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## SLEEP AND ALCOHOL USE

# Current Alcohol Use is Associated with Sleep Patterns in First-Year College Students

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**Study Objectives:** To examine whether differences exist in self-reported sleep patterns and self-reported alcohol use for first-semester college students who do or do not report drinking during the last 6 months (mo) of high school.

**Methods:** Participants were 878 first-year college students. Students completed a survey in late May/early June about alcohol use and consequences, during the last 6 mo of high school; they later completed a daily record of sleep behavior and alcohol use across the first 9 weeks of the first semester of college. High school drinking status (past 6 mo) was classified as positive (HS-6 mo+) or negative (HS-6 mo-) based on any indication of drinking on the May/June survey. Collegiate drinking was determined from first-semester daily diary alcohol reports as non-drinkers (0 reported drinks), drinkers (one or fewer heavy episodic drinking episodes (HED)), and drinkers reporting more than one HED episode. Sleep patterns were compared for non-drinkers, drinkers, and HED with no high school drinking history (HS-6 mo-/HED). In addition, a separate analysis compared sleep patterns for college HED with (HS-6 mo+/HED) and without (HS-6 mo-/HED) high school self-reported alcohol use.

**Results:** Increased alcohol consumption in the first semester of college was associated with later bedtimes and rise times. We found no association of high school alcohol use and sleep in those with collegiate HED.

**Conclusions:** Later sleep timing in those with greater alcohol use, supports a connection between sleep patterns and alcohol use. Such an early appearance of this connection may herald the development of alcohol use disorder in some individuals.

**Keywords:** alcohol, college, first semester, sleep

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## Significance

Excessive alcohol use is a problem in college students and is associated with a number of negative outcomes. An association between disturbed sleep and reduced hours of sleep is well established. The current study shows that the timing of sleep (i.e., later times) is associated with increased alcohol consumption in first-semester college students. In contrast to previous studies, we did not observe the association of reduced total sleep time and increased alcohol consumption. Thus, these data indicate that future studies should investigate the role of sleep timing and circadian rhythms on alcohol consumption. A better understanding of the associations between sleep, circadian rhythms, and alcohol may help to inform alcohol interventions and treatment.

## INTRODUCTION

Excessive alcohol use is problematic on college campuses in the United States, where almost half of college students report engaging in heavy episodic drinking (HED, defined as five or more drinks in one occasion for males and four or more for females<sup>1,2</sup>), at least once in the past month.<sup>3</sup> HED increases the risk of academic difficulties, physical illnesses, legal involvement, and accidental death.<sup>4,5</sup> HED also increases risk of campus and public policy violations, as alcohol use is restricted or prohibited on a large number of college campuses.<sup>6</sup> A significant number of college students meet diagnostic criteria for alcohol use disorders<sup>7</sup>; thus, alcohol use in college students is a major public health concern, and reducing alcohol use on campus is a prominent goal of many universities.

The first year of college is a particularly risky period for alcohol use and consequences due in part to substantial changes in daily routines and peer group affiliations.<sup>8</sup> Heavy drinking during the first year of school can have long-term implications, as many students continue to exhibit heavy drinking behavior after graduation.<sup>9</sup> The dynamic nature of the transition from high school to university in the United States together with significant health implications of heavy drinking make this period of transition an advantageous time to study the association between alcohol use and sleep.

