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The Effects of Bedtime and Sleep Duration on Academic and Emotional Outcomes in a Nationally Representative Sample of Adolescents

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A B S T R A C T

Purpose: The overall aim of this study was to clarify and better characterize the sleep/circadian patterns of adolescents in a nationally representative sample.
Methods: We used three waves of data from the National Longitudinal Study of Adolescent Health to assess sleep/circadian patterns of 2,700 adolescents in grades seven through 12.
Results: Late school year bedtime was associated with shorter total sleep time cross-sectionally, whereas late summertime bedtime was not. Moreover, late school year bedtime was not associated with late summertime bedtime cross-sectionally. Late school year bedtime in Wave I (1994–1995) was associated with worse educational outcomes and emotional distress 6–8 years later. In addition, late summertime bedtime in Wave II (1996) was associated with more emotional distress at Wave III (2001–2002). Short total sleep time was not associated longitudinally with changes in emotional and academic functioning. Across Waves I and II, more than three quarters of adolescents who went to sleep at 11:15 A.M. or later during the school year or 1:30 A.M. or later during the summer reported sleeping fewer than the recommended 9 hours.
Conclusions: These findings underscore the significance of evaluating and monitoring bedtime in adolescents and the importance of intervention strategies that target bedtimes in an effort to reduce associated functional impairments, and improve academic and emotional outcomes.

IMPLICATIONS AND CONTRIBUTION

The unique contribution of the current article is to clarify the significance of late bedtime, sleep duration, and sleep constrained by school start times on academic and emotional outcomes. The data suggest that roughly one third of adolescents with late bedtimes perform worse in school and experience increased emotional distress than their more phase-advanced counterparts.

Teenagers report regular insufficient sleep and excessive daytime sleepiness. Estimates indicate that between 45% and 85% of sixth- to 12th-grade students report sleeping less than the recommended amount on school nights [1,2], and 44% of students report difficulty staying awake during school [2].

The epidemic of insufficient sleep among adolescents is particularly alarming given the accumulating evidence that sleep is needed to support optimal cognitive and emotional functioning [3,4]. In youth, more sleep is consistently associated with better grades in school [5,6], and sleep quality and quantity are closely related to student learning and academic performance [7]. In the emotional domain, prospective studies indicate that half of all lifetime mental disorders start by 14 years of age [8], and evidence indicates that sleep problems in teens predict worse mental health [9–13].

Importantly, evidence indicates that the quantity of sleep obtained is not the only contributor to burden. Approximately 40% of teens select later bedtimes, a pattern of behavior often referred to as an evening circadian preference [14–16]. These evening preference adolescents exhibit a delayed sleep schedule, whereby teens increase activity later in the day and both go to sleep and get

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up later [17]. Factors such as parental monitoring, social influences, academic pressure, and technology use may influence bedtime selection in teens [1]. However, evening preference has also been linked to the onset and progression of puberty [17]. Researchers examined the circadian timing system by measuring the timing of melatonin secretion, demonstrating that more mature children showed a later phase of melatonin secretion offset [18]. Consistently, research indicates that 45% of 10th- through 12-graders reported going to bed later than midnight during the school week [19]. This tendency toward late bedtimes is problematic. Numerous cross-sectional studies indicate that later bedtimes are associated with adverse outcomes including worse academic performance and more emotional distress [13,20]. One goal of the present study was to evaluate the contributions of later bedtime and inadequate sleep quantity on outcomes in youth longitudinally into adulthood.

There is a critical and understudied distinction between late bedtime and sleep quantity. According to the two-process model of Borbély and Wirz-Justice [21], the sleep–wake cycle is regulated by two processes. The first process is the circadian system (Process C), which influences the internal organization of the timing of daily sleep–wake cycles. The second factor (Process S), the sleep homeostat, primarily regulates the length and depth of sleep [21]. The two processes are interrelated and overlapping but are independent. Taken together, this model points to three possible sources of sleep difficulties in adolescents: a circadian process, a sleep process, and the convergence of the two processes. One unique contribution of the present report is that it clarified the significance of these three possible sources of sleep difficulties in adolescents in a large longitudinal epidemiological study. Proxies for the three sleep/circadian variables of interest were used. Based on previous research using biological markers of circadian phase and the sleep homeostat, we used the following correlates as estimates: We used summertime bedtime as a proxy for the circadian process [22], habitual total sleep time (TST) as a proxy for the sleep process [23], and school year bedtime as a proxy for the convergence of the sleep and circadian processes [22].

