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Original article

Sleep Patterns and Predictors of Disturbed Sleep in a Large Population of College Students

Hannah G. Lund, B.A.[a], Brian D. Reider, B.A.[b], Annie B. Whiting, R.N.[c], and J. Roxanne Prichard, Ph.D.[b,*]

[a]*Department of Psychology, Virginia Commonwealth University, Richmond, Virginia*
[b]*Department of Psychology, University of St. Thomas, St. Paul, Minnesota*
[c]*Massachusetts General Hospital, Boston, Massachusetts*

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Abstract

Purpose: To characterize sleep patterns and predictors of poor sleep quality in a large population of college students. This study extends the 2006 National Sleep Foundation examination of sleep in early adolescence by examining sleep in older adolescents.

Method: One thousand one hundred twenty-five students aged 17 to 24 years from an urban Midwestern university completed a cross-sectional online survey about sleep habits that included the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale, the Horne-Ostberg Morningness–Eveningness Scale, the Profile of Mood States, the Subjective Units of Distress Scale, and questions about academic performance, physical health, and psychoactive drug use.

Results: Students reported disturbed sleep; over 60% were categorized as poor-quality sleepers by the PSQI, bedtimes and risetimes were delayed during weekends, and students reported frequently taking prescription, over the counter, and recreational psychoactive drugs to alter sleep/wakefulness. Students classified as poor-quality sleepers reported significantly more problems with physical and psychological health than did good-quality sleepers. Students overwhelmingly stated that emotional and academic stress negatively impacted sleep. Multiple regression analyses revealed that tension and stress accounted for 24% of the variance in the PSQI score, whereas exercise, alcohol and caffeine consumption, and consistency of sleep schedule were not significant predictors of sleep quality.

Conclusions: These results demonstrate that insufficient sleep and irregular sleep–wake patterns, which have been extensively documented in younger adolescents, are also present at alarming levels in the college student population. Given the close relationships between sleep quality and physical and mental health, intervention programs for sleep disturbance in this population should be considered.

Keywords: Sleep quality; Sleep disturbance; Adolescence; Stress; Mood; College students

Little doubt exists among health professionals about the fundamental importance of sufficient, restorative sleep in maintaining one's physical and mental health. Troubled sleep is considered both a predictive sign and symptom of many illnesses, and is associated with substantial decrements in the quality of life. Briefly, chronic sleep disturbances are associated with an increased risk of work absenteeism and accidents [1], as well as significant decrements in vitality, social functioning, physical and mental health, and general quality of life [1–4].

Sleep in younger adolescents (ages 12–17) has been extensively documented. Because of a multitude of intrinsic and environmental factors, younger adolescents are particularly vulnerable to disturbed sleep, and are one of the most sleep deprived age groups in the country [5]. First, pubertal adolescents experience a biologically based phase change in their circadian rhythm that delays sleep and wake onset, making

*Address correspondence to: J. Roxanne Prichard, Ph.D., University of St. Thomas, 2115 Summit Avenue, JRC LL56, St. Paul, MN 55105.
E-mail address: jrprichard@stthomas.edu

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it physically harder to maintain earlier bedtimes [6,7]. Second, external factors like increasing caffeine consumption and late night use of electronics further delay sleep onset [5,8,9]. Third, early start times for middle schools and high schools demand earlier weekday risetimes [10–12]. Finally, even with sufficient sleep times, adolescents have increased daytime sleepiness and a greater physiological need for sleep compared to prepubertal children, which may result from maturational changes in neuronal connectivity [13,14].

The consequences of this sleep deprivation are severe, impacting adolescents' physical and mental health, as well as daytime functioning. Population and clinic-based studies in younger adolescents (ages 11–17) have shown strong associations between chronic sleep restriction and anxiety, depression, and somatic pain [9,15–17]. Younger adolescents who report shorter sleep also show decrements in academic performance [5,18], and increased risk-taking behaviors including drug use and drowsy driving [9,19]. A 12-month prospective study by Roberts et al. [20] demonstrated that insomnia in younger adolescents significantly increased the risk for subsequent declines in social, psychological, physical, and mental health.

By comparison, fewer studies have examined how sleep patterns change when older adolescents enter college, a time of minimal adult supervision, erratic schedules, and easy access to over-the-counter (OTC), prescription, and recreational drugs. Of these publications, most have focused on sleep patterns, fatigue, and academic performance [17,21,22]. Little is known about what factors contribute to or exacerbate sleep difficulties in this population. The current study measures the extent of sleep deprivation and poor-quality sleep in a large population of college students (ages 17–24), and extends the current literature on adolescent sleep by examining factors that are both precipitating and perpetuating of poor sleep in this age group. Using a multibehavioral analysis in a nonclinical population, we focused on three main questions: (a) What are the sleep habits of college students? (b) What behavioral outcomes are associated with poor sleep quality? (c) What physical, emotional, and psychosocial factors predict poor-quality sleep in college students?