The association between disturbed sleep and alcohol use is well established in adults. Several studies have shown that both acute and chronic alcohol consumption alter the architecture of physiologically measured sleep.<sup>10–16</sup> Alterations resulting from acute alcohol use include shorter sleep onset latency, a decrease in amount of rapid eye movement sleep, more stage 4 sleep in the first half of the night, an increase in wake during sleep, and an increase in delta electroencephalography power. Research indicates an association between irregular self-reported sleep patterns and increased alcohol consumption. Specifically, self-report of insomnia is associated with a twofold increase in self-reported alcohol abuse.<sup>17</sup> Furthermore, associations have been detected between self-reported short-sleep ( $\leq 6$  h per night) and increased alcohol consumption in adult men and women (ages 18–64 y),<sup>18</sup> and self-reported insomnia symptoms and HED adults older than 50 years,<sup>19</sup> and associations between problems falling and staying asleep and HED in adolescents and young adults.<sup>20</sup>

These patterns are also evident in a few studies assessing adolescents and college students.<sup>21–26</sup> For example, Hasler and colleagues<sup>21</sup> found that youths with alcohol use disorders compared to those without report more insomnia, hyper-somnia, and greater variability in weekday to weekend sleep duration. Wong and colleagues<sup>22</sup> analyzed data from a large

database ( $n = 6,504$ ) which contained two sleep questions: “Please tell me how often you have had each of the following conditions in the past 12 mo—Trouble falling asleep or staying asleep?” and “How many hours of sleep do you usually get?” Self-report of trouble falling or staying asleep once a week, every day or almost every day, and fewer hours of sleep predicted increased number of alcohol-related problems in older adolescents.<sup>22</sup> Furthermore, Singleton and Wolfson<sup>23</sup> found that college students who reported consuming an increase in alcoholic drinks over a 2-w period also reported less nighttime sleep, later sleep times, sleeping more on weekends compared to weekdays, and greater delays in sleep timing between weekday and weekend bedtimes. An association between retrospective self-reported sleep and alcohol is well established, but few studies have assessed the association of sleep patterns and alcohol use using daily diaries in college students.

This study examines drinking patterns of first-semester university students who participated in a study of sleep and mood.<sup>27</sup> To date, most studies have relied on retrospective self-reports of sleep patterns and alcohol consumption. In contrast, our approach combined retrospective survey data with daily reports of concurrent sleeping and drinking patterns summarized over the course of the first semester of college (9 w) to examine two hypotheses. First, we examined differences in sleep patterns for college students who reported no alcohol use on our high school assessments (HS–) and (1) reported no alcohol use on the first-semester daily diaries (non-drinkers), (2) reported alcohol use in college but did not engage in HED more than once (drinkers), or (3) endorsed HED on first semester daily diaries more than once (HS+/HED). We hypothesized that students reporting more alcohol consumption would also report later sleep times (e.g., bedtime, wake time) and less sleep compared to students reporting less or no alcohol use. Second, past research has not explored associations between history of alcohol use and sleep patterns in college students. We examined these associations by assessing differences in sleep patterns between students who reported heavy episodic drinking in college and either did (HS+/HED) or did not (HS–/HED) report alcohol use in high school. Given known associations between alcohol and sleep and a proposed succession of poor sleep self-medicated with alcohol in turn leading to worse sleep and increased alcohol use,<sup>17</sup> we hypothesize worse sleep (i.e., less total sleep time and later timing of sleep) in HS+/HED than in the HS–/HED students. In addition, sex differences exist in sleep<sup>28,29</sup> and in college drinking patterns,<sup>30</sup> especially in first-year students<sup>31–37</sup>; however, it is not known whether sex influences the relation between sleep patterns and alcohol use. Therefore, we include sex in our analyses to assess whether there is an interaction between sex and alcohol group on sleep patterns.

## METHODS

### Participants

Students ( $n = 8,417$ ) who accepted admission to a private northeast 4-y university in 6 consecutive years were recruited

to participate in a prospective study that assessed sleep and mood, across the first 8 to 10 w of classes in their first semester. Participants were also asked to complete a measure of previous alcohol consumption after they were accepted but before they arrived at university. No exclusion criteria were used in year 1; in subsequent years, the only exclusion criterion was age younger than 18 y. All participants provided informed consent and they received monetary compensation for taking part in this study, which was approved by the Lifespan Institutional Review Board for the Protection of Human Subjects. The analyses included data from 878 students (see next section) who completed the study.

