Earlier Parental Set Bedtimes as a Protective Factor Against Depression and Suicidal Ideation

James E. Gangwisch, PhD[1]; Lindsay A. Babiss, BA[2]; Dolores Malaspina, MD[3]; J. Blake Turner, PhD[4]; Gary K. Zammit, PhD[5]; Kelly Posner, PhD[4]

[1]Division of Cognitive Neuroscience, Department of Psychiatry, College of Physicians and Surgeons, Columbia University, New York, NY; [2]New York State Psychiatric Institute, New York, NY; [3]Department of Psychiatry, School of Medicine, New York University, New York, NY; [4]Division of Child and Adolescent Psychiatry, Department of Psychiatry, College of Physicians and Surgeons, Columbia University, New York, NY; [5]Department of Psychiatry and Clinilabs Sleep Disorders Institute, College of Physicians and Surgeons, Columbia University, New York, NY

Study Objectives: To examine the relationships between parental set bedtimes, sleep duration, and depression as a quasi-experiment to explore the potentially bidirectional relationship between short sleep duration and depression. Short sleep duration has been shown to precede depression, but this could be explained as a prodromal symptom of depression. Depression in an adolescent can affect his/her chosen bedtime, but it is less likely to affect a parent's chosen set bedtime which can establish a relatively stable upper limit that can directly affect sleep duration.
Design: Multivariate cross-sectional analyses of the ADD Health using logistic regression.
Setting: United States nationally representative, school-based, probability-based sample in 1994-96.
Participants: Adolescents (n = 15,659) in grades 7 to 12.
Measurements and Results: Adolescents with parental set bedtimes of midnight or later were 24% more likely to suffer from depression (OR = 1.24, 95% CI 1.04-1.49) and 20% more likely to have suicidal ideation (1.20, 1.01-1.41) than adolescents with parental set bedtimes of 10:00 PM or earlier, after controlling for covariates. Consistent with sleep duration and perception of getting enough sleep acting as mediators, the inclusion of these variables in the multivariate models appreciably attenuated the associations for depression (1.07, 0.88-1.30) and suicidal ideation (1.09, 0.92-1.29).
Conclusions: The results from this study provide new evidence to strengthen the argument that short sleep duration could play a role in the etiology of depression. Earlier parental set bedtimes could therefore be protective against adolescent depression and suicidal ideation by lengthening sleep duration.
Keywords: Partial sleep deprivation, depression, suicidal ideation, adolescents, epidemiology
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ADOLESCENCE IS A PERIOD OF SIGNIFICANT PHYSICAL, COGNITIVE, EMOTIONAL, AND SOCIAL CHANGE THAT CAN AFFECT SLEEP DURATION. IT IS A COMMON perception and societal expectation that adolescents do not need as much sleep as preadolescents, yet laboratory data suggest that adolescents may actually require more sleep.[1] It has been estimated that adolescents need just over 9 h of sleep per night[2], however, a host of issues prevent them from getting enough. Adolescence is associated with a circadian phase delay with an increasing preference to sleep at later hours[3]; despite this, in most U.S. school districts school days begin progressively earlier as students transition from elementary to middle school and then from middle school to high school.[4] Adolescents in Rhode Island between the ages of 13 and 19 were found not to go to bed significantly earlier to compensate for earlier school start times.[5] Transitions to earlier school start times were shown in another sample of Rhode Island adolescents (14–16 years old) to be associated with significant sleep deprivation.[6] Adolescent

sleep time competes with a host of other nighttime options, such as cable television, cell phones, the internet, video games, and social activities.[7] Finally, parents are less likely to set bedtimes as their children get older.[1,4] Inadequate sleep resulting from these influences can have detrimental effects on teenagers.

The relationship between short sleep duration and depression has been theorized to be bidirectional,[7] with chronic partial sleep deprivation being a potential risk factor for depression. Cross-sectional studies have found associations between inadequate sleep and depression in adolescents,[3,8] and a longitudinal study has shown that getting less sleep over time heightened depressive symptoms among middle school students.[9] Short sleep duration has also been shown to be associated with suicidal ideation[10] and suicidal behavior[11] in adolescents and adults[12] in cross-sectional studies.

Referring to partial sleep deprivation as a risk factor for depression is complicated by the fact that sleep parameters are not phenomenologically distinct from the diagnostic symptom cluster for depression. Intimations of a cause-effect relationship between partial sleep deprivation and depression gleaned from associations found in epidemiological studies can be weakened by the argument that partial sleep deprivation is simply a precursor or prodromal symptom of depression. Experimental studies have the ability to control the magnitude of change in sleep duration and the temporal relationship between sleep duration and depression to strengthen the counterfactual argument that if partial sleep restriction had not occurred then depression would not have occurred. Partial sleep restriction in experimen-

tal studies has been shown to result in dysphoric mood changes in ninth to twelfth graders[13] and mood disturbances in adults.[14] The experimental administration of continuous wakefulness for 56 h has been shown to result in statistically and clinically significant increases in depressive symptoms in adults.[15] Experimental sleep restriction studies have the drawbacks of being expensive, having small sample sizes with limited generalizability, and having untoward side effects given the known detrimental effects of sleep deprivation. Quasi-experiments provide some of the benefit of controlled experimental studies without the drawbacks. A quasi-experiment is a naturally occurring instance of observable phenomenon that approximates the properties of a controlled experiment.

