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SCIENTIFIC INVESTIGATIONS

Insomnia and behaviorally induced sleep syndrome in undergraduates tested during the COVID-19 pandemic: associations with health, stress, and GPA

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Study Objectives: This study was conducted to determine (1) whether the distribution of undergraduates who endorse insomnia or behaviorally induced insufficient sleep syndrome (BISS) varied during the coronavirus disease 2019 (COVID-19) pandemic relative to normal sleepers and in comparison to values reported pre-pandemic and (2) whether group (insomnia, BISS, and normal sleepers) was differentially associated with health, stress, and academic achievement mid-pandemic.

Methods: Two hundred ninety-three undergraduates completed online questionnaires assessing demographics, global sleep quality, insomnia severity, health, and perceived stress; cumulative grade point averages (GPAs) were also collected for each participant.

Results: The proportion of participants in each group did not differ from the pre-pandemic values reported in Williams et al (2020). Relative to the normal-sleepers group, the insomnia group reported poorer sleep quality, greater insomnia severity, poorer functioning on measures of physical health, and increased stress; only 1 significant difference was found concerning the BISS group. Group differences were not found on GPA.

Conclusions: Despite the various challenges brought about by the COVID-19 pandemic, the distribution of participants by group was similar to those reported pre-pandemic. The insomnia group fared most poorly in terms of sleep quality, insomnia severity, physical health, and stress. As such, additional effort should be devoted to identifying undergraduates with insomnia to provide treatment that may improve their sleep and their health.

Keywords: sleep, insomnia, health, stress, COVID-19

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Previous research has evaluated the distribution and consequences of insomnia or behaviorally induced insufficient sleep syndrome (BISS) in undergraduates tested before the coronavirus disease 2019 (COVID-19) pandemic. The present study was conducted to evaluate whether the distribution of undergraduates with these conditions varied mid- relative to pre-pandemic and to identify associations with health, stress, and academic achievement.

Study Impact: Relative to normal sleepers, BISS was not associated with poorer health, increased stress, or lower academic achievement, whereas insomnia was related to poorer health and greater stress. Based on these findings, additional effort should be devoted to identifying undergraduates with insomnia to provide treatment that may improve their sleep and health.

INTRODUCTION

Undergraduate students frequently experience poor-quality sleep.^{1,2} Short nighttime sleep duration is particularly problematic, commonly resulting either from insomnia or behaviorally induced insufficient sleep syndrome (BISS). Insomnia is characterized by short nighttime sleep duration due to challenges initiating or maintaining sleep despite the desire to obtain an adequate night of rest. A recent meta-analysis indicated that approximately 19% of undergraduate students experience insomnia relative to approximately 7% of the general population.³ Nighttime sleep restriction results from BISS, a condition in which individuals actively postpone sleep to complete other activities (eg, spending time with friends, watching television), ultimately resulting in daytime sleepiness; prevalence

estimates range from 10% to 19% in adolescents and young adults.^{4,5} Insomnia and BISS have been associated with poorer mental health and cognitive functioning in adolescent and young-adult samples before the coronavirus disease 2019 (COVID-19) pandemic, including increased depression (BISS⁶; insomnia and BISS⁷), suicidality (BISS⁶), and lower academic achievement (BISS⁶; insomnia⁸). The goal of the present study was to evaluate the distribution of undergraduates with insomnia or BISS during and after the COVID-19 pandemic and to identify the implications of these classifications on student health, stress, and academic achievement mid-pandemic.

The COVID-19 pandemic significantly impacted the everyday lives of university students: course content was delivered online, individuals were required to comply with periodic stay-at-home orders, nonessential businesses closed for extended periods, and

individuals experienced heightened stress associated with health and financial concerns, among others (eg, Figure 1 of Lukowski et al⁹). These social ecological changes were accompanied by alterations in undergraduate student sleep. For example, when considering measures that contribute to global sleep quality, undergraduates tested mid-pandemic reported later bedtimes and wake times, more sleep disturbances, longer latency to sleep onset, and more time spent in bed relative to undergraduates tested pre-pandemic⁹; similar results have been found in other work.¹⁰ When considering sleep quality, some studies revealed no changes¹⁰ or even positive quarantine-related effects,¹¹ whereas other work conducted later in the pandemic has shown that undergraduates tested mid-pandemic reported poorer quality sleep and greater insomnia relative to pre-pandemic samples⁹ (for meta-analyses from the general population, see Yuan et al¹² and Mahmud et al¹³). A recent literature review indicates that many undergraduates around the world experienced sleep problems and disrupted sleep patterns during the pandemic, with variability apparent in measures of sleep duration, sleep quality, and rates of insomnia depending on various moderating factors.¹⁴ Poorer mental health was also evident mid- relative to pre-pandemic,¹⁵ with associations between poorer sleep quality and mental health found for female undergraduates tested mid-pandemic in particular.⁹ Research has not yet been conducted to determine whether the prevalence of BISS varies mid- relative to pre-pandemic, and whether insomnia and BISS are differentially associated with health, stress, and academic achievement in undergraduates tested mid-pandemic.

