Popular remedies don't help, strong beliefs do: Behavioral and cognitive factors of college students' sleep quality and sleep-related mental health

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Remedies Do Not Help, Strong Beliefs Do: College Students' Self-Report Sleep Quality and Mental Health

Attaining quality sleep is a major concern for college students in the USA, who often sacrifice sleep to meet academic and social pressures (Buboltz et al., 2001; Lund et al., 2010). Surveys have found only 34% of US undergraduate students exhibit optimal sleep (Lund et al., 2010), 27% are at risk for a sleep disorder (Gaultney, 2010) and 78% feel tired or sleepy three or more days of the week (American College Health Association, 2022). Sleep education, which can include behavioural recommendations for individuals to improve sleep quality, such as maintaining a consistent sleep schedule and reducing alcohol consumption, has consequently been of high interest to academics and the public alike (Chung et al., 2018). Despite such interest, college students remain an understudied population in sleep research (Albers et al., 2022; Jones et al., 2020). College students face unique challenges that can negatively impact their sleep habits, such as adjusting to living away from home, balancing schoolwork with other responsibilities (e.g., jobs and family roles), and navigating academic pressures. This study therefore explores several areas that may inform future interventions, including cognitive and social predictors of sleep, perceived effectiveness of commonly used remedies, and associations between poor sleep and mental health, ultimately offering theoretical and practical guidance for health communicators, educators, and practitioners promoting healthy sleep among college students.

Successful health interventions require tailored communication that appeal to the beliefs and behaviours of specific audiences. Understanding the social and cognitive predictors of sleep quality among college students is thus an important step in enhancing education and intervention strategies (Friedrich and Schlarb, 2018). The theory of planned behavior (Ajzen, 1985) and

health belief model (Rosenstock, 1974) are seminal, well-supported frameworks used to predict health behaviours (Carpenter, 2010; Steinmertz et al., 2016). In short, the TPB posits attitudes, perceived social norms, and perceived behavioural control (i.e., perceived ability in performing a behaviour) to predict behavioural intentions. Previous research has found that TPB variables are predictive of sleep-related behaviors in college students (Branscum et al., 2019; Fakroune and Van den Broucke, 2023; Knowlden et al., 2012). However, fewer studies have tested the same utility of the HBM, which incorporates perceptions of susceptibility and severity of a health threat, benefits and barriers of a health response, self-efficacy (akin to perceived behavioural control), and cues to action that prompt behaviour (Alamir et al., 2022; Knowlden and Sharma, 2014). Accordingly, the present research tests both the HBM (Study 1) and TPB (Study 2) for predicting sleep-related outcomes among US college students and further extends this research by examining associated mental health correlates.

During 2020-2021, more than 60% of US college students from 373 schools met the criteria for one or more mental health issues (Lipson et al., 2022). In relation to sleep, mental health has been found to act as both a contributor to poor sleep (Lund et al., 2010) and an adverse outcome (Al-Khani et al., 2019). The current research sought to further inform this latter relationship by testing the relationship between socio-cognitive mechanisms, sleep quality, and mental health outcomes (i.e., depression, anxiety, and mental well-being). Although work has examined these relationships separately, including socio-cognitive predictors of healthy sleep (e.g., Alamir et al., 2022) and the effects of sleep on mental health (e.g., Al-Khani et al., 2019), this investigation is among the first to test the relationship in its entirety, looking at how cognitive factors identified in the HBM and TPB contribute to mental health through sleep quality.

Past research has investigated the effectiveness of behaviours taken to achieve sleep, such as the effects of music (Trahan et al., 2018) and sleep schedules (Lu et al., 2024) among US college students. However, existing research often focuses on one behaviour at a time in lab settings. Such an approach, although maintaining high research control, fails to look at the possibility that individuals may utilise a combination of remedies concurrently. For instance, mobile apps that allow users to test the effectiveness of different combinations of sleep remedies suggest people use a variety of methods rather than just one (McCurdie et al., 2012). Thus, a discrepancy between extant research and how sleep-related behaviours are practised is likely to exist. The present research lastly investigates not only the frequency with which college students report using popular sleep remedies but also tests how their usage may be associated with sleep quality and subsequent mental health outcomes.

The Current Research

This paper presents results from two cross-sectional sub-studies testing the predictive utility of the HBM (Study 1) and the TPB (Study 2) regarding sleep quality of US college students. It is specifically predicted, in alignment with the HBM, that sleep quality will be associated with higher perceived susceptibility and severity of adverse health consequences from poor sleep, higher perceived benefits of gaining quality sleep, lower perceived barriers to gaining quality sleep, greater perceived cues of action prompting quality sleep, and greater self-efficacy. Regarding the TPB, sleep quality is expected to be related to more positive attitudes toward quality sleep, stronger social norms about sleep, and greater self-efficacy.

