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Teen Sleep and Suicidality: Results from the Youth Risk Behavior Surveys of 2007 and 2009

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SCIENTIFIC INVESTIGATIONS

Study Objectives: Suicide in the adolescent population is a tragic and preventable cause of death. Previous studies have confirmed both long and short total sleep times (TSTs) are associated with suicidal ideation in the adult population. We hypothesized that both long and short TSTs are risk factors for serious suicide attempt in the adolescent population as well.

Methods: We tested this hypothesis using the Youth Risk Behavior Surveys from 2007 and 2009, which consist of school-based, nationally representative samples (N = 12,154 for 2007, N = 14,782 for 2009). Logistic regression models were used to assess the relationship between suicidality and sleep after adjusting for confounders including age, sex, race/ethnicity, feelings of sadness, and substance abuse.

Results: Of the total sample, roughly 15% reported suicidal ideation, 10% planned suicide, 5% attempted and 2% reported an attempt requiring treatment. Teens who reported sleeping ≤ 5 or ≥ 10 h had a significantly higher risk for suicidality compared to those with a TST of 8 h. The largest odds ratios were found among the most severe forms of suicidality (attempt requiring treatment) with an odds ratio of 5.9 for a TST ≤ 4 h and 4.7 for a TST ≥ 10 h.

Conclusion: Both short and long TSTs are risk factors for suicidality among teens and extremes in TST may indicate more serious suicidality. Self-reported sleep duration may be a useful screening question for suicide risk. Future studies should examine whether sleep duration is a causal and/or modifiable risk factor for suicidality in teens.

Keywords: Suicide, sleep, child and adolescent psychiatry, epidemiology

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Suicide is a tragic and preventable cause of death. In the adolescent population, suicide is the third leading cause of mortality after accidents and homicide, according to data from the CDC.[1] Traditionally suicide accounts for approximately 4,000-5,000 teen deaths per year in the U.S.([1]), and attempted suicides exceed that number. A variety of risk factors for teen suicide have been identified, including previous attempt, psychiatric disorder, impulsive aggression, availability of lethal means, feelings of hopelessness or worthlessness, family history of depression or suicide, loss of parent, family discord, physical or sexual abuse, lack of a support network, and dealing with homosexuality in an unsupportive environment.[2] Specific psychiatric disorders are also associated with suicidality in teens, including depression, bipolar disorder, conduct disorder, and substance abuse.[2] Each of these, with the possible exception of conduct disorder, is strongly associated with sleep disruption both by self-report and polysomnographic findings.[3-6] This association raises the possibility that sleep may itself constitute a risk factor for suicidality.

In the adult population associations between sleep and suicide have been demonstrated in cross-sectional and longitudinal studies.[7-16] Some studies report insomnia as an immediate indicator of suicide risk,[17] and longer prospective studies also report insomnia as one of the strongest predictive symptoms prior to completed suicide.[10] Previous cross-sectional studies have found those reporting any sleep problem had an odds risk of 2.5 for suicide attempt compared to those without any insomnia compliants, and those with specific complaints of difficulty initiating sleep were 7.5 times more likely to have attempted suicide in the last 12 months compared to those without such compliant.[16]

As adolescence is marked by profound changes in sleep and circadian regulation, as well as by environmental and social influences on sleep, the potential relationship between sleep and suicidality may be particularly relevant among teens. One study found that adolescents with a total sleep time (TST) ≤ 8 h were 3 times as likely to make a suicide attempt as those with a TST ≥ 9 h.[18] However, the extent of that risk assessment could be underestimated by a dichotomous categorization of sleep; grouping more normative TSTs, like 7, 8, and 9 h, with more extreme

BRIEF SUMMARY

Current Knowledge/Study Rationale: Adolescent sleep is influenced greatly by both circadian and environmental factors often resulting in sleep durations that are out of line with traditional guidelines. In adults both short and long sleep are known to be associated with a variety of negative outcomes and disturbed sleep is a specific risk factor for suicide, leading us to investigate the impact of various sleep durations on suicidality in the teenage population.

