DEVELOPMENT AND VALIDATION OF A UNIVERSAL SLEEP SCREENER FOR COLLEGE STUDENTS

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ABSTRACT

Sleep problems are highly prevalent in adolescents, especially for college students. Students with poor sleep quantity and quality are at-risk for various academic, behavioral, and medical problems. Universal sleep hygiene screeners may help detect students who need more support with sleep habits and prevent future negative outcomes associated with inadequate sleep. Self-report data were collected from a sample of 292 university students on sleep hygiene behaviors and typical bedtimes and wake times using the *Adolescent Sleep Hygiene Scale, revised* (ASHSr). Students also completed rating scales related to excessive daytime sleepiness and health-related quality of life factors. Using confirmatory factor analysis, a sleep hygiene questionnaire for the university setting (ASHS-College) was established. Items were further eliminated to create the ASHS-Screener. Based on a receiver operator characteristic analysis, the ASHS-College and ASHS-Screener yielded high diagnostic accuracy with a measure of excessive daytime sleepiness. An ASHS-College cut score of 3.07 and ASHS-Screener cut-score of 2.50 yielded adequate sensitivity and specificity, although the false-positive rate was high. Support for concurrent and convergent validity was observed through comparison with other self-reported data. Implications for research and practice are discussed.

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CHAPTER I: INTRODUCTION & LITERATURE REVIEW

The concept of prevention, as used in public health, suggests the necessity of efforts to screen, identify those at-risk, and treat early problem indicators. The high prevalence of sleep problems is a public health concern, especially for adolescents and young adults. Approximately 60% of high school and college students do not obtain the recommended amount of sleep (Cassoff et al., 2013). Consistently, 60% of college students endorse daytime sleepiness on at least three days out of a typical week (Hershner & Chervin, 2014; American College Health Association, 2019). Poor sleep correlates with short-term and long-term challenges, including academic problems, medical problems (e.g., obesity), behavioral challenges (e.g., impulsivity), and mental health challenges (e.g., suicidal ideation; Friedrich & Schlarb, 2017; Lund et al., 2010). Although various methods to assess sleep exist, few options are available for screening sleep problems among adolescents, and the available screeners have not been validated for use as part of universal screening protocols within the university setting. This dissertation project addresses this gap. Table 1 defines terms that are important to this literature review and study and will be used frequently throughout the dissertation.

Table 1

Sleep-Related Definitions

Term	Definition
Excessive Daytime Sleepiness (EDS)	Reduced ability to remain awake or alert during the daytime (Young, 2004)
Sleepy Debt/ Deficit	The discrepancy between the amount of sleep one needs and the amount of sleep obtained accumulates after multiple days of sleep loss (Basner et al., 2007)

Term	Definition
Sleep Duration	The amount of time an individual spends sleeping (Adelantado-Renau et al., 2019) For example, if one falls asleep at 9:00 pm and wakes up at 6:00 am, their sleep duration equals 9 hours
Sleep Efficiency	Percent of time spent sleeping while in bed (Hargens et al., 2021) For example, out of the nine hours someone spends in bed, three hours are spent on their phone, and six hours are spent sleeping. Consequently, the sleep efficiency would equal (6/9)x100 = 66.67%
Sleep Onset Latency	The amount of time it takes to fall asleep (Shrivastava et al., 2014) For example, if someone turns out the lights and gets into bed at 9:00 pm and falls asleep at 9:30 pm, they have a sleep onset latency of 30 minutes.
Sleep Quality	How well the individual reports sleeping (Adelantado-Renau et al., 2019)
Sleep Hygiene	Behaviors and environmental factors that influence sleep quality and quantity (e.g., avoiding screens at night, caffeine usage, consistent bedtime; Lawless et al., 2020; Stepanski & Wyatt, 2003)