Although previous research has examined perceived descriptive norms (i.e., what most others do) and injunctive norms (i.e., what is approved/disapproved upon) as separate predictors of sleep quality (Branscum et al., 2019), their relationship to mental health in the context of sleep

quality has not yet been explored. In response, Study 2 tested how TPB variables, distinguishing between descriptive and injunctive norms, predict mental health through sleep intentions and reported sleep quality. To better examine the relationship between sleep and mental health amongst college students, the effect of sleep quality on mental health outcomes as predicted by socio-cognitive factors was also tested. Lastly, the frequency of use and self-reported impact of popular sleep remedies and hygiene practises on sleep quality were explored in both studies.

Method

Participants and Procedure

Participants were recruited from a large Midwest university in the USA through the university's research recruitment and study management software in exchange for course or extra credit. The subject pool comprised undergraduate students enrolled in communication and journalism-related courses. Students who participated in Study 1 were excluded from Study 2, ensuring distinct and non-overlapping samples. Both studies were conducted online, took approximately 10 minutes to complete, and were approved by the Institutional Review Board of [UNIVERSITY].

Study 1 had a final sample size of 315 after excluding 47 participants for failing an attention check item (e.g., select the choice "2"), including 55.6% women, 36.5% men, 1.9% nonbinary (racial/ethnic identities: 69.2% White, 8.9% Asian, 5.4% African American, 1.9% Latino/a, and 6.0% interracial). Study 2 had a final sample size of 341 after excluding 57 participants for attention check failure, including 44% men, 55% women, and .6% nonbinary (racial/ethnic breakdown: 73% White, 7% Asian, 8% African American, 3% Latino/a, and 7% interracial).

Measures

All items were randomized within their measurement scale. Unless otherwise indicated, measurements were collected in both studies.

The **use of popular sleep remedies** was measured for 14 behaviours derived from the Phillips Global Sleep Survey (2018) and other research (Groeger et al., 2004), including both healthy (e.g., meditating) and unhealthy actions (e.g., drinking alcohol) taken to achieve sleep (see Table 2).

Sleep quality during the past month was captured with the Pittsburgh Sleep Quality Index (Buysse, 1989) which produces a sleep quality score ranging between 0-21. Higher scores indicate worse sleep quality (Study 1: M=3.23, SD=1.04; Study 2: M=6.58, SD=3.54).

Depression (Study 1: M=2.00, SD=0.84, Cronbach's α=0.94; Study 2: M=1.85, SD=0.78, α=0.93) and **anxiety** (Study 1: M=2.58, SD=1.00, α=0.95; Study 2: M=2.44, SD=0.95, α=0.94) were measured with their respective 8-item PROMIS® scales (Pilkonis et al., 2011), including items such as "I feel depressed." Self-reported general **mental well-being** was measured with three items adapted from van Brakel et al. (2023) and asked level of agreement to statements such as "In most ways my life is close to ideal" (Study 1: M=4.41, SD=1.28 α=0.87; Study 2: M=4.75, SD=1.27, α=0.86).

HBM measures (Study 1 only) were taken from Knowlden and Sharma (2014) and used 5-point scales. **Perceived susceptibility** was measured with six items asking participants how likely it would be to experience adverse health issues (e.g., developing an illness) from a lack of sleep (M=2.61, SD=0.90, α=0.87). **Perceived severity** was measured with five items assessing the perceived gravity a lack of sleep would have, such as on their physical health (M=3.12, SD=1.01, α=0.90). **Perceived benefit** was measured with four items asking how beneficial getting good sleep (i.e., 7-8 hours) would be, such as on "energy levels" (M=4.26, SD=0.86,

α=0.94). The **perceived barriers** construct was measured with four items asking participants how likely it would be to get good sleep due to various reasons (e.g., "you feel behind on your work") (*M*=2.90, *SD*=1.01, α=0.80). Six items measured **cues to action** and asked how likely it would be for participants to get good sleep in different motivational states (e.g., "feeling up to date with personal responsibilities") (*M*=3.48, *SD*=0.86, α=0.87). Participants reported **self-efficacy** through six items, evaluating their perceived confidence in getting good sleep through corrective actions, e.g., "relax(ing) your mind before bedtime" (*M*=3.41, *SD*=0.80, α=0.81).