Study Impact: In two independent, nationally representative samples of teens, controlling for a variety of confounders including feelings of sadness and substance abuse, both long and short self-reported sleep durations were negatively associated with suicidality and the strongest associations were seen in those with a history of attempts that required treatment. Assessing total sleep time in teens may be a useful measure to screen for suicide risk in the adolescent population.

TSTs, such as < 5 or > 10 could be misleading. In another study, adolescents with bedtimes of midnight or later, consequently resulting in shorter TSTs on school nights, were 24% more likely to suffer from depression and 20% more likely to have SI.[19] Although this study did not give data on more serious acts of suicidality, it did find that suicidal ideation (SI) and TST had a U-shaped relationship, wherein both short and long sleep times were significantly associated with increased risk of SI. Given these reports and the constant change in environmental pressures on teen sleep time, it is important to assess the association between TST and suicidality among adolescents, addressing the full spectrum of suicidal behavior from ideation to attempts requiring treatment. The current study used a large, recent, nationally representative sample of US teens to test these associations and had the further advantage of testing these findings using 2 waves of independent data. We hypothesized that sleep duration and suicidality among adolescents would have a U-shaped relationship.

METHODS

Ethical Approval

The current analyses included only de-identified data and were determined to be exempt from institutional review board approval by the University of Arkansas for Medical Sciences Institutional Review Board. In the original study, local parental consent procedures were followed in each school and individual subjects were allowed to refuse participation.

Study Design

The Youth Risk Behavior Survey (YRBS) is a biennial cross-sectional school based survey maintained by the Center for Disease Control and Prevention (CDC) since 1991 to monitor youth behavior that influences health.[20-23] It uses a 3-stage cluster sample design to collect a representative sample of 9th through 12th grade American students from both public and private schools. Data from 2007 and 2009 are discussed in this paper, as surveys prior to this time did not include any question regarding sleep. A weighting factor was applied to each student record to adjust for non-response and the oversampling of black and Hispanic students in the sample for both 2007 and 2009 data. The YRBS is a voluntary survey, and any school official can on behalf of the school opt out or in. The response rates in 2007 were 81% for schools and 84% for students within those schools, for an overall response rate of 68% of potential respondents. A total of 14,103 of the 16,662 sampled students submitted questionnaires, and 14,041 questionnaires were usable after data editing.[22] The response rates in 2009 were 81% for schools and 88% for students within those schools, for an overall response rate of 71% of potential respondents. Of 18,573 sampled students, 16,460 of submitted questionnaires; 16,410 questionnaires were usable after data editing.[22] The race and ethnicity variable used in the analysis was generated by the YRBS after combining 2 variables: race (American Indian, Asian, African-American, Pacific Islander, White) with ethnicity (Hispanic or Non-Hispanic). Four of these categories, Asian and Pacific Islander/Hispanic and Non-Hispanic, were then collapsed into the category of Asian/Pacific Islander. Complete information on the YRBS methodology is available via the CDC website at http://www.cdc.gov/HealthyYouth/yrbs/index.htm.

Exposure Variables

A single self-reported item was used to assess sleep. Total sleep time (TST) was assessed by Item 97: "On an average school night, how many hours of sleep do you get?" The fixed-choice responses were ≤ 4 h, 5 h, 6 h, 7 h, 8 h, 9 h, and ≥ 10 h.