Sleep Problems in Adolescents and College Students

Sleep problems are a public health concern for children and adolescents. In elementary school, one in three children exhibits sleep challenges. By high school, 60% of high school students obtain less than the recommended amount of sleep, and approximately 60% of college students consistently endorse inadequate sleep quality and quantity (Cassoff et al., 2013; Lund et al., 2010). Some research indicates that around 27% of college students possibly qualify for a sleep disorder, such as obstructive sleep apnea (OSA), narcolepsy, and restless leg syndrome. However, due to inconsistent research results and lack of assessment, the true prevalence of sleep disorders in college students is unclear (Gaultney, 2010). Alternatively, sleep problems, such as poor sleep duration, are highly prevalent in adolescents, even if they do not qualify for a sleep disorder (Cassoff et al., 2013). Most college students lack adequate sleep, and EDS is a common consequence of poor sleep duration. Approximately 50% to 60% of college students report experiencing continuous EDS, compared to 35% of adolescents and adults who are not enrolled in college (Hershner & Chervin, 2014; American College Health Association, 2019).

Poor sleep is correlated with a variety of negative outcomes in adolescents, including behavior problems (e.g., hyperactivity, impulsivity, risky decisions), emotional dysregulation, health concerns (e.g., obesity), and poor academic performance (Owens et al., 2014). Sleep problems are associated with various psychiatric diagnoses (e.g., major depressive disorder), medical diagnoses (e.g., anemia, hypothyroidism, chronic pain), and side effects of multiple medications (e.g., stimulants). Furthermore, challenges associated with certain medical and psychiatric conditions, such as executive functioning deficits associated with Attention-deficit/hyperactivity disorder (ADHD), can exacerbate sleep problems (Friedrich & Schlarb, 2017; Lund et al., 2010).

Despite the recognition that adolescent sleep problems are prevalent, linked to adverse outcomes, and comorbid with psychiatric and medical conditions, sleep screening and intervention rarely occur in the primary care setting, post-secondary education setting, or as part of psychological evaluations or interventions (Everhart, 2011; Owens et al., 2017). Self-report questionnaires may be a practical solution for screening and assessing sleep problems. However, brief screening measures are not well-established for adolescent sleep hygiene, particularly in university settings (Honaker & Meltzer, 2016; Everhart, 2011).

Factors Impacting Adolescent Sleep

A variety of factors play a role in adolescents' sleep outcomes. Copious amounts of schoolwork, pressure to earn high grades and maintain scholarships, employment, and social activities may push bedtimes later (Owens et al., 2014; Wheaton et al., 2016). Compared to younger children and older adults, adolescents often do not fall asleep until later in the evening due to biological factors. However, adolescents are still expected to maintain early start times for school, work, and extracurricular activities (Gilbert & Weaver, 2010; Lund et al., 2010).

The transition to college encompasses numerous factors that impact sleep, including routine changes, academic pressure, emotional stress, social opportunities, and inconsistent schedules (Lund et al., 2010; Liguori et al., 2011; Haile et al., 2017). When students transition from high school to college, their bedtime also shifts later. Compared with high school students, college students are estimated to fall asleep about 75 minutes later than their high school peers on school nights (Gilbert & Weaver, 2010). Freshmen report challenges balancing new social opportunities and academic course loads with sleep. Consequently, first-year students are more likely to sacrifice sleep duration for academic tasks and social experiences (Adams et al., 2017). As students become more experienced in college, research suggests sleep quality and duration improve. However, most students still do not obtain the recommended sleep duration (Doane et al., 2015). As discussed below, the sleep environment plays a significant role in sleep outcomes. Out of the college students who have roommates, 41% report nighttime awakenings due to noise from other people (Schlarb et al., 2017). An individual student may not be able to reduce noise levels in a dorm setting entirely. However, individual students can modify other sleep hygiene behaviors (e.g., using white noise machines), and universities may be able to make system-wide modifications (Hershner & Chervin, 2014).