### Procedure

In the 2 w following acceptance of admission (early May 2009–2014), students were sent a four-page survey that queried a number of behaviors, including alcohol use during the past 6 mo. Participants returned the surveys in postage-paid envelopes. All students who returned a completed survey ( $n = 2,832$ ) were invited to enroll in the second phase of the project that involved completing an online daily diary prompted by Email for approximately 9 w from the start of the term. A total of 1,400 students agreed to complete these daily diaries. In-person consent and study description occurred at the start of this phase and included a review of the National Institute on Alcohol Abuse and Alcoholism “standard” drink chart in the last 3 y of the project. Daily surveys that assessed sleep and drinking in the past 24 h were made available for students to complete online beginning on the first day of classes. At week 9 of the semester (before the Thanksgiving holiday), participants completed an online outcome survey that included the Brief-Young Adult Alcohol Consequences Questionnaire (B-YAACQ) among other measures. Illume software (DatStat, Inc., Seattle, Washington) was used to collect the online data through a secure website.

### Measures

#### Sleep

Daily diaries included the following questions about the major sleep episode in the past 24 h: “What time did you try to fall asleep?” “Estimate how many minutes it took you to fall asleep,” “Estimate how many minutes you were awake after you fell asleep,” and “What time did you finally wake up?”

Sleep patterns were determined for each participant across all completed diaries as the mean and standard deviation of diary-reported bedtimes and rise times. Total sleep time was computed from the elapsed time from bedtime to rise time minus sleep onset latency and wake after sleep onset.

#### Alcohol Use

Determination of high-school drinking status as positive or negative was based on students’ responses to two measures from the initial high school survey. A threshold for positive high-school drinking history included a positive endorsement of the question, “during the past 6 mo, how often did you use alcohol?” and/or a score of greater than zero on the

**Table 1**—Alcohol drinking variables stratified by alcohol group and sex.

	Non-drinkers		Drinkers		HS-/HED		HS+/HED	
	Men	Women	Men	Women	Men	Women	Men	Women
n	128	197	78	121	64	59	111	63
% days drinking	–	–	6.8 (6.8)	6.1 (5.2)	20.1 (8.9)	20.8 (9.2)	27.7 (11.9)	24.1 (9.7)
Mean drinks on drinking days	–	–	2.2 (1.4)	2.0 (1.2)	5.5 (1.5)	4.1 (1.2)	5.5 (1.4)	4.5 (1.2)
B-YAACQ	0.1 (0.3)	0.0 (0.1)	1.6 (3.7)	1.0 (2.6)	4.4 (3.2)	4.1 (2.9)	5.1 (3.6)	5.6 (3.7)

Values presented as mean (SD). B-YAACQ, Brief-Young Adult Alcohol Consequences Questionnaire; HED, heavy episodic drinking; HS, high school; SD, standard deviation.

B-YAACQ.<sup>38</sup> Details about this measure are included in the next section. Thus, for these analyses students were classified as positive for high-school drinking history based on a question that assessed alcohol use over “the past 6 mo” of high school and any self-reported alcohol consequences over the past month of high school.

The first-semester college daily diaries included an alcohol question: “how many drinks did you have today?” and the participant could select from 10 response options (0, 1, 2, 3, 4, 5, 6, 7, 8, or 9+). We used this item to create the following groups (non-drinkers, drinkers, HED) and variables: latency to first college drinking day (number of diary days between first day of classes and first reported alcoholic drink), percent of diary days drinking (% Drinking), and mean number of drinks reported on drinking days.