Outcome Variables

Suicidality was assessed with 4 self-report items, Items 24-27: (1) Suicidal ideation: "During the past 12 months, did you ever seriously consider attempting suicide?" (2) Suicide planning: "During the past 12 months, did you make a plan about how you would attempt suicide?" (3) Suicide attempt: "During the past 12 months, how many times did you actually attempt suicide?" (4) Attempt leading to treatment: "If you attempted suicide during the past 12 months, did any attempt result in an injury, poisoning, or overdose that had to be treated by a doctor or nurse?" Sadness was assessed by Item 23: "During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?" Responses to all suicide and depression questions were dichotomous ("yes" or "no"), with the exception of question 26 regarding number of attempts. Responses to question 26 were divided into 4 categories ("No attempts," "1 attempt," "2 attempts," "3 attempts," and "4 or more attempts"). Because it had a strongly skewed distribution (the large majority of respondents indicating "No attempts"), this variable was dichotomized (presence or absence of attempt) in the regression models. Tobacco and alcohol questions were also recoded to presence or absence using Items 30 and 41: (1) "During the last 30 days, on how many days did you smoke cigarettes?" (2) "During the past 30 days, on how many days did you have at least one drink of alcohol?" Presence of bullying was assessed in the 2009 YRBS with the following yes/no question: "During the past 12 months, have you ever been bullied on school property?" This item did not appear on the 2007 survey and was not included in our regression analysis.

Statistical Analysis

The reference category chosen for all comparisons was 8 h. This TST was based on the fact that previous data indicate that persons at this age group most likely require 9.2 h of sleep but most actually sleep 7-8 h.[19,24,25] Descriptive statistics are presented for each outcome variable by exposure level. Association between exposure (TST on an average school night) and each outcome of interest (suicidality questions) was measured with logistic regression after adjusting for potential confounders including sex, age, race/ethnicity, and sadness. Results are expressed as odds ratios and 95% confidence intervals. Crude and adjusted odds ratios were calculated, with and without weighting. Data from 2007 and 2009 are presented separately because they include independent samples.

RESULTS

Sample descriptors, clinical variables, and prevalence of suicidality are presented for the 2007 and 2009 samples in

Table 1A—2007 YRBS sample description and distributions

	Total Sample	Self-Reported Sleep Duration						
		≤ 4 h	5 h	6 h	7 h	8 h	9 h	≥ 10 h
Total	12,154	758	1,249	2,740	3,623	2,792	742	250
Percent of Total	100.0	6.2	10.3	22.5	29.8	23.0	6.1	2.1
Age								
Mean Age (SD)	16.2 (1.2)	15.9 (1.2)	16.4 (1.3)	16.4 (1.2)	16.4 (1.2)	16.2 (1.2)	15.7 (1.2)	15.9 (1.2)
Gender (%)*								
$\chi^2(6) = 89.39, p < 0.005$								
Male	52.1	43.9	45.0	52.2	52.5	58.4	60.3	50.3
Race/Ethnicity (%)**								
$\chi^2(42) = 291.4, p < 0.005$								
White	62.7	52.3	55.8	62.1	67.7	64.9	57.1	44.9
African American	14.7	20.1	20.0	16.5	11.7	12.9	14.4	22.5
Hispanic	15.8	17.0	17.0	13.8	14.9	15.9	22.6	22.3
Asian/Pacific Islander	6.8	10.3	7.6	7.7	5.7	6.3	6.0	10.3
Clinical Variables (%)*								
Sadness	28.2	52.2	39.6	32.5	23.1	20.4	23.5	30.7
$\chi^2(6) = 446.7, p < 0.005$								
Tobacco Use	21.2	38.6	26.7	25.0	19.6	14.4	14.9	21.2
$\chi^2(6) = 199.2, p < 0.005$								
Alcohol Use	46.1	58.5	55.9	52.4	45.5	36.7	35.1	43.5
$\chi^2(6) = 264.3, p < 0.005$								
Suicidality (%)*								
Suicidal Ideation	14.6	34.6	19.3	17.8	11.7	8.5	13.0	17.8
$\chi^2(6) = 384.6, p < 0.005$								
Suicide Planning	11.2	30.3	15.7	13.5	8.2	6.3	8.5	16.8
$\chi^2(6) = 416.3, p < 0.005$								
Suicide Attempt	6.9	25.1	7.8	8.0	5.0	3.6	5.9	12.5
$\chi^2(6) = 395.5, p < 0.005$								
Attempt Requiring Treatment	1.9	10.0	3.0	1.9	1.1	0.6	1.6	4.8
$\chi^2(6) = 257.5, p < 0.005$								

*Values indicate the percent of respondents answering "Yes" for each sleep duration (identified by column). "No" responses are not shown. Columns and rows therefore do not add to 100%. **Percent reporting for each column. All responses are present. Columns add to 100%.