Method

Participants

Participants were students between the ages of 17 and 24 (N = 1,125; 420 male, 705 female) at a large private university in the Midwest. Of these participants, 27% were freshmen (N = 305), 27% were sophomores (N = 312), 24% were juniors (N = 271), and 20% were seniors (N = 232). The mean age was 20 (SD = 1.3 years). Survey respondents were representative of the age and ethnic diversity of the school; 86% of participants were Caucasian (N = 978), 5% were Asian or Pacific Islander (N = 58), 2% were African American (N = 23), 2% were biracial (N = 24), 1% were American Indian or Alaskan Native, 0.4% were Hispanic, and the remaining 3% identified as other or elected not to respond. However, there was a female responder bias; although males and females were enrolled in equal proportions, females comprised 63% of the survey respondents.

Measures

The online survey included five published scales related to sleep, mood, and stress: (a) the Pittsburgh Sleep Quality Index (PSQI), (b) the Epworth Sleepiness Scale (ESS), (c) the Horne-Ostberg Morningness Eveningness Scale (MES), (d) the Subjective Units of Distress Scale (SUDS), and (e) the Profile of Mood States (POMS). The PSQI differentiates between ''poor-'' and ''good-''quality sleepers by measuring seven areas: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the past month [23]. Scoring is based on a 0–3 Likert scale, where a score of 3 reflects the negative extreme. A global score greater than 5 is indicative of a poor-quality sleeper, whereas a score of 5 or less is indicative of a good-quality sleeper. For this study, global PSQI scores were split into three categories: optimal ($\leq$5), borderline (6–7), and poor ($\geq$8) sleep quality; these categories were created using the specified cutoff scores for the purpose of achieving relatively even group sizes. The internal consistency of the PSQI, estimated by Cronbach's alpha, is .73.

The Epworth Sleepiness Scale is a questionnaire used to identify excessive sleepiness associated with accumulated sleep debt or clinical sleep disorders [24]. This eight-item scale assesses how sleepy one has felt in the past 6 months; participants indicate the likelihood that they would fall asleep while doing certain activities (e.g., watching TV, sitting and talking to someone, or stopped at a traffic light), with responses from (0 = *would never doze* to 3 = *high chance of dozing*. Scores range from 0 to 24, with scores over 10 indicative of significant levels of daytime sleepiness. Internal consistency for the ESS, estimated by Cronbach's alpha, is .75.

The Horne-Ostberg Morningness Eveningness Scale is used to distinguish between chronotypes (an endogenous characteristic describing one's preference for either morning or evening patterns of activity) [25]. Scores range from 16 to 86, corresponding to extreme eveningness (lower numbers) to extreme morningness (higher numbers). Questions target individual preferences for sleep and wake times, etc., such as: ''Considering only your own 'feeling best' rhythm, at what time would you get up if you were entirely free to plan your own day?'' In response, participants are directed to select a time between the hours of 5:00 a.m. and 12:00 p.m. Internal consistency for the MES, estimated by Cronbach's alpha, is 86.

The Subjective Units of Distress Scale is used to assess an individual's baseline level of stress [26]. Participants indicate how stressed they feel on a typical day using a scale of 1 to 100, where 1 = *lowest possible stress* and 100 = *highest possible stress*.

The POMS is used to assess how severely participants experience depression, tension, fatigue, confusion, vigor,

and anger [27]. The shortened version includes a list of 30 adjectives that relate to the six different mood states; participants are asked to rank on a five-point scale from ''not at all'' to ''extremely'' how much they experience these mood descriptors on a typical day. Internal consistency for the POMS, estimated by Cronbach's alpha, is .79.

In addition to the five published scales and basic demographic information, we also included questions relating to academic performance, physical health, and psychoactive drug use. To assess academic performance, we asked participants to provide their grade-point average (on a 4.0 scale) and information about class attendance. To assess physical health, we asked students about regularity of exercise and frequency of missing class because of illness. To assess psychoactive drug use, we assessed the average week and weekend frequency and intake of caffeine, alcohol, nicotine, marijuana, and prescription and OTC stimulants and sleep aids. Alcohol use was measured by total number of drinks (glass of wine, bottle/can of beer, shot of liquor, etc.) during the week (Sunday–Thursday) and during the weekend (Friday–Saturday); caffeine was measured in drinks per weekday or weekend day (8 oz. serving of coffee, espresso, tea, soft drinks, hot chocolate, or 1.5 oz. of chocolate); nicotine was measured by the number of cigarettes per day, and marijuana was measured by the number of uses per week, as well as the number of inhalations per use. Students were asked to identify motivations for using particular drugs (e.g., to increase wakefulness, to increase alertness, to be social, to complement meals, to promote sleep, etc.).

Procedure

Participants were recruited through an e-mail sent to all full-time undergraduate students (n = 5,401). The first page of the survey informed participants of the purpose and nature of the study, assured them of their anonymity, and asked participants to provide informed consent by clicking a statement before proceeding to the first data collection page of the survey. As incentives for participation, participants received either class credit if they were enrolled in select psychology courses (the type of credit depended on the class), or were entered into a raffle for a chance to win one of four monetary prizes ($25–$150 gift certificates). After the survey was completed, students were directed to a separate Web site to enter into the raffle. The survey was accessible online for 4 weeks in the middle of the semester. The procedure was approved by the university's institutional review board. Approximately 21% of the University's undergraduate students completed the survey. Of these respondents, students older than 24 were excluded from the study (<0.5% of respondents), as were students with incomplete surveys (<10% of respondents).