The present study was conducted to identify the prevalence of insomnia and BISS in undergraduates tested during the COVID-19 pandemic using the criteria outlined in Williams et al⁷ as well as to examine whether group (insomnia, BISS, and normal sleepers) was differentially associated with health, stress, and academic achievement. Based on previous research and given the increased stress experienced by undergraduates mid-pandemic,⁹ we anticipated that students tested during the COVID-19 pandemic would more commonly endorse insomnia relative to the pre-pandemic participants in Williams et al.⁷ The increased temporal flexibility encountered by undergraduates during the pandemic (eg, reduced need to attend class or work early in the morning) led to our prediction that a greater proportion of undergraduates tested mid-pandemic would endorse BISS relative to the participants tested pre-pandemic in Williams et al.⁷ Based on previous research citing more negative mental health among undergraduates with insomnia in particular,⁷ we anticipated that participants in the insomnia group would report poorer functioning (eg, poorer health, greater stress, and lower academic achievement) relative to the normal-sleepers group; we also expected that the BISS and normal-sleepers groups would also differ, based on work conducted with adolescents.^{4,6} In particular, we anticipated that participants with BISS would report shorter nighttime sleep durations and greater daytime sleepiness relative to normal sleepers.⁶ Taken together, these findings would provide another indication that undergraduates tested mid-pandemic experienced more problematic sleep relative to students tested pre-pandemic, and that the experience of sleep problems (insomnia, in particular) was negatively associated with their daily functioning.

METHODS

Participants

Three hundred eleven undergraduates (264 females) were recruited from the Human Subjects Lab Pool at a large public university in the southwestern United States to participate in a cross-sectional study examining undergraduate student sleep, health, and well-being during the COVID-19 pandemic. Participants were tested online from November to December 2020; additional information about the larger study from which these participants were drawn can be found in Lukowski et al.⁹ After excluding participants for various reasons (eg, failure to correctly answer the included “attention check” questions), the final sample included 293 undergraduates (251 females). Participants received 1 extra-credit point in appreciation for their involvement.

We compared the data from our sample with findings reported in Williams et al.⁷ This report featured a secondary data analysis project conducted with 989 third-year undergraduate students who participated in a large longitudinal study on genetics, health, and substance use called Spit for Science¹⁶; additional information on this study is available here. The data analyzed in Williams et al⁷ were collected in Spring 2014; to be eligible for inclusion in that analysis, participants also had to have completed measures in 2011, when they were freshmen.

Measures

Participants provided demographic information (**Table 1**) and completed multiple questionnaires including the 19-item Pittsburgh Sleep Quality Index (PSQI¹⁷; $\alpha = .68$), the 7-item Insomnia Severity Index (ISI¹⁸; $\alpha = .85$), the 10-item Perceived Stress Scale (PSS¹⁹; $\alpha = .88$), and the RAND-36²⁰ measure of physical, mental, and general health, including the impact of emotional and physical health problems on daily functioning (referred to as “role limitations;” α values ranged from .73 to .89). Cumulative grade point average (GPA) was collected from the university registrar for each participant at the end of Fall 2020.

Procedure

This study was approved by the UC Irvine Institutional Review Board (HS #20184872: Sleep and Well-Being). Undergraduates read the advertisement for this study on the Human Subjects Lab Pool website and clicked a link to proceed. Students then read a study information sheet (ie, a waiver of written informed consent) and clicked to indicate whether they agreed to participate; participants also completed a Family Educational Rights and Privacy Act (FERPA) consent document allowing for the release of their GPA from the university registrar. Only students who agreed to participate in the study and consented to the release of their GPA data proceeded to the online questionnaire.

Group classification

Because our data-collection procedures did not include individual questions previously used to classify participants into insomnia, BISS, and normal-sleepers groups,^{4-6,21} the PSQI data were used for this purpose as described in Williams et al.⁷ Participants in the insomnia group reported short nighttime sleep duration (≤ 6.5 hours) along with (1) poor quality sleep

Table 1—Demographic information by group classification for participants in the mid-pandemic sample.

	Overall (n = 293)	Insomnia (n = 75)	BISS (n = 12)	Normal Sleepers (n = 206)
Age, mean ± SE, y	21.03 ± 0.37	21.60 ± 0.40	20.58 ± 0.99	20.90 ± 0.24
Sex, % female	86%	88%	92%	84%
Athletic participation, % yes	12%	16%	17%	11%
Academic standing				
Freshman	7%	4%	0%	9%
Sophomore	19%	24%	25%	17%
Junior	36%	32%	42%	37%
Senior	38%	40%	33%	37%
Race*				
Asian	35%	27%	17%	39%
Hispanic	30%	48%	17%	24%
White	18%	11%	25%	21%
Other	16%	15%	42%	16%
Sleep medication, % yes	6%	7%	8%	5%
Sleep problems, % yes	3%	5%	0%	2%
Psychoactive medication, % yes	6%	7%	8%	3%
Therapy, % yes	10%	15%	17%	8%
Living arrangements, % alone	7%	7%	8%	6%
Sleeping arrangements, % alone in own room	74%	75%	75%	74%

*Significant group differences ($P < .05$). BISS = behaviorally induced insufficient sleep syndrome, SE = standard error.