The overall aim of the present study was to better characterize the sleep/circadian patterns of adolescents in a nationally representative sample across three waves of data collection. The first aim was to describe sleep/circadian patterns cross-sectionally. The sleep variables used were summer bedtime, habitual TST, and school year bedtime. Three hypotheses were tested: (1) Later school year bedtimes will be associated with shorter habitual TST; (2) later summertime bedtimes will be associated with shorter habitual TST; and (3) and later school year bedtimes will be associated with later summertime bedtimes. Our predictions were based on the finding that sleep deprivation in adolescents may be attributable to their bedtime preference, and that summertime and school year sleep duration differed by 19 minutes on average [22]. The second aim was to determine the longitudinal relationship between each sleep/circadian variable at Waves I and II and overall cumulative grade point average GPA by Wave III. We predicted that late summertime bedtime, late school year bedtime, and shorter TST in Waves I and II would be associated with worse GPA by Wave III. The third aim was to determine the longitudinal relationship between each sleep/circadian variable at Waves I and II and emotional health at Wave III. We predicted that late summertime bedtime, late school year bedtime, and short TST in Waves I and II would be associated with more emotional distress at Wave III.

Methods

Sample

The National Longitudinal Study of Adolescent Health (Add Health) is a longitudinal study in the United States containing data on the health and behavior of adolescents across three waves of data collection (Table 1). The current study included data from the public-use dataset of participants who participated in the first three waves of data collection. The collection of data followed informed consent procedures approved by the Institutional Review Board at the University of North Carolina, Chapel Hill.

Measures

Demographic characteristics assessed included age, gender, race/ethnicity, welfare status, and pubertal status. A proxy for puberty was obtained via self-reported menarche for girls and levels of voice change for boys [24].

Sleep/circadian variables were determined via self-report measures. School year bedtime, a proxy for the convergence of the sleep and circadian processes, was defined by response to the question, "During the school year, what time do you usually go to bed on week nights?" The top tertile of school year bedtimes was defined as the late school year bedtime group, whereas the middle tertile was defined as the intermediate school year bedtime group. The top tertile cutoff for school year bedtimes was later than 11:15 P.M. in Waves I and II. The middle tertile cutoffs were between 10:15 P.M. and 11 P.M. in Waves I and II. Participants who responded that they went to sleep between 12 P.M. and 7 P.M. during the school year were excluded from the present study. Summertime bedtime, a proxy for the circadian process, was defined by responses to the question, "During the summer, what time do you usually go to bed on week nights?" The top tertile of summertime bedtimes was defined as the late summertime bedtime group and the middle tertile was defined as the intermediate summertime bedtime group. Summertime bedtime was used to best represent adolescent sleep patterns when least constrained by school and/or work obligations [25,26]. Summertime bedtimes were not available for Wave I data. The top tertile cutoff was later than 1:30 A.M. in Wave II and the middle tertile was between 11:45 P.M. and 1 A.M. Adolescents with early bedtimes were not included in these analyses because we would expect different risk variables to be associated with those groups. Total sleep time, a proxy for the sleep process, was defined by response to the question, "How many hours of sleep do you usually get?" Based on empirical research by Carskadon and colleagues [27] indicating that the recommended

Table 1
Time points for three waves of data collection and variables used in each wave

	Wave I (1995) grades 7–12	Wave II (1996) grades 8–12	Wave III (2001–2002) ages 18–26
School year bedtime	X	X	
Summertime bedtime		X	
Total sleep time	X	X	
Academic achievement[a]			X
Emotional distress			X

X values indicate that the variable was available for that wave of data.

[a] The Adolescent Health and Academic Achievement transcript release form was signed during Wave III of data collection; however, the academic outcome data provided in Wave III reflect overall cumulative high school grade point average by Wave III of data collection.

quantity of sleep for adolescents is 9.2 hours of sleep, short TST was defined as adolescents who reported sleeping fewer than the recommended 9 hours of sleep habitually [27,28]. Adequate TST was defined as adolescents who reported sleeping 9 or more hours habitually.