TPB measures (Study 2 only) were adapted from Lao et al. (2016) and used 7-point scales. **Attitudes** toward getting good sleep were measured with seven pairs of semantic differentials (i.e., *bad/good, unhealthy/health, unrewarding/rewarding, unnecessary/necessary, not enjoyable/enjoyable, detrimental to my social life/beneficial to my social life, foolish/wise*) (*M*=6.22, *SD*=0.98, α=0.92). **Perceived behavioural control** asked participants to indicate their level of agreement (*strongly disagree* to *strongly agree*) to three statements, including "If I wanted to, I am sure I could sleep for 7-8 consecutive hours every night" (*M*=4.42, *SD*=1.42, α=0.87). **Injunctive norms** about sleep measured the perceived approval of health sleep for four proximal social referents (i.e., parents, supervisors, friends, most people) (*M*=4.80, *SD*=0.73, α=0.79). **Descriptive norms** about sleep were measured by how four social referents (i.e., parents, supervisors, friends, most people) behave themselves regarding sleep (e.g., "My friends sleep 7-8 consecutive hours every night") (*M*=4.42, *SD*=1.18, α=0.81). **Behavioural intention** was captured with three statements, i.e., "In the next 24 hours, I intend/plan/will try to sleep 7-8 consecutive hours" (*M*=5.32, *SD*=1.41, α=0.93).

Statistical Analysis

Analyses were computed with the Lavaan package (version 4.3.2) in R. A saturated model was tested for both theoretical models, resulting in fit indices that were perfect and not meaningful for interpretation. Estimates of indirect effects were the products of the direct effects included in the path. Error terms from parallel variables were allowed to covary, i.e., exogenous variables with exogenous variables, and endogenous variables with endogenous variables. Missing data was addressed with full information maximum likelihood (Graham, 2003). Coefficients were unstandardized and confidence intervals were computed from 5,000 bias-corrected bootstrapped samples.

Results

Study 1 Results

Perceived susceptibility, perceived barriers, and self-efficacy were significantly associated with sleep quality (see Figure 1). Weaker self-efficacy, greater perceived barriers, and greater perceived susceptibility to adverse health outcomes from poor sleep were associated with worse sleep quality. The relationships between severity, benefits, cue to action, and sleep quality were not statistically significant. Regarding mental health outcomes, participants' self-reported sleep quality was significantly associated with depression, anxiety, and well-being. Better sleep quality was associated with better mental well-being, whereas worse sleep quality was related to more severe depression and anxiety.

[ENTER FIGURE 1 HERE]

For indirect effects (see Table 1), perceived susceptibility to adverse health outcomes from poor sleep was associated with worse sleep, which in turn was associated with more severe depression and anxiety. The same pattern was found for perceived barriers on depression and anxiety. However, stronger self-efficacy was associated with better sleep, which was in turn

associated with reduced depression and anxiety. Perceived susceptibility and barriers related to worse sleep, which was then associated with reduced well-being. Perceived self-efficacy was associated with better sleep, which was in turn associated with better mental well-being.

[ENTER TABLE 1 HERE]

On average, participants tried three types of home remedies in the past month (M = 2.91, SD = 1.63), with the top three behaviours being the use of a sleep schedule, playing soothing music, and improving air quality (see Table 2). Most remedies were not significantly associated with sleep quality (see Table 3). Participants who used prescription medication for sleep, over-the-counter sleep aids, or marijuana reported worse sleep than those who did not. Taken together, none of the tested remedies positively predicted quality sleep. Similar patterns were observed in the indirect effects. Most indirect effects with popular remedies as exogenous variables were not statistically significant yet participants who used prescription medication for sleep, over-the-counter sleep aids, or marijuana reported greater depression and anxiety, as well as decreased mental well-being, through worse sleep quality.

[ENTER TABLE 2 HERE]

[ENTER TABLE 3 HERE]

Study 2 Results

When testing how TPB constructs predicted participants' sleep quality, all tested paths were statistically significant (see Figure 2). Stronger attitudes, injunctive norms, descriptive norms and perceived behaviour control were all associated with stronger behavioural intentions toward getting good sleep, which was in turn associated with better self-reported sleep-quality.

[ENTER FIGURE 2 HERE]

When considering mental health and well-being, tested paths were again all statistically significant (see Table 1). Stronger attitudes, injunctive and descriptive norms, and behaviour control were all associated with a stronger behavioural intention to get good sleep. This increased behavioural intention was associated with better sleep and reduced depression and anxiety symptoms. This increased intention was also associated with better sleep quality and mental well-being.

Findings regarding popular remedies aligned with Study 1 results. Participant tried an average of two sleep remedies during the past month (M=2.45, SD=1.54). However, none of the tested remedies were related to improved sleep quality but were either not significantly related or contributed to worse sleep quality (i.e., soothing music, sleep aids, prescription medication, alcohol, and other remedies). When examining indirect effects, most paths were again not statistically significant (see Table 3). Participants who used soothing music, sleep aids, prescription medication, alcohol, or other remedies reported stronger depression and anxiety, and worse mental well-being. These relationships were mediated through worse sleep quality.