(fairly bad or very bad) or (2) long sleep latency (≥ 30 minutes). Participants in the BISS group reported (1) short nighttime sleep duration (≤ 6.5 hours) and (2) daytime sleepiness (being sleepy during the day less than once per week or more; scoring criteria clarified by A. Williams, personal communication, August 6, 2021) along with good quality sleep (fairly good or very good) and short sleep latency (< 30 minutes). All other participants were classified as normal sleepers.

Data reduction

Data-reduction procedures for the individual questionnaires were described previously: PSQI,¹⁷ ISI,¹⁸ PSS,¹⁹ and RAND-36.²⁰ As was done in Williams et al,⁷ we reduced data from the PSQI including continuous measures of sleep duration and sleep latency, the sleep quality subscore, and data from 1 question pertaining to daytime sleepiness. We also computed a continuous measure of global sleep quality from the PSQI and categorized those data as described previously¹⁷ into good or poor sleep quality groups. Unless otherwise specified, the findings described next only include data from the insomnia, BISS, and normal-sleepers groups collected in this study, not from those included in Williams et al.⁷

RESULTS

Because unequal sample sizes may be problematic due to potential issues with heterogeneity of variance,²² we initially

examined whether the continuous outcome variables had any outlying values, identified as those that were 2.5 standard deviations above or below the mean. Outlying values were truncated to the highest or lowest acceptable value in the dataset, respectively, as has been done in previous work with this sample.⁹

Examination of potential covariates

Chi-square analyses and analyses of variance (ANOVAs) were initially conducted to evaluate whether demographic differences were apparent by group (insomnia, BISS, or normal sleepers). As shown, group differences were not found on the majority of demographic characteristics. However, a chi-square analysis revealed that group differences were apparent by race: Fisher's exact test (FET) = 21.20, $P < .001$. Based on this significant result, we then examined whether race was associated with any of the outcome measures. An ANOVA revealed that race was significantly associated with global sleep quality: $F(3, 289) = 3.13$, $P = .026$. Follow-up pairwise comparisons indicated that Asian ($6.13 \pm .32$) and White ($6.37 \pm .44$) participants reported better sleep quality than Hispanic participants ($7.50 \pm .35$; $P \leq .045$); sleep quality did not differ between Asian and White participants. Race-related differences were also found on cumulative GPA: $F(3, 285) = 9.71$, $P < .001$, such that Hispanic participants ($3.34 \pm .043$) had lower cumulative GPAs relative to the other 3 groups (Asian: $3.58 \pm .04$; Other: $3.50 \pm .06$; White: $3.68 \pm .06$; $P \leq .026$); participants of other races also reported lower GPAs relative to White participants ($P = .023$) (Table 1).

Because race differed by group and because this demographic characteristic was associated with at least 1 outcome variable, race was dummy-coded using 3 categorical variables with White participants as the reference group. These 3 variables were included as categorical covariates in the following analyses. In the subsequent sections, significant results are reported when $P < .05$.

Primary analyses

After relevant covariates were identified, a chi-square analysis was conducted to determine whether the distribution of participants varied by group in comparison to those reported in Williams et al.⁷ Nighttime sleep duration is shown by and across groups for the mid-pandemic sample in **Figure 1**; comparable data for the pre-pandemic comparison group can be found in Figure 1 of Williams et al.⁷ Between-subject analyses of covariance (ANCOVAs) and chi-square analyses were then conducted to determine whether group was associated with select measures from the PSQI (those featured in Williams et al.⁷) and insomnia severity. Additional ANCOVAs were conducted to determine whether group was related to measures of health from the RAND-36, perceived stress, and academic achievement. Finally, partial correlations were conducted to identify associations among the 4 PSQI measures used to determine group classification and measures of daily functioning.

Participant distribution by group across studies

A 3 (group: insomnia, BISS, or normal sleepers) \times 2 (study: pre-pandemic data featured in Williams et al.⁷ or mid-pandemic data featured in this report) chi-square analysis was conducted to evaluate whether the distribution of participants varied by

group across studies. This analysis was not statistically significant (**Table 2**).