Analyses

t-Tests were used to test for gender differences and paired *t*-tests were used to determine differences between week and weekend behaviors. Multivariate analysis of variance was used to explore differences among optimal-, borderline-, and poor-quality sleepers on a number of variables, including mood (POMS), stress (SUDS), and caffeine and alcohol use. Chi-squared analyses were used to assess differences between optimal-, borderline-, and poor-quality sleepers in ordinal and nominal variables. Multiple stepwise regression analyses were employed to determine predictors of sleep quality. Variables that have been shown in previous studies to correlate with sleep quality (including individual components of the POMS, stress [SUDS], morningness/eveningness [MES], caffeine and alcohol use, frequency of exercise, and regularity of sleep scheduling [weekend oversleep and bedtime delay]), but that are not themselves components of the PSQI score (e.g., total sleep time, sleep latency, pain during sleep), or direct measures of sleepiness (e.g., Epworth Sleepiness Score or the fatigue component of the POMS), were used as independent variables in the regression.

Results

Sleeping behavior: quantity and quality

Overall, college students reported chronically restricted sleep. Mean total sleep time (time spent actually sleeping, as opposed to being awake in bed) was 7.02 hours (SD = 1.15). Twenty-five percent of students reported getting less than 6.5 hours of sleep a night, and only 29.4% of students reported getting 8 or more hours of total sleep time per night, the average amount required for young adults [28]. Sleep was particularly restricted on weeknights; mean weekday bedtime was 12:17 a.m. (SD = 71 minutes) and weekday rise time was 8:02 a.m. (SD = 76 minutes). Sleep schedules were erratic. Mean bedtimes (1:44 a.m., SD = 79 minutes) were delayed and mean rise times (10:08 a.m., SD = 88 minutes) were extended on weekends. Additionally, 20% of students reported staying up all night at least once in the last month, and 35% reported staying up until 3 a.m. at least once a week.

Figure 1 outlines the differences in bedtimes and risetimes by year, beginning in ninth grade and extending through the end of college (high school data are from the 2006 National Sleep Foundation Sleep in America Poll) [9]. Both weekday bedtimes and risetimes appear to be 75 minutes later in our cohort of first year college students when compared to a cohort of seniors in high school. Sleep schedule differed significantly by year in school. First-year students had significantly later bedtimes and rise times than juniors and seniors during the weekends, $F(3,994) = 5.92, 7.06$; $\eta^2 = .018, .021$, respectively, $p < .001$, but not during the weekdays, leading to a more pronounced delay in weekend bedtime and weekend oversleep among first year students and sophomores, compared to juniors and seniors, $F(3,994) = 4.57, 5.41$; $\eta^2 = .014, .026$, respectively, $p < .001$. Sleep schedule also differed significantly by sex. Males had significantly later

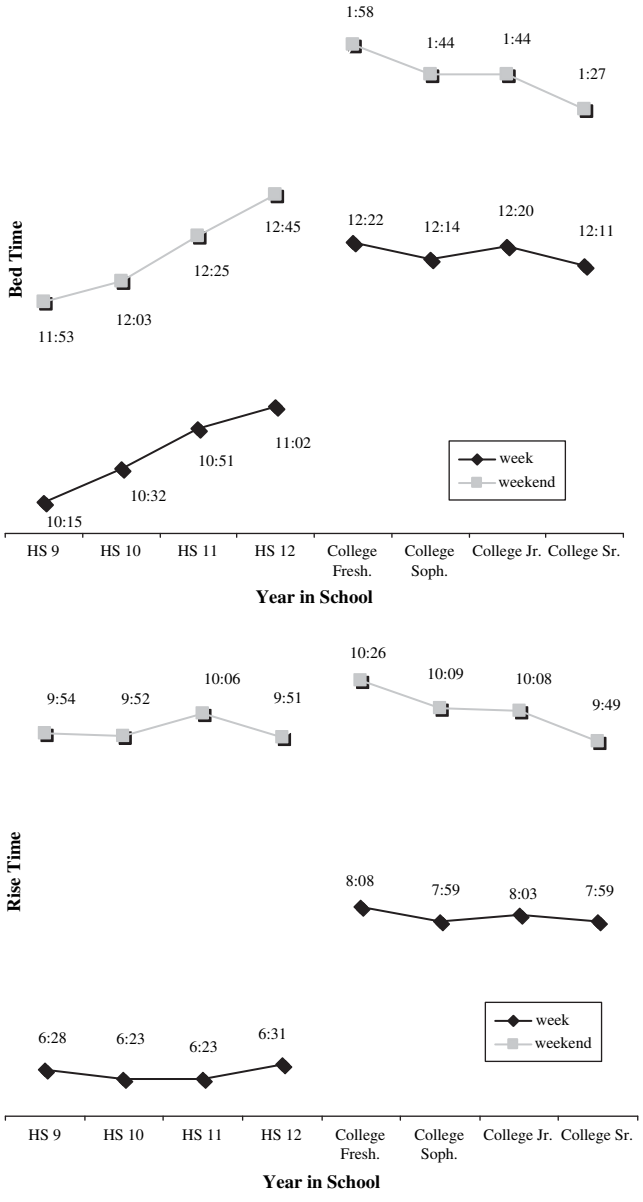

Figure 1. Bedtimes and rise times by year in school. Data from the high school bins are taken from the 2006 Sleep in America Poll (n = 1,602) [9].

bedtimes and risetimes during the week than did females, $t(998) = 5.34$, 2.18, respectively, $p < .001$, but not during the weekends.

