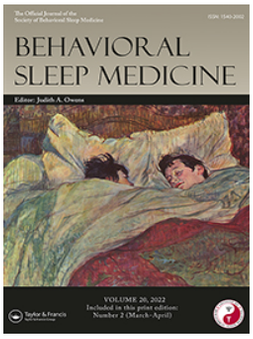

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Behavioral Sleep Medicine

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/hbsm20

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To cite this article: Scott Graupensperger, Brittney A. Hultgren, Anne M. Fairlie, Christine M. Lee & Mary E. Larimer (2022): Using Alcohol and Cannabis as Sleep Aids: Associations with Descriptive Norms Among College Students, Behavioral Sleep Medicine, DOI: 10.1080/15402002.2022.2040505

To link to this article: https://doi.org/10.1080/15402002.2022.2040505

Published online: 12 Feb 2022.

BEHAVIORAL SLEEP MEDICINE
https://doi.org/10.1080/15402002.2022.2040505

Using Alcohol and Cannabis as Sleep Aids: Associations with Descriptive Norms Among College Students

Scott Graupensperger, Brittney A. Hultgren, Anne M. Fairlie, Christine M. Lee, and Mary E. Larimer

Department of Psychiatry and Behavioral Sciences, University of Washington, Seattle, Washington, USA

ABSTRACT

Purpose: Young adults may use alcohol and cannabis as sleep aids, a risky behavior that can worsen sleep health over time and lead to substance dependence. Perceived norms for such risky behaviors are often overestimated and related to one's own use. This cross-sectional study examined: (a) the extent to which college students overestimated the prevalence of alcohol and cannabis use as sleep aids (i.e., perceived descriptive norms), and (b) the extent to which perceived descriptive norms were associated with students' own use of alcohol and cannabis as sleep aids.

Methods: 2,642 undergraduate college students (M_{age} = 18.84 years) reported past 30-day use of alcohol and cannabis as sleep aids. Participants also estimated the percent of college students who use alcohol and cannabis as sleep aids (i.e., perceived descriptive norms).

Results: One-sample *t*-tests revealed participants, on average, overestimated the norms for using alcohol and cannabis as sleep aids. Participants who endorsed past 30-day use of these substances as sleep aids overestimated these norms to an even greater extent. Count regression models showed perceived descriptive norms were associated with students' use of alcohol and of cannabis as sleeps aids, in respective models, even when controlling for sleep difficulties.

Conclusions: College students may overestimate the prevalence of using alcohol and cannabis as sleep aids, and students who believe these behaviors are more normative report more frequent use of these substances as sleep aids. Taken together, findings may highlight the potential for norm-correcting strategies as a prudent approach to reducing/preventing the use of alcohol and cannabis as sleep aids.

Sleep health is critical to physical and mental health (Luyster et al., 2012; Ramar et al., 2021), but U.S. national data show over 20% of young adults struggle with falling and staying asleep (Grandner et al., 2012), and approximately 62% of college students meet the criteria for "poor sleep" (Becker et al., 2018). Moreover, young adults face more negative impacts of poor sleep (e.g., more attentional failure), relative to older adults (Zitting et al., 2018). Specifically in college students, sleep issues have been associated with poorer health, academic struggles, and increased risky behavior (Becker et al., 2018; May et al., 2020; Owens et al., 2017). Sleep struggles among this age group are concerning given sleep's critical role in brain development (Bruce et al., 2017; Galván, 2020), which is a process that continues into young adulthood (Casey et al., 2019; Lebel & Deoni, 2018). In an attempt to improve sleep, college students may turn to substances such as alcohol and cannabis (Goodhines, Gellis et al., 2019; Goodhines, Gellis, Kim, et al., 2019; Lee et al., 2009; Patrick et al., 2018); however, these substances have adverse short- and long-term effects on sleep and may lead to issues with substance use.