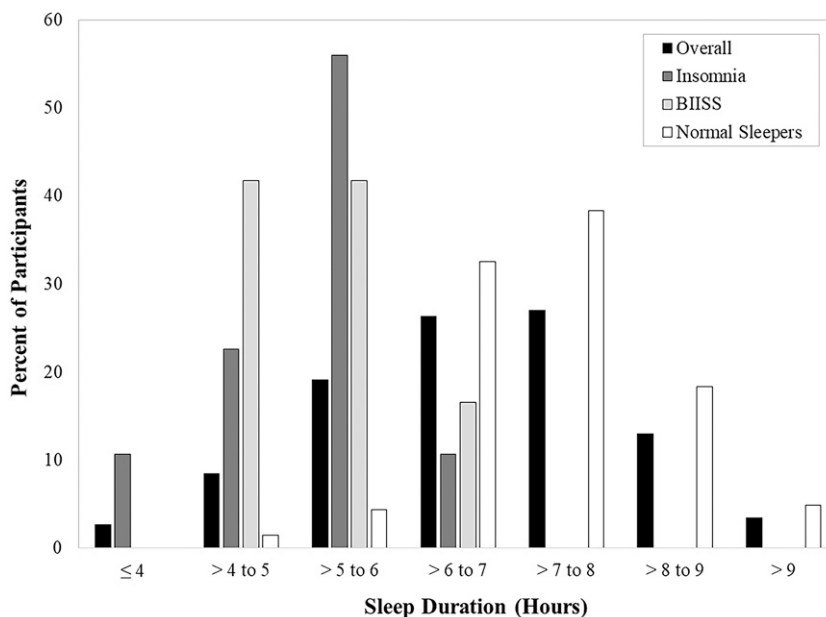
Sleep quality and insomnia severity by group

Sleep quality

To further characterize associations between group and sleep quality, a 3 (group) \times 2 (categorical sleep quality: good or poor) chi-square analysis was conducted to evaluate whether the distribution of participants varied by group across sleep quality categories from the PSQI. A significant effect was found: $\chi^2(2, n = 293) = 64.21, P < .001$. Additional chi-square analyses were conducted by separate 2-group pairings to more conclusively identify specific group differences. Significant effects were found when comparing the insomnia and BISS groups [$\chi^2(1, n = 87) = 9.71, P = .002$] and the insomnia and normal-sleepers groups [$\chi^2(1, n = 281) = 63.50, P < .001$], such that a greater proportion of participants in the insomnia group had poor-quality sleep relative to participants in the BISS and normal-sleepers groups, which did not differ. A main effect of group was also found on the continuous PSQI composite score: $F(2, 287) = 84.33, P < .001$; the pattern of group differences revealed through follow-up pairwise comparisons was identical to that reported for the categorical data (**Table 3**).

Additional analyses evaluated group differences on the 4 variables used to classify participants, as described in Williams et al.⁷ Main effects of group were found on each variable [nighttime sleep duration: $F(2, 287) = 161.38, P < .001$; sleep latency: $F(2, 287) = 16.59, P < .001$; sleep quality: $F(2, 287) = 49.78, P < .001$; daytime sleepiness: $F(2, 287) = 14.77, P < .001$]. The insomnia and BISS groups did not differ from one another on sleep duration, although they both slept less at night relative to

Figure 1—Distribution of hours slept for participants in the mid-pandemic sample by and across groups.



BISS = behaviorally induced insufficient sleep syndrome. Data for the pre-pandemic reference sample can be found in Figure 1 of Williams et al.⁷

Table 2—Distribution of participants by group across samples (pre- and mid-pandemic).

	Insomnia	BISS	Normal Sleepers
Current study (mid-pandemic)	26%	4%	70%
Williams et al (2020; pre-pandemic)	22%	10%	68%

The percentage of participants in each group was determined based on information provided in Williams et al.⁷ Chi-square analyses were conducted with weighted frequencies to identify statistically significant differences across studies and groups as described in the text. BISS = behaviorally induced insufficient sleep syndrome.

normal sleepers. Participants in the insomnia group reported longer sleep latency relative to those with BISS and those in the normal-sleepers group; participants in the normal-sleepers group also reported longer sleep latency relative to those with BISS. The insomnia group also had poorer sleep quality relative to the BISS and normal-sleepers groups, whose scores did not differ. Finally, the BISS group reported greater daytime sleepiness relative to the insomnia and normal-sleepers groups, whose scores did not differ.

Insomnia severity

A main effect of group was found on the ISI composite [$F(2, 283) = 33.36, P < .001$], such that the insomnia group reported greater insomnia severity relative to the BISS and normal-sleepers groups, whose scores did not differ.

Associations among group and functional outcomes

Health

Significant main effects of group were found on 5 of the subscales from the RAND-36 [pain: $F(2, 287) = 9.73, P < .001$; role limitations due to physical functioning: $F(2, 287) = 5.66,$

$P = .038$; social functioning: $F(2, 287) = 3.51$; energy or fatigue: $F(2, 287) = 3.89, P = .022; P = .031$ general health: $F(2, 287) = 8.27, P < .001$]. For each of these analyses, follow-up pairwise comparisons indicated that the insomnia group had poorer functioning relative to the normal-sleepers group. Only 1 significant difference was found concerning the BISS group, such that these participants reported poorer functioning on role limitations due to physical health relative to the normal-sleepers group; the scores of the BISS and insomnia groups did not differ (Table 4).

Perceived stress

A significant main effect of group was found on the PSS composite [$F(2, 287) = 6.10, P = .003$], such that the insomnia group reported greater stress relative to the normal-sleepers group; the other groups did not differ.

Academic achievement

Significant group differences were not found on GPA.