Biological Factors

Biological factors contribute to poor sleep quality and quantity. Women are more likely to experience fatigue and EDS than men (Medic et al., 2017). Genetic factors also contribute to poor sleep and sleep disorders. For example, variations in the Period Circadian Regulator 3 gene have been linked to Delayed Sleep Phase Disorder (Zhang, 2016), estimated to impact 7% to

16% of individuals (American Academy of Sleep Medicine, 2014). Research suggests that over 50% of individuals with idiopathic restless leg syndrome have a positive family history. Furthermore, sleep disruptions have been associated with various neurotransmitter levels (e.g., norepinephrine, dopamine, catecholamine) and iron metabolism (Medic et al., 2017).

The circadian rhythm drastically impacts adolescent sleep. The biological circadian rhythm favors later bedtimes during puberty due to delayed melatonin released at night. The shift continues throughout adolescence, with most adolescents having trouble falling asleep before 11:00 pm (Carskadon & Acebo, 2002; Carskadon, 2011). Consequently, adolescents with early school and work start times are at an increased risk for sleep problems due to inadequate sleep durations (Lund et al., 2010).

Despite the well-recognized shift in circadian rhythm, students are expected to continue early morning schedules. Research indicates that early morning classes do not lead to earlier bedtimes (Lund et al., 2010). Adolescents' first obligation in the morning (e.g., class at 8:00 am) generally impacts their school week sleep duration (Paavonen et al., 2016). Thus, adolescents generally experience a sleep deficit of one to three hours on school nights (Lund et al., 2010). Poor school week sleep durations are followed by attempts to compensate for missed sleep on weekends, further disrupting sleep schedules and delaying the circadian rhythms (Paavonen et al., 2016; John et al., 2016).

Delaying school start times tends to lead to increased school week sleep durations. Students sleep longer when start times are postponed, as bedtimes remain consistent, but wake times occur later (Wheaton et al., 2016; Hershner & Chervin, 2014). Delaying high school start times has also been associated with lower automobile accidents, positive health and psychological outcomes, improved daytime alertness, better concentration, increased school attendance, and higher graduation rates (Danner & Phillips, 2008).

Sleep Hygiene Factors

Sleep hygiene is another predictor of sleep quality, sleep duration, and sleep onset latency, which refers to the time it takes an individual to fall asleep. Sleep hygiene includes behaviors related to maintaining consistent sleep schedules, along with behaviors occurring during the daytime (e.g., caffeine usage, exercise, napping) and nighttime (e.g., turning off bedroom lights; Tan et al., 2012; Bartel et al., 2015)

Sleep Schedules and Durations. Maintaining a consistent sleep schedule, often referred to as sleep stability, is essential for healthy sleep hygiene. Going to bed later is associated with longer sleep onset latency for adolescents. Adolescents who go to bed later and take longer to fall asleep tend to wake up later and sleep less during the school week (Tzischinsky & Shochat, 2011). Although some instability in wake times is not problematic, research indicates that wake times during the school week and weekends should only vary by two hours (Crowley & Carskadon, 2010). College students may be particularly vulnerable to inconsistent schedules, leading to irregular bedtimes and wake times (Lund et al., 2010; Gilbert & Weaver, 2010).

Adolescents with parent-set bedtimes at 10:00 pm or earlier are less likely to experience depression and suicidal ideation than adolescents with bedtimes at midnight or later (Fitzgerald et al., 2011). However, in the United States, about 48.20% of women and 41.80% of men, ages 18 to 24, report living outside their parent or caregiver's home (Owens et al., 2017). College students may not have parental support to help with bedtimes, even if they live in the same house. However, education about healthy sleep hygiene and problem-solving ways to maintain a consistent sleep schedule may improve sleep problems, resulting in fewer mood and behavior concerns.