The Adolescent Health and Academic Achievement (AHAA) transcript study links Add Health data to educational data. All Wave III respondents were asked to complete a release form that authorized study personnel to collect official school transcripts. Academic achievement was measured by cumulative grade point average (GPA) for all years of high school completed by Wave III [29]. Of the total 2,700 students, 2,684 had completed high school by Wave III.

Emotional distress was defined as a composite of feeling sad, feeling depressed, feeling bothered by things that do not normally bother you, not being able to shake the blues for a lot of the time over the past week, and crying more than once a week over the past year [30]. Participants who endorsed moderate levels of distress on two or more of the emotional distress variables were categorized as distressed.

Statistical analyses

All analyses compared adolescents who had late bedtimes with adolescents in the middle tertile of bedtimes and short TST to the remainder of the sample. Cross-sectional bivariate associations of late bedtimes with demographic characteristics were examined at Waves I and II using chi-square tests for categorical variables and adjusted Wald *F*-tests for continuous variables. All analyses were performed using StataSE 12 (Stata Corp., College Station, TX) using methods for cluster design survey data. Covariates for all analyses included sex, race/ethnicity, welfare status, pubertal status, and age [31].

Sample size

Of those with data across all three waves (n = 3,342), five people were missing race, 215 were missing welfare status, 25 were missing pubertal status at Wave II, and one additional respondent was missing bedtime during the summer in Wave II. Moreover, 642 people were missing AHAA data. A total of 642 adolescents had missing AHAA or demographic data and therefore were excluded. Thus, the final sample included 2,700 adolescents. No significant differences were observed between the group that was excluded because of missing values and those remaining in the sample.

Results

At Wave I, 23% (n = 772) of the adolescent respondents reported going to bed at 11:15 P.M. or later during the school year. In addition, at Wave I, 73% (n = 1,792) of the adolescent respondents reported "usually" sleeping fewer than the recommended 9 hours of sleep.

Table 2 provides descriptive data on the sample characteristics for Wave I (1994–1995). Compared with the intermediate bedtime group, adolescents with late bedtimes during the school year in Wave I were more likely to be older and male, and to sleep fewer hours per night habitually. Compared with the adequate TST group, adolescents with short TST in Wave I were less likely to be Caucasian, more likely to be older, female, and postpubertal, and more likely to have later school year bedtimes.

At Wave II, 22% (n = 733) of the adolescent respondents reported going to bed at 1:30 A.M. or later during the summer. In addition, 23% (n = 757) of the adolescent respondents reported going to bed at 11:15 P.M. or later during the school year. Moreover, 80% (n = 2,038) reported "usually" sleeping fewer than the recommended 9 hours of sleep.

Table 3 provides descriptive data on the sample characteristics for Wave II (1996). Compared with the intermediate summertime bedtime group, adolescents with late summertime bedtimes did not significantly differ in any of the demographic characteristics. Compared with adolescents with intermediate school year bedtimes, adolescents with late school year bedtimes in Wave II were less likely to be Caucasian and more likely to be older, have a parent who was receiving public assistance, and to sleep fewer hours per night habitually. Compared with the adequate TST group, adolescents with short TST at Wave II were more likely to be older, female, and postpubertal, and to go to sleep later during the school year.

Table 2
Comparison of adolescents with late and intermediate school year bedtimes, and short and adequate total sleep times in Wave I (1994–1995) sample characteristics

	School year bedtimes			Total sleep time		
	Late (n = 772)	Intermediate (n = 1,111)	*p*	Short (n = 1,792)	Adequate (n = 908)	*p*
	Mean (SD) or %	Mean (SD) or %		Mean (SD) or %	Mean (SD) or %	
Age, years	15.67 (1.57)	15.2 (1.54)	.00	15.2 (1.62)	14.44 (1.44)	.00
Biological sex						
Male/female	48%/52%	44%/56%	.05	43%/57%	48%/52%	.01
Race/ethnicity						
Caucasian	57.07%	60.85%	.09	60.03%	65.56%	.00
African-American	26.46%	22.95%	.08	23.77%	17.88%	.00
Hispanic/Latino	7.78%	8.19%	.74	7.57%	8.17%	.57
Asian/Pacific Islander	4.54%	4.32%	.83	4.61%	3.09%	.05
Native American	4.15%	3.69%	.62	4.03%	5.30%	.11
Parent receives public assistance	8.13%	7.86%	.83	8.00%	9.26%	.2
Postpubertal	74.84%	74.89%	.94	74.78%	65.07%	.00
Hours of sleep	7.5 (1.77)	7.7 (1.18)	.02	7.27 (.95)	9.58 (.88)	.00
Bedtime	12:31 A.M. (1.13)	10:47 P.M. (.25)	.00	10:44 P.M. (1.18)	10:19 P.M. (1.34)	.00