Discussion

Using two surveys, this study demonstrated the effectiveness of the health belief model and theory of planned behaviour in predicting sleep outcomes among US college students. Additionally, the relationships between popular home remedies and self-reported sleep quality were examined, ultimately finding none of the measured behaviours to be associated with greater sleep quality. The tried remedies were either not statistically related to college students' sleep or worked against self-reported sleep quality. Still, college students were found on average, to engage in at least two behaviours to achieve better sleep within the past month. These results may indicate a strong interest among college students in improving their sleep, as well as

highlight the need for research exploring how different sleep behaviors interact and combine to affect sleep quality.

Conversely, results demonstrated socio-cognitive beliefs about sleep to be significantly associated with college students' sleep quality as the HBM and TPB were respectively partially and fully validated. In Study 1, participants who believed they were susceptible to negative sleep-related health consequences or that there were significant barriers in achieving sleep were more likely to report poor sleep. However, participants who were confident about their corrective sleep actions indicated better sleep quality. In Study 2, attitudes, social norms - including descriptive and injunctive norm types - and perceived behavioural control were associated with better sleep through stronger sleep intentions. Overall, this study highlights the importance of college students' beliefs about sleep and suggests that future educational efforts should focus on enhancing their mindset around sleep behaviors. For example, to make salient the susceptibility of sleep-related risks, future campaigns and programs should emphasize future-oriented communication and highlight the negative consequences of chronic sleep deprivation. Regarding perceived barriers and self-efficacy, it may be fruitful to add affirmation messages to existing sleep hygiene programs to increase students' confidence that sleep-related issues can be solved. Indeed, while there are many mHealth applications (apps) for sleep quality, rarely do any of these apps include messages explicitly appealing to a person's self-efficacy or control (Arroyo and Zawadzki, 2022).

In validating the TPB, both descriptive and injunctive norms were found to be associated with college students' sleep quality, contributing to the growing body of literature supporting social norms as an influential factor (Hamilton et al., 2020; Lao et al., 2016). Descriptive norms refer to perceptions of what others typically do, providing cues about what is considered correct

behavior (Cialdini et al., 1991). In contrast, injunctive norms reflect individuals' beliefs about whether their actions will be approved or disapproved of by important others, thereby motivating behavior in anticipation of social rewards or punishments (Cialdini et al., 1991). Although sleep is typically considered a solitary behavior, which likely limits the influence of social norms (Arroyo & Zawadzki, 2022), college students often live in environments where sleep is more observable, such as sharing rooms or participating in late-night activities. For this population, social norms may thus play a strong role in shaping sleep intentions, as evidenced by the current results. These norms should therefore be incorporated into future sleep-related education and communication. For example, a norms-based campaign could be launched on campus using materials such as flyers to encourage students to consider the sleep expectations of referent groups that would disapprove of bad sleep (e.g., parents and lecturers). This could help make a pro-sleep injunctive norm more salient, counteracting potentially negative sleep norms reinforced by peers. Furthermore, messages communicating a positive descriptive norm (e.g., that most other university students prioritize getting quality sleep) could also be implemented – indeed, this is a popular strategy used on university campuses for other health behaviours (Berkowitz, 2005).

This study also demonstrated that mental models may contribute not only to college students' sleep quality but also indirectly to their mental health. Although the sleep and mental health relationship may be reciprocal, this study focused on impaired mental health as an outcome of poor sleep, which is influenced by individual beliefs. Across the HBM and TPB models, about one-fifth of the variance of depression, anxiety, and mental well-being was explained by sleep quality and sleep-related cognitive variables. Mediation analyses revealed that lower self-efficacy contributed to poorer sleep, which was subsequently linked to higher levels of

depression, anxiety, and decreased well-being. Students might be more inclined to try cognitive-based therapy for mental health concerns than for sleep issues, but even so, these results suggest that targeting sleep-related beliefs could positively influence both sleep and mental health. This reasoning is speculative, and future research should continue exploring the relationship between cognitive beliefs, sleep behaviors, and mental health.

Limitations and Future Research

Regarding study limitations, causal conclusions cannot be made due to the cross-sectional design of both studies. For example, prior research has found the relationship between sleep quality and mental health to operate in both directions (Dinis and Bragança, 2018). The present research modeled mental health variables as the outcomes of sleep quality; however, future research should cross-validate the results with experimental and longitudinal data. Second, participants were asked to select all remedies they used to improve their sleep during the past month. With this measure, for a participant who selected multiple options, we are unsure whether they tried one remedy at a time or a combination of remedies at the same time. This is an important question for future research to answer. Existing research tends to test one strategy to address sleep issues, which is suitable for determining causality in a lab setting. Yet the present results suggest college students try a combination of sleep-related tactics, calling for future research to mimic this pattern and investigate the potential interaction effect between tactics. Lastly, our research focused on individual-level behavioural and cognitive variables that relate to college students' sleep quality. However, we did not directly test the potential influence of cultural and structural factors. We recommend future research to explicitly investigate the effects of cultural and structural impacts which may also play an important role in shaping college students' sleep.