The National Longitudinal Study of Adolescent Health (Add Health)[16] provides a unique opportunity to examine the relationships between parental set bedtimes, sleep duration, and depression as a quasi-experiment to explore the question of whether chronic partial sleep deprivation can increase the risk for depression. We are not aware of any previous published studies that have explored these relationships. The Add Health study included the administration of in-home interviews with parents and their adolescent children. Parental interviews contained a question on what time the adolescent had to go to bed on weeknights; while the adolescent interviews included questions on sleep duration, perception of getting enough sleep, depression, and suicidal ideation. Given the need to get up for school on weekdays, parental set bedtimes can directly affect sleep duration by establishing a relatively stable upper limit on bedtimes. Adolescents who are more free to choose their own bedtimes have been found to go to bed later on average than adolescents who are less free to choose.[1] The presence of depression in an adolescent can affect his or her choice of bedtime, but it is less likely to affect a parent's choice of a set bedtime. We hypothesize that later parental set bedtimes would be associated with shorter sleep durations and perceptions of not getting enough sleep. We theorize that later parental set bedtimes would be associated with depression and suicidal ideation and that these associations would be mediated by sleep duration and perception of getting enough sleep. An alternative explanation for associations between parental set bedtimes, depression, and suicidal ideation is that adolescents whose parents set earlier bedtimes could infer that their parents care more about them, which, in turn, could be protective against depression and suicidal ideation. We therefore also tested the alternative hypothesis that the subjects' self-perception of their parents caring about them could act as a mediator of the relationships between parental set bedtime, depression, and suicidal ideation.

METHODS

Participants

Subjects for this study were participants in Wave 1 of the National Longitudinal Study of Adolescent Health (Add Health), a school-based, nationally representative, probability based sample of adolescents in grades 7 to 12 in the United States in 1994–96.[16] The Add Health study was designed to examine relationships between health-related behaviors, social contexts, and health outcomes in adolescence and young adulthood. Data were collected from adolescents and their parents through in-

home interviews. A total of 18,922 subjects were assigned a grand sample weight in the Wave 1 in-home sample.[17] All of the subjects who answered the depression and suicidal ideation questions and for whom a parent answered the bedtime question were included in the analyses (82.8%, n = 15,659). All Add Health participants and parents signed informed consent forms. We received approval from the Columbia University, Department of Psychiatry Institutional Review Board to conduct analyses of these data.

Measures

The primary dependent variables for this study were depression and suicidal ideation. Participants in the Add Health study were administered an 18 item version of the Centers for Epidemiologic Study-Depression Scale (CES-D) to assess depressive symptoms.[18] The CES-D is valid for use in both junior and senior high school student populations.[19] CES-D scores ≥ 24 in females and ≥ 22 in males have been used to indicate depressed mood for adolescents,[20] so we created a dichotomous variable indicating depressed mood based on these cutpoints. The presence of suicidal ideation was determined by the subjects' yes or no responses to the question: "During the past 12 months, did you ever seriously think about committing suicide?"

The primary independent variable for this study was parental set bedtime. The adolescents' parents, preferably mothers or other female heads of household, were asked: "What time does {name} have to go to bed on weeknights?" with responses coded as: 9:00 PM or earlier, by 10:00 PM, by 11:00 PM, by 12:00 AM/midnight, by 1:00 AM, after 1:00 AM, or (He/she) has no set bedtime. Few parents reported that their children had to go to bed by 1:00 AM (n = 126) or after 1:00 AM (n = 76), so we created a category for having to go to bed by or after midnight (n = 1,067). If we apply parental set bedtime as a continuous variable in the regression models, then the assumption would have to be made that each progressively later parental set bedtime is associated with the same change in the dependent variables. We checked the validity of these assumptions by running logistic regression models with the different parental set bedtimes as the independent variable and depression and suicidal ideation as the dependent variables. We then plotted the β coefficients for each parental set bedtime and found that the plots were not linear and, therefore, indicated that each progressively later bedtime is not associated with the same change in the log odds of depression and suicidal ideation. We therefore chose to categorize the parental set bedtime variable rather than applying it as a continuous variable. The β coefficients for the 2 earliest bedtimes [9:00 PM or earlier and by 10:00 PM] and for the 2 latest bedtimes [by or after 12:00 AM/midnight, and (He/she) has no set bedtime] were similar for both depression and suicidal ideation, so we trichotomized the parental set bedtime variable between 10:00 PM or earlier, by 11:00 PM, and by or after 12:00 AM/midnight.

