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Sleep Predicts Collegiate Academic Performance: Implications for Equity in Student Retention and Success

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KEYWORDS

• Academic success • Sleep quality • Retention • Social determinants of health • Sleep environment

KEY POINTS

- Multiple aspects of sleep, including total sleep time, sleep schedule regularity, chronotype, and nap behavior, predict academic success.
- Sleep quality is a barometer of social capital on college campuses; ethnic, racial, and sexual majority students have better sleep, as do students without histories of trauma, harassment, disability, and adverse childhood experiences.
- Sleep intervention programs, especially those that include in-depth sleep education and cognitive behavior therapy for insomnia, are successful at improving some components of student sleep.
- Improving sleep through screening, education, and improving the social and physical environments of college residences has potential to reduce educational and health disparities.

INTRODUCTION

Mary Carskadon described sleep in adolescence as the "perfect storm" of factors that impair sleep: a biological phase delay and decreased sensitivity to the homeostatic sleep drive, coupled with zeitgebers that delay sleep and necessitate early awakening.[1] Chief among these are increased use of screen-based media[2] and early high school start times, 90% of which are out of compliance with US Centers for Disease Control and Prevention recommendations.[3] These conditions have created a generation of young adults who enter college without an embodied understanding of what it feels like to be well-rested.

This perfect storm continues to rage in college, when students face additional challenges to their sleep. Sleep measures, including weekday total sleep time (TST), sleep efficiency, sleep latency, and sleep time variability, worsen in the 3 years following high school graduation.[4] This review describes the evidence linking poor sleep with impaired academic performance; discusses mediating environmental, behavioral, and demographic factors; and highlights examples of successful health promotion initiatives. Given that students who are traditionally minoritized on college campuses tend to have worse sleep, improving sleep health emerges as an important issue for retention, equity, and inclusion.

Normative Sleep in College Students

The general consensus is that most young adults need 7 to 9 hours of sleep a night for optimal restoration and performance.[5] However, most college students report chronic insufficient sleep. Data from the spring 2018 undergraduate reference report of the American College Health Association National College Health Assessment-IIc (ACHA-NCHA), a comprehensive health survey of 140 colleges and universities in the United States

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(n>70,000), show that 45% of students report getting enough sleep to feel rested fewer than 3 days a week.[6] In addition more than a third identified sleep difficulties as "traumatic or very difficult to handle"; only academics and finances were ranked as more problematic.[6] In addition to insufficient sleep, college students also report excessive daytime sleepiness and poor sleep quality, with most students endorsing scores more than 5 on the Pittsburgh Sleep Quality Index (PSQI).[7–9]

Despite the widespread evidence of poor sleep among college students, only about a quarter of students report having received any health information regarding sleep from their universities.[10] Sleep ranks second to last of 19 health-related topics undergraduate students report receiving information about.[6] Thus, sleep health represents an underused area to address in health promotion.

SLEEP AND ACADEMIC PERFORMANCE

More than 23% of students identify sleep problems as impediments to their academic success, third after stress (35.3%) and anxiety (28.1%). Multiple single-institution and multi-institution cross-sectional and longitudinal studies show a positive relationship between sufficient, good-quality sleep and academic success. Taylor and colleagues[11] used a prospective sleep diary approach (n = 867) to compare unique contributions of sleep problems to grade point average (GPA), controlling for health variables, high school GPA, and standardized test scores. TST and sleep schedule inconsistency emerged as the most significant predictors of academic success after high school GPA and standardized test scores, with students sleeping less than 6 or more than 9 hours a night achieving the lowest grades. Similarly, a Portuguese study (n = 1654) found that sufficient sleep was the third most important variable in predicting grades, after previous academic achievement and class attendance.[12] In a longitudinal study of more than 3000 students, those who endorsed frequent sleep deprivation in their first year had lower GPAs, 4-year graduate rates, and development of leadership skills than those who said they were only rarely or occasionally sleep deprived.[13,14]

In addition to TST, sleep quality and more consistent sleep/wakefulness schedules have been linked to academic success. Students with higher GPAs were less likely to oversleep (n = 231)[15] and had greater sleep schedule regularity (n = 61)[16] than students with lower GPAs. A prospective semester-long study of 88 students in the same introductory chemistry class found that TST, sleep schedule regularity, and sleep quality (as measured by a Fitbit algorithm) over the semester accounted for a 25% of the variance in students' course performance. Sleep on the night before exams were not predictive of next day performance.[17] A detailed analysis of the spring 2009 ACHA-NCHA dataset (n = 55,322) found that for each additional day per week an undergraduate student reported a sleep problem (eg, daytime sleepiness, difficulty falling asleep, waking up too early), the student's cumulative GPA decreased by 0.02 and the likelihood of dropping a course increased 10%, holding all other variables (eg, demographic, health, and time use demands) constant.[10]