Conclusion

Two studies consistently supported the importance of socio-psychological factors on college students' sleep quality. Overall, psychological factors but not popular behavioural remedies were significantly associated with improved sleep quality, which was in turn associated with better mental health and well-being. These findings call for future research and sleep interventions targeting college students to understand more about how to induce stronger mental determinants rather than merely focusing on promoting behaviour changes. Our findings also highlight that improved sleep could be an important gateway to college students' better mental health and well-being.

References

Ajzen I (1985) From intentions to actions: A theory of planned behavior. In *Action-Control: From Cognition to Behavior*. Springer, pp. 11-39.

Alamir YA, Zullig KJ, Kristjansson AL, Wen S, Misra R and Montgomery-Downs H (2022) A theoretical model of college students' sleep quality and health-related quality of life. *Journal of Behavioral Medicine* 45(6): 925-934.

Albers LD, Grigsby TJ, Benjamin SM, Rogers CJ, Unger JB, and Forster M (2022) Adverse childhood experiences and sleep difficulties among young adult college students. *Journal of Sleep Research* 31(5): e13595.

Al-Khani AM, Sarhandi MI, Zaghloul MS, Ewid M and Saquib N (2019) A cross-sectional survey on sleep quality, mental health, and academic performance among medical students in Saudi Arabia. *BMC Research Notes* 12: 665.

American College Health Association-National College Health Assessment III: Undergraduate Student Reference Group Executive Summary Spring 2022. (2022). American College Health Association. Available at: https://www.acha.org/documents/ncha/NCHA-III_SPRING_2022_UNDERGRAD_REFERENCE_GROUP_EXECUTIVE_SUMMARY.pdf.

Arroyo AC and Zawadzki MJ (2022) The implementation of behavior change techniques in mHealth apps for sleep: Systematic review. *JMIR Mhealth Uhealth* 10(4): e33527

Berkowitz, A.D., 2005. An overview of the social norms approach. *Changing the culture of college drinking: A socially situated health communication campaign, 1*: 193-214.

Boehm MA, Lei QM, Lloyd RM and Prichard JR (2016) Depression, anxiety, and tobacco use: Overlapping impediments to sleep in a national sample of college students. *Journal of American College Health* 64(7): 565-574.

Branscum P and Qualls Fay K (2019) What determines young adults' attitudes, perceived norms, and perceived behavioral control towards healthy sleep behaviors? A reasoned action approach. *Health Behavior Research* 2(4): 1-12.

Buboltz WCJ, Brown F and Soper B (2001) Sleep habits and patterns of college students: A preliminary study. *Journal of American College Health* 50(3): 131-135.

Buysse DJ, Reynolds III CF, Monk TH, Berman SR and Kupfer DJ (1989) The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research* 28(2): 193-213.

Carpenter CJ (2010) A meta-analysis of the effectiveness of health belief model variables in predicting behavior. *Health Communication* 25(8): 661-669.

Cialdini RB, Kallgren CA, and Reno RR (1991) A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology*, *24*: 201-234.

Chung KF, Lee CT, Yeung WF, Chan MS, Chung EWY and Lin WL (2018) Sleep hygiene education as a treatment of insomnia: A systematic review and meta-analysis. *Family Practice* 35(4): 365-375.

Dietrich SK, Francis-Jimenez CM, Knibbs MD, Umali IL and Truglio-Londrigan M (2016) Effectiveness of sleep education programs to improve sleep hygiene and/or sleep quality in college students: A systematic review. *JBI Evidence Synthesis* 14(9): 108-134.

Dinis J and Bragança M (2018) Quality of sleep and depression in college students: A systematic review. *Sleep Science* 11(4): 290-301.

Dotson KB, Dunn ME and Bower CA (2015) Stand-alone personalized normative feedback for college student drinkers: A meta-analytic review, 2004 to 2014. *PLOS ONE* 10(10): e013951.

Fakroune S and Van den Broucke SV (2023) Determinants of unhealthy sleeping habits among Belgian university students: An application of the theory of planned behavior. *Journal of American College Health* 73(2): 691-699.

Friedrich A and Schlarb AA (2018) Let's talk about sleep: A systematic review of psychological interventions to improve sleep in college students. *Journal of Sleep Research* 27(1): 4-22.

Gaultney JF (2010) The prevalence of sleep disorders in college students: Impact on academic performance. *Journal of American College Health* 59(2): 91-97.

Graham JW (2003) Adding missing-data-relevant variables to FIML-based structural equation models. *Structural Equation Modeling* 10(1): 80-100.