Tables 1A and **1B**. Results are shown for the entire sample in each year and for samples stratified by self-reported TST. For example, while 14.6% of the total sample in 2007 reported SI, among those with ≤ 4 h of sleep 34.6% reported SI. The same pattern was seen on the 2009 data.

The mean age of students participating in the survey was 16 years and did not differ significantly between categories on either survey. Sadness and substance use were more frequent at the extremes of TST and lowest at 8 h, confirming a consistent U-shaped curve seen with TST and both mental health outcomes and risk-taking behaviors.

Percentage of each TST was consistent between surveys, with 23% reportedly sleeping in the reference category of 8 h. While 6% reported sleeping ≤ 4 h, only 2% reported sleeping ≥ 10 h. Roughly 15% of the total sample reported SI; 10% planned suicide; 5% attempted suicide; and 2% reported an attempt requiring treatment. Eighty-four percent of those who had an attempt requiring treatment reported sleeping either ≤ 6 or ≥ 10 h. By contrast, only 57% of those with suicidal ideation slept outside of the 7-9 h range. Although there was a trend towards shorter TST in subjects reporting more than one attempt, we found no statistically significant difference in TST across number of attempts (YRBS 2007: $F = 1.0$, $p = 0.4$; YRBS 2009: $F = 2.3$, $p = 0.07$).

There was a strong and consistent association in both surveys between the shortest and longest reported TSTs and the most severe forms of suicidality (attempt and attempt requiring treatment) after adjusting for age, gender, race, feelings of sadness, and substance abuse. Adjusted odds ratios and 95% confidence intervals are presented in **Table 2**. In regard to the confounder of bullying, a separate regression was done for the 2009 data to see if adding this variable had any impact on the significance of the estimates. No impact was found on the estimates, and it was not included in the adjusted odds presented.

In the category of SI, self-reported TSTs of 6 h, 5 h, and ≤ 4 h displayed significantly higher risk, a pattern that was consistent between surveys. Suicidal planning had an identical trend in regards to consistency between surveys; however the category of a self-reported TST of 5 h was not significant with the outcome variable of suicide attempt in the 2007 data. Attempt requiring

treatment was the only measure for which a long self-reported TST was consistently significant in both surveys. However, this measure contained one of the largest odds ratios (6.0, 95% CI 2.3-16.5), surpassed only by the odds ratio for TST ≤ 4 h (6.5, 95% CI 3.2-13). The odds ratios estimates rose with each successive outcome variable analyzed, such that the highest odds

Table 1B—2009 YRBS sample description and distributions

	Total Sample	Self-Reported Sleep Duration						
		≤ 4 h	5 h	6 h	7 h	8 h	9 h	≥ 10 h
Total	14,782	923	1,569	3,222	4,419	3,440	891	318
Percent of Total	100.0	6.2	10.6	21.8	29.9	23.3	6.0	2.2
Age								
Mean Age (SD)	16.1 (1.2)	16.2 (1.2)	16.3 (1.2)	16.3 (1.2)	16.2 (1.2)	15.9 (1.2)	15.8 (1.3)	15.7 (1.2)
Gender (%)*								
$\chi^2(6) = 122.4, p < 0.005$								
Male	52.2	54.4	43.1	48.6	53.9	55.2	61.4	61.0
Race/Ethnicity (%)**								
$\chi^2(42) = 338.8, p < 0.005$								
White	61.4	47.7	56.0	62.0	65.3	62.8	59.7	43.9
African American	14.5	25.7	19.0	14.6	11.4	12.9	14.8	26.5
Hispanic	16.9	16.0	15.5	15.4	16.9	18.2	19.8	20.6
Asian/Pacific Islander	7.2	10.6	9.5	8.0	6.4	6.0	5.7	9.0
Clinical Variables (%)*								
Sadness	26.0	50.3	36.9	29.9	22.4	18.5	18.8	26.4
$\chi^2(6) = 525.4, p < 0.005$								
Tobacco Use	19.8	32.4	24.9	23.5	18.0	15.2	14.3	15.8
$\chi^2(6) = 199.2, p < 0.005$								
Alcohol Use	42.3	54.8	51.0	48.3	41.2	35.8	29.3	26.7
$\chi^2(6) = 264.3, p < 0.005$								
Suicidality (%)*								
Suicidal Ideation	13.8	32.3	22.1	14.8	11.4	8.7	10.2	14.6
$\chi^2(6) = 433.7, p < 0.005$								
Suicide Planning	10.9	26.8	17.2	12.4	8.4	6.8	7.3	12.2
$\chi^2(6) = 386.7, p < 0.005$								
Suicide Attempt	6.3	24.1	12.6	5.9	3.9	3.2	4.4	12.7
$\chi^2(6) = 565.1, p < 0.005$								
Attempt Requiring Treatment	2.0	13.9	3.6	1.6	0.8	1.0	1.4	5.6
$\chi^2(6) = 505.4, p < 0.005$								