Regarding sleep duration, adolescents ages 14 to 17 are recommended to sleep for eight to 10 hours. Older adolescents, ages 18 and older, are encouraged to obtain seven to nine hours of sleep. However, about 60% of university students consistently do not receive adequate sleep durations (Lund et al., 2010). Consistent with middle and high school students, research indicates that college students who start class later in the day tend to have longer sleep durations, less EDS, and improved class attendance (Onyper et al., 2012). Inadequate sleep duration during the school week can increase sleep difficulties, including night awakenings. In addition, adolescents who do not obtain adequate sleep during the school week tend to have longer sleep durations on the weekend, further contributing to delayed melatonin release (Crowley & Carskadon, 2010; Garmy & Ward, 2017).

In addition to stable bedtimes, wake times, and sleep durations, avoiding naps, particularly in the afternoon and evenings, is vital for maintaining a consistent sleep schedule. Previous research has observed unstable sleep schedules in college students who nap at least three times per week for more than two hours between 6:00 pm and 9:00 pm (Ye et al., 2015). Naps typically only provide temporary relief, as napping usually results in disrupted sleep due to an altered circadian rhythm. Compared to individuals who rarely nap, frequent nappers are more likely to fall asleep at school, go to bed later, sleep for shorter periods during the school week, and sleep for more extended periods on the weekend (Brown et al., 2002; Calamaro et al., 2009; Gilbert & Weaver, 2010). Despite the challenges associated with napping, naps are prevalent among adolescents. For example, in a group of adolescents 12 to 18 years old in Pennsylvania, 33% of the sample reported falling asleep a minimum of two times per day during school, 37% reported napping after school, and 42% reported taking weekend naps (Calamaro et al., 2009).

College students may have even more flexibility to incorporate naps during their day than high school students or adolescents not enrolled in college (Gilbert & Weaver, 2010). Napping for 10 minutes to 45 minutes may have benefits, including improved energy and emotional states. Previous research demonstrates that napping around 3:00 pm may be optimal to counteract decreased daytime arousal (Dhand & Sohal, 2007). However, research on the impact of brief afternoon naps on cognitive performance is inconsistent (Ru et al., 2019).

Sleep Environment. Maintaining a consistent and healthy sleep environment, which includes a comfortable room temperature, low noise level, and sufficient darkness, is essential to sleep hygiene (Noland et al., 2009). Poor Sleep Environment has been associated with negative sleep factors, including delayed sleep onset, increased night awakening, EDS, and sleep instability (Storfer-Isser et al., 2013; National Sleep Foundation, 2019). University students living in residence halls tend to have less control over their environment. The dorm environment may disrupt sleep due to increased outside lighting, different schedules among roommates, uncomfortable room temperatures, and loud noise (Qin & Brown, 2017).

Disruptive lights (e.g., phone screens, streetlights, dorm hallway lights) and noises (e.g., roommates talking, cars driving, loud music) can interfere with sleep quality by increasing sleep onset latency, delaying bedtimes, increasing night awakenings, and reducing sleep durations (Muzet, 2007; Hershner & Chervin, 2014). Bright lights can delay the circadian rhythm and suppress melatonin release (Cain & Gradisar, 2010), and adolescents appear to be more affected by melatonin suppression than adults (Liu et al., 2019a). Prior research suggests that 33.00% to 42.50% of college students endorsed noise interfering with sleep (Lund et al., 2010; American

College Health Association, 2019). Loud noises can lead to sleep disruptions, including delayed sleep onset, sudden and frequent night awakenings, and poor sleep quality. Noisy sleep environments may lead to more disrupted sleep and lower quality of life (Muzet, 2007).

Due to noise and light exposure, technology use contributes to unhealthy sleep hygiene habits (e.g., delayed bedtime), resulting in poor sleep. Even in dark rooms, the light from screens and noises from notifications worsen sleep disruptions (Mireku et al., 2019; Fossum et al., 2014). High school students who only text before turning their lights out endorse lower EDS than students who text after lights out (Grover et al., 2016). For adolescents 13 to 21 years old, increased technology use at bedtime and night awakenings due to cellphone notifications correlated with waking up earlier than planned and EDS (Johansson et al., 2016). Similarly, self-reported poor sleep quality in college students was significantly associated with increased daily text messages, awareness of phone notifications at night, and urges to check the notifications observed over seven days (Murdock et al., 2017). Previous research showed improvements in sleep quality, sleep duration, and night awakenings a week after students engaged in a 22-minute sleep hygiene intervention, including information about reducing technology usage around bedtime (Barber & Cucalon, 2017).

