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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.