02	(0.89–1.16)	0.79
Used computers ≥ 3 h/day ^{c,e}	26.9	(25.1–28.7)	20.3	(18.5–22.4)	1.58	(1.38–1.80)	0.00
In a physical fight ≥ 1 time ^f	36.9	(35.0–38.9)	32.0	(30.2–33.9)	1.40	(1.24–1.60)	0.00
Current cigarette use ^g	24.0	(21.3–27.0)	15.0	(12.8–17.4)	1.67	(1.45–1.93)	0.00
Current alcohol use ^h	50.3	(48.0–52.7)	36.7	(34.4–39.0)	1.64	(1.46–1.84)	0.00
Current marijuana use ⁱ	23.3	(21.3–25.5)	15.6	(13.8–17.7)	1.52	(1.31–1.76)	0.00
Currently sexually active ^j	39.1	(36.5–41.8)	27.8	(25.1–30.6)	1.41	(1.25–1.59)	0.00
Felt sad or hopeless ^k	31.1	(29.7–32.5)	21.6	(19.7–23.6)	1.62	(1.43–1.84)	0.00
Seriously considered attempting suicide ^e	16.8	(15.5–18.2)	9.8	(8.8–11.0)	1.86	(1.60–2.16)	0.00

^a Odds ratio (OR) and 95% confidence interval (CI) adjusted for sex, age, and race/ethnicity.^b Not including diet soda or diet pop, during the 7 days before the survey.^c Were not physically active doing any kind of physical activity that increased their heart rate and made them breathe hard some of the time for a total of at least 60 min/day on ≥ 5 days during the 7 days before the survey.^d On an average school day.^e For something that was not school work.^f During the 12 months before the survey.^g Smoked cigarettes on ≥ 1 day during the 30 days before the survey.^h Had at least one drink of alcohol on ≥ 1 day during the 30 days before the survey.ⁱ Used marijuana ≥ 1 time during the 30 days before the survey.^j Had sexual intercourse with ≥ 1 person during the 3 months before the survey.^k Almost every day for at least 2 or more weeks in a row so that they stopped doing some usual activities.

chronic sleep insufficiency on cognition, decreasing adolescents' ability to comprehend consequences of risk behaviors or increasing susceptibility to peer pressure (O'Brien and Mindell, 2005). Insufficient sleep and substance use combined can have a synergistic influence on cognitive abilities (concentration, vigilance, alertness) and coordination, leading to an increased risk of accidents and may contribute to other risk-taking behaviors, like sexual activity. Psychiatric problems have been found to underlie the relationship between sleep and some risk behaviors (Johnson and Breslau, 2001, Patten et al., 2000) as well as parental control (O'Brien and Mindell, 2005).

There are several limitations to our findings. Due to cross-sectional study design, the temporality of associations cannot be determined. Results are representative of youth who attend public and private school only. Data are based on self-report; however, the questions have been shown to demonstrate good test-retest reliability (Brener et al., 2002).

Conclusions

More than two-thirds of US high school students report insufficient sleep on an average school night which is associated with a variety of health-risk behaviors. Continued national surveillance and research examining sleep duration and associated factors among adolescents is needed.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Conflict of interest statement

The authors declare that there are no conflicts of interest.

References

- American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision. Washington, DC, American Psychiatric Association, 2000.
- Brener, N.D., Kann, L., McManus, T., Kinchen, S.A., Sundberg, E.C., Ross, J.G., 2002. Reliability of the 1999 youth risk behavior survey questionnaire. *J. Adolesc. Health* 31, 336–342.
- Carskadon, M.A., Acebo, C., Jenni, O.G., 2004. Regulation of adolescent sleep: implications for behavior. *Ann. N. Y. Acad. Sci.* 1021, 276–291.
- Centers for Disease Control and Prevention, 2008. Youth risk behavior surveillance – United States, 2007. *MMWR Surveill. Summ.* 57 (SS-4), 1–131.
- Dahl, R.E., Lewin, D.S., 2002. Pathways to adolescent health: sleep regulation and behavior. *J. Adolesc. Health* 31 (6 Suppl.), 175–184.
- Institute of Medicine of the National Academies, 2006. *Sleep Disorders and Sleep Deprivation*. National Academies Press, Washington, DC.
- Johnson, E.O., Breslau, N., 2001. Sleep problems and substance use in adolescence. *Drug Alcohol Depend.* 64, 1–7.
- Liu, X., 2004. Sleep and adolescent suicidal behavior. *Sleep* 27, 1351–1358.
- National Sleep Foundation, 2006. *Sleep in America poll: summary of findings*. Available at: http://www.sleepfoundation.org/sites/default/files/2006_summary_of_findings.pdf. 2006.
- O'Brien, E.M., Mindell, J.A., 2005. Sleep and risk-taking behavior in adolescents. *Behav. Sleep Med.* 3, 113–133.
- Patten, C.A., Choi, W.S., Gillin, C., Pierce, J.P., 2000. Depressive symptoms and cigarette smoking predict development and persistence of sleep problems in US Adolescents. *Pediatrics* 106 (e23), 1–9.
- Research Triangle Institute, 2007. *SUDAAN Language Manual*, Release 9.0.3. Research Triangle Park, NC: Research Triangle Institute.
- Schuen, J.N., Millard, S.L., 2000. Evaluation and treatment of sleep disorders in adolescents. *Adolesc. Med.* 11, 605–616.