The adolescents' sleep duration and perception of getting enough sleep were the primary variables theorized to act as mediators of the relationship between the independent variable of parental set bedtime and the dependent variables of depression and suicidal ideation. The subjects' self reported sleep duration was measured using their answers to the question: "How many hours of sleep do you usually get?" with responses ranging from

1 to 20. Few subjects reported getting ≤ 4 h of sleep (n = 184) or ≥ 11 h of sleep (n = 425), so we collapsed the shortest sleep duration category into ≤ 5 h of sleep and the longest sleep duration category into ≥ 10 h of sleep. We categorized the sleep duration variable, as opposed to applying it as a continuous variable, because each additional hour of sleep was not associated with the same change in the dependent variables. The mode sleep duration in this sample was 8 h, and the mean sleep duration was approximately 8 h (7 h 53 min), so we chose 8 h as the reference category. The subjects' perception of getting enough sleep was assessed by their yes or no responses to the question: "Do you usually get enough sleep?" The adolescents were also asked "What time do you usually go to bed on weeknights?" with responses ranging from 12:00 AM/midnight to 11:59 PM.

The subjects' self-perception of parents caring was determined by their answers to the question: "How much do you feel that your parents care about you?" with responses including "not at all," "very little," "somewhat," "quite a bit," and "very much." Other covariates that we included in our multivariate models included age (continuous variable), sex, race/ethnicity (Caucasian, African American, Hispanic, Other—including Native American, Asian, and Other), parental marital status (single/never married, married, widowed, divorced, separated), and family's receipt of public assistance (yes, no).

Statistical Analyses

We performed univariate analyses and bivariate analyses using χ^2 tests for categorical variables and t-tests for continuous variables. In an effort to gauge the accuracy of our assumption that depression in an adolescent is unlikely to affect their parent's choice of a set bedtime, we compared between depressed and non-depressed subjects and between subjects with and without suicidal ideation, the average differences between parental set bedtimes and adolescent set bedtimes. To evaluate the accuracy of our assumption that parental set bedtimes establish a relatively stable upper limit on bedtimes, we compared parental set bedtimes with adolescent set bedtimes. We determined the number and percentage of subjects who reported bedtimes at or earlier than the bedtimes set by their parents. Among adolescents who reported going to bed later than their parents' set bedtimes, we calculated the percentage of subjects who reported going to bed within an hour of their parent's set bedtimes.

We used two separate sets of logistic regression analyses to further examine the relationships between parental set bedtime and depression and between parental set bedtime and suicidal ideation. In the set of analyses for depression, covariates in the first adjusted multivariate model (Model 2) included age, sex, race/ethnicity, parental marital status, and family's receipt of public assistance. Covariates in the second adjusted model (Model 3) included the variables in Model 2 plus self-perception of parents caring to test whether this variable acted as a partial mediator of the relationship between parental set bedtime and depression. Model 4 included the variables in Model 3 plus sleep duration and perception of getting enough sleep to assess whether these variables acted as mediators. The first 3 multivariate models for suicidal ideation included the same covariates as those used for depression. Model 4 included the variables in Model 3 plus depression to examine whether it acted as a mediator, while Model 5 included the variables in Model

4 plus sleep duration and perception of getting enough sleep to test whether they acted as mediators. To test for mediation we looked at the amount of the change in the β coefficients of the main exposure term (parental set bedtime) after introducing the hypothesized mediating variables (sleep duration and enough sleep). We considered a change ≥ 10% as a cutoff for an attenuation sufficient to be consistent with mediation.[21] To evaluate whether there were collinearity issues in using both parental-set bedtime and child-reported sleep duration in the same regression models, we conducted multicollinearity diagnostic statistics using the PROC REG procedure with options VIF TOL with SAS software[22] and found the variance inflation factor well below the threshold indicative of multicollinearity. To obtain unbiased estimates from the Add Health data, we corrected for complex sampling design effects and unequal probability of selection using the SAS Callable Version of SUDAAN software.[23] We divided the individual weights by the total mean weight to maintain the original sample size. The use of weights in categorical analyses resulted in sample sizes that were not whole numbers, so we rounded sample sizes to the nearest integer. The significance of individual coefficients in the logistic regression models were determined by the 95% confidence limits for odds ratios.