CONTACT Scott Graupensperger graups@uw.edu University of Washington. Center for the Study of Health and Risk Behaviors Department of Psychiatry & Behavioral Sciences | UW Medicine Box 357238, Seattle, WA 98105,

Alcohol can provide an initial sedating effect, but also has been shown to cause disruptions in sleep stage transitions and sleep-related respiratory issues resulting in sleep fragmentation and early awakening in both healthy adults and adolescents as well as individuals with an alcohol use disorder (Angarita et al., 2016; Ebrahim et al., 2013; Kolla et al., 2018; Kwon et al., 2019). Specifically, epidemiological studies have shown that in adolescents and young adults, alcohol use is associated with reduced sleep duration (Kwon et al., 2021; Patte et al., 2018). Laboratory studies have shown associations between alcohol use and reduced rapid eye movement (REM) sleep, waking after sleep onset in the latter part of sleep (Ebrahim et al., 2013), and increased scores on the apnea-hypopnea index (Kolla et al., 2018). Daily-diary research has found that young adults report poorer sleep health on nights following consumption of relatively greater amounts of alcohol (Graupensperger, Fairlie et al., 2021); however, among young adults with insomnia, slightly improved sleep quality was reported on heavier drinking days (Miller et al., 2021). Many college students also believe that cannabis use can promote better sleep (Goodhines, Gellis et al., 2019; Lee et al., 2009), and sleep is a commonly reported motive for using cannabis (Patrick et al., 2018). Acute cannabis use can promote drowsiness and increase slow-wave sleep, but also decreases REM sleep that is critical to learning, memory, and mood (Babson et al., 2017; Garcia & Salloum, 2015; Li et al., 2017). A daily study indicated on days when cannabis use was used as a sleep aid next-day fatigue was higher even though sleep duration for that night was longer (Goodhines, Gellis et al., 2019). Chronic cannabis use is also associated with poorer subjective sleep quality and increased symptoms of insomnia (Conroy et al., 2016; Winiger et al., 2021). Specific to young adults, those who use cannabis more frequently report more symptoms of insomnia, on average (Graupensperger, Fairlie et al., 2021). Experimental studies have reported that withdrawal from chronic cannabis use can increase sleep onset latency and decrease slow wave sleep, total sleep, and sleep efficiency, highlighting adverse consequences of chronic cannabis use on sleep health (Bolla et al., 2008).

Notably, use of alcohol or cannabis can facilitate tolerance, requiring escalating amounts of use (Bedi et al., 2010; Roehrs & Roth, 2018). For example, Roehrs and Roth (2018) reported that after six days of consecutive alcohol use the sedative effect of alcohol is markedly reduced and tolerance was associated with using more alcohol prior to sleep as a sleep aid. This is an example of the feed-forward effect that substances like alcohol and cannabis are thought to have with sleep issues (Babson et al., 2017; Brower, 2003; Koob & Colrain, 2020). The feed-forward effect is also indicated with cannabis use as studies have shown associations between poor sleep indices and the likelihood and severity of cannabis relapse (Babson et al., 2013; Haney et al., 2013). Thus, use of these substances as sleep aids can promote a cycle of sleep problems and increased substance use over time. Additionally, some research suggests using alcohol and cannabis as sleep aids is associated with increased alcohol-related consequences (Goodhines, Gellis, Kim, et al., 2019; Taylor & Bramoweth, 2010) and problematic cannabis use (Drazdowski et al., 2021). Due to the problematic and risky nature of using alcohol and cannabis as sleep aids, there is a need to develop harm-reduction strategies specific to these behaviors, but preliminary evidence is needed to inform these efforts.

Social norms approaches to behavior change

Social norms – perceptions of others' behaviors and attitudes – play a salient role in young adults' decisions to engage in health/risk behaviors (Miller & Prentice, 2016). Indeed, social norms are central to several behavioral theories such as Social Norms Theory (Berkowitz, 2004) and the Theory of Reasoned Action (Fishbein & Ajzen, 2011). In particular, descriptive norms (i.e., individuals' perceptions of the prevalence of a given behavior; Cialdini et al., 1991) serve as robust predictors of college students' health-related behaviors such as alcohol use (Graupensperger, Jaffe et al., 2021; Neighbors et al., 2007), risky sexual behavior (Lewis et al., 2014), and vaccine uptake (Graupensperger, Abdallah et al., 2021). However, people tend to misperceive social norms – often perceiving that others engage

in more risky behavior (e.g., alcohol use; Cox et al., 2019) and less protective behavior (e.g., adhering to COVID-19 guidelines; Graupensperger, Lee et al., 2021) than is actually the case. Thus, correcting normative misperceptions has been a promising harm-reduction strategy (Dempsey et al., 2018).