#### Alcohol-Related Problems

Alcohol-related consequences were assessed at baseline and follow-up using the 24-item B-YAACQ. Dichotomous items (yes/no) are summed for a total number of alcohol-related consequences experienced in the past month. The B-YAACQ is a 24-item subset of the YAACQ<sup>39</sup> that was created using item-response theory analysis to extract those items that most efficiently capture a single dimension of alcohol problems with nonredundant items spread across a continuum of severity. The B-YAACQ has been found to be reliable yet sensitive to changes in alcohol use over time and has demonstrated high internal consistency in research with college students ( $\alpha = 0.89$ ),<sup>40</sup> mandated college students ( $\alpha = 0.89$ ),<sup>41</sup> and the current sample ( $\alpha = 0.84$ ).

#### Analytic Approach

##### Drinking Group Assignment

Our initial sample included all participants who completed more than half (mean percentage of diaries completed = 88.7%, standard deviation = 11.4%) of the daily diaries and the final B-YAACQ form ( $n = 975$ ). Few students ( $n = 97$ ) reported high school drinking but limited college drinking, and these participants were excluded from subsequent analyses. Of the remaining 878 participants, 647 (66%; 488 female, ages 18–22 y, mean age = 18.6) reported no evidence of high-school drinking in the past 6 mo as defined previously. We divided this presumptive non-high-school drinking sample into three groups based on the alcohol reports in their first-semester college

daily diaries. See Figure S1 in the supplemental material for more details on how groups were determined.

- “Non-drinkers” ( $n = 325$ ; 33%, female = 197) reported no alcohol use on the diaries;
- “Drinkers” ( $n = 199$ ; 20%, female = 121) reported using alcohol on at least 1 day but no more than one HED episode (HED: defined as  $\geq 4$  drinks for women and  $\geq 5$  drinks for men reported on the same daily diary 24-h period);
- “HS-/HED” ( $n = 123$ ; 13%, female = 59) reported more than one HED episode in the first semester.

A fourth group (“HS+/HED,”  $n = 231$ , female = 111) comprises individuals who had a positive self-report for alcohol in the last 6 mo of high school and reported more than one HED episode on daily diaries in college, comparable to the HS-/HED group.

#### Analyses

To contextualize the four drinking groups across commonly used indices of drinking behavior (i.e., mean drinks on drinking days, percent days drinking, and the B-YAACQ total score), we report descriptive statistics by drinking group and by sex in Table 1. Group differences were evaluated using analyses of variance (ANOVA), where drinking group, participant sex, and the drinking group by sex interaction were tested.

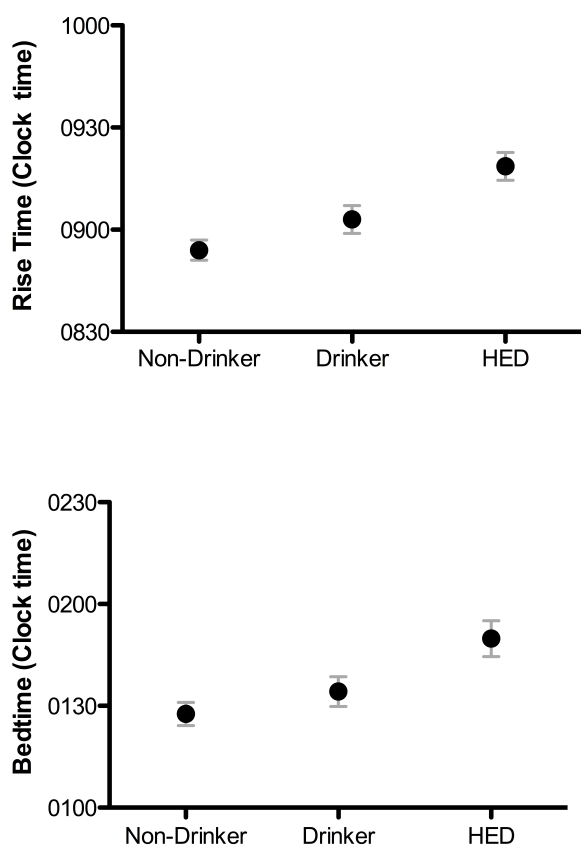
Next, we evaluated our first aim using ANOVAs, with alcohol group (“Non-drinkers,” “Drinkers,” “HS-/HED”) and sex (male, female) as independent factors. Consistent with our hypothesis that increased alcohol consumption is related to sleep patterns, a linear contrast across the three groups was used for each sleep outcome.