Groeger JA, Zijlstra FRH and Dijk DJ (2004) Sleep quantity, sleep difficulties and their perceived consequences in a representative sample of some 2000 British adults. *Journal of Sleep Research* 13(4): 359-371.

Hamilton K, Ng HTH, Zhang C-Q, Phipps DJ, and Zhang R (2021) Social psychological predictors of sleep hygiene behaviors in Australian and Hong Kong university students. *International Journal of Behavioral Medicine* 28: 214-226.

Jones RD, Jackson WB, Mazzei A, Chang AM, Buxton OM and Jackson CL (2020) Ethnoracial sleep disparities among college students living in dormitories in the United States: A nationally representative study. *Sleep Health* 6(1): 40-47.

Knowlden AP and Sharma M (2014) Health belief structural equation model predicting sleep behavior of employed college students. *Family & Community Health* 37(4): 271-278.

Lao HCF, Tao VYK and Wu AMS (2016) Theory of planned behaviour and healthy sleep of college students. *Australian Journal of Psychology* 68(1): 20-28.

Lipson SK, Zhou S, Abelson S., et al. (2022) Trends in college student mental health and help-seeking by race/ethnicity: Findings from the national Healthy Minds Study, 2013-2021. *Journal of Affective Disorders* 306: 138-147.

Lu S, Stone JE, Klerman, EB, McHill AW, et al. (2024) The organization of sleep-wake patterns around daily schedules in college students. *Sleep* 47: 1-13.

Lund HG, Reider BD, Whiting AB and Prichard JR (2010) Sleep patterns and predictors of disturbed sleep in a large population of college students. *Journal of Adolescent Health* 46(2): 124-132.

McCurdie T, Taneva S, Casselman M, Yeung M, McDaniel C, Ho W and Cafazzo J (2012) mHealth consumer apps: the case for user-centered design. *Biomedical Instrumentation & Technology* 46(s2): 49-56.

Mead MP and Irish LA (2022) The theory of planned behaviour and sleep opportunity: an ecological momentary assessment. *Journal of Sleep Research* 31(1): e13420.

Phillips Global Sleep Survey (2018*)* Phillips. Available at: https://www.philips.com/c-dam/b2c/master/experience/smartsleep/world-sleep-day/2018/WorldSleepDaySurveyReport_2018.pdf

Pilkonis PA, Choi SW, Reise SP, Stover AM, Riley WT, Cella D and PROMIS Cooperative Group (2011) Item banks for measuring emotional distress from the Patient-Reported

Outcomes Measurement Information System (PROMIS®): depression, anxiety, and anger. *Assessment* 18(3): 263-283.

Rosenstock IM (1974) Historical origins of the health belief model. *Health Education Monographs* 2(4): 328-335.

Steinmetz H, Knappstein M, Ajzen I, Schmidt P, and Kabst R (2016) How effective are behavior change interventions based on the theory of planned behavior. *Zeitschrift für Psychologie* 224(3): 216-233.

Trahan T, Durrant SJ, Müllensiefen D, and Williamson, VJ (2018) The music that helps people sleep and the reasons they believe it works: A mixed methods analysis of online survey reports. *PLoS One* 14(13): e0206531.

van Brakel V, Barreda-Ángeles M and Hartmann T (2023) Feelings of presence and perceived social support in social virtual reality platforms. *Computers in Human Behavior* 139: 107523.

Table 1
Indirect Path Analyses Results

Study 1 (HBM)	Coeff.
susceptibility→SQ→depression	**.07[.02, .13]**
severity→ SQ→depression	.01[-.04, .05]
benefit→ SQ→depression	.01[-.02, .06]
barrier→ SQ→depression	**.09[.05, .15]**
cue to action→ SQ→depression	-.02[-.06, .02]
self-efficacy→ SQ→depression	**-.08[-.15, -.04]**
susceptibility→ SQ→anxiety	**.09[.03, .17]**
severity→ SQ→anxiety	.01[-.05, .07]
benefit→ SQ→anxiety	.02[-.03, .08]
barrier→ SQ→anxiety	**.12[.07, .19]**
cue to action→ SQ→anxiety	-.02[-.08, .03]
self-efficacy→ SQ→anxiety	**-.11[-.19, -.05]**
susceptibility→ SQ→well-being	**-.05[-.14, -.09]**
severity→ SQ→well-being	-.01[-.04, .03]
benefit→SQ→well-being	-.01[-.06, .02]
barrier→SQ→well-being	**-.07[-.14, -.02]**
cue to action→SQ→well-being	.01[-.02, .06]
self-efficacy→SQ→well-being	**.07[.02, .15]**
Study 2 (TPB)	**Coeff.**
attitude→BI→SQ→depression	**-.02[-.04, -.01]**
injunctive norm→BI→SQ→depression	**-.02[-.04, -.003]**
descriptive norm→BI→SQ→depression	**-.01[-.03, -.01]**
behaviour control→BI→SQ→depression	**-.02[-.03, -.01]**
attitude→BI→SQ→anxiety	**-.02[-.04, -.01]**
injunctive norm→BI→SQ→anxiety	**-.02[-.04, -.003]**
descriptive norm→BI→SQ→anxiety	**-.01[-.03, -.01]**
behaviour control→BI→SQ→anxiety	**-.02[-.03, -.01]**
attitude→BI→SQ→well-being	**.02[.01, .04]**
injunctive norm→BI→SQ→well-being	**.01[.003, .04]**
descriptive norm→BI→SQ→well-being	**.01[.005, .03]**
behaviour control→BI→SQ→well-being	**.02[.01, .03]**
attitude→BI→SQ	**-.19[-.35, -.08]**
injunctive norm→BI→SQ	**-.17[-.37, -.02]**
descriptive norm→BI→SQ	**-.16[-.29,-.06]**
behaviour control→BI→SQ	**-.20[-.31, -.11]**