Experimental Studies on Sleep and Learning

Healthy sleep supports students' learning capacity. In short, sleep loss is associated with poor procedural and declarative learning, and manipulation by sleep deprivation or extension worsens or improves, respectively, performance on a variety of prefrontal cortex-dependent neurocognitive tasks.[18] Teens (n = 56) assigned to 2 weeks of 9 hours in bed outperformed those assigned to 5 hours in bed on learning GRE vocabulary words on examinations the same day, 1 day, and 5 days after studying.[19] The sleep-restricted teens also showed deterioration in mood, working memory, sustained attention, and executive function.[20] In classroom studies, actigraphy-measured sleep parameters in the week between a lecture and examination accounted for 13% of the variance in scores, with short TST and later bedtimes associated with worse performance (n = 78).[21] Sleep extension challenges for extra credit (students showing $\geq$8 hours of TST per night in the week leading up to an examination) increased test performance, controlling for previous performance in the class.[22]

Sleep Disorders and Academic Performance

Sleep disorders are likely underdiagnosed in the college population. Only 3.7% of undergraduates report having been diagnosed or treated in the last year for insomnia, and 2.5% for any other sleep disorder. The SLEEP-50 Questionnaire screens for those at risk for sleep disorders, including obstructive sleep apnea (OSA), insomnia, narcolepsy, circadian rhythm disorders, parasomnias, and poor sleep hygiene.[23] In a cross-sectional study of students (n = 1845), the 27% who screened positive for possible sleep disorders on this scale were significantly more likely to have GPAs less than 2.0.[24] In a prospective 3-year study using the same instrument (n = 900), the 40% of students who screened positive for sleep disturbances as first-year students had lower GPAs and retention rates over the next

2 years than those who did not.[25] A separate study found that students at high risk of OSA (5%) had twice the rate of poor academic performance of their peers.[26] Screening students for sleep disorders offers an important opportunity for addressing both the health and academic success of college students.

Chronotypes and Academic Performance

First-year college students, who often have a disproportionately number of early-morning classes, have the latest bedtimes and shortest TSTs,[7] and the impact of poor sleep on academic success is 40% more pronounced for first-year students than for the general population.[10] A survey of 500 students from 2 UK universities found that first-year students in particular endorsed excessive sleepiness and a desire to start university class times 2 hours later.[27] Students with evening chronotypes, who often need to take classes at their nonpreferred learning times, are at a distinct academic disadvantage and have reduced weekday sleep quality compared with morning types.[28–31] Changes to align school start times with teens' circadian rhythms increase objectively measured weekday TSTs[29] and improve attendance and well-being in high school students.[30] At the university level, starting the academic day 50 minutes later at the US Air Force Academy resulted in improvement in grades for classes throughout the day.[31]

Physical Health

Some of the relationship between poor sleep and reduced academic performance is likely mediated by physical health. The connection between immune dysfunction and susceptibility to contagious illness is well documented.[32] Approximately 20% of undergraduates report negative academic consequences because of acute illness and an additional 2.5% because of injury.[6] A months-long prospective actigraphy study of high school students found that those who contracted acute illnesses had shorter TST overall, as well as shorter TST in the week leading up to the illness.[33] High school and college students who report sufficient sleep also report fewer orthopedic[34] and concussion[35] sports injuries, better glucose management,[36] and higher overall physical well-being.[7,37]

SLEEP HYGIENE CONSIDERATIONS

Residential Sleep Environment

Physical elements of the sleep environment, including air, noise, and light pollution, contribute to poor sleep quality.[38] Social elements such as a neighborhood's safety, walkability, and trust in neighbors are associated with better sleep.[38,39] The sleep environment for college students is notoriously cramped, noisy, and imbued with complicated social relationships. Sexton-Radek and Hartley[40] provide a wealth of information in their informative mixed methods study on sleep in the college residences. The most common environmental disturbances to sleep were in-room noise, sunlight, hallway noise, and heat; sleep efficiency negatively correlated with scores on the Young Adult Sleep Environment Inventory. Both surveys and in-depth interviews with first-year residential students emphasized noise and complex social relationships as major impediments to sleep.[41,42] Students' preferred strategies for improving sleep (eg, watching television, using alcohol, over-the-counter or prescription drugs) were often at odds with best practices in sleep hygiene.[43]