p values represent results from chi-square analyses for categorical variables and Student's *t*-tests for continuous variables; all time values are hours and minutes (hours:minutes).
SD = standard deviation.

Figure 1 displays the distribution of sleep among late and intermediate bedtime teens at Waves I and II. Cross-sectional linear regression analyses of bedtime predicting TST, controlling for demographic characteristics, were examined among Waves I and II. At Wave I, 77.64% of late school year bedtime adolescents reported sleeping less than the recommended 9 hours of sleep (Figure 1A) and later bedtime was associated with shorter TST ($B = -.03$; $p < .05$). In Wave II, 91.15% of adolescents with a late school year bedtime got less than 9 hours of sleep (Figure 1B) and later bedtime was associated with shorter TST ($B = -.19$; $p < .001$). Although 80.49% of adolescents with a late summertime bedtime in Wave II slept <9 hours (Figure 1C), later bedtime was not significantly associated with shorter TST ($B = -.01$, $p > .05$). Next, logistic regression analyses controlling for demographic characteristics indicated that school year bedtimes at Wave II did not predict summertime bedtimes at Wave II (odds ratio, 1.12; 95% confidence interval, .83–1.5).

Table 4 presents linear regression analyses examining the contribution of sleep/circadian patterns in Waves I and II prospectively on cumulative high school GPA by Wave III, controlling for demographic characteristics. Results indicated that late school year bedtimes in both Waves I and II predicted a lower cumulative GPA by Wave III. However, late summertime bedtime in Wave II did not predict a lower cumulative GPA by Wave III. Neither short TST in Waves I or II predicted GPA by Wave III.

Next, we examined whether sleep at Waves I and II predicted emotional distress in Wave III. Table 4 presents results from logistic regression analyses controlling for demographic characteristics. The results indicate that late school year bedtimes in Wave I predicted emotional distress in Wave III. Late school year bedtimes in Wave II did not predict emotional distress in Wave III. However, late summertime bedtimes in Wave II predicted more emotional distress at Wave III. Finally, short TST in Waves I or II did not predict emotional distress in Wave III.

Discussion

The first aim was to describe sleep/circadian patterns cross-sectionally in Waves I (1994–1995) and II (1996). Across Waves I and II, more than three quarters of adolescents who went to sleep at 11:15 P.M. or later during the school year or 1:30 A.M. or later during the summer reported sleeping fewer than the recommended 9 hours. Consistent with our first hypothesis, later school year bedtimes were associated with shorter TST in Waves I and II. Contrary to our second hypothesis, late summertime bedtime was not associated with shorter TST in Wave II. Contrary to our third hypothesis, later school year bedtimes were not associated with late summertime bedtimes in Wave II. These findings clarify some important points. First, during the school year when adolescents are required to wake early for school, late bedtime is associated with less sleep. Second, during the summer when bedtimes are unconstrained by early school start times, late bedtime is not necessarily associated with shorter TST. Third, adolescents who go to bed late during the school year are not necessarily the same group of teens who go to bed late during the summer. These findings are consistent with previous research investigating adolescents with late bedtimes [18,19]; however, they highlight possible concerns with the use of school year bedtime as a marker of late circadian phase. Taken together, these findings point to the importance of the two-process model [21] in the study of adolescents' sleep/circadian patterns. Bedtimes and sleep are clearly interrelated and overlapping processes, but are also independent.