Research has indicated that college students with heavy technology usage tend to sleep less during the school week and more during weekends. Increased EDS can also lead to elevated screentime usage as students attempt to stay awake (Liu et al., 2019b). Using multiple forms of technology is associated with reduced sleep duration, increased fatigue during school, and elevated caffeine consumption than adolescents who use one screen at night (Liu et al., 2019a). The increased physiological arousal likely leads to more sleep disruptions and worse EDS (Liu et al., 2019b). Interactive use of technology, such as playing video games and engaging in social media conversations, can lead to heightened cognitive alertness, causing prolonged sleep latency when played around bedtime (Liu et al., 2019a). Li and Barkley (2015) suggest that college students with poor control over phone use at night tend to have later bedtimes, lower academic performance, and worse sleep quality than same-aged peers. In a study of 503 female college students, ages 15 to 22, moderate to severe internet addiction was associated with worse sleep quality than students with no to mild internet addictions (Lin et al., 2019).

Exercise. Along with maintaining a consistent sleep schedule, healthcare professionals commonly recommend regular exercise to improve sleep hygiene. Exercise is a typical recommendation to help prevent future problems (e.g., heart disease), cope with various medical problems (e.g., diabetes, pain, hypertension), and improve mental health symptoms (e.g., depression, anxiety, impulsivity, inattention; Glavin et al., 2021a). Sedentary behavior is associated with poor sleep quality, but increasing activity levels can improve sleep (Hargens et al., 2021). The timing of exercise is an essential consideration for sleep hygiene. For example, Glavin and colleagues (2021b) found that college students (n = 909) who preferred to exercise in the morning had earlier bedtimes, improved quality, and higher sleep efficiency than students who preferred to exercise in the evenings. Conversely, a systemic review showed that evening exercise might benefit sleep when comparing healthy adults who exercised in the evening to healthy adults who did not. However, intense exercise an hour or less before bedtime appears to disrupt sleep (Stutz et al., 2019).

Substance Use. Substance use commonly occurs in university settings. Chronic sleep concerns, such as persistent EDS, increase adolescents' likelihood to use drugs and alcohol (Owens et al., 2014). Delayed weekend bedtimes have been associated with increased substance use, which may be related to the timing of social events (Sun et al., 2019). About 35% of college students reported binge drinking, classified as drinking five or more beverages at least once every two weeks. College students may mix alcohol and caffeinated beverages, disrupting sleep (Patrick et al., 2018). Research indicates that around seven to 16% of college students use over-the-counter medication, marijuana, or alcohol as sleep aids (Hershner & Chervin, 2014; Goodhines et al., 2019). However, consuming some substances may be counterproductive, as they increase cortical arousal and wakefulness and can increase sleep-disordered breathing (Heinzer et al., 2015; Patrick et al., 2018).

Substance use and depression appear to be associated with amplified adolescent insomnia symptoms (Bromberg et al., 2020). However, the casual relationship between substance use, poor sleep, and mental health symptoms is unclear, but they likely exacerbate the impact of each other (Boehm et al., 2016). Based on a survey of 85,138 college students in the United States, daily tobacco use had a stronger correlation with sleep disruptions than illegal drug use, binge drinking, gender, obesity, and working more than 20 hours per week. Students experiencing elevated depression and/or anxiety symptoms tended to have higher tobacco use and worse sleep (Lohsoonthorn et al., 2013; Boehm et al., 2016). Binge drinking alcohol leads to decreased sleep duration, poor sleep quality, and increased EDS the following day (Paul et al., 2016).