*Values indicate the percent of respondents answering "Yes" for each sleep duration (identified by column). "No" responses are not shown. Columns and rows therefore do not add to 100%. **Percent reporting for each column. All responses are present. Columns add to 100%.

Table 2—Weighted and adjusted odds ratios (95% confidence intervals) for suicidality and TST*

	Self-Reported Sleep Duration						
	≤ 4 h	5 h	6 h	7 h	8 h	9 h	≥ 10 h
2007							
Suicidal Ideation	**3.3 (2.5-4.4)**	**1.7 (1.2-2.2)**	**1.7 (1.29-2.10)**	**1.3 (1.0-1.7)**	1.0 (1.0-1.0)	**1.6 (1.1-2.3)**	1.5 (0.8-2.9)
Suicide Planning	**3.4 (2.5-4.8)**	**1.9 (1.4-2.5)**	**1.7 (1.3-2.2)**	1.2 (0.90-1.6)	1.0 (1.0-1.0)	1.2 (0.8-1.9)	**2.2 (1.2-4.1)**
Suicide Attempt	**4.3 (2.9-6.4)**	1.3 (0.9-1.9)	**1.5 (1.1-2.2)**	1.3 (0.9-1.9)	1.0 (1.0-1.0)	1.5 (0.8-2.5)	1.7 (0.8-4.0)
Attempt Requiring Treatment	**5.9 (2.8-12.6)**	**2.5 (1.1-5.6)**	1.5 (0.7-3.4)	1.3 (0.6-2.9)	1.0 (1.0-1.0)	2.1 (0.7-6.6)	**4.8 (1.3-17.1)**
2009							
Suicidal Ideation	**2.7 (2.0-3.7)**	**2.0 (1.5-2.6)**	**1.3 (1.0-1.7)**	1.2 (1.0-1.6)	1.0 (1.0-1.0)	1.2 (0.9-1.8)	1.4 (0.9-2.2)
Suicide Planning	**2.6 (1.9-3.5)**	**1.8 (1.4-2.5)**	**1.5 (1.2-1.8)**	1.2 (0.9-1.5)	1.0 (1.0-1.0)	1.1 (0.7-1.6)	1.2 (0.7-2.0)
Suicide Attempt	**4.3 (2.9-6.2)**	**2.7 (1.8-4.1)**	1.3 (0.9-1.8)	1.1 (0.8-1.5)	1.0 (1.0-1.0)	1.5 (0.9-2.6)	**3.0 (1.6-5.5)**
Attempt Requiring Treatment	**6.5 (3.2-13.0)**	**2.3 (1.1-4.5)**	0.9 (0.5-1.7)	0.7 (0.3-1.4)	1.0 (1.0-1.0)	2.1 (0.7-6.1)	**6.1 (2.3-16.5)**

*Odds ratios are adjusted for age, sex, race/ethnicity, and feelings of sadness. Reference is 8-h TST. Bolded values are significant at p < 0.005.

ratios were associated with the most serious reported suicidality. Throughout both survey years and suicidality severity, a U-shape trend was observed.