Electronics

Widespread use of electronics at night is ubiquitous, and common practices like online assignments due at midnight tacitly promote late night electronic use in college students. Screen-based media use compromises adolescent sleep through time displacement, psychological stimulation, and light-induced delays in the circadian timing system.[44,45] Two international studies have found that more than 20% of students meet the criteria for smartphone addiction, and more than 33% report negative sleep consequences from smartphone use.[46,47] A naturalistic study of 83 college students' text message habits showed that, over the course of a week, poorer subjective sleep quality was related to increased daily social media use and receiving nighttime notifications.[48] In a detailed path analysis (n>700), Rosen and colleagues[49] showed that the connection between emotional distress and sleep problems was partially mediated via smartphone usage. Research on the effectiveness of various health promotion strategies to improve sleep via healthier screen-based media strategies is warranted.

Naps

Daytime sleep is common among college students, both inadvertently falling asleep during class (>15%)[7] as well as taking intentional naps. A detailed factor analysis (n = 450) found that 50% of students napped at least once a week, and those who napped for restoration (as opposed to emotional reasons) reported better overall quality sleep.[50] Another cross-sectional survey of 440 students found that those who napped more than 3 times a week, for longer than 2 hours, or later than 6 PM had lower sleep quality than those

with healthier nap behaviors.[51] Longer and later naps can reduce sleep pressure and contribute to circadian dyssynchrony, but students tend not to attribute sleep disturbances to naps.[52]

Psychoactive Substance Use

Alcohol misuse is widespread, with more than 25% of students reporting high-risk drinking in the last 2 weeks[6] and 89% reporting secondhand harm (eg, threat of violence, disruption to sleep or studies) from someone else's alcohol use in the past 30 days.[53] In the last year, more than 20% of the undergraduate population reported taking prescription psychiatric medication, and at least half as many reported nonmedical use (NMU) of prescription medications.[6] NMU of prescription stimulants and sedatives by college students has increased since 2003, and NMU eclipses prescribed use.[54] In the 2018 ACHA-NCHA, approximately 1 in 5 students reported cannabis use in the last month,[6] a figure that is expected to increase as more states decriminalize medical and recreational cannabis. A study in Canada, where medicinal cannabis has been legal since 2001, found that, of the 11% of students who were medicinal marijuana users, 80% used it for mental health conditions not included in prescribing guidelines, 85% used it recreationally, and 14% met the criteria for cannabis use disorder.[55] Last-month use of tobacco products was about 10% for undergraduates, with e-cigarettes more commonly used than cigarettes or other forms of tobacco.[6] Given the widespread use of recreational and prescription drugs by college students, sleep hygiene discussions in this population must include the impact of such substances, all of which alter sleep neurophysiology.

Self-Medication of Fatigue and Insomnia

Substantial evidence supports widespread self-medication to both induce sleep and promote wakefulness among college students. Students with greater insomnia symptoms and/or shorter TSTs are more likely to report using tobacco,[56] energy drinks,[57,58] NMU of prescriptions drugs,[59,60] alcohol,[61] and cannabis.[62,63] Sleep disorders and substance use disorders are well documented to interact in a feed-forward system, whereby substance use disrupts sleep, and disrupted sleep promotes substance misuse.[64] A two-wave longitudinal survey (n = 171) found that 25% of students reported substance use to promote sleep at least once in the last 2 weeks.[61] Students with high PSQI scores are twice as likely to report using alcohol to get to sleep, and students who report drinking to promote sleep consume ~40% more drinks a week than those who drink for social reasons.[7] In multivariate regression studies, regular tobacco use emerges as the pharmacologic factor most predictive of both bad sleep[56,65] and academic problems.[10] Given that problematic substance use independently predicts reduced academic success, albeit on levels less than or on par with sleep disturbances,[10] it is likely that substance use partially mediates the connection between sleep and academic performance.

DEMOGRAPHIC FACTORS IN SLEEP QUALITY

Ethnicity and Discrimination

Sleep quality can serve as a barometer for social capital in a particular society. People who experience material hardships (eg, employment instability, financial problems, housing instability, food insecurity, forgone medical care), discrimination, and trauma have reduced TSTs and worse sleep quality than the general population.[66,67] Also, experiencing racial discrimination independently predicts sleep disturbance, after controlling for multiple covariates (odds ratio [OR], 1.60).[68] More than 44% of black students at primarily white institutions seeking support from counseling services (n = 1500) reported being at least moderately distressed by racial discrimination.[69] In regression analyses, the level of perceived racial discrimination accounted for 37% of the variance in the presenting problems checklist, and was associated with lower-quality sleep.[69] For American Indian college students (n = 90), sense of belongingness to the university community predicted better actigraphy-measured sleep, including TST, sleep efficiency, and global subjective sleep quality.[70] These findings underscore the need to consider the social environment as a significant predictor of sleep, especially for individuals who are minorities in the social context of the university.