RESULTS

The average adolescent sleep duration was 7 h 53 min, which contrasted sharply with an estimated adolescent sleep duration need of 9 h.[2] As the adolescents' self-reported sleep durations increased, their likelihood of perceiving that they were getting enough sleep progressively increased (X^2 = 293.43, P < 0.0001). With the exception of sleep duration ≥ 10 h, higher average self-reported sleep durations were associated with progressively earlier average bedtimes, with sleep durations of ≤ 5 h, 6 h, 7 h, 8 h, 9 h, and ≥ 10 h associated with average bedtimes of 11:15 PM, 10:45 PM, 10:40 PM, 10:21 PM, 10:03 PM, and 10:16 PM, respectively. In support of our assumption that parental set bedtimes establish a relatively stable upper limit on adolescent bedtimes, we found adolescents to largely comply with parental set bedtimes. Over two-thirds (n = 10,922, 69.7%) of the adolescents reported going to bed at a time that complied with their parents reported set bedtime. Among adolescents who reported going to bed later than their parents' set bedtimes, two-thirds reported going to bed within an hour of their parent's set bedtimes. Among adolescents whose parents set specific bedtimes at or before 1:00 AM, adolescents reported going to bed an average of only 2.7 min later than their parents' set bedtimes. In comparison to non-depressed adolescents, depressed adolescents reported going to bed an average of 4.9 min later than their parents' set bedtimes, but this difference was not statistically significant (P = 0.47). In comparison to adolescents without suicidal ideation, adolescents with suicidal ideation reported going to bed an average of 7.3 min later than their parents' set bedtimes, and this difference approached statistical significance (P = 0.06).

Tables 1 and 2 show results from bivariate analyses. Table 1 shows the relationships between depression, suicidal ideation, and covariates. On average adolescents suffering from depression and suicidal ideation self-reported going to bed later. Depression and suicidal ideation were associated with later

Table 1—Relationships between parental set bedtimes, covariates, depression, and suicidal ideation

	Depression			Suicidal Ideation		
	Yes	**No**		**Yes**	**No**	
n (%)	1,050 (7%)	14,609 (93%)		2,038 (13%)	13,621 (87%)	
	Mean	**Mean**	**t-test (P-value)**	**Mean**	**Mean**	**t-test (P-value)**
Adolescent-reported average bedtime	10:36 PM	10:25 PM	1.74 (P = 0.0834)	10:34 PM	10:25 PM	2.31 (P = 0.0227)
Adolescent-reported average sleep duration	7 h 23 min	7 h 55 min	7.97 (P < 0.0001)	7 h 36 min	7 h 55 min	7.77 (P < 0.0001)
	n (Row %)	**n (Row %)**	**X^2 (P-value)**	**n (Row %)**	**n (Row %)**	**X^2 (P-value)**
Parental set bedtime on weekday nights						
10:00 PM or earlier	495 (6%)	7,976 (94%)	20.14 (P = 0.0001)	1,012 (12%)	7,459 (88%)	14.10 (P = 0.0012)
By 11:00 PM	231 (7%)	3,108 (93%)		451 (14%)	2,888 (86%)	
By or after midnight	324 (8%)	3,525 (92%)		575 (15%)	3,274 (85%)	
Adolescent-reported sleep duration						
≤ 5 h	118 (18%)	524 (82%)	76.86 (P < 0.0001)	152 (24%)	490 (76%)	82.29 (P < 0.0001)
6 h	170 (11%)	1,412 (89%)		302 (19%)	1,279 (81%)	
7 h	257 (8%)	3,023 (92%)		470 (14%)	2,810 (86%)	
8 h	289 (5%)	5,628 (95%)		654 (11%)	5,263 (89%)	
9 h	115 (4%)	2,452 (96%)		246 (10%)	2,321 (90%)	
≥ 10 h	100 (6%)	1,570 (94%)		213 (13%)	1,457 (87%)	
Self-perception of getting enough sleep						
No	570 (14%)	3,437 (86%)	142.86 (P < 0.0001)	804 (20%)	3,203 (80%)	89.60 (P < 0.0001)
Yes	480 (4%)	11,172 (96%)		1,234 (11%)	10,418 (89%)	
Adolescent-reported bedtime before parental set bedtime						
No	349 (7%)	4,388 (93%)	2.21 (P = 0.1398)	675 (14%)	4,062 (86%)	6.41 (P = 0.0126)
Yes	701 (6%)	10,221 (94%)		1,363 (12%)	9,559 (88%)	
Sex						
Female	596 (8%)	7,063 (92%)	14.59 (P = 0.0002)	1,220 (16%)	6,438 (84%)	45.43 (P < 0.0001)
Male	454 (6%)	7,546 (94%)		818 (10%)	7,183 (90%)	
Age (y)						
11-13	29 (4%)	622 (96%)	35.38 (P < 0.0001)	64 (10%)	587 (90%)	10.70 (P = 0.0348)
14-15	249 (5%)	4,879 (95%)		597 (12%)	4,531 (88%)	
16-17	408 (8%)	4,977 (92%)		776 (14%)	4,609 (86%)	
18-19	329 (8%)	3,908 (92%)		561 (13%)	3,676 (87%)	
20-21	34 (13%)	223 (89%)		39 (15%)	218 (85%)	
Parents marital status						
Single, never married	84 (10%)	752 (90%)	27.93 (P < 0.0001)	104 (12%)	732 (88%)	1.33 (P = 0.8559)
Married	653 (6%)	10,609 (94%)		1,437 (13%)	9,826 (87%)	
Widowed	45 (10%)	420 (90%)		65 (14%)	400 (86%)	
Divorced	187 (8%)	2,168 (92%)		331 (14%)	2,024 (86%)	
Separated	81 (11%)	659 (89%)		101 (14%)	639 (86%)	
Family receives public assistance						
No	850 (6%)	13,225 (94%)	32.43 (P < 0.0001)	212 (13%)	1,371 (87%)	0.10 (P = 0.7528)
Yes	200 (13%)	1,384 (87%)		1,826 (13%)	12,250 (87%)	