DISCUSSION

Data from a nationally representative school based sample of American students between the ages of 12 to 18 years demonstrates that both short and long TSTs are associated with higher risk of reporting suicidality and actual suicide attempts, even after controlling for demographic and clinical factors including sad mood. Independent samples from 2007 and 2009 demonstrated very similar patterns, confirming the reliability of these associations. The largest odds ratios were seen when looking at the most severe form of nonlethal suicidality, attempt requiring treatment. These findings suggest that self-reported TST is a robust risk factor for suicidality in adolescents, and that suicide surveillance efforts should routinely assess sleep.

Delineation of our reference group of 8 hours was based upon the average between the current recommended TST in this age group, a little over 9 hours,[19] and the average TST of this group, 7 hours. The portion of the sample sleeping eight hours also had the lowest percentage of sadness. A sizable portion of the total sample of teens (41%) reported sleeping outside a TST of 7-9 hours, which raises public health concerns since several studies showing both negative mental and physical health effects have been published in regards to both long and short TST.[19,26-28] In the future it will be important to address whether short or long TSTs play a causal role in health outcomes for this population.

Experimental sleep deprivation studies have shown negative effects on judgment, concentration, affect regulation, and impulse control.[29-34] Although the nature of the relationship between poor sleep and suicidality is unclear at this time, extreme sleep durations may influence mood via greater mood instability and/or impulsivity. Regardless, close surveillance of sleep duration in teens with other risk factors may help to identify those at highest risks. Interventions to increase TST may be beneficial in regards to suicidality and other neurobehavioral outcomes, but such studies have not yet been conducted. Other attributes of sleep besides TST may also be important to affect regulation and suicidality. Electroencephalographic studies of sleep in patients with a history of suicide attempt found decreased slow wave sleep activity compared to non-attempters with depression, suggesting that not only the quantity, but also the quality of sleep may be different.[35] Thus public education about the importance of sleep and its relationship to mood, further research into neurobiological mechanisms, and exploring these relationships in longitudinal studies are all needed.

While our study was both recent and large, including a nationally representative sample that looked at a range of suicidality and provided confirmatory findings via two waves of independent data it did have several limitations. First, the way in which TSTs were categorized made it unclear how respondents with sleep durations outside of the fixed options responded. Second, the grouping of long TSTs as 10 hours or more might be misleading. The U-shaped relationship found in regards to TST and suicidality may indicate that sleep durations of 10 hours might not have statistical significance, but appears to carry such risk because it was included with more extreme TSTs like 12 or more hours. Future research to further look at long TSTs and suicidality will be helpful in delineating at what specific TST this association begins to be present.Third, we could not corroborate our findings with objective sleep data such as polysomnography or actigraphy. Along the same lines, corroborating retrospective subjective data with prospective sleep diaries or parent reports would enhance confidence in our findings. Systematic data regarding the presence or absence of treated and untreated specific psychiatric and/or sleep disorders would also be useful in future studies. Fourth, although our study did control for presence of sadness and substance abuse, there are other potential confounders such as anxiety that were not assessed. As stated previously, the presence of bullying was assessed in the 2009 YRBS data with the following yes/no question: "During the past 12 months, have you ever been bullied on school property?" This item did not appear on the 2007 survey, and addition of this item as a control variable did not result any significant change with the 2009 data. Parental history of suicidality was also a consideration that was not accounted for in these analyses due to missing data. Lastly, the design of this study was cross sectional; prospective studies are needed to begin to address causal relationships. However, these limitations are balanced by several important strengths including large, representative samples of US teens, independent replications two years apart, and assessments of a range of suicidality.

In conclusion, results from the 2007 and 2009 YRBS are consistent with published reports from the adult population and the limited available data from studies of adolescents. Both short and long total sleep times are associated with suicidality among teens, after controlling for age, sex, sadness, and substance abuse. TST may be a useful measure to help screen for suicide risk among teens.

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