Poverty and Economic Insecurity

Studies in college students support the strong associations between economic security and sleep quality. Food insecurity is widespread on college campuses, with estimates of ~40% either experiencing or being at risk for food insecurity, and is correlated with fewer days a week with sufficient sleep and greater odds of poor sleep quality (OR, 2.32).[71–76] Food-insecure students were also more likely to report high stress (OR, 4.65), and a GPA < 3.0 (OR, 1.91). Black and Latinx students[74] and students who were Pell-grant recipients or living off campus[75] were most likely to be food insecure.

Work obligations are also important mediators of sleep, well-being, and academic success. More than 60% of undergraduates work while taking classes, and, of those, 36% work 20 hours or more a week.[6] A 5-day actigraphy study of sleep in full-time working students found mean weekday TSTs less than 6 hours.[72] Barone[73] frames working students as exploiting their so-called health capital as a trade-off for economic stability. In structured interviews with 19 working students, students reported being aware of their excessive tiredness, and of the connection between sleep and health, but were resigned to prioritizing sleep last in their schedules.[73]

Gender, Sexuality, and Gender-Based Violence

Gender, gender-based violence, and sexual minority status predict multiple aspects of sleep. In the 2018 ACHA-NCHA, 35.7% of college women reported that their sleep problems were traumatic or very difficult to handle, compared with 28.5% of men,[6] and women tend to have lower sleep efficiency, longer sleep latencies, and more sleep disturbances than men.[7,9] Sexual harassment and assault are linked to 36% increased odds for reporting worse sleep[74] and greater nightmares and insomnia,[75] and, among female undergraduates, 7% report stalking, 9% report abusive relationships, and 13% report unwanted sexual touching in the last 12 months.[6] In teens, sexual minority status is associated with increased odds of very short ($\leq$5 hours) TST, and this relationship is mediated by experiences of victimization.[76]

MENTAL HEALTH

Sleep quality and mental health are intricately intertwined and bidirectional,[77,78] so chronic insufficient sleep and circadian disruption must be considered as both contributing to and a consequence of eroding mental health in college students. The uptick of mental health concerns among college students has been described as a crisis and epidemic[79]; between 2011 and 2015 there was a 53% increase in adolescent psychiatric emergency department visits.[80] This rate mirrors the increasing population of adolescents over the last decade who report insufficient sleep.[2] A UK national health survey showed that, between 2005 and 2015, the percentage of 14-year-olds reporting less than 8 hours of TST doubled, and there was ~50% increase in depression, emotional distress, and self-harm, but a decrease in hazardous substance use.[81] Among college students, there was a 22% increase between 2009 and 2018 in those reporting significant difficulties in daytime sleepiness and a 37% increase in those describing their sleep problems as traumatic or very difficult to handle.[6] More population-level research is needed understand the unique contributions of insufficient sleep to the increase in mental distress.

Sleep disturbances are clinically relevant for both the evaluation and treatment of mental health concerns. Fragmented sleep and increased wake after sleep onset serves as a transdiagnostic imbalance in the arousal system, and alterations in delta power and rapid eye movement sleep pressure are present in most mental illnesses other than seasonal affective disorder and attention-deficit/hyperactivity disorder (ADHD).[82] Attention disorders are characterized by shorter TSTs,[83] but, because the symptoms of chronic insufficient sleep mirror ADHD, it can be difficult to dissociate the two diagnostically.[84] Fragmented sleep, sleep hallucinations, and insomnia symptoms are linked with student reports of psychosislike experiences.[85] It is unlikely that most student mental health providers include a thorough assessment of sleep behaviors on intake, although this information would be helpful for accurate diagnosis and treatment.

Depression/Anxiety

Approximately one-third of students have been diagnosed or treated by a professional in the last year for depression and/or anxiety.[6] Results from a 6-campus survey (n>7000) found that although both anxiety and depression were associated with decreased sleep quality on a variety of PSQI subscales, anxiety symptoms were uniquely associated with more sleep disruptions and sleep medication use, whereas depressive symptoms were more associated with daytime dysfunction.[9] However, the PSQI shows poor divergent validity discrimination with anxiety, depression, and perceived stress in college students.[86] A study of the spring 2011 ACHA-NCHA dataset added to the literature by including students who self-reported high levels of emotional distress but who had not yet interacted with a health care provider. Of the students reporting severe emotional distress, only 45% had received a diagnosis and 35% had received treatment from a professional in the last year.[56] Clinically relevant depression or anxiety symptoms, or comorbid symptoms, were associated with a ~1 d/wk and a ~1.5 d/wk increase, respectively, in sleep disturbances compared with nonsymptomatic students. Because daytime sleepiness predicts both severe mental distress and lower academic achievement,[87] these changes in sleep quality have important implications for academic success.