Along with alcohol, stimulant use (e.g., nicotine, caffeine, Adderall) is widespread on college campuses. Students consuming extensive amounts of caffeine and stimulant medication for non-medical purposes is increasing (Garnier-Dykstra et al., 2012). Stimulants are associated with poor sleep duration, extended sleep onset latency, worsened sleep quality, and suppressed REM sleep (Lohsoonthorn et al., 2013; Hershner & Chervin, 2014; Patrick et al., 2018). Deep sleep reduction caused by stimulants contributes to memory and learning problems (Roehrs &

Roth, 2008). However, stimulant medication may increase adherence to improved health-related behaviors (e.g., adherence to routines) in individuals with ADHD (Martin et al., 2020).

Mental Health Factors

The role between mental health concerns and sleep is not fully understood. Several studies revealed that poor sleep duration is related to several mental health concerns (e.g., emotional dysregulation, mood instability, anxiety, impulsivity, hyperactivity; Kaplan et al., 2014). Numerous studies suggest a bi-directional relationship between sleep outcomes and mental health challenges (Zou et al., 2020). Sleep problems and disorders occur at increased rates for some diagnoses, such as depressive disorders, anxiety disorders, ADHD, and autism spectrum disorder (ASD; Martin et al., 2020). Invidious with ADHD experience elevated sleep problems and often have increased challenges in executive functioning, resulting in inconsistent sleep hygiene behaviors (Martin et al., 2020). Sleep difficulties are also listed as part of the diagnostic criteria for Major Depressive Disorder (i.e., fatigue, trouble falling or staying asleep, or sleeping too much) and Generalized Anxiety Disorder (i.e., difficulty falling or staying asleep, or restless, unsatisfying sleep; American Psychiatric Association, 2013), both commonly diagnosed in college students (Pedrelli et al., 2015). Most college students do not meet the criteria for a mental health disorder or a sleep disorder in the *D*iagnostic *and Statistical Manual of Mental Disorders, fifth edition* (DSM-5). However, college students with poor sleep endorsed elevated mental health challenges, such as depression, difficulty concentrating, and loneliness (American Psychiatric Association, 2013; Milojevich & Lukowski, 2016).

Anxiety and depression have been highlighted as contributing factors to poor sleep. Experiencing elevated cognitive-emotional arousal before bedtime can lead to trouble falling asleep and obtaining quality sleep (Henrich et al., 2021). In young adults, research suggests that sleep quality is reduced in adolescents diagnosed with depression who also experience elevated cognitive-emotional arousal (e.g., rumination) before bed (Henrich et al., 2021). High cognitive-emotion arousal at bedtime may predict depression (Henrich et al., 2021). In addition, college students with clinical depression tend to have increased technology usage, leading to delayed melatonin release and intensified cognitive-emotional arousal at bedtime. Unfortunately, increased technology usage and depression lead to social withdrawal (Liu et al., 2019b). As previously discussed, technology usage can delay melatonin release. Previous research highlighted that people with depression tend to experience lower melatonin secretion, which leads to delayed sleep onset and further disrupts their circadian rhythm (Robillard et al., 2013). In a study using self-report measures, adolescents admitted to an inpatient psychiatry unit had worse sleep hygiene behaviors than previous samples of adolescents with chronic pain and undergoing chemotherapy (Kaplan et al., 2014).