Norm-correcting approaches have been employed to facilitate constructive behavior change across a range of domains including alcohol use (Dotson et al., 2015), sun protection (Reid & Aiken, 2013), and problematic gambling (Peter et al., 2019). For example, correcting inflated normative perceptions about heavy alcohol use has been an effective and widely utilized strategy for reducing college student drinking (e.g., LaBrie et al., 2013). Although unexplored to date, it follows that norm-correcting strategies may be useful for targeting substance use for sleep aid purposes. One study of adolescent social networks found that both sleeping fewer hours and using substances, including cannabis, readily diffuse among friends and social connections within an individuals' network (Mednick et al., 2010). Thus, there is theoretical and emerging empirical support indicating social norms may be a modifiable risk-factor for sleep-motivated substance use. However, norm-correcting strategies are only prudent when (a) individuals' estimates of a behavioral norm are inaccurate (e.g., overestimated norms for risky behaviors), and (b) normative perceptions are associated with one's own behavior. Therefore, additional evidence is needed to determine whether norm-correcting strategies can be utilized to reduce alcohol and cannabis use as sleep aids.

Current study

This cross-sectional study was designed to assess the degree to which college students exhibit a normative misperception of using alcohol or cannabis as a sleep aid and examine associations between substance use and descriptive norms, which can be used as early-stage evidence for the potential to use norm-correcting strategies targeting the use of alcohol or cannabis as sleep aids. Similar to previous studies on college student alcohol use norms (e.g., Carey et al., 2020), we hypothesized that college students, on average, would overestimate the prevalence of students using alcohol and cannabis as sleep aids (i.e., perceived descriptive norms) (**Aim 1a**). Moreover, we hypothesized that normative overestimation would be greatest among those students who have recently endorsed using these respective substances as sleep aids, even when accounting for other relevant covariates (**Aim 1b**). Central to the utilization of norm-correcting strategies, we also hypothesized that perceived descriptive norms would be positively associated with participants' use of the substance as a sleep aid (tested separately for alcohol and cannabis) (**Aim 2**). Because severity of sleep issues may also be associated with college students' use of these substances as sleep aids, frequency of insomnia symptoms was also assessed, and we hypothesized the associations between norms and use would remain even when controlling for these symptoms.

Method

Participants and procedures

Between November 2019 and February 2021,[1] 8,247 college students from a large public university in the Pacific Northwest were invited via e-mail to complete a screening survey for a randomized clinical trial (parent study clinical trial registration #NCT04030325). Students were randomly invited from a list provided by the university registrar's office. Across six cohorts, 2,642 college students (32.04% of those invited) completed the screening survey containing questions relevant to the current study. No substance use selection criteria were implemented for the current study; thus, the sample included students who did and did not use alcohol/cannabis. The mean age of the analytic sample was 18.84 years (*SD* = 0.89, range 18–25); 60.82% identified as female. The ethnoracial demographics were: 37.89% White non-Hispanic (NH), 39.21% Asian NH, 10.98% Hispanic, 6.89% multiracial NH,

[1]1900 (71.92%) participants completed the survey on or after March 1, 2020, the start of the COVID-19 pandemic.

and 5.03% other or did not disclose, which is similar to the university's student body. Cohorts 1–5 received a $10 e-gift card for survey completion, which increased to $20 in cohort 6 to increase response. Both medicinal (age 18+) and recreational (age 21+) cannabis use is legal in the state in which data were collected. Procedures were approved by the university's Institutional Review Board and no adverse events were reported.

Measures

Participants indicated how many times in the last 30 days they used (a) alcohol and (b) cannabis to help them fall asleep (e.g., "In the past 30 days, how many times did you use THC-containing marijuana/cannabis products to help you fall asleep?"). Response options ranged from 0 to 30 days. Two similar items asked participants to estimate the descriptive norms for the percentage of college students that use alcohol and cannabis as sleep aids (e.g., "What percentage of college students do you think use alcohol to help them fall asleep?"). Response options ranged from 0% to 100%.

Three items that align with the DSM-5 criteria for insomnia were used as indices of past 30-day sleep difficulties and were included as covariates in primary analyses. These items pertained to prolonged sleep onset latency (i.e., "taking longer than 30 minutes to fall asleep"), nocturnal awakening (i.e., "waking up in the middle of the night for 30 minutes or more"), and early awakening ("waking up an hour or more earlier than planned"). Response options for these items ranged from 0–30 days.