Table 1 continued on following page

Table 1 *(continued)*—Relationships between parental set bedtimes, covariates, depression, and suicidal ideation

	n (Row %)	n (Row %)	X² (P-value)	n (Row %)	n (Row %)	X² (P-value)
Race/Ethnicity						
Caucasian	604 (6%)	9,942 (94%)	32.54 (P < 0.0001)	1,415 (13%)	9,131 (87%)	7.67 (P = 0.0581)
African American	208 (9%)	2,082 (91%)		256 (11%)	2,034 (89%)	
Hispanic	45 (6%)	716 (93%)		85 (11%)	676 (89%)	
Other	194 (9%)	1,870 (91%)		282 (14%)	1,781 (86%)	
Self-perception of how much parents care						
1 – Not at all	15 (27%)	39 (73%)	91.48 (P < 0.0001)	15 (29%)	39 (71%)	118.63 (P < 0.0001)
2 – Very little	28 (29%)	68 (71%)		38 (40%)	57 (60%)	
3 – Somewhat	103 (26%)	298 (74%)		153 (38%)	247 (62%)	
4 – Quite a bit	203 (12%)	1,476 (88%)		389 (23%)	1,290 (77%)	
5 – Very much	702 (5%)	12,728 (95%)		1,442 (11%)	11,988 (89%)	
Depression						
Yes				499 (47%)	551 (53%)	150.41 (P < 0.0001)
No				1,539 (11%)	13,070 (89%)	

parental set bedtime, shorter sleep duration, self-perception of not getting enough sleep, female sex, older age, and lower self-perception of how much parents care. African American subjects and subjects of other races/ethnicities were at greater risk for depression than Caucasian and Hispanic subjects. Previous studies have found African American adolescents to have both higher[24] and lower[25] rates of depression compared to whites. Caucasian subjects and subjects of other races/ethnicities were at greater risk for suicidal ideation than African American and Hispanic subjects. Parental marital status and receipt of public assistance were significantly associated with depression, but not with suicidal ideation. Table 2 shows the relationships between parental set bedtimes and covariates. Later parental set bedtimes were generally associated with later adolescent self-reported bedtimes, shorter sleep durations, self-perceptions of not getting enough sleep, male sex, older age, and lower self-perception of how much parents care. African American, Hispanic, and subjects of other racial/ethnic groups were more likely than Caucasian subjects to have set bedtimes by 10:00 PM or earlier. Parental marital status and receipt of public assistance were significantly associated with parental set bedtimes.

Table 3 shows the odds ratios for depression as computed by logistic regression analyses. In results from unadjusted analyses (Model 1), adolescents with parental set bedtimes of 12:00 AM/ midnight or later and 11:00 PM were 42% and 15% more likely to suffer from depression, respectively, than adolescents with parental set bedtimes of 10:00 PM or earlier. The odds ratios were reduced with the inclusion of the demographic variables in Model 2. The results were attenuated with the inclusion of the self-perception of parents caring variable in Model 3, but the reduction in the β coefficient was less than 10%, falsifying the alternative hypothesis that this variable significantly explained the relationship between parental set bedtime and depression. Parental set bedtimes by or after 12:00 AM/midnight continued to be significantly associated with increased risk for depression (OR = 1.24, 95% CI 1.04-1.49). In support of the study hypothesis that sleep duration and perception of getting enough sleep

would act as significant mediators of the relationship between parental set bedtimes and the risk for depression, the inclusion of sleep duration and getting enough sleep in Model 4 appreciably attenuated the association (OR = 1.07, 95% CI 0.88-1.30). The relationship between depression and sleep duration was U-shaped, with both short and long sleep duration being associated with depression, although only sleep durations ≤ 5 h per night were significantly associated with depression (OR = 1.71, 95% CI 1.22-2.39). Subjects who reported getting enough sleep were significantly less likely to suffer from depression (OR = 0.35, 95% CI 0.28-0.43).

Table 4 shows the logistic regression results for suicidal ideation. Adolescents with parental set bedtimes of 12:00 AM/ midnight or later and 11:00 PM were 30% and 15% more likely to suffer from suicidal ideation respectively in comparison to adolescents with parental set bedtimes of 10:00 PM or earlier in the unadjusted analyses (Model 1). The inclusion of the demographic variables in Model 2 reduced the odds ratios. The inclusion of the self-perception of parents caring variable in Model 3 attenuated the results, but the change in the β coefficient was < 10%, so this variable did not significantly explain the relationship. The results were appreciably attenuated with a change in the β coefficient > 10% in Model 4 with the inclusion of depression, which supports the study hypothesis that depression would act as a mediating variable between parental set bedtime and suicidal ideation. Parental set bedtimes by or after midnight continued to be significantly associated with increased risk for suicidal ideation (OR = 1.20, 95% CI 1.01-1.41). The appreciable attenuation in the odds ratio with the inclusion of sleep duration and perception of getting enough sleep in Model 5 (OR = 1.09, 95% CI 0.92-1.29) supported the study hypothesis that these variables would act as significant mediators of the relationship between parental set bedtimes and the risk for suicidal ideation. Subjects who reported getting ≤ 5 h and 6 h of sleep were significantly more likely to have suicidal ideation than subjects who reported getting 8 h of sleep. Sleep durations ≥ 9 h were not significantly associated with suicidal