In addition to low sleep quantity, students also exhibited poor sleep quality. Table 1 shows responses to individual questions on the PSQI. Only 34.1% of students scored in the ''good'' range of the PSQI (≤5), and 38% had PSQI scores over 7, indicating poor-quality sleep. The primary contributors to these high PSQI scores were restricted total sleep time, low enthusiasm, long sleep latencies, and ''other'' factors regularly interfering with sleep (Question 5j). Specifically, 52% of students reported lacking enthusiasm to get things done at least once a week, and 32% reported an inability to fall asleep within 30 minutes at least once a week. Over one-third of students cited ''other'' reasons for sleep disturbances at least once a week; of these responses, the most common reasons provided for these disturbances were stress (35%), excess noise (33%), and cosleeping (sharing the bed with a partner; 7%).

Students also reported significant sleepiness-related decrements in daytime performance (Table 2). Mean scores on the Epworth Sleepiness Scale were 6.8 for weekdays and 6.7 for weekends; 25% of students scored 10 or above on the scale, indicating significant levels of daytime sleepiness. Seventy-five percent of students reported feeling ''dragged out, tired, or sleepy'' once a week or more, and 15% reported falling asleep in class once a week or more.

Sleep quality, mood, and health

Poor sleep quality was associated with significantly higher self-reported negative moods. Participants categorized as having poor-quality sleep (PSQI scores ≥8) had significantly greater negative mood subscale scores (anger, confusion, depression, fatigue, and tension), compared to those with good-quality sleep; for all cases, $F(2,897) > 25$, $p < .001$ (Table 3). Poor-quality sleepers also reported higher levels of stress during the week and weekends, compared to optimal-quality sleepers, $F(2,916) = 72.4$; 37.7, respectively, $p < .001$ (Table 3).

Poor-quality sleepers also reported significantly more physical illness than optimal- and borderline-quality sleepers, $\chi^2(12, n = 947) = 39.9$, $p < .05$. Twelve percent of poor-quality sleepers reported missing class three times or more in the last month because of illness, compared to less than 4% of borderline- or good-quality sleepers. Higher scores on the PSQI were also associated with significantly increased instances of falling asleep in class and skipping class for reasons other than illness (Table 3).

Sleep quality was also related to the use of prescription, OTC, and recreational drugs to help regulate sleep and wakefulness (Table 3). Specifically, those with poor sleep quality were more than twice as likely to report using OTC or prescription stimulant medications at least once a month to help keep them awake, compared to those with good sleep quality. However, the number of caffeinated drinks per day did not significantly differ between PSQI groups. Likewise, more than 33% of students who scored equal to or greater than 8 on the PSQI used prescription or OTC sleep aids at least once a month, compared to less than 5% of optimal-quality sleepers. Finally, poor-quality sleepers reported drinking more alcohol per day than optimal-quality sleepers, and were twice as likely to report using alcohol to induce sleep compared to those with PSQI scores less than 8 (Table 3). Furthermore, of poor-quality sleepers, those who said they used alcohol to induce sleep drank significantly more alcoholic beverages per week, compared to those drinkers who did not use alcohol to sleep: 12 versus 21, $t(282) = -2.43$, $p = .02$.

Table 1
Prevalence of sleep disturbances as measured by the PSQI

Pittsburgh Sleep Quality Index	Bedtime	Sleep latency	Risetime	Total sleep time
Mean, SD	12:21 a.m. 74 min	23.8 min, 19.2 min	8:05 a.m.,76 min	7.02 hours, 1.15 hours
How often have you had trouble sleeping because…	Not during the past month	Less than once a week	Once or twice a week	3 or more times a week
Cannot get to sleep within 30 minutes	26.2%	41.4%	21.5%	10.9%
Wake up in middle of night or early morning	44.2%	34.2%	16.0%	5.6%
Wake up to use the bathroom	56.1%	32.7%	7.4%	3.8%
Cough or snore loudly	87.5%	9.6%	2.1%	0.7%
Cannot breathe comfortably	80.6%	13.3%	4.7%	1.4%
Feel too cold	71.0%	23.4%	4.5%	1.1%
Feel too hot	33.5%	42.8%	19.3%	4.5%
Have bad dreams	70.2%	21.7%	6.5%	1.6%
Have pain	73.1%	19.2%	5.4%	2.3%
Other reasons	49.4%	17.3%	22.0%	11.0%
How often have you…				
Taken medicine to aid in sleep?	82.1%	11.0%	4.0%	2.9%
Had trouble staying awake during social activities?	75.7%	20.8%	3.3%	20.0%
Had a problem getting the enthusiasm to get things done?	19.8%	30.1%	33.0%	17.2%
Rate overall sleep.	Very good	Fairly good	Fairly bad	Very bad
	11.0%	55.0%	30.0%	3.9%
	Global PSQI	Optimal(1–5)	Borderline(6–7)	Poor(≥8)
		34.1%	27.7%	38.2%

PSQI = Pittsburgh Sleep Quality Index.