Partial correlations between sleep and functional outcomes

Partial correlations between the 4 sleep measures used to classify participants and daily functioning revealed no significant associations with academic achievement but widespread associations with measures of health and stress. After excluding the nonsignificant correlations with cumulative GPA, sleep latency and sleep quality were associated with 100% of the measured functional outcomes; sleep duration and daytime sleepiness were associated with 78%. All of the significant correlations were in the expected direction (ie, shorter sleep duration, longer sleep latency, poorer sleep quality, and greater daytime sleepiness were associated with poorer functioning) (Table 5).

DISCUSSION

Pre-pandemic research conducted with undergraduate students has documented the distribution of participants with insomnia,

Table 3—Sleep measures by group for the mid-pandemic sample.

	Overall (n = 293)	Insomnia (n = 75)	BISS (n = 12)	Normal Sleepers (n = 206)
PSQI data				
Sleep duration*	6.29 ± .10	5.51 ± .11 ^a	5.61 ± .28 ^b	7.76 ± .07 ^{ab}
Sleep latency*	28.72 ± 2.94	47.47 ± 3.24 ^{ab}	10.44 ± 8.01 ^{bc}	28.23 ± 1.93 ^{ac}
Sleep quality*	1.30 ± .06	1.89 ± .07 ^{ab}	.91 ± .17 ^b	1.08 ± .04 ^a
Daytime sleepiness*	.64 ± .05	.56 ± .06 ^{ab}	1.01 ± .14 ^{ac}	.34 ± .03 ^{bc}
Additional composite measures				
Sleep quality (% good)*	44%	5% ^{ab}	33% ^a	59% ^b
PSQI composite*	7.18 ± .28	10.17 ± .31 ^{ab}	5.86 ± .76 ^a	5.52 ± .18 ^b
ISI composite*	10.12 ± .53	13.25 ± .59 ^{ab}	9.54 ± 1.44 ^a	7.59 ± .35 ^b

Means and standard errors are presented. Analyses were conducted controlling for race (3 dummy variables with White participants as the reference group). *Significant group differences ($P < .05$). Values with the same superscript alphanumeric character differ significantly from one another. BISS = behaviorally induced insufficient sleep syndrome, ISI = Insomnia Severity Index, PSQI = Pittsburgh Sleep Quality Index.

Table 4—Group differences in functional outcomes for the mid-pandemic sample.

	Overall (n = 293)	Insomnia (n = 75)	BISS (n = 12)	Normal Sleepers (n = 206)
RAND-36				
Physical functioning	90.66 ± 1.37	89.11 ± 1.50	90.26 ± 3.72	92.61 ± .90
Pain*	80.57 ± 1.62	75.61 ± 1.79 ^a	81.23 ± 4.43	84.86 ± 1.06 ^a
Role limitations due to physical health*	59.70 ± 3.90	58.30 ± 4.30 ^a	48.39 ± 10.65 ^b	72.40 ± 2.56 ^{ab}
Role limitation due to emotional health	34.62 ± 4.50	31.32 ± 4.96	32.77 ± 12.27	39.76 ± 2.95
Emotional well-being	56.00 ± 2.10	52.06 ± 2.32	57.95 ± 5.73	57.98 ± 1.38
Social functioning*	66.21 ± 2.74	61.54 ± 3.02 ^a	66.20 ± 7.48	70.89 ± 1.80 ^a
Energy or fatigue*	36.65 ± 1.95	35.14 ± 2.15 ^a	33.31 ± 5.33	41.50 ± 1.28 ^a
General health*	60.41 ± 2.30	54.32 ± 2.53 ^a	60.56 ± 6.27	66.35 ± 1.51 ^a
Additional outcomes				
PSS composite*	22.10 ± .72	23.06 ± .79 ^a	23.24 ± 1.97	20.01 ± .47 ^a
Cumulative GPA	3.50 ± .04	3.44 ± .05	3.51 ± .12	3.54 ± .03

Means and standard errors are presented. Analyses were conducted controlling for race (three dummy variables with White participants as the reference group). *Significant group differences ($P < .05$). Values with the same superscript alpha-numeric character differ significantly from one another. BISS = behaviorally induced insufficient sleep syndrome, GPA = grade point average, PSS = Perceived Stress Scale.

BISS, and normal sleep pre-pandemic and revealed that an insomnia classification was associated with the greatest risk of depression.⁷ The present study was conducted to address similar questions in undergraduate students tested during the COVID-19 pandemic. In particular, we (1) evaluated the distribution of participants with insomnia and BISS during the COVID-19 pandemic relative to pre-pandemic samples and (2) identified whether these classifications were differentially associated with health, stress, and academic achievement mid-pandemic.

Participant distribution and sleep characteristics: insomnia and BISS

Our first prediction was that the environmental changes resulting from the pandemic would yield a different distribution of participants by group relative to what was reported pre-pandemic. In particular, we expected that a greater percentage of participants tested mid-pandemic would be in the BISS group given the increased flexibility undergraduates experienced during the pandemic. This hypothesis, however, was unsupported, as there were no differences in the percentage of

Table 5—Correlations between sleep and functional outcomes for the mid-pandemic sample.