Table 2—Relationships between parental set bedtimes and covariates

	Parental Set Bedtime On Weekday Nights			
	10:00 PM or Earlier	By 11:00 PM	By or after midnight	
N (%)	8,471 (54%)	3,339 (21%)	3,849 (25%)	
	Mean	**Mean**	**Mean**	**t-Test (P-value)**
Adolescent-reported average bedtime	10:04 PM	10:45 PM	10:59 PM	273.12 (P < 0.0001)
Adolescent-reported average sleep duration	8 h 10 min	7 h 37 min	7 h 30 min	268.57 (P < 0.0001)
	n (Column %)	**n (Column %)**	**n (Column %)**	**X^2 (P-value)**
Adolescent-reported sleep duration				
≤ 5 h	191 (2%)	150 (4%)	301 (8%)	348.44 (P < 0.0001)
6 h	535 (6%)	420 (13%)	627 (16%)	
7 h	1,338 (16%)	948 (28%)	995 (26%)	
8 h	3,584 (42%)	1,202 (36%)	1,131 (29%)	
9 h	1,771 (21%)	355 (11%)	442 (11%)	
≥ 10 h	1,052 (12%)	265 (8%)	353 (9%)	
Self-perception of getting enough sleep				
No	1,720 (20%)	1,020 (31%)	1,266 (33%)	100.17 (P < 0.0001)
Yes	6,751 (80%)	2,319 (69%)	2,583 (67%)	
Sex				
Female	4,294 (51%)	1,498 (45%)	1,866 (48%)	15.62 (P = 0.0006)
Male	4,176 (49%)	1,841 (55%)	1,983 (52%)	
Age (y)				
12-13	562 (7%)	60 (2%)	29 (1%)	405.46 (P < 0.0001)
14-15	3,943 (47%)	730 (22%)	454 (12%)	
16-17	2,747 (32%)	1,433 (43%)	1,206 (31%)	
18-19	1,125 (13%)	1,070 (32%)	2,042 (53%)	
20-21	93 (1%)	47 (1%)	117 (3%)	
Parents marital status				
Single, never married	503 (6%)	159 (5%)	174 (5%)	17.25 (P = 0.0350)
Married	6,142 (73%)	2,338 (70%)	2,782 (72%)	
Widowed	241 (3%)	106 (3%)	118 (3%)	
Divorced	1,191 (14%)	562 (17%)	601 (16%)	
Separated	393 (5%)	174 (5%)	174 (5%)	
Family receives public assistance				
No	7,511 (89%)	3,047 (91%)	3,517 (91%)	6.79 (P = 0.0366)
Yes	959 (11%)	292 (9%)	332 (9%)	
Race/Ethnicity				
Caucasian	5,493 (65%)	2,274 (95%)	2,779 (72%)	17.56 (P = 0.0104)
African American	1,287 (15%)	508 (2%)	494 (13%)	
Hispanic	485 (6%)	153 (0.6%)	123 (3%)	
Other	1,206 (14%)	404 (2%)	453 (12%)	
Self-perception of how much parents care				
1 – Not at all	29 (.3%)	8 (.2%)	18 (0.4%)	33.41 (P = 0.0002)
2 – Very little	47 (.6%)	20 (.6%)	29 (0.8%)	
3 – Somewhat	187 (2%)	95 (3%)	118 (3%)	
4 – Quite a bit	784 (9%)	423 (13%)	471 (12%)	
5 – Very much	7,424 (87%)	2,794 (84%)	3,212 (83%)	

ideation in comparison to sleep durations of 8 h. Subjects who reported getting enough sleep were significantly less likely to suffer from suicidal ideation (OR = 0.71, 95% CI 0.61-0.84).