Predictors of sleep quality

Several lines of evidence point to stress as a major contributor to poor sleep quality in college students. First, 20.1% of students reported stress interfering with sleep at least once a week. Women were significantly more likely to report stress-related sleep troubles than men; $t(927) = 5.49$, $p < .001$. Second, when asked to provide a written answer to PSQI question 5j, ''How often have you had trouble sleeping because of other reason(s); please describe reasons,'' the most common answers were related to stress. Answers such ''stress about school,'' ''racing thoughts,'' or ''worry about the future,'' accounted for 35% of the responses, followed by excess noise (33%), cosleeping (7%), and talking with friends (6%). Third, when asked ''If your sleep is at all compromised, to what one factor do you most strongly attribute this?'' in forced-choice question, the majority of students responded that academic (39%) or emotional (25%) stress most interfered with their sleep. By comparison, light or noise accounted for 17% of the responses, illness or pain accounted for 8%, and cosleeping accounted for an additional 4% of responses. Moreover, when asked what factor most interferes with initiating sleep, 68% of students responded with stress, compared to 10% citing temperature, and 8% responding with light or noise.

To evaluate what factors predict sleep quality, we performed a multiple stepwise regression using factors previously shown to be related to sleep quality (e.g., mood, caffeine and alcohol use, regularity of sleep schedule, and electronics exposure). The tension component of the Profile of Mood States predicted 21% of the variance in sleep quality (PSQI score), with stress (SUDS) accounting for an additional 3%, and morningness/eveningness (MES) accounting for another 2% of the variance (Table 4). Alcohol per day, caffeine per day, exercise frequency, and daily hours of television and video game exposure were not significant predictors of the PSQI score.

Discussion

Overall, the results demonstrate that the epidemic of insufficient sleep documented in high school students extends past early and midadolescence to college students. Total sleep time is similar between high school and college students, but bedtimes and risetimes are shifted later by about 90 minutes on both week and weekend days. The tendency to delay bedtimes and extend risetimes during weekends also continues into young adulthood. In addition to short sleep and irregular schedules, college students also experience low sleep quality, when assessed by standard measures. Surprisingly, perceived stress (rather than sleep schedule regularity, alcohol or drug use, exercise frequency, or electronics usage) provided the most explanatory power for poor sleep in this population.

Limitations

The results of this study must be interpreted in light of the limitations inherent in its design. First, this sample consisted of college students from one geographic area who were generally healthy and well-educated, and thus our findings are not necessarily generalizable to the United States young adult population. However, basic sleep schedules (week

Table 2
Sample characteristics by class and gender

		N	Mean	SD			N	Mean	SD
ESS week					Morningness/eveningness				
Class	1	262	7.3	3.6	Class	1	273	49.3	9.0
	2	270	7.1	3.9		2	279	50.4	9.3
Post hoc	3	244	6.7	3.7		3	255	49.4	9.9
1 > 4	4	205	6.2	3.7		4	213	50.3	10.1
*Gender	M	359	6.2	3.6	Gender	M	378	49.6	10.0
	F	625	7.2	3.8		F	645	50.0	9.4
ESS weekend					Caffeinated drinks/weekday				
Class	1	262	6.7	3.5	*Class	1	305	0.7	1.0
	2	270	6.8	3.7		2	312	0.7	1.1
	3	244	6.6	3.8		3	271	0.9	1.1
	4	205	6.4	3.5	1 < 3,4 2 < 4	4	232	1.0	1.2
*Gender	M	359	6.0	3.6	Gender	M	420	0.8	1.2
	F	625	7.0	3.6		F	705	0.8	1.0
Total PSQI					Caffeinated drinks/weekend day				
Class	1	254	6.7	3.0	Class	1	305	0.9	1.0
	2	254	6.9	3.1		2	312	1.0	1.3
	3	236	7.3	3.3		3	271	1.2	1.6
	4	202	7.1	3.1	1 < 3	4	232	1.1	1.6
Gender	M	349	6.7	3.1	Gender	M	420	1.0	1.3
	F	600	7.2	3.2		F	705	1.1	1.5
SUDS week					Alcoholic drinks/weekday				
*Class	1	248	55.1	25.1	*Class	1	305	0.2	0.6
	2	244	62.3	22.3		2	312	0.2	0.6
	3	234	63.0	21.7		3	271	0.5	0.9
1 < 2,3,4	4	196	62.2	24.5	1,2 < 3,4	4	232	0.5	0.8
*Gender	M	345	53.6	26.0	*Gender	M	420	0.5	1.0
	F	580	64.7	21.1		F	705	0.3	0.5
SUDS weekend					Alcoholic drinks/weekend day				
*Class	1	248	34.9	23.0	Class	1	305	2.8	4.2
	2	243	40.2	23.1		2	312	2.5	3.7
	3	234	40.9	22.7		3	271	3.0	4.0
1 < 3	4	195	39.1	24.1		4	232	3.2	4.0
*Gender	M	345	31.8	23.4	*Gender	M	420	3.9	5.1
	F	578	43.0	22.3		F	705	2.2	3.0

Difference from total N reflects omissions in survey reporting. Asterisks indicate significant differences between class or gender. Bonferroni tested significant differences ($\alpha = .01$) between classes are provided in the left side of the columns.