	Sleep Duration	Sleep Latency	Sleep Quality	Daytime Sleepiness
RAND-36				
Physical functioning	.13*	-.17*	-.21*	-.11
Pain	.19*	-.14*	-.25*	-.23*
Role limitations due to physical health	.14*	-.15*	-.23*	-.13*
Role limitation due to emotional health	.09	-.21*	-.25*	-.16*
Emotional well-being	.11	-.27*	-.40*	-.16*
Social functioning	.13*	-.22*	-.23*	-.23*
Energy or fatigue	.14*	-.18*	-.33*	-.14*
General health	.18*	-.22*	-.32*	-.10
Additional outcomes				
PSS composite	-.20*	.21*	.39*	.15*
Cumulative GPA	.10	-.02	-.12	.02

Analyses were conducted controlling for race (3 dummy variables with White participants as the reference group). *Significant group difference ($P < .05$). GPA = grade point average, PSS = Perceived Stress Scale.

participants who were classified into the BISS, insomnia, and normal-sleepers groups relative to what was reported pre-pandemic by Williams et al.⁷

In addition, our findings revealed the same pattern of group differences reported by Williams et al.⁷ when considering the 4 different PSQI measures used to classify participants. That is, the insomnia and BISS groups were similar on nighttime sleep duration, a variable that was not used to determine group classification. The insomnia group reported longer sleep latency and poorer sleep quality relative to the BISS group, differences that were expected as longer sleep latency or poorer sleep quality were used to classify participants into the insomnia group. The BISS group reported greater daytime sleepiness relative to the insomnia group, another expected difference as greater daytime sleepiness was necessary for classification into the BISS group. Taken together, these findings indicate that, despite changes in the landscape of undergraduate student sleep during the COVID-19 pandemic, the distribution of students by group and the characteristics used to classify them did differ significantly from students tested pre-pandemic.

Group classification and daily functioning

Our second prediction was that participants in the insomnia group would experience poorer health, greater stress, and lower academic achievement relative to students in the normal-sleepers group; we also expected that the BISS group would report poorer daily functioning relative to normal sleepers. These expectations conceptually parallel what was reported for depression in Williams et al.,⁷ who indicated that the insomnia group reported increased depression relative to normal sleepers and relative to the BISS group; the BISS group also reported greater depression relative to normal sleepers. Our findings indicated that the insomnia group scored more poorly on multiple aspects of health relative to the normal-sleepers group, including pain, role limitations due to physical functioning, social functioning, energy or fatigue, and general health; they also reported greater stress relative to the normal-sleepers group. Only 1 significant group difference was found concerning the BISS group, such that these participants scored more poorly than normal sleepers on role limitations due to physical functioning; their scores did not differ from those of the insomnia group. This finding indicates that the physical health of participants with both insomnia and BISS was limited when considering what they could accomplish on their work or other daily tasks, an effect that should be further investigated and replicated in future work.

Partial correlations provide additional insight as to the particular aspects of insomnia and BISS that may be related to daily functioning. A greater number of correlations were found between (1) sleep latency and functional outcomes ($n = 9$ significant correlations) and (2) sleep quality and functional outcomes ($n = 9$ significant correlations) relative to nighttime sleep duration ($n = 6$ significant correlations with functional outcomes) and daytime sleepiness ($n = 6$ significant correlations with functional outcomes). These findings suggest that sleep latency and quality in particular may be related to health-related outcomes and perceived stress. Importantly, longer sleep

latency and poorer sleep quality were uniquely used to classify participants into the insomnia group, suggesting that these features of insomnia may be preferentially associated with poorer functioning in undergraduate students. These findings corroborate those reported previously⁷ and provide an indication that these particular aspects of sleep should be targeted in future intervention efforts (eg, Schlarb et al.²³).

Implications and future directions

Identifying associations among insomnia and BISS in undergraduates is particularly important as undergraduates commonly experience both sleep problems and mental health issues. As has been previously demonstrated,²⁴ sleep problems can be both cause and consequence of poorer mental health, yet undergraduates are not routinely screened for sleep problems at university health centers.⁷ Previous research with this sample⁹ indicated that continuous measures of global sleep quality and insomnia severity were associated with poorer mental health during the COVID-19 pandemic in undergraduate females.⁹ Group classification was unrelated to measures of mental health from the RAND-36 in these analyses, perhaps due to the use of categorical groupings instead of continuous measures or because sex could not be analyzed as a factor due to the small sample in the BISS group. Future research should evaluate whether sex differences in the distribution of participants vary by group in undergraduates, as has been reported previously in other samples (with greater prevalence in females relative to males^{21,25,26}; but see Roehrs et al.²⁷ for data reflecting no sex difference), taking care to ensure similar measures and procedures are used to classify participants across studies (for a discussion, see Williams et al.⁷). Future studies should also be conducted to determine the prevalence and consequences of insomnia and BISS longitudinally, taking care to include both objective measures of sleep (eg, actigraphy) in combination with self-report questionnaires. Additional work in this area should also evaluate whether the individual questions used to group participants in previous research, including those that differentiate between weeknight and weekend sleep,^{4-6,21} yield comparable estimates to classifications obtained when using the PSQI.