Analyses

Aim 1a entailed comparing participants' estimated percentages of students who use alcohol and cannabis as sleep aids to the percentage of students in the current sample who actually endorsed using alcohol/cannabis as sleep aids at least once in the past 30 days. To estimate these contrasts, separate one-sample *t*-tests were conducted for (a) the full sample (N= 2,642) and (b) the subset of students who endorsed using alcohol or cannabis as sleep aids in the past 30 days (n= 200 and 450, respectively). Then (Aim 1b), to examine predictors[2] of normative overestimation of substance use as sleep aids, we fit regression models with overestimation operationalized as participants' estimated prevalence minus the sample-derived prevalence (testing separate alcohol and cannabis models). Thus, larger regression coefficients indicate a stronger association with overestimating the normative prevalence relative to the prevalence of the current sample.

To test Aim 2, we examined associations between participants' use of alcohol/cannabis as sleep aids and perceived descriptive norms for these respective behaviors. Because use of alcohol and use of cannabis as sleep aids were both positively skewed count variables with large variability and a large number of zeros, models were estimated using negative binomial count regression to account for overdispersion. Moreover, comparing the negative binomial model to a zero-inflated negative binomial (ZINB) model via Vuong's non-nested likelihood ratio test (Vuong, 1989) indicated the ZINB model was significantly better fit to the data ($p < .001$ for both the alcohol and cannabis model). ZINB regression is a form of mixture modeling that estimates two simultaneous models: (a) a logistic regression sub-model estimating likelihood of a zero vs. non-zero response to the outcome variable and (b) a truncated count regression model estimating the variability in non-zero counts on the outcome variable. The logistic component used a logit link function to estimate adjusted odds-ratios (AOR), and the count component uses natural logarithm link function that estimates count ratios (CR). AORs from the logistic model indicate the association between the covariate and a respondent answering with a zero (i.e., no use of alcohol/cannabis to fall asleep in the past 30 days). AORs above 1 indicate a positive association (i.e., increased odds of reporting zero) and AORs below 1 indicated an inverse association (i.e., decreased odds of reporting zero). The CRs from count model estimate the

[2]We use the term "predict" throughout in the statistical sense, but do not imply causal inferences due to cross-sectional data.

association between the covariate and the number of times a respondent engaged in the outcome behavior (i.e., days of using alcohol/cannabis to fall asleep). CRs represent proportional change in the outcome variable for each unit increase in the covariate (e.g., a ratio of 1.05 = 5% increase in the outcome variable for each unit change in the covariate). Covariates in the models included age, birth sex, race/ethnicity, sleep difficulties, and a dummy-coded variable for whether the survey was completed before or after the start of the COVID-19 pandemic (March 1, 2020).

Results

Descriptive results

Across the full sample, 7.57% of students endorsed using alcohol as a sleep aid at least once in the past 30 days (Figure 1). Of those who had used alcohol as a sleep aid at least once, the mean number days that alcohol was used as a sleep aid was 3.87 days in the past 30 days (*SD* = 3.82; *Range* = 1–21 days). Pertaining to cannabis use as a sleep aid, 17.05% of participants indicated they used cannabis as a sleep aid at least once in the past 30 days (Figure 1). Of those who had endorsed cannabis use as a sleep aid at least once, the mean number of days that cannabis was used as a sleep aid was 10.41 days (*SD* = 9.82, *Range* = 1–30 days). Moreover, 12% of participants in this subgroup reported using cannabis as sleep aid on *all* of the previous 30 days.

Interestingly, only 99 participants endorsed using both alcohol and cannabis as sleep aids in the past month (3.75%), indicating that most students who use cannabis as a sleep aid had a preference to solely use cannabis as a sleep aid, whereas approximately half of the students who use alcohol as a sleep