SUDS = Subjective Units of Distress Scale; PSQI = Pittsburgh Sleep Quality Index; ESS = Epworth Sleepiness Scale.

and weekend bedtimes and risetimes) in this report were similar to ones at a Chinese university and a small liberal arts college in New England [22,29]. Also, with respect to differences between student and nonstudent sleep patterns, Oginska and Pokorski [17] documented similar relationships between shortened sleep and excessive drowsiness, poor mood, and tension in both university students and working young adults in a European population.

Second, as this study consisted of a one-time survey, it is impossible to determine directionality in the relationships between poor sleep quality, mood, and stress, or to what extent poor sleep is secondary to or predictive of stress and anxiety. However, much evidence suggests that this is a complex, bidirectional relationship. In a large population-based study (N = 14,915), mood disorder diagnoses were more often preceded by, rather than concurrent with, periods of poor sleep [30]. Furthermore, in longitudinal studies, periods of disturbed sleep are significant predictors of developing depressive mood disorder [31,32]. Also, as in any survey data, there is the potential for a recall bias.

Sleep and stress

In this age group, tension and stress seemed to be the most important factors in predicting sleep quality, accounting for 24% of the variance in PSQI score. Similarly, in a study of Chinese younger adolescents (N = 1,629), perceived stress was the most significant risk factor for poor sleep quality, accounting for 13.5% of the variance in sleep quality score [18]. Perceived stress can serve as predisposing, precipitating, and perpetuating factors for sleep difficulties in this population. First, the college lifestyle creates precipitating factors that enhance stress-related sleeping difficulties (e.g., erratic schedules, high-stress periods like final exams). Second, students may be more susceptible to hyperarousal-related sleep difficulties because of maturational changes in

Table 3
Differences in behavior by PSQI group

Sleep schedule	(df)	F	p	$\acute{\eta}^2$	Post hoc	Optimal	Borderline	Poor
Total sleep time (h)	2,952	102.8	<.001	.01	O > B>P	7.61	7.08	6.47
Bedtime, weekday	2,948	9.5	<.001	.02	O,B < P	12:07 a.m.	12:13 a.m.	12:28 a.m.
Risetime, weekday	2,948	2.8	0.062	<.01		8:06 a.m.	7:54 a.m.	8:06 a.m.
Bedtime, weekend	2,946	5.5	0.004	.01	O < P	1:34 a.m.	1:42 a.m.	1:52 a.m.
Risetime, weekend	2,947	3.0	0.060	<.01		10:03 a.m.	10:03 a.m.	10:16 a.m.
Bedtime Delay (h)	2,946	0.8	0.448	<.01		1.46	1.48	1.38
Weekend Oversleep (h)	2,947	4.0	0.019	<.01		1.95	2.7	2.2
Morningness/Eveningness	2,949	33.1	<.001	.07	O > B>P	53	50	47
	(df),N	$\chi 2$	p			Optimal	Borderline	Poor
Stayed up to 3 a.m. >1×/week	6,948	46.4	<.001			25%	32%	46%
All-nighter >1×/month	6,947	30.8	<.001			12%	16%	28%
Stress and mood	(df)	F	p	$\acute{\eta}^2$	Post hoc	Optimal	Borderline	Poor
Anger	2,897	66.8	<.001	.13	O < B<P	7.48	9	10.61
Confusion	2,897	32.2	<.001	.07	O < B<P	8.6	9.56	10.31
Depression	2,897	71.2	<.001	.14	O < B<P	7.01	8.76	10.66
Fatigue	2,897	146.2	<.001	.25	O < B<P	9.44	12.09	14.92
Tension	2,897	81.1	<.001	.16	O < B<P	8.29	9.96	11.82
Vigor	2,897	28.4	<.001	.06	O > B>P	14.29	13.38	12.09
Weekday distress (SUDS)	2,916	72.4	<.001	.14	O < B<P	49.9	59.9	70.7
Weekend distress (SUDS)	2,916	37.7	<.001	.08	O < B<P	30.8	38	46.6
Psychoactive drug use	(df)	F	p	$\acute{\eta}^2$	Post hoc	Optimal	Borderline	Poor
Caffeinated drinks/day	2,952	0.53	0.59	<.01		1.0	0.990	1.08
Alcoholic drinks/day	2,952	3.42	0.03	<.01		1.07	1.24	1.35
	(df),N	$\chi 2$	p			Optimal	Borderline	Poor
Use OTC/Rx meds to wake >1×/month	6,871	23.3	0.003			12%	22%	26%
Use OTC/Rx meds to sleep >1×/month	6,949	118	<.001			4%	13%	33%
Use alcohol to get to sleep	2,681	14.0	<.001			5%	2%	10%
Sleepiness and performance	(df)	F	p	$\acute{\eta}^2$	Post hoc	Optimal	Borderline	Poor
Epworth SS weekday	2,917	42.2	<.001	.04	O < B<P	5.32	6.95	8.08
Epworth SS weekend	2,915	16.7	<.001	.10	O < B<P	5.58	6.83	7.34
	(df),N	$\chi 2$	p			Optimal	Borderline	Poor
Fall asleep in class ≥1×/week	6,951	39.2	<.001			9%	12%	21%
Skip class >2/mo, due to illness	12,948	39	<.001			4%	3%	12%
Skip class >2/months, other reasons	10,950	29.3	<.001			16%	18%	22%