Future research should also account for some of the limitations of the present study. First, the number of participants in the BISS group was quite small, a sampling issue that could be eliminated in future research by screening a large number of participants before randomly selecting evenly balanced samples that meet the criteria for the insomnia, BISS, and normal-sleepers groups.⁶ Second, the participants in this sample were predominantly female; this sample also included a greater percentage of Asian-American and Hispanic students relative to the broader landscape of American colleges and universities.²⁸ The demographic composition of this sample mirrors that of our university population more broadly and is due to the fact that our university has received federal designations as an Asian-American and Native American Pacific Islander-Serving Institution (AANAPISI) and a Hispanic Serving Institution (HSI); as such, at least 30% of undergraduate students identify as Asian and at least 25% identify as Hispanic. Consumers of

this work should be mindful of the demographic characteristics of this sample as they evaluate the generalizability of these findings to other undergraduate populations. Third, future work should include other measures to address potential associates of the phenomena reported herein, including mental health issues (eg, anxiety, depression) and particular sleep conditions (eg, sleep onset vs sleep maintenance insomnia²⁹).

In particular, future researchers should examine delayed sleep phase syndrome (DSPS), a circadian rhythm disorder characterized by a mismatch between one's circadian and social clock. DSPS results in delayed nighttime sleep onset and is clinically important as affected individuals may also report insomnia, daytime sleepiness, mental health issues,³⁰ and reduced academic achievement.³¹ Pre-pandemic, about twice as many undergraduates endorsed DSPS relative to the general population³² (~10% of 1 sample³² and 17% of another³³). During the COVID-19 pandemic, quarantining changed daily routines, impacted individual activity levels, and reduced exposure to light,^{34–36} ultimately resulting in circadian misalignment³⁶; these alterations in social zeitgebers were also associated with increased symptoms of DSPS.³⁷ Future research is needed to better understand how the return to pre-pandemic conditions may have impacted rates of DSPS as well as interrelationships among sleep, health, and academic achievement, as it is clear that these associations are complex and multidetermined.

In conclusion, although additional work is certainly needed, the present study suggests that specific environmental perturbations that negatively impact other aspects of undergraduate student sleep (ie, the COVID-19 pandemic) did not measurably affect the prevalence of insomnia and BISS. In addition, BISS was not associated with poorer health, increased stress, or lower academic achievement in this sample relative to normal sleepers; insomnia, on the other hand, was related to poorer health and greater stress relative to normal sleepers. Based on these findings, additional effort should be devoted to identifying undergraduates with insomnia to provide treatment (eg, cognitive behavioral therapy^{38,39}) that may improve not only their sleep, but also their health.

ABBREVIATIONS

BISS, behaviorally induced insufficient sleep syndrome
 COVID-19, coronavirus disease 2019
 DSPS, delayed sleep phase syndrome
 GPA, grade point average
 PSQI, Pittsburgh Sleep Quality Index
 PSS, Perceived Stress Scale