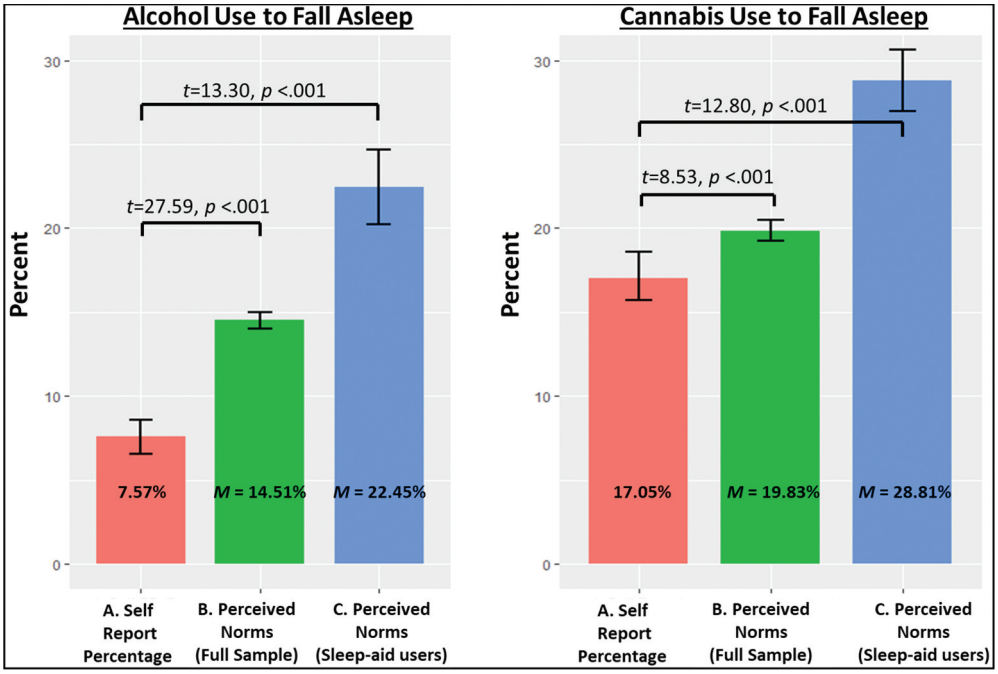

Figure 1. Bar plots comparing (A) self-reported percentage of sample participants (*N*= 2642) that use alcohol/cannabis to help them fall asleep to (B) normative perceptions of the full sample for the percent of college students that use alcohol/cannabis to help them fall asleep, and (C) normative perceptions of the subset of participants that reported past month alcohol (*n*= 200) or cannabis (*n*= 450) use, respectively, to help them fall asleep. Error bars represent 95% confidence intervals. *t* values are derived from one-sample *t*-tests.

aid also use cannabis as a sleep aid. Of the 551 students who reported using either substance as a sleep aid, 63.70% reported cannabis only, 18.33% alcohol only, and 17.97% reported both alcohol and cannabis use as sleep aids.

Aim 1: normative estimates for the prevalence of using alcohol/cannabis as sleep aid

One-sample *t*-tests revealed participants, on average, overestimated the descriptive norms for this behavior with a mean estimation that 14.51% of students use alcohol as sleep aid – nearly double the percentage of participants who actually endorsed this behavior (Figure 1). Next, we contrasted the perceived norms for the subset of participants who reported using alcohol as a sleep aid at least once in the last 30 days. This subset, on average, overestimated the descriptive norms to an even greater extent with a mean estimation of 22.45% – almost three times the actual percentage of students who actually reported using alcohol as a sleep aid. Pertaining to cannabis use, the full sample, on average, slightly overestimated the descriptive norm for this behavior (i.e., 19.83%); however, the subset of participants who had used cannabis as a sleep aid at least once in the past month overestimated the descriptive norm to a greater extent (i.e., 28.81%).

Models examining predictors of normative overestimation are shown in Table 1 (Aim 1b). For both substances, overestimation was greater among relatively older participants and among female participants. Finally, after statistically controlling for age, sex, and race/ethnicity, participants who reported more frequent use of alcohol and cannabis as sleep aids overestimated the prevalence of these respective behaviors to a greater extent.

Aim 2: associations between perceived norms and using alcohol/cannabis as sleep aids

ZINB regression models (Table 2) were used to simultaneously estimate (a) adjusted odds ratios for reporting zero days of using alcohol/cannabis as sleep-aids in the past month, and (b) count ratios estimating associations between covariates and the number of days that alcohol/cannabis was used as a sleep aid in the past month among the subset of participants who reported a non-zero response. Pertaining to alcohol use, the logistic component of the model showed that perceived descriptive norms were significantly associated with any past month use of alcohol as sleep aid, even after controlling for symptoms of insomnia. That is, every 1% increase in estimated norms for prevalence of alcohol use as sleep aid was associated with 4% greater odds of reporting any past-month use of alcohol as a sleep aid themselves. The count component of the model further revealed that, among those who used alcohol as sleep aid at least once, perceived descriptive norms significantly predicted

Table 1. Regression models examining predictors of normative overestimation for prevalence of alcohol and cannabis use as sleep aids.