Note: 95% CI is presented in the square bracket next to each coefficient. Coefficients with confidence intervals that do not contain zero are bolded. SQ=sleep quality; BI=behavioural intention.
Study 1: $R^2_{depression}$ = .19. $R^2_{anxiety}$ = .32. $R^2_{well\text{-}being}$ = .17
Study 2: $R^2_{depression}$ = .20. $R^2_{anxiety}$ = .17. $R^2_{well\text{-}being}$ = .17

Table 2

Distribution of Popular Remedies Use to Improve Sleep Quality (Study 1 & 2)

	Study 1		Study 2	
	Yes (%)	No	Yes (%)	No
Bedtime/wake-up schedule	132 (45%)	164	153 (45%)	188
Soothing music	81 (27%)	215	97 (28%)	244
Improved air quality of room	85 (29%)	211	81 (24%)	323
No caffeine after a certain time	74 (25%)	222	95 (28%)	246
Over-the-counter sleep aids	72 (24%)	224	82 (24%)	259
No electronics after a certain time	69 (23%)	227	73 (21%)	268
Marijuana	63 (21%)	233	75 (22%)	266
No eating after a certain time	54 (18%)	242	58 (17%)	283
Essential oil	35 (12%)	261	36 (11%)	305
Meditation	24 (8%)	272	36 (11%)	305
Alcohol	19 (6%)	277	24 (7%)	317
Mobile device application	19 (6%)	277	24 (7%)	317
Other	14 (5%)	282	15 (4%)	326
Prescription medication	13 (4%)	283	18 (5%)	323
CBD oil	8 (3%)	288	7 (2%)	334

Table 3
Popular Remedies Path Analysis Results (Study 1 and 2)

	Coeff. (Study 1)	Coeff. (Study 2)
Direct Paths with Sleep Quality as Outcome		
music→SQ	.02[-.81, .76]	**1.02[.21, 1.74]**
bedtime→SQ	-.08[-.79, .72]	-.50[-1.17, .17]
meditation→SQ	.83[-.50, 2.54]	.45[-.53, 1.37]
sleep aids→SQ	**3.08[2.18, 3.94]**	**2.75[1.98, 3.57]**
medication→SQ	**3.32[1.89, 5.60]**	**4.27[1.80, 6.47]**
air quality→SQ	-.15[-.94, .65]	.40[-43, 1.34]
marijuana→SQ	**1.11[.27, 2.02]**	.26[-.58, 1.02]
CBD oil→SQ	1.66[-1.52, 5.11]	2.03[-1.66, 5.67]
essential oil→SQ	.43[-.67, 1.64]	.36[-.50, 1.55]
alcohol→SQ	1.36[-.29, 2.84]	**2.30[.67, 3.84]**
app→SQ	1.17[-.21, 2.96]	.56[-.94, 2.10]
no electronics→SQ	-.01[-.86, .78]	.87[-.06, 1.69]
no eating→SQ	.54[-.30, 1.33]	.78[-.19, 1.95]
no caffeine→SQ	-.25[-1.05,.54]	.16[-.61, .96]
other→SQ	.58[-.75, 1.76]	**1.95[.47, 3.20]**
Indirect Paths with Mental Health & Well-being Outcomes		
music→SQ→depression	.002[-.08, .08]	**.10[.03, .19]**
bedtime→SQ→depression	-.01[-.08, .07]	-.05[-.13, .01]
meditation→SQ→depression	.08[-.05, .26]	.04[-.06, .15]
sleep aid→SQ→depression	**.31[.20, .44]**	**.27[.19, .40]**
medication→SQ→depression	**.33[.12, .61]**	**.43[.19, .72]**
air quality→SQ→depression	-.01[-.10, .07]	.04[-.03, .12]
marijuana→SQ→depression	**.11[.03, .22]**	.03[-.06, .10]
CBD oil→SQ→depression	.18[-.14, .53]	.20[-.14, .63]
essential oil→SQ→depression	.04[-.07,.17]	.04[-.05, .18]
alcohol→Q→depression	.14[-.02, .31]	**.23[.07, .43]**
app→SQ→depression	.12[-.02, .32]	.06[-.09, .22]
no electronics→SQ→depression	-.001[-.09, .08]	.09[-.001, .18]
no eating→ SQ→depression	.05[-.03, .14]	.08[-.01, .21]
no caffeine→ SQ→depression	-.02[-.11, .05]	.02[-.06, .09]
other→ SQ→depression	.06[-.07, .18]	**.19[.06, .35]**
music→SQ→ anxiety	.002[-.11, .10]	**.10[.02, .19]**
bedtime→SQ→ anxiety	-.01[-.11, .09]	-.05[-.13, .01]
meditation→SQ→ anxiety	.11[-.06, .33]	.04[-.06, .15]
sleep aid→SQ→ anxiety	**.41[.27, .60]**	**.27[.16, .40]**
medication→SQ→ anxiety	**.45[-17, .81]**	**.41[.17, .74]**
air quality→SQ→ anxiety	-.02[-.13, .09]	.04[-.04, .12]
marijuana→SQ→ anxiety	**.15[.04, .29]**	.03[-.06, .10]
CBD oil→SQ→ anxiety	.24[-.19, .70]	.20[-.14, .63]