To compare the sleep data in students who reported heavy drinking in the first semester of college (HS-/HED) versus heavy drinking students who reported high-school drinking (HS+/HED) (Aim 2), each sleep variable was examined using ANOVAs with independent factors alcohol group (“HS-/HED” versus “HS+/HED”) and sex (male, female). The influence of sex on the relationship between drinking group and sleep patterns were evaluated by including a sex by drinking group interaction in both sets of analyses. Effect sizes for all analyses were calculated using partial eta squared ( $\eta^2$ ). We will only report statistically significant findings. Multiple comparisons were addressed using a Bonferroni correction, with  $\alpha < 0.008$  for sleep variables. Statistical tests and effect sizes of

**Table 2**—Sleep variables stratified by alcohol group and sex.

	Non-drinkers		Drinkers		HS-/HED		HS+/HED	
	Men	Women	Men	Women	Men	Women	Men	Women
n	128	197	78	121	64	59	111	63
Rise time (clock time, min) * <sup>a</sup>	9.1 (0.9)	8.8 (0.8)	9.2 (0.9)	9.0 (1.0)	9.6 (0.7)	9.0 (0.7)	9.6 (0.8)	9.4 (0.8)
Variability (SD) in rise time (min) <sup>†b</sup>	1.4 (0.5)	1.3 (0.5)	1.5 (0.5)	1.3 (0.4)	1.6 (0.4)	1.3 (0.3)	1.5 (0.4)	1.4 (0.4)
Bedtime (clock time, min) <sup>‡c</sup>	25.6 (1.1)	25.4 (1.0)	25.7 (1.1)	25.5 (1.0)	26.0 (0.9)	25.6 (1.0)	26.0 (0.9)	25.8 (0.8)
Variability (SD) in bedtime (min)	1.3 (0.6)	1.2 (0.5)	1.4 (0.5)	1.3 (0.4)	1.3 (0.3)	1.3 (0.3)	1.3 (0.4)	1.4 (0.4)
Total sleep time (h)	7.2 (0.7)	7.1 (0.7)	7.2 (0.7)	7.2 (0.7)	7.2 (0.7)	7.1 (0.7)	7.3 (0.6)	7.2 (0.6)
Variability (SD) in total sleep time (h)	1.4 (0.5)	1.4 (0.5)	1.5 (0.5)	1.3 (0.4)	1.5 (0.4)	1.4 (0.3)	1.5 (0.4)	1.5 (0.4)

Values presented as mean (SD). Analyses for three groups with no self-reported precollege drinking (non-drinkers, drinkers, and HS-/HED). \*Main effect of alcohol group ( $F_{1,641} = 7.78, P < 0.001, \eta^2 = 0.024$ ); linear contrast for alcohol group ( $F_{1,641} = 15.23, P < 0.001$ ); main effect of sex ( $F_{1,641} = 25.09, P < 0.001, \eta^2 = 0.038$ ). <sup>†</sup>Main effect of sex ( $F_{1,641} = 29.15, P < 0.001, \eta^2 = 0.044$ ). <sup>‡</sup>Main effect of alcohol group ( $F_{1,641} = 5.07, P = 0.007, \eta^2 = 0.016$ ); linear contrast for alcohol group ( $F_{1,641} = 10.05, P = 0.002$ ); main effect of sex ( $F_{1,641} = 10.04, P = 0.002, \eta^2 = 0.015$ ). Analyses for two HED groups (HS-/HED and HS+/HED). <sup>a</sup>Main effect of sex ( $F_{1,350} = 22.48, P < 0.001, \eta^2 = 0.075$ ). <sup>b</sup>Main effect of sex ( $F_{1,350} = 14.89, P = 0.001, \eta^2 = 0.044$ ). <sup>c</sup>Main effect of sex ( $F_{1,350} = 11.73, P < 0.001, \eta^2 = 0.015$ ). HED, heavy episodic drinking; HS, high school; SD, standard deviation.