	Normative Overestimation	
	Prevalence of Alcohol Use to Help Fall Asleep	Prevalence of Cannabis Use to Help Fall Asleep
	b (SE)	*b* (SE)
Age	0.85 (0.28)**	0.92 (0.36)**
Birth Sex (0 = F, 1 = M)	−1.92 (0.50)***	−4.16 (0.64)***
Race/Ethnicity (REF = White)		
Asian/Asian American	3.04 (0.56)***	−0.91 (0.72)
Hispanic/Latinx	3.51 (0.85)***	6.09 (1.08)***
Multiracial	1.13 (1.01)	0.97 (1.30)
Other	2.62 (1.18)*	2.31 (1.51)
Self-reported days of alcohol use as sleep aid in past month	1.43 (0.17)***	–
Self-reported days of cannabis use as sleep aid in past month	–	0.61 (0.06)***

Table 2. Negative binomial count regression models estimating associations between past-month use of alcohol and cannabis as sleep aids and perceived descriptive norms for these behaviors.

	Alcohol Use to Help Fall Asleep (*Self-reported # of days in past month*)		**Cannabis Use to Help Fall Asleep** (*Self-reported # of days in past month*)	
	Logistic Zero Component	Count Component	Logistic Zero Component	Count Component
	Adjusted Odds Ratio [95% C.I.]	Count Ratio [95% C.I.]	Adjusted Odds Ratio [95% C.I.]	Count Ratio [95% C.I.]
Age	0.81 [0.67, 0.97]*	1.26 [1.03, 1.54]*	0.86 [0.76, 0.98]*	1.05 [0.93, 1.18]
Birth Sex (0 = F, 1 = M)	0.53 [0.36, 0.77]***	1.12 [0.76, 1.65]	1.05 [0.82, 1.33]	1.25 [0.98, 1.59]
Race/Ethnicity (REF = White)				
Asian/Asian American	2.15 [1.40, 3.29]***	0.73 [0.47, 1.14]	2.78 [2.10, 3.69]***	0.73 [0.55, 0.97]*
Hispanic/Latinx	1.58 [0.88, 2.84]***	0.94 [0.51, 1.72]	1.27 [0.87, 1.85]	0.58 [0.41, 0.82]**
Multiracial	1.02 [0.45, 2.33]	0.45 [0.20, 1.00]*	1.40 [0.89, 2.21]	0.84 [0.54, 1.31]
Other	1.17 [0.50, 2.72]	0.66 [0.29, 1.50]	1.55 [0.91, 2.62]	0.95 [0.57, 1.58]
Prolonged Sleep Onset Latency (# of days)	0.97 [0.95, 0.99]***	1.00 [0.98, 1.02]	0.99 [0.98, 1.01]	1.01 [1.00, 1.03]*
Nocturnal Awakening (# of days)	0.97 [0.94, 1.00]*	1.01 [0.98, 1.04]	0.98 [0.96, 1.01]	1.00 [0.98, 1.02]
Early Awakening (# of days)	0.99 [0.97, 1.02]	1.02 [0.99, 1.05]	0.98 [0.96, 1.00]*	1.02 [1.00, 1.04]
COVID Cohort (0 = No, 1 = Yes)	0.82 [0.53, 1.27]	0.75 [0.46, 1.24]	1.25 [0.96, 1.63]	1.23 [0.95, 1.58]
Descriptive Norms: Estimated percent of college students that use alcohol to help fall asleep	0.96 [0.95, 0.98]***	1.02 [1.00, 1.03]**	–	–
Descriptive Norms: Estimated percent of college students that use cannabis to help fall asleep	–	–	0.97 [0.96, 0.97]***	1.02 [1.00, 1.03]**

a greater frequency of use days. A 1% increase in estimated norms for prevalence of alcohol use as sleep aid was associated with 2% more days of using alcohol as a sleep aid in the past month. Thus, perceived descriptive norms significantly predicted both prevalence and frequency of using alcohol as a sleep aid.

Similar patterns were revealed for the cannabis use models (Table 2). Greater estimated prevalence was significantly associated with any past month use of cannabis as a sleep aid. Specifically, every 1% increase in estimated norms for prevalence of cannabis use as sleep aid was associated with 3% greater odds of reporting any past-month use of alcohol as a sleep aid themselves. The count component of the model indicated that greater normative estimates also predicted more frequent use of cannabis as a sleep aid among those who endorsed using cannabis as sleep aid at least once in the past month. A 1% increase in estimated norms for prevalence of cannabis use as sleep aid was associated with 2% more days of using cannabis as a sleep aid in the past month. Taken together, perceived descriptive norms were a salient predictor of using these substances as sleep aid, even after controlling for symptoms of insomnia.