O = optimal (PSQI >6), B = borderline (PSQI = 6–7), P = poor (PSQI >7). $\alpha = .01$.
PSQI = Pittsburgh Sleep Quality Index; OTC = over the counter.

the neuroendocrine system. Developmental changes in the HPA axis during adolescence result in increased perisleep onset cortisol secretion [33]. This neuroendocrine hyperactivity could contribute to both the hyperarousal observed in delayed sleep onset [34] as well as increased feelings of anxiety and depression. Third, college students may have not yet developed sufficient coping strategies for handling stressful events, and subsequently experience more internalizing, rumination, and worry [35]. Thus, biological factors (e.g., hyperarousal of the autonomic nervous system and HPA axis overactivation) provide a predisposition for stress-induced sleep difficulties, stressful events common in this population (e.g., midterm examinations, relationship troubles) precipitate bouts of sleep difficulties, and rumination and worry can perpetuate the sleep difficulty.

Of particular concern is the tendency for older adolescents to self-medicate sleep-wakefulness. Self-administration of OTC medication in an older adolescent population is associated with psychological distress [36]. In our sample, poor-quality sleepers reported higher alcohol consumption and more frequent use of alcohol and OTC drugs to help regulate their sleep/wake schedule. A potential consequence of such behaviors is the stimulant–sedation loop (use of caffeine and other stimulants to counteract daytime sleepiness, and subsequent use of depressants to counteract the effects of the stimulants). Students who get caught in this pattern may be at a higher risk for developing drug dependence [37]; approximately 90% of adolescents entering drug rehab programs report self-medicating with psychoactive drugs to control sleep and combat fatigue [38].

Table 4
Stepwise multiple regression predicting PSQI scores

$F(5,877) = 882$, $p < .001$	B	Std. Error	Beta	t	Sig.
(Constant)	7.449	3.453		2.158	.031
Predictors, $R^2 = 29\%$					
POMS-Tension	.118	.041	.143	2.857	.004
SUDS	.024	.005	.182	5.278	<.001
MES	−.060	.014	−.187	−4.290	<.001
POMS-Depression	.112	.036	.149	3.088	.002
POMS-Anger	.102	.038	.119	2.669	.008
Nonsignificant variables					
Age	.080	.071	.034	1.125	.261
Sex	.152	.210	.024	.724	.469
Ethnicity	.115	.288	.012	.398	.691
Caffeine/day	−.103	.083	−.038	−1.247	.213
Alcohol/day	.105	.067	.052	1.561	.119
Bedtime delay	−.178	.104	−.054	−1.707	.088
Weekend oversleep	.031	.082	.013	.377	.706
GPA	−.214	.250	−.027	−.858	.391
Hrs Exercise/week	−.065	.071	−.028	−.906	.365
Hrs TV/Video/week	−.018	.055	−.010	−.323	.747
POMS-Confusion	−.010	.046	−.009	−.222	.825

GPA = grade-point average; PSQI = Pittsburgh Sleep Quality Index; SUDS = Subjective Units of Distress Scale; MES = Morningness Eveningness Scale; POMS = Profile of Mood States.

Recommendations

These results highlight a growing need for professionals to focus on the quality as well as the quantity of sleep when promoting mental and physical health in adolescents and young adults. College students who are consistently getting poor-quality sleep are at risk for problems far more serious than simply struggling to function in daily activities. As chronic insomnia is a risk factor for major mood [39] and substance abuse disorders [40], physicians, college health-care professionals, and residence life workers should be more proactive in screening for sleep difficulties and in articulating the importance of sufficient, restorative sleep in college students' well-being.

Disclosure Statement

The authors have indicated no financial conflicts of interest.