Table 3 continued

Indirect Paths with Mental Health & Well-being	Coeff. (Study 1)	Coeff. (Study 2)

Outcomes		
essential oil→SQ→ anxiety	.06[-.09, .22]	.03[-.05, .16]
alcohol→SQ→ anxiety	.18[-.03, .40]	**.22[.07, .41]**
app→SQ→ anxiety	.16[-.02, .42]	.05[-.08, .22]
no electronics→SQ→ anxiety	-.001[-.11, .11]	.08[.003, .19]
no eating→SQ→ anxiety	.07[-.03, .19]	.08[-.02, .19]
no caffeine→SQ→ anxiety	-.03[-.14, .07]	.02[-.06, .09]
other→SQ→ anxiety	.08[-.09, .25]	**.19[.06, .36]**
music→SQ→ well-being	-.002[-.10, .10]	**-.15[-.28, -.04]**
bedtime→SQ→ well-being	.01[-.09, .11]	.08[-.02, .19]
meditation→SQ→ well-being	-.10[-.34, .16]	-.07[-.22, .08]
sleep aid→SQ→ well-being	**-.39[-.59, -.22]**	**-.42[-.60, -.27]**
medication→SQ→ well-being	**-.42[-.83, -.15]**	**-.65[-.1.11, -.27]**
air quality→SQ→ well-being	.02[-.08, .12]	-.06[-.19, .05]
marijuana→SQ→ well-being	**-.14[-.31, -.03]**	-.04[-.16, .09]
CBD oil→SQ→ well-being	-.22[-.72, .17]	-.31[-.93, .24]
essential oil→SQ → well-being	-.05[-.24, .08]	-.05[-.25, .07]
alcohol→SQ→ well-being	-.17[-.41, .02]	**-.35[-.64, -.10]**
app→SQ→ well-being	-.15[-.43, .02]	-.09[-.34, .12]
no electronics→SQ→ well-being	.001[-.10, .11]	-.13[-.27, .003]
no eating→SQ→ well-being	8.60[-4.73, 21.30]	12.43[-3.11, 31.12]
no caffeine→SQ→ well-being	.03[-.07, .15]	-.02[-.14, .08]
other→SQ→ well-being	-.07[-.25, .08]	**-.30[-.53, -.10]**

Note: 95% CI is presented in the square bracket next to each coefficient. Coefficients with confidence intervals that do not contain zero are bolded. Music=soothing music. Sleep aid=over-the-counter sleep aids. Medication=prescription medication. Bedtime=bedtime/wake-up schedule. Air quality=improved air quality of room. App=mobile device application. No electronics=no electronics after a certain time. No eating=no eating after a certain time. No caffeine=no caffeine after a certain time. SQ=sleep quality.
Study 1: $R^2_{depression}$ = .20, $R^2_{anxiety}$ = .29, $R^2_{well\text{-}being}$ = .13
Study 2: $R^2_{depression}$ = .26, $R^2_{anxiety}$ = .21, $R^2_{well\text{-}being}$ = .20

Figure 1
Direct Path Coefficients (Study 1)

Figure 2.
Direct Path Coefficients (Study 2)