Discussion

Improving sleep health is a critical public health priority (Barnes & Drake, 2015). Using alcohol and/or cannabis use as a sleep aid is relatively prevalent among college students (Goodhines, Gellis et al., 2019) and sleep-aid is an often cited motive for use (Lee et al., 2009), which is likely due to acute effects of these substances on sleep onset latency (Miller et al., 2021; Sznitman et al., 2020). There is nevertheless abundant evidence that these substances have adverse short- and long-term effects on sleep (e.g., Kwon et al., 2019). In the current sample of college students, 7.57% reported past-month alcohol use as a sleep aid and 17.05% reported past-month cannabis use as a sleep aid. This is similar to a previous two-wave study of college students that found 7–10% used alcohol and 14–15% used cannabis as a sleep aid in the past 2 weeks (Goodhines, Gellis, Kim, et al., 2019); however, it should be noted that direct comparisons of prevalence are not possible given that Goodhines and colleagues implemented an inclusion criterion of past 30-day alcohol use while the current study had no inclusion criteria pertaining to substance use. These prevalence estimates indicate a subset of students are using substances as a sleep aid (particularly cannabis), which is a risky behavior given the potential for a cyclical feed-forward loop that can exacerbate issues with both sleep and substance use (e.g., Brower, 2003). Moreover, the subset of students who did use these substances as a sleep aid did so with alarming frequency. Those who had used cannabis as a sleep aid reported this behavior frequently (on over one-third of days in the past month, on average) and 12% of this subset reported using cannabis as a sleep aid every single day in the past month. This is consistent with a recent study reporting positive associations between using cannabis as a sleep aid and frequency of cannabis use (Drazdowski et al., 2021). This past study also showed using cannabis as a sleep aid was associated with higher levels of problematic cannabis use and sleep disturbances in college students, further suggesting that cannabis used as a sleep aid may cause increased problems rather than alleviate sleep issues. Some students may perceive their cannabis use as strictly for medicinal reasons, and future research should consider how this perception may impact both the perceived norms and use of cannabis as a sleep aid compared to students who use cannabis for non-medical reasons. Findings also indicated that using alcohol and cannabis as sleep aids was more prevalent among older participants who, if over age 21, could purchase these substances legally and then use them as a perceived sleep aid, whereas students under age 21 may only have access to these substances at parties and in social settings which may somewhat constrain their use as sleep aids.

A total of 99 students (3.75%) reported using both alcohol and cannabis as sleep aids, indicating, for a relatively small subset of students, co-use of substances may serve as an additional factor in impaired sleep and motivation to use substances to help fall asleep. Additional research is needed to determine how students who use both alcohol and cannabis as sleep aids may differ in risk of problematic use of these substances, related consequences, and long-term sleep and health effects. Of all the students who

reported using either substance as a sleep aid, nearly two-thirds reported cannabis use only (63.70%), while only 18.33% reported alcohol use only, indicating that cannabis use as a sleep aid may be a more salient concern than alcohol use, among college students.

The current findings also indicated students, particularly those who reported using the substance as a sleep aid, may overestimate descriptive norms for use of these substances as sleep aids. This is troubling given that young adults' health behaviors are strongly influenced by perceptions of peers' behaviors, and in such cases, use may reflect conformity to an overestimated norm (i.e., Social Norms Theory; Berkowitz, 2004). Indeed, we found that perceptions of these norms were significantly associated with students' use of alcohol and cannabis as sleep aids, even after accounting for relevant covariates such as indices of sleep difficulties. Those who perceived substance use for sleep aid purposes to be more normative among their peers reported greater use of these substances to aid with their own sleep.