**Figure 1**—Rise time and bedtime of alcohol groups. Mean (standard error of the mean) rise time (top) and mean (standard error of the mean) bedtime (bottom) in clock time for non-drinkers, drinkers, and HS-/HED demonstrating the significant linear association between later rise time and bedtime and increased alcohol consumption. HED, heavy episodic drinking; HS, high school.

## RESULTS

### Data Screening and Descriptive Statistics

We tested whether differences in bedtime, wake time, total sleep time, B-YAACQ score, or drinking status differed between those who completed the survey and those who enrolled in the first semester portion of the study. No differences were observed for any of these variables.

Descriptive statistics stratified by drinking group and sex are provided in Table 1. Substantial differences between drinking groups on all of the drinking measures were found, and all were in expected directions. Thus, students whose reports indicated heavy episodic drinking also reported drinking on more days with a higher amount of alcohol per drinking day. Scores on the B-YAACQ completed at the end of data collection also captured a greater number of alcohol-related consequences in the HED groups than for those who did not report drinking or reported light alcohol use. Sex differences in drinking behavior were also observed (Bonferroni correction, with  $\alpha < 0.013$  used for alcohol variables): women reported fewer mean drinks on drinking days ( $F_{1,530} = 51.69, P < 0.001, \eta^2 = 0.089$ ) than men.

Furthermore, a significant interaction between sex and alcohol group was observed for mean number of reported drinks on drinking days ( $F_{1,641} = 7.59, P < 0.001, \eta^2 = 0.028$ ). Specifically, the mean number of reported drinks on drinking days were greater in HS-/HED and HS+/HED men compared to women.

### Sleep Variables for High-School Alcohol History Negative Students (Hypothesis 1, Table 2)

Our examination of the sleep variables across three groups of students who did not report high school drinking showed no group differences in the amount of sleep, with average reported sleep time of approximately 7 h and 15 min each night. Differences were observed for variables capturing the timing of sleep (rise time:  $F_{1,641} = 15.23, P < 0.001, \eta^2 = 0.024$ ; bedtime:  $F_{1,641} = 10.05, P = 0.002, \eta^2 = 0.016$ ), later bedtime and rise time were associated with greater reported drinking as evidenced

Aim 1 are listed in Table S1 in the supplemental material. All analyses were performed using STATA (StataCorp., Version 13.1.216, College Station, Texas).



by a significant linear trend (rise time:  $F_{1,641} = 15.23$ ,  $P < 0.001$ ; bedtime:  $F_{1,641} = 10.05$ ,  $P = 0.002$ ; see Figure 1). No other sleep variables showed significant differences as a function of the alcohol group.

### **HS+/HED Versus HS-/HED Sleep Variables (Hypothesis 2, Table 2)**

Although we hypothesized distinguishable differences in the sleep variables when comparing the students whose heavy episodic drinking occurred on the background of high-school drinking versus those without prior drinking, our hypothesis was not supported.