Sleep and Behavioral Health Feedback Loops

Sleep disruptions exacerbate the symptoms of mental illness,[88] and mental illnesses impair sleep.[89,90] Among college students, the most commonly reported barrier to sleep is stress,[7] and poor sleep enhances physiologic responses to stressors.[91–93] Prospective population studies show that disturbed sleep is a risk factor for onset, exacerbation, and relapse of mood disorders in adolescents,[88] and that sleep disturbances, including insomnia and insufficient sleep, predict social anxiety, substance use, loneliness, social withdrawal, depression, and suicidal thoughts,[88,94–96] which 13% of undergraduates report.[6] Two actigraphy studies have shown prospective relationships between poor sleep (sleep timing variability, short sleep, insomnia) and subsequent suicidal ideation,[97] and sleep variability was a better longitudinal predictor of suicidal ideation than depressive symptoms in students at risk for suicide.[98]

However, the converse is also true: healthy sleep is a protective mental health factor for well-being in both clinical and nonclinical populations,[99,100] and treating insomnia improves depression and anxiety symptoms.[101,102] Although students with higher levels of adverse childhood experiences (ACEs) show greater sleep impairment than their peers,[103] sleep quality mediates the relationship between ACEs and multiple measures of physical and mental health.[104] Further research is needed on the capacity of sleep to serve as a modifiable protective mental health factor in college students.

SLEEP HEALTH PROMOTION

The disconnect between students who desire information from their universities regarding sleep health (60%) and those receiving it (25%)[10] suggests room for improvement in health promotion. Unless clinicians complete additional training in sleep or behavioral sleep medicine, it is unlikely they will receive more than a few hours of education about sleep in either medical school or clinical psychology doctoral programs.[105,106] According to the 2018 Center for Collegiate Mental Health annual report, of 11,000 students who indicated sleep disturbances on intake, only 44 had that concern prioritized by clinicians.[107] College health communities could improve their practices by offering continuing education opportunities about sleep for college health providers.

In spring 2019, the National Collegiate Athletic Association (NCAA) issued its first consensus statement regarding sleep in collegiate varsity athletes,[108] and it is likely that more organizations will follow suit. The top recommendations included sleep screening and evidence-based education programs for both student-athletes and athletic staff members. When sleep questions are included as part of a universal behavioral health screening program, more than 10% of students request support for their sleep concerns.[109] Screening for disturbances in students' sleep in health services intake questionnaires, athlete preparticipation examinations, and as part of academic advising appointments could identify students with undiagnosed sleep disorders and those most in need of behavior sleep medicine.

Intervention Studies

Experimental studies of the impact of sleep education on sleep behaviors have ranged from studies of simple text messages and public media campaigns to intensive, semester-long courses on sleep.[8,110] Several before-after studies have shown that students report reduced sleep latency, fewer maladaptive beliefs about sleep, and a better understanding of sleep hygiene practices after receiving sleep education from an educational Web site with personalized feedback,[111] or a 3-hour in-person course.[112] Two months after taking a full-semester course on sleep, students showed better sleep hygiene and reduced sleep latency, as well as improved symptoms of depression and anxiety, compared with students taking another psychology class.[113]

A recent systematic review found that education about sleep hygiene was associated with modest effect sizes in improving student sleep, but cognitive behavior therapy for insomnia (CBTi) interventions were much more effective.[114] In college students, rumination and repetitive negative thinking mediate the relationship between stress and sleep quality,[90,115] and subjective stress explains more of the variance in students' PSQI scores than do sleep hygiene factors.[7] Low-cost digital delivery of CBTi improves both sleep and mental health outcomes in college students,[116] and an e-mail–delivered CBTi program outperformed a stress management module of similar length.[117]

SUMMARY

Sleep health emerges as an underused, highly requested, cost-efficient way to improve students' well-being and academic performance.[118] A research challenge for any examination of student success will be to sufficiently address multicollinearity among behavioral, social, and environmental variables that correlate with sleep. As university staff and administrators work toward reducing racial, ethnic, gender, and socioeconomic

disparities in measures of academic success, they would be well served to prioritize Maslow's hierarchy of needs and Bloom's taxonomy.

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The author has nothing to disclose.

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