DISCUSSION

We found that later adolescent reported bedtimes were associated with shorter sleep durations and a perception of not getting enough sleep. School start times were likely to have contributed toward these results by limiting how late the students could sleep in the morning. Consistent with previous epidemiological studies on the associations between sleep duration, depression,[3,8] and suicidal ideation,[10] we found that adolescents who suffered from depression and had suicidal ideation had later bedtimes, shorter sleep durations, and greater likelihood of perceiving that they were not getting enough sleep. Given the fact that sleep parameters are part of the symptom cluster for depression, it would be expected that the presence of depression in adolescents would affect their choice of bedtime, sleep duration, and perception of getting enough sleep. However, we would not expect parents' choices of set bedtimes for their adolescent children to be affected by the presence of depression in those adolescents. Consistent with this assumption, we did not find significant differences between depressed and non-depressed adolescents in their reports of going to bed at times different from their parents' set bedtimes. Parental set bedtimes can establish relatively stable upper limits on the bedtimes of adolescents. We wanted to check the accuracy of this assumption since parental set bedtimes do not strictly determine what time adolescents go to bed and to sleep since they can stay up later in their rooms after bedtime reading, surfing the internet, watching television, or listening to music. We found that the adolescents in this study complied to a large extent with their parents' set bedtimes, with adolescents reporting going to bed only about 5 minutes later on average than their parental set bedtimes, and over two-thirds of adolescents reporting going to bed at a time that complied with their parents reported set bedtimes. We hypothesize that earlier parental set bedtimes function to lengthen sleep durations and to increase the likelihood of getting enough sleep. Consistent with this hypothesis, we found that adolescents with earlier parental set bedtimes were significantly less likely to have short sleep duration and were significantly more likely to report getting enough sleep. These findings concur with results from previous studies showing that as adolescents' freedom to choose their own bedtimes increases, they tend to choose to go to bed later.[1] Earlier versus later parental set bedtimes could therefore represent naturalistic quasi-experimental conditions that can be used to model chronic partial sleep deprivation.

We found that adolescents with earlier parental set bedtimes were significantly less likely to suffer from depression and to have suicidal ideation after controlling for demographic variables. We theorized that the relationships between parental set bedtime, depression, and suicidal ideation may be partially mediated by the adolescents' perception of how much their parents cared about them, but the inclusion of this variable in the multivariate models only slightly attenuated the associations. The inclusion of sleep duration and getting enough sleep in the multivariate models appreciably attenuated the associations between parental set bedtime and the risks for depression and suicidal ideation. These findings are in accord with our hypothesis that sleep duration and getting enough sleep would mediate the relationships between parental set bedtime and the risks for depression and suicidal ideation. Later parental set bedtimes therefore appear to result in shorter sleep durations and a higher likelihood of not getting enough sleep, which in turn are associated with depression and suicidal ideation.

There are a number of potential mechanisms by which chronic partial sleep deprivation could contribute toward depression and suicidal ideation. First, in an experimental sleep deprivation

Table 3—Odds ratios (95% CI) for depression

	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Parental set bedtime on weekday nights				
10:00 PM or earlier	1.00	1.00	1.00	1.00
By 11:00 PM	1.15 (0.94-1.40)	1.13 (0.90-1.42)	1.10 (0.87-1.39)	0.97 (0.76-1.24)
By or after midnight	1.42 (1.21-1.67)	1.28 (1.07-1.52)	1.24 (1.04-1.49)	1.07 (0.88-1.30)
Self-perception of how much parents care				
1 – Not at all			6.82 (3.11-14.98)	5.88 (2.79-12.40)
2 – Very little			8.32 (4.58-15.12)	6.73 (3.49-12.98)
3 – Somewhat			5.50 (3.72-8.13)	4.93 (3.32-7.30)
4 – Quite a bit			2.43 (1.89-3.13)	2.16 (1.69-2.76)
5 – Very much			1.00	1.00
Adolescent-reported sleep duration				
≤ 5 h				1.71 (1.22-2.39)
6 h				1.29 (0.97-1.70)
7 h				1.19 (0.96-1.48)
8 h				1.00
9 h				1.17 (0.88-1.56)
≥ 10 h				1.34 (0.95-1.89)
Enough Sleep				0.35 (0.28-0.43)

[a]**Model 1** – Unadjusted.
[b]**Model 2** – Adjusted for age, sex, race/ethnicity, parent's marital status, and family receipt of public assistance.
[c]**Model 3** – Adjusted for variables in Model 2 plus self perception of how much parents care.
[d]**Model 4** – Adjusted for variables in Model 3 plus adolescent reported sleep duration and perception of getting enough sleep.

Table 4—Odds ratios (95% CI) for suicidal ideation

	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e]
Parental set bedtime on weekday nights					
10:00 PM or Earlier	1.00	1.00	1.00	1.00	1.00
By 11:00 PM	1.15 (0.98-1.35)	1.15 (0.98-1.36)	1.12 (0.95-1.33)	1.12 (0.95-1.32)	1.04 (0.88-1.23)
By or after midnight	1.30 (1.13-1.49)	1.25 (1.07-1.45)	1.23 (1.05-1.44)	1.20 (1.01-1.41)	1.09 (0.92-1.29)
Self-perception of how much parents care					
1 – Not at all			3.78 (1.91-7.46)	2.55 (1.24-5.24)	2.45 (1.21-4.97)
2 – Very little			5.08 (3.15-8.19)	3.60 (2.01-6.43)	3.26 (1.82-5.81)
3 – Somewhat			5.17 (3.79-7.06)	3.75 (2.62-5.37)	3.56 (2.51-5.06)
4 – Quite a bit			2.51 (2.12-2.98)	2.23 (1.86-2.66)	2.14 (1.79-2.55)
5 – Very much			1.00	1.00	1.00
Depression				6.57 (5.32-8.11)	5.83 (4.68-7.27)
Adolescent-reported sleep duration					
≤ 5 h					1.48 (1.06-2.06)
6 h					1.44 (1.17-1.79)
7 h					1.17 (0.97-1.40)
8 h					1.00
9 h					0.88 (0.69-1.13)
≥ 10 h					1.22 (0.97-1.53)
Enough Sleep					0.71 (0.61-0.84)