### **Sex Differences**

Overall sex differences emerged from both Hypotheses 1 and 2. In the former, the women's data showed earlier ( $F_{1,641} = 25.09$ ,  $P < 0.001$ ,  $\eta^2 = 0.038$ ) and less variable rise times ( $F_{1,641} = 29.15$ ,  $P < 0.001$ ,  $\eta^2 = 0.044$ ) and earlier bedtimes ( $F_{1,641} = 10.04$ ,  $P = 0.002$ ,  $\eta^2 = 0.015$ ) than men. The latter analyses (Hypothesis 2) also showed sex differences including earlier rise time ( $F_{1,350} = 28.48$ ,  $P < 0.001$ ,  $\eta^2 = 0.075$ ) and less variable rise time ( $F_{1,350} = 14.89$ ,  $P = 0.001$ ,  $\eta^2 = 0.041$ ), as well as earlier bedtime ( $F_{1,350} = 11.73$ ,  $P < 0.001$ ,  $\eta^2 = 0.032$ ) for women. No additional sex differences were observed and no significant interactions between sex and drinking group were observed. The absence of sex\*drinking group interactions indicate that sex did not moderate the associations of alcohol use with sleep patterns.

## **DISCUSSION**

The current study examined differences in self-reported sleep in students reporting alcohol use in the first semester of college, some of whom reported evidence of precollege alcohol use. The participants' drinking histories and collegiate drinking were derived from self-reports.

We found several expected associations between sleep and alcohol when we examined collegiate sleep patterns in students with no reported evidence of alcohol use in the past 6 mo of high school. First, later sleep patterns in those reporting alcohol use were observed. Indeed, increased alcohol consumption was associated with later bedtimes and rise times. In contrast to other studies,<sup>18,23</sup> reported total sleep time was not significantly associated with alcohol use in our participants. Second, current alcohol consumption rather than history of alcohol use was most strongly associated with the average timing of sleep patterns and the relation of sleep patterns. Considering these findings in the context of the Brower model,<sup>17</sup> a cycle of poor sleep and subsequent use of alcohol to treat poor sleep ultimately lead to alcohol use disorders; thus, we would have expected to see worse sleep patterns in students who used alcohol in high school. The finding that history of alcohol use in high school does not play a role in college sleep patterns suggests this association may be more subtle in young adults and highlights the importance of examining the association between sleep and alcohol use in young people beginning to use alcohol.

The findings that sleep patterns are later in students consuming more alcohol indicate that the average clock times of sleep behavior rather than the amount of sleep *per se* are more closely associated with alcohol intake in our first-year college

students. College lifestyle may be implicated in the lack of an association between total sleep time and alcohol, because students in general have considerable flexibility in their sleep schedules. Thus, even though the collegiate drinkers reported later bedtimes overall than the moderate drinkers or non-drinkers, unconstrained rise times may have mitigated sleep loss that can occur if one must wake up for daily activities.

As noted earlier, we did not observe less sleep for participants reporting heavier alcohol consumption. We expected to see shorter sleep linked to alcohol use based on previous literature demonstrating that risk-taking and impulsivity—and hence perhaps proclivity for alcohol use—increases with reduced sleep. We may have missed this “signal” by using averaged sleep and alcohol ingestion patterns across the entire study period. Thus, our future analyses will examine sleep patterns more proximal to HED episodes to assess whether we can relate sleep length to individual alcohol use events.

Sex differences in sleep variables were consistent with previous literature<sup>42,43</sup>; for example, women reported earlier bedtimes and earlier rise times on average than men. Of note, however, we observed no interactions of sex and reported alcohol consumption for any sleep variable, indicating that the associations between sleep patterns and alcohol consumption do not differ for men and women.

We note some limitations to the current analyses. First, we did not assess lifetime alcohol use history in these students; as such, these high-school drinking histories differentiate those students who reported consuming alcohol in the “past 6 mo” of high school compared to those who did not report consuming alcohol. Second, these findings are from college students at a private residential university in the Northeast United States; thus, these findings may not be generalizable to all college students.

In summary, we found an association between alcohol consumption and sleep patterns in first-semester college students. Specifically, we found that later bedtimes and rise times were associated with increased alcohol consumption. In contrast to previous studies, our findings indicate that sleep timing, rather than sleep length, is associated with current alcohol use level. These findings suggest that interventions targeting alcohol use/misuse in college students may benefit from addressing how to improve sleep timing and sleep hygiene in general.

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