The second aim was to determine the longitudinal relationship between each sleep/circadian variable at Waves I and II and overall cumulative GPA by Wave III (2001–2002). In partial support of our hypothesis, late bedtime during the school year in Waves I and II predicted worse overall academic performance. This result is consistent with previous findings that adolescents with later school year bedtimes reported worse academic outcomes [28]. In addition, previous research found that when adolescents with an evening preference were tested in the morning, they performed worse on cognitive tasks [20]. The latter provides a possible explanation for our finding that late school year bedtime is predictive of GPA. Therefore, late school year bedtimes appear to be a marker of risk within the domain of cognitive academic performance.

Table 3
Comparison of adolescents with late and intermediate school year bedtimes, late and intermediate summertime bedtimes, and short and adequate total sleep times in Wave II (1996) sample characteristics

	School year bedtimes			Summertime bedtimes			Total sleep time		
	Late (n = 757)	Intermediate (n = 1,231)	*p*	Late (n = 733)	Intermediate (n = 1,334)	*p*	Short (n = 2,038)	Adequate (n = 662)	*p*
	Mean (SD) or %	Mean (SD) or %		Mean (SD) or %	Mean (SD) or %		Mean (SD) or %	Mean (SD) or %	
Age, years	16.71 (1.54)	15.99 (1.58)	.00	15.93 (1.62)	15.89 (1.67)	.69	15.99 (1.64)	15.43 (1.61)	.00
Male/female	47%/53%	46%/54%	.87	45%/55%	45%/55%	.74	44%/56%	48%/52%	.05
Race/ethnicity									
Caucasian	55.76%	63.04%	.00	62.16%	61.56%	.79	61.19%	62.93%	.42
African-American	26.36%	21.85%	.02	21.17%	21.62%	.81	22.64%	20.27%	.19
Hispanic/Latino	8.74%	7.96%	.55	7.65%	7.88%	.85	7.81%	7.41%	.73
Asian/Pacific Islander	5.30%	3.09%	.01	5.46%	4.35%	.26	4.30%	3.78%	.55
Native American	3.84%	4.06%	.8	3.55%	4.58%	.27	4.07%	5.60%	.09
Receives public assistance	9.28%	6.14%	.02	7.92%	7.86%	.87	8.00%	9.82%	.14
Postpubertal	79.09%	77.94%	.61	76.79%	75.64%	.59	77.75%	71.78%	.00
Hours of sleep	6.88 (1.54)	7.54 (1.33)	.00	7.66 (1.34)	7.66 (1.41)	.94	7.14 (.98)	9.64 (1.08)	.00
Bedtime									
School year	12:42 A.M. (1.02)	10:46 P.M. (.25)	.00	10:34 P.M. (1.09)	10:36 P.M. (1.22)	.52	10:44 P.M. (1.1)	10:06 P.M. (1.08)	.00
Summertime	12:16 A.M. (1.97)	12:10 A.M. (1.91)	.31	2:42 A.M. (1.26)	12:25 A.M. (.47)	.00	12:14 A.M. (1.99)	12:14 A.M. (1.64)	.92

p values represent results from chi-square analyses for categorical variables and Student's *t*-tests for continuous variables; all time values are hours and minutes (hours:minutes).
SD = standard deviation.