[a]**Model 1** – Unadjusted.
[b]**Model 2** – Adjusted for age, sex, race/ethnicity, parent's marital status, and family receipt of public assistance.
[c]**Model 3** – Adjusted for variables in Model 2 plus self perception of how much parents care.
[d]**Model 4** – Adjusted for variables in Model 3 plus depression.
[e]**Model 5** – Adjusted for variables in Model 4 plus adolescent reported sleep duration and perception of getting enough sleep.

study with healthy participants using fMRI, investigators from Harvard Medical School and the University of California, Berkeley, found that a lack of sleep resulted in inappropriate modulation of human emotional brain responses to aversive stimuli. Sleep deprived participants exhibited a hyper-limbic response by the amygdala in response to exposure to increasingly negative picture stimuli.[25] According to the authors of the study, their results may provide insights into the relationship between sleep deprivation and mood disorders, "which instead of being viewed as co-occurring, may be more causally related." Second, moodiness resulting from insufficient sleep has been theorized to interfere with teenagers' abilities to cope with daily stresses and to impair their relationships with peers and adults.[1] Adverse and stressful life events have been shown to contribute to depression,[27] and inadequate skills to cope with these events could exacerbate these effects. Deteriorations in relationships with peers and parents can lead to deficits in social support, which have been shown to be associated with depression.[28] Third, the association between short sleep duration and suicidality has been hypothesized to be due, in part, to the negative effects of insufficient sleep on judgment, concentration, and impulse control.[11] Treatment of sleep disorders has been shown to significantly reduce aggressive and impulsive behaviors in hospitalized youth.[29]

The associations between parental set bedtimes, depression, and suicidal ideation that we found should be considered in light of the limitations of these analyses. Some of these limitations relate to how closely the study has the characteristics of an ideal quasi-experiment. In an ideal quasi-experiment, the independent variable is exogenously determined. In this case the independent variable (parental set bedtime) could be influenced by characteristics and behaviors of the adolescent. For instance, we found that males and younger adolescents were significantly more likely to have earlier parental set bedtimes, but we continued to find significant differences after controlling for these variables. Another characteristic of an ideal quasi-experiment is the occurrence of the independent variable temporally before the dependent variable. Although we hypothesize that parental set bedtimes and resultant short sleep durations were relatively stable and therefore were likely to have preceded the adolescents' depression, some of these bedtimes could have been established while the adolescent suffered from depression. We would not expect the presence of depression in adolescents to affect their parents' choices of set bedtimes. However, it is possible that adolescents' depression and associated symptoms could influence their parents to set either earlier or later bedtimes. The parental and adolescent at home interviews were conducted in close proximity, so the cross-sectional nature of these analyses limits our ability to determine the temporal relationships between parental set bedtimes, sleep duration, and depression. Future studies on the relationship between parental set bedtimes and

depression should include longitudinal designs and repeated measures to assess the influence of parental set bedtimes on sleep duration and depression and to more clearly delineate the temporal relationships between the variables. The Add Health study also did not include questions about school start times, so we were unable to explore the relationships between school start times, parental set bedtimes, adolescent reported bedtimes, and sleep duration. Another limitation of this study is the use of self-reported sleep duration rather than objectively measured sleep duration. Some studies have found good agreement between self-reported sleep duration and sleep duration measure by actigraphic monitoring,[30,31] but other studies have found self-reported sleep duration to overestimate that measured by actigraphic[32] and polysomnographic[33] monitoring.

Our findings suggest that later parental set bedtimes contribute to shorter sleep durations and perceptions of not getting enough sleep, which in turn are associated with depression and suicidal ideation. The results from this study provide new evidence to strengthen the argument that inadequate sleep could play a role in the etiology of depression. Earlier parental set bedtimes could therefore be protective against depression and suicidal ideation in adolescents. Behavioral interventions that involve educating adolescents and their parents about healthier sleep hygiene practices and helping them modify maladaptive sleep habits could serve as primary preventative measures against depression and suicidal ideation. Further research is needed to investigate the mechanisms by which short sleep duration could contribute to depression and suicidal ideation. Previous findings suggest that areas ripe for further research include the ways by which inadequate sleep could affect emotional brain responses to aversive stimuli[28] and impact teenagers' abilities to cope with adverse life events, garner social support,[1,27] and control aggressive impulses.[11,29]

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