REFERENCES

- Oswalt SB, Wyatt TJ. Who needs more sleep? Comparing undergraduate and graduate students' sleep habits in a national U.S. sample. *Int J High Educ*. 2015; 4(1):77–85.
- Yang CM, Wu CH, Hsieh MH, Liu MH, Lu FH. Coping with sleep disturbances among young adults: a survey of first-year college students in Taiwan. *Behav Med*. 2003;29(3):133–138.
- Jiang X-L, Zheng X-Y, Yang J, et al. A systematic review of studies on the prevalence of insomnia in university students. *Public Health*. 2015;129(12):1579–1584.
- Lee YJ, Cho SJ, Cho IH, Kim SJ. Insufficient sleep and suicidality in adolescents. *Sleep*. 2012;35(4):455–460.
- Pallesen S, Saxvig IW, Molde H, et al. Brief report: behaviorally induced insufficient sleep syndrome in older adolescents: prevalence and correlates. *J Adolesc*. 2011;34(2):391–395.
- Lee YJ, Park J, Kim S, Cho SJ, Kim SJ. Academic performance among adolescents with behaviorally induced insufficient sleep syndrome. *J Clin Sleep Med*. 2015;11(1):61–68.
- Williams AB, Dzierzewski JM, Griffin SC, Lind MJ, Dick D, Rybarczyk BD. Insomnia disorder and behaviorally induced insufficient sleep syndrome: prevalence and relationship to depression in college students. *Behav Sleep Med*. 2020;18(2):275–286.
- Gaultney JF. The prevalence of sleep disorders in college students: impact on academic performance. *J Am Coll Health*. 2010;59(2):91–97.
- Lukowski AF, Karayianis KA, Kamliot DZ, Tsukerman D. Undergraduate student stress, sleep, and health before and during the COVID-19 pandemic. *Behav Med*. 2022:1–15.
- Benham G. Stress and sleep in college students prior to and during the COVID-19 pandemic. *Stress Health*. 2021;37(3):504–515.
- Gao C, Scullin MK. Sleep health early in the coronavirus disease 2019 (COVID-19) outbreak in the United States: integrating longitudinal, cross-sectional, and retrospective recall data. *Sleep Med*. 2020;73:1–10.
- Yuan K, Zheng YB, Wang YJ, et al. A systematic review and meta-analysis on prevalence of and risk factors associated with depression, anxiety and insomnia in infectious diseases, including COVID-19: a call to action. *Mol Psychiatry*. 2022; 27(8):3214–3222.
- Mahmud S, Mohsin M, Dewan MN, Muyeed A. The global prevalence of depression, anxiety, stress, and insomnia among general population during COVID-19 pandemic: a systematic review and meta-analysis. *Trends in Psychol*. 2023;31(1):143–170.
- Valenzuela RLG, Velasco RIB, Jorge MPPC 2nd. Impact of COVID-19 pandemic on sleep of undergraduate students: a systematic literature review. *Stress Health*. 2023;39(1):4–34.
- Maia BR, Dias PC. Ansiedade, depressão e estresse em estudantes universitários: O impacto da COVID-19. *Estud Psicol Campinas*. 2020;37: e200067.
- Dick DM, Nasim A, Edwards AC, et al. Spit for Science: launching a longitudinal study of genetic and environmental influences on substance use and emotional health at a large US university. *Front Genet*. 2014;5(47):47.
- Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193–213.
- Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med*. 2001;2(4):297–307.
- Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983;24(4):385–396.
- Ware JE Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992;30(6):473–483.
- Komada Y, Inoue Y, Hayashida K, Nakajima T, Honda M, Takahashi K. Clinical significance and correlates of behaviorally induced insufficient sleep syndrome. *Sleep Med*. 2008;9(8):851–856.
- Ruscio J, Roche B. Variance heterogeneity in published psychological research: a review and a new index. *Methodology*. 2012;8(1):1–11.
- Schlarb AA, Friedrich A, Claßen M. Sleep problems in university students—an intervention. *Neuropsychiatr Dis Treat*. 2017;13:1989–2001.
- Lustberg L, Reynolds CF. Depression and insomnia: questions of cause and effect. *Sleep Med Rev*. 2000;4(3):253–262.
- Hublin C, Kaprio J, Partinen M, Koskenvuo M. Insufficient sleep—a population-based study in adults. *Sleep*. 2001;24(4):392–400.
- Eaton DK, McKnight-Eily LR, Lowry R, Perry GS, Presley-Cantrell L, Croft JB. Prevalence of insufficient, borderline, and optimal hours of sleep among high school students—United States, 2007. *J Adolesc Health*. 2010;46(4):399–401.
- Roehrs T, Zorick F, Sicklesteal J, Wittig R, Roth T. Excessive daytime sleepiness associated with insufficient sleep. *Sleep*. 1983;6(4):319–325.

28. Institute of Education Sciences National Center for Education Statistics. Status and trends in the education of racial and ethnic groups. February 2019. https://nces.ed.gov/programs/raceindicators/indicator_REB.asp. Accessed July 28, 2023.
29. Gardani M, Bradford DRR, Russell K, et al. A systematic review and meta-analysis of poor sleep, insomnia symptoms and stress in undergraduate students. *Sleep Med Rev*. 2022;61:101565.
30. Reid KJ, Zee PC. Circadian rhythm disorders. *Semin Neurol*. 2009;29(4):393–405.
31. Sivertsen B, Glozier N, Harvey AG, Hysing M. Academic performance in adolescents with delayed sleep phase. *Sleep Med*. 2015;16(9):1084–1090.
32. Brown FC, Soper B, Buboltz WC. Prevalence of delayed sleep phase syndrome in university students. *Coll Stud J*. 2001;35(3):472–477.
33. Lack LC. Delayed sleep and sleep loss in university students. *J Am Coll Health*. 1986;35(3):105–110.
34. Bryson WJ. Circadian rhythm sleep-wake disorders and the COVID-19 pandemic. *J Clin Sleep Med*. 2020;16(8):1423.
35. Morin CM, Carrier J, Bastien C, Godbout R; Canadian Sleep and Circadian Network. Sleep and circadian rhythm in response to the COVID-19 pandemic. *Can J Public Health*. 2020;111(5):654–657.
36. Salehinejad MA, Azarkolah A, Ghanavati E, Nitsche MA. Circadian disturbances, sleep difficulties and the COVID-19 pandemic. *Sleep Med*. 2022;91:246–252.
37. Otsuki R, Matsui K, Yoshiike T, et al. Decrease in social zeitgebers is associated with worsened delayed sleep-wake phase disorder: findings during the pandemic in Japan. *Front Psychiatry*. 2022;13:898600.
38. Smith MT, Neubauer DN. Cognitive behavior therapy for chronic insomnia. *Clin Cornerstone*. 2003;5(3):28–40.
39. Williams J, Roth A, Vattauer K, McCrae CS. Cognitive behavioral treatment of insomnia. *Chest*. 2013;143(2):554–565.

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DISCLOSURE STATEMENT

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