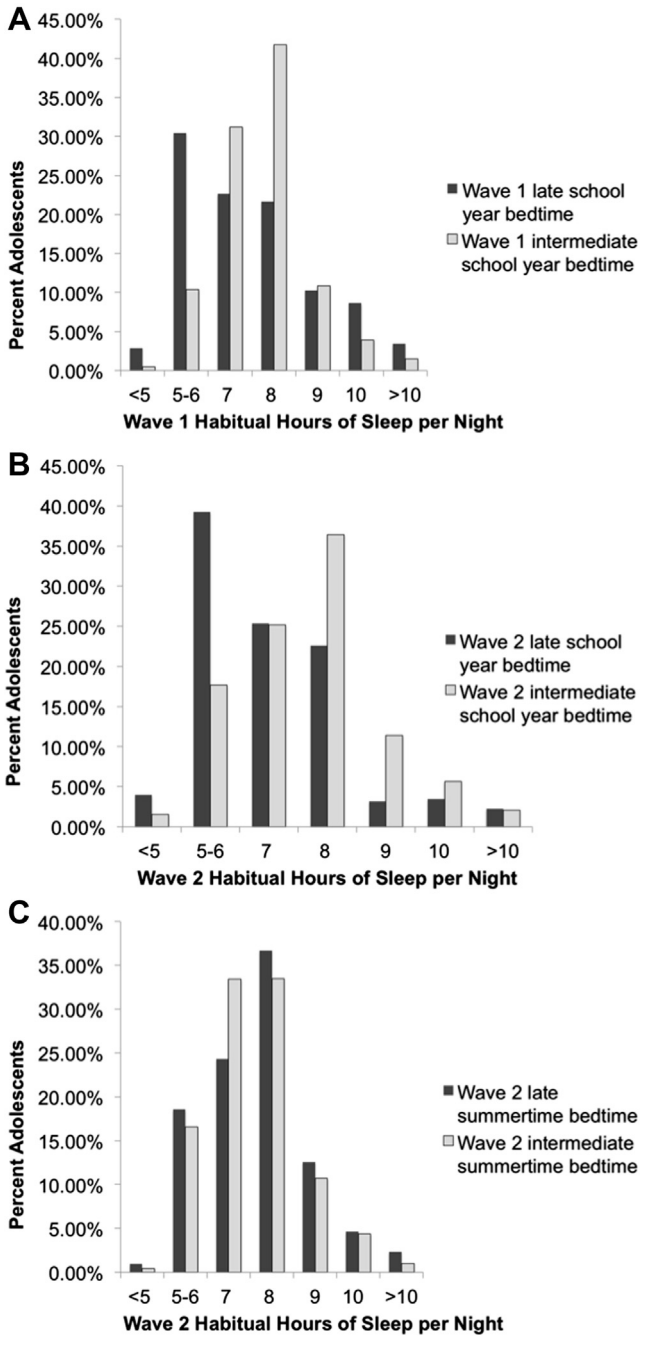

Figure 1. Distribution of hours of sleep of adolescents with late and intermediate school year bedtimes in Wave I (A), adolescents with late and intermediate school year bedtimes in Wave II (B), and late and intermediate summertime bedtimes in Wave II (C).

Our hypothesis was only partially supported. Contrary to our prediction, late summertime bedtime at Wave II was not predictive of academic performance in Wave III. Similarly, our prediction that short TST in Waves I and II would predict worse cumulative academic performance at Wave III was not confirmed. Our finding that short TST was not predictive of cumulative GPA between 1 and 6 years later was surprising. There are at least two possible explanations for this finding. First, although cross-sectional studies have indicated that acute sleep deprivation diminishes performance on cognitive tasks [3,4,32], there is a dearth of longitudinal studies on the long-term cognitive effects of sleep deprivation in adolescents. Second, some research suggests that with maturation, adolescents experience a decrease in sensitivity to sleep deprivation and extended wakefulness [33,34]. Therefore, it is possible that the age of our sample (ages 13–18) represents a group who are less sensitive to sleep deprivation.

Table 4
Weighted beta coefficients, odds ratios, *p* values, and 95% confidence intervals for all predictors from regression models predicting cumulative grade point average and emotional distress at Wave III

	Wave III cumulative grade point average			Wave III emotional distress		
	β	*p*	95% CI	OR	*p*	95% CI
School year bedtimes						
Wave I late school year bedtimes	−.27	<.001***	−.37–.17	1.35	<.05*	1.03–1.76
Wave II late school year bedtimes	−.13	<.01**	−.24–.023	1.26	>.05	.96–1.66
Summertime bedtimes						
Wave II late summertime bedtimes	.01	>.05	−.09–.1	1.4	<.01**	1.08–1.81
Total sleep times						
Wave I Short TST	.07	>.05	−.02–.15	.95	>.05	89–1.01
Wave II Short TST	.08	>.05	−.02–.18	1.13	>.05	87–1.46

CI = confidence interval; OR = odds ratio; TST = total sleep time.
*$p < .05$; **$p < .01$; ***$p < .001$.

The third aim addressed the longitudinal relationship between each sleep/circadian variable at Waves I and II and emotional health at Wave III. In partial support of this hypothesis, late bedtime during the school year in Wave I and late summertime bedtime in Wave II predicted greater emotional distress in Wave III. This finding is supported by several lines of evidence that indicate that later bedtime is associated with more emotional distress [11–13].