References

[1] Léger D, Massuel MA, Metlaine A, SISYPHE Study Group. Professional correlates of insomnia. Sleep 2006;29:171–8.
[2] Léger D, Scheuermaier K, Phillip P, et al. SF-36: Evaluation of quality of life in severe and mild insomniacs compared with good sleepers. Psychosom Med 2001;63:49–55.
[3] Katz DA, McHorney CA. The relationship between insomnia and health-related quality of life in patients with chronic illness. J Fam Pract 2002;51:229–35.
[4] Roth T, Jaeger S, Jin R, et al. Sleep problems, comorbid mental disorders, and role functioning in the national comorbidity survey replication. Biol Psychiatry 2006;60:1364–71.
[5] Wolfson AR, Carskadon MA. Understanding adolescents' sleep patterns and school performance: a critical appraisal. Sleep Med Rev 2003;7:491–506.
[6] Taylor DJ, Jenni OG, Acebo C, et al. Sleep tendency during extended wakefulness: insights into adolescent sleep regulation and behavior. J Sleep Res 2005;14:239–44.
[7] Crowley SJ, Acebo C, Carskadon MA. Sleep, circadian rhythms, and delayed phase in adolescence. Sleep Med 2007;8:602–12.
[8] Van den Bulck J. Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. Sleep 2004;27:101–4.
[9] National Sleep Foundation: Sleep in America Poll, 2006 [Online]. Available at: http://www.sleepfoundation.org. Accessed July 15, 2008.
[10] Carskadon MA, Wolfson AR, Acebo C, et al. Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. Sleep 1998;21:871–81.
[11] Hansen M, Janssen I, Schiff A, et al. The impact of school daily schedule on adolescent sleep. Pediatrics 2005;115:1555–61.
[12] Wolfson AR, Spaulding NL, Dandrow C, et al. Middle school start times: the importance of a good night's sleep for young adolescents. Behav Sleep Med 2007;5:194–209.
[13] Campbell IG, Higgins LM, Trinidad JM, et al. The increase in longitudinally measured sleepiness across adolescence is related to the maturational decline in low-frequency EEG power. Sleep 2007;30:1677–87.
[14] Carskadon MA, Harvey K, Duke P, et al. Pubertal changes in daytime sleepiness. Sleep 1980;2:453–60.
[15] Roberts RE, Roberts CR, Chen IG. Functioning of adolescents with symptoms of disturbed sleep. J Youth Adolesc 2001;30:1–18.
[16] Fredricksen K, Rhodes J, Reddy R, et al. Sleepless in Chicago: tracking the effects of adolescent sleep loss during the middle school years. Child Dev 2004;75:84–95.
[17] Oginska H, Pokorski J. Fatigue and mood correlates of sleep length in three age-social groups: school children, students, and employees. Chronobiol Int 2006;23:1317–28.
[18] Chung KF, Cheung MM. Sleep–wake patterns and sleep disturbance among Hong Kong Chinese adolescents. Sleep 2008;31:185–94.
[19] O'Brien EM, Mindell JA. Sleep and risk-taking behavior in adolescents. Behav Sleep Med 2005;3: 133–33.

[20] Roberts RE, Roberts CR, Duong HT. Chronic insomnia and its negative consequences for health and functioning of adolescents: a 12-month prospective study. J Adolesc Health 2008;42:294–302.
[21] Medeiros ALD, Mendes DBF, Lima PF, et al. The relationships between sleep–wake cycle and academic performance in medical students. Bio Rhythm Res 2001;32:263–70.
[22] Tsai LL, Li SP. Sleep patterns in college students: gender and grade differences. J Psychosom Res 2004;56:231–7.
[23] Buysse DJ, Reynolds CF 3rd, Monk TH, et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193–213.
[24] Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. Sleep 1992;15:376–81.
[25] Horne JA, Otsberg O. A self-assessment questionnaire to determine morningness–eveningness in human circadian rhythms. Int J Chronobiol 1976;4:97–110.
[26] Wolpe J. The Practice of Behavioral Therapy, 3rd ed. New York: Pergamon Press, 1982.
[27] McNair DM, Lorr M, Droppleman LF. Profile of mood states. EdITS Manual for the Profile of Mood States. San Diego, CA: EdITS/Educational and Industrial Testing Service, 1992.
[28] Roehrs T, Shore E, Papineau K, et al. A two-week sleep extension in sleepy normals. Sleep 1996;19:576–82.
[29] Lund HG, Whiting AB, Prichard JR. The relationship between sleep quality, mood, and stress in college Women. Sleep Abstr 2006;29.
[30] Ohayon MM, Roth T. Place of chronic insomnia in the course of depressive and anxiety disorders. J Psychiatr Res 2003;37:9–15.
[31] Breslau N, Roth T, Rosenthal L, Andreski P. Sleep disturbances and psychiatric isorders: a longitudinal epidemiological study of young adults. Biol Psychiatry 1996;39:411–8.
[32] Chang PP, Ford DE, Mead LA, et al. Insomnia in young men and subsequent depression. The Johns Hopkins Precursors Study. Am J Epidemiol 1997;146:105–14.
[33] Forbes EE, Williamson DE, Ryan ND, et al. Peri-sleep-onset cortisol levels in children and adolescents with affective disorders. Biol Psychiatry 2006;59:24–30.
[34] Drake C, Richardson G, Roehrs T, et al. Vulnerability to stress-related sleep disturbance and hyperarousal. Sleep 2004;27:285–91.
[35] Jose PE, Ratcliffe V. Stressor frequency and perceived intensity as predictors of internalizing symptoms: gender and age differences in adolescence. N Z J Psychol 2004;33:145–54.
[36] Stasio MJ, Curry K, Sutton-Skinner KM, et al. Over-the-counter medication and herbal or dietary supplement use in college: dose frequency and relationship to self-reported distress. J Am Coll Health 2008; 56:535–47.
[37] Brower KJ, Aldrich MS, Robinson EA, et al. Insomnia, self-medication, and relapse to alcoholism. Am J Psychiatry 2001;158:399–404.
[38] Bootzin RR, Stevens SJ. Adolescents, substance abuse, and the treatment of insomnia and daytime sleepiness. Clin Psychol Rev 2005; 25:629–44.
[39] Neckelmann D, Mykletun A, Dahl AA. Chronic insomnia as a risk factor for developing anxiety and depression. Sleep 2007;30:873–80.
[40] Roane BM, Taylor DJ. Adolescent insomnia as a risk factor for early adult depression and substance abuse. Sleep 2008;31:1351–6.