Central to this early-stage study, findings that college students overestimate the normative prevalence of substance use for sleep aid, and that these normative perceptions are associated with one's own use, highlight the potential utility in employing norm-correcting harm-reduction strategies. In future work, these normative misperceptions can be corrected to potentially reduce alcohol and cannabis use for sleep aid purposes, especially among those who report using these substances for sleep aid as these students tended to overestimate the descriptive norms to a greater extent. Personalized normative feedback interventions may be designed to present individuals with tailored feedback highlighting discrepancies between their own behavior, perceptions of peers' behaviors, and peers' *actual* behaviors, which may be especially impactful for those who hold extremely inflated normative perceptions (e.g., Carey et al., 2020). Importantly, research on personalized normative feedback has not shown any iatrogenic effects when the students report drinking less than the norm (Prince et al., 2014), and personalized normative feedback has been shown to reduce overestimations of cannabis use even among cannabis abstainers (Elliott & Carey, 2012). Therefore, we would expect programs using personalized normative feedback to reduce overestimations for norms of substance use as a sleep aid and no iatrogenic effects among students who do not engage in these behaviors. Alternatively, the normative feedback may also be tailored as a preventative approach to students who do not use alcohol or cannabis as sleep aids. The perception that more peers abstain from alcohol has been associated with less alcohol use in college students (Litt & Lewis, 2015). Therefore, providing students who abstain from using alcohol and cannabis as sleep aids with normative feedback that includes the large percentage of students who also choose not to engage in these behaviors may prevent future use. Thus, the next step in this line of research is to develop and test a personalized normative feedback intervention specifically targeting students' use of alcohol and cannabis for sleep aid purposes, which may have utility as a standalone intervention but could also be integrated alongside psychoeducational interventions highlighting long-term risks of using substances as sleep aids, and/or integrated with existing interventions for sleep disorders and substance use (e.g., Cognitive-Behavioral Therapy for Insomnia, Van der Zweerde et al., 2019; Personalized Feedback for Alcohol and Marijuana Prevention; Carey et al., 2020).

One final implication of the current study pertains to the COVID-19 pandemic. Data were collected both before and during the pandemic and, given recent findings that the COVID-19 pandemic may relate to increased sleep difficulties (Lin et al., 2021) and changes in alcohol/cannabis use patterns among young adults (Graupensperger, Fleming et al., 2021), we statistically controlled for whether participants completed the survey before or during the pandemic. Interestingly, we found no significant effects related to COVID-19, which suggests that use of alcohol and cannabis as sleep aids may not have changed during the pandemic among a general college student sample, relative to pre-pandemic. Nevertheless, additional studies should be designed specifically to address this research question before inferences can be made.

Limitations

Although this study provides preliminary support that perceived descriptive norms may play an important role in college students' use of alcohol and cannabis as sleep aids, limitations should be considered. First, students were from one public university in a state where non-medicinal cannabis use is legal for adults 21 + . Replication studies are needed in other geographic regions and with more diverse samples (including non-college samples). National data on use of alcohol and cannabis as sleep aids would allow for more accurate estimates regarding the accuracy of college students' normative estimates, whereas we used the sample-derived prevalence as the baseline estimate for calculating overestimation. Relatedly, more precise measurement on normative estimates could examine normative overestimation for reference groups at varying levels of proximity to the participant, including norms for students at the same school versus national norms for all college students. The cross-sectional design limits inferences regarding associations between norms and behavior, though previous longitudinal studies indicate perceived norms are a prospective antecedent to substance use behavior (e.g., Ferrer et al., 2012; Graupensperger et al., 2020). The items for alcohol/cannabis use as sleep aids asked about use pertaining to *falling* asleep, but not other indices of sleep such as duration or quality, which may be important to explore in future studies. Lastly, we did not examine normative perceptions of peers' attitudes and beliefs (i.e., injunctive norms), which may be similarly modifiable and may be leveraged in future norms-based interventions (e.g., Pedersen et al., 2017; Reid & Aiken, 2013).

Conclusions

Findings from this study supported both Aim 1 and Aim 2 hypotheses: (a) college students overestimated the normative prevalence of both alcohol and cannabis use as sleep aids, especially among those who reported using these substances as sleep aids, and (b) normative perceptions were associated with college students' use of alcohol/cannabis to aid with sleep, even after controlling for self-reported sleep difficulties. Taken together, these initial findings represent a critical first-step for prevention, by indicating that norm-correcting strategies may be a prudent approach for reducing and preventing the use of substances as sleep aids.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This study was conducted with support from the National Institute on Alcohol Abuse and Alcoholism (R34AA026909, R37AA012547, & T32AA007455). Partial support for this research came from a Eunice Kennedy Shriver National Institute of Child Health and Human Development research infrastructure grant, P2CHD042828, to the Center for Studies in Demography & Ecology at the University of Washington. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

ORCID

Mary E. Larimer http://orcid.org/0000-0002-2003-2312

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