Recall that as part of our third aim, we also hypothesized that late school year bedtime in Wave II and short TST in Waves I and II would predict increased emotional distress in Wave III. Contrary to this hypothesis, late bedtime during the school year in Wave II did not predict emotional distress in Wave III. One possible explanation for this finding comes from research [16] that found that older adolescents with an evening preference (aged 16–18 years) adapt better to sleep irregularity and sleep restriction than younger adolescents (aged 14–16 years). In the present study, the mean age of the Wave I late school year and the Wave II late summertime bedtime group falls in the age category of 14–16 years, whereas the mean age of the Wave II late school year bedtime group falls into the age category of 16.1–18 years. Thus, the older age of the Wave II late school year bedtime group could potentially account for the finding that Wave II adolescents with a late school year bedtime were not at increased risk for emotional distress. Also contrary to the hypothesis, short TST in Wave I or II did not predict emotional distress at Wave III. Although the acute effects of sleep deprivation on emotion are well documented [3,35], there has been a dearth of research on the long-term effects of chronic short TST in adolescents.

Taking together, a noteworthy pattern emerges. Later school year bedtime (a proxy for the convergence of the sleep and circadian processes) during the first wave of data collection

appears to be the most consistent predictor of academic and emotional risk. Indeed, researchers have posited that adolescents who have difficulty shifting their weeknight bedtime to accommodate an early morning school schedule represent a particularly high-risk group [28]. The results imply that future research should focus on school year bedtime, particularly in adolescents aged 14–16 years, as a prime target for preventative interventions in the emotional and academic domains.

The results of the present study should be interpreted within the confines of several limitations. First, we did not use reference standard measures or assess bedtime during the summer at Wave I, disallowing comparisons of school year versus summer bedtimes on Wave III outcomes of interest. However, the Add Health questions used as proxies have been used previously [22,25]. Moreover, using an 11:15 P.M. bedtime during the school year (in Waves I and II) and 1:30 A.M. bedtime during the summer (in Wave II) as the cutoffs for late bedtimes in adolescents is consistent with previous research [16]. In addition, there are potential concerns with categorizing adolescents who slept fewer than 9 hours as the short TST group. To confirm that the results were not due to this cut point, we also conducted the analyses by dividing the sample into those who slept fewer than 7 hours.[1] The results were similarly nonsignificant. Moreover, all of the data are based on self-report. While adolescents appear to be largely accurate and reliable on self-report measures [36], there is some concern about the accuracy of reporting. For example, participants may have been influenced by biases such as most recent night or most salient night sleep [37], and adolescents may have incorporated their weekend bedtimes and total sleep times into their assessment of what is usual. Although impractical in large data sets, future research in smaller samples should endeavor to use reference standard tools for the measurement of sleep/circadian rhythms, such as sleep diaries, actigraphy [38], and/or forced desynchrony protocols [39]. Finally, given the high comorbidity between learning disorders and attention-deficit hyperactive disorder with late bedtimes [40], it is possible that the late school year bedtime group may struggle academically for reasons in addition to late bedtimes.

The current data underscore the significance of evaluating and monitoring bedtime in adolescents. Within the domain of academic performance, the data highlight that roughly one third of adolescents are unable to get to sleep before 11:30 P.M. during the school year and will likely perform worse in school than their more phase-advanced counterparts. Within the domain of emotional health, the data suggest that targeting adolescents (before age 16 years) with late bedtime patterns may be important. Attention needs to extend to research on this high-risk group and to interventions designed to mitigate the deleterious consequences of late bedtimes in early adolescence.

[1] Because the literature has found robust effects when short total sleep time is defined as fewer than 6 hours of habitual sleep [10], we also conducted analyses for aims 2 and 3 using fewer than 6 hours as the cutoff for short total sleep time. A total of 132 and 173 adolescents slept fewer than 6 hours habitually in Waves 1 and 2, respectively. Sleeping <6 hours of sleep habitually at Wave 1 ($B = -.3$; $p < .01$) and Wave 2 ($B = -.3$; $p < .05$) was associated with worse academic outcomes at Wave 3. However, sleeping <6 hours of sleep habitually at Wave 1 ($B = 1.3$; $p > .05$) and Wave 2 ($B = 1.46$; $p > .05$) was not associated with emotional distress at Wave 3.

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