Medical Factors

Several studies have observed that medical conditions can contribute to poor sleep and that poor sleep can worsen medical symptoms. For example, increased prevalence of sleep problems and sleep disorders (e.g., sleepwalking, night terrors, sleep paralysis) occur in individuals experiencing migraines. However, migraines also lead to sleep disturbances (Miller et al., 2003). Adolescents with acute and chronic medical conditions may experience heightened sleep disturbances and the additional risk of psychological challenges (Lewandowski et al., 2011). Comorbid chronic medical conditions and mental health concerns are associated with difficulty falling asleep and staying asleep (Hysing et al., 2009; Taylor & Bramoweth, 2010). For example, in adolescents experiencing pain, increased cognitive-emotional arousal at night and poor sleep hygiene were predictors of developing insomnia (Henrich et al., 2021). Furthermore, several sources have demonstrated that medications used to treat medical and psychiatric conditions (e.g., anticonvulsants, antidepressants, antihistamines) can influence sleep (Lewandowski et al., 2011).

Allergic rhinitis and asthma are among numerous medical conditions associated with sleep challenges (Hanson & Chen, 2008; Liu et al., 2020). Allergies can make it harder for individuals to fall and stay asleep, and worse allergy symptoms are also linked with increased snoring and OSA (Liu et al., 2020). Consistently, researchers have been unable to identify the causality between sleep disturbances and asthma symptoms (Hanson & Chen, 2008). Individuals with asthma risk experiencing sleep disturbances from nighttime coughing and sleep-disorder breathing (Hanson & Chen, 2008). For youth with asthma, sleep disturbances and sleep-disordered breathing can lead to elevated asthma symptoms and heightened disruptive behavior the following day (Hanson & Chen, 2008; Lewandowski et al., 2011). Behavioral interventions that target healthy sleep hygiene practices may improve sleep quality, health-related quality of life, sustained attention, and disruptive behavior in youth with asthma (Lawless et al., 2020). Consequently, sleep screening may be beneficial for multidisciplinary teams of health care professionals (e.g., psychologists, pulmonologists, primary care providers) when assessing and treating sleep and asthma symptoms.

Several previous studies have identified that improvements in healthy weight behaviors (e.g., exercise) tend to be associated with enhanced sleep and lower body mass index (BMI). Similar to other medical conditions, the relationship between obesity and sleep is complicated. Obesity is associated with increased sleep challenges and disorders (e.g., sleep-disordered breathing; Heinzer et al., 2015). However, poor sleep can also lead to weight gain (Wang & Biro, 2021). Hence, improving sleep hygiene behaviors may be essential to weight-loss interventions (Valrie et al., 2015).

Coronavirus Disease 2019 (COVID-19) Pandemic

Data collection for this study began around the start of the coronavirus disease 2019 (COVID-19) pandemic in March 2021. Students who participated in the data collection shifted to virtual learning for the remainder of the spring semester. Long-term implications of the pandemic remain unknown, but the numerous transitions, such as shifts in daily routines, academic settings, income, living circumstances, and social activities, likely interfered with sleep. Preliminary research posits that diminished sleep and exercise during the pandemic predicted elevated stress levels in 550 college students when controlling for employment status, annual income, and gender (Moriarty et al., 2021).

Research across various samples indicated a significant change in later bedtimes and wake times during the pandemic. Changes in sleep duration varied by study, but adolescents appeared more likely than other age groups to display increased sleep duration on weekdays (Cellini et al., 2020; Gao & Scullin, 2020; Li et al., 2020; Wright et al., 2020). Benham (2020) compared college students' sleep before the COVID-19 pandemic, in the spring of 2019, to college students' sleep during the pandemic in the spring and summer of 2020. Extended sleep duration was observed, along with later bedtimes and wake times (Benham, 2020). The increase in sleep duration is consistent with previous research regarding extended sleep durations during school breaks and when school start times are delayed (Lufi et al., 2011). Consistently, in an international study of 845 youth ages three to 17 years old, later bedtimes were noted for all ages during the pandemic. During the school week, 89.8% reported going to bed after 10:00 pm compared to 57.1% before the pandemic. Wake times later than 8:00 am were endorsed by

81.2% during the school week, compared to 10.3% days before the pandemic (Kaditis et al., 2021). Global research conducted later in the pandemic by Ellakany and colleagues (2022) suggested that students reported more substantial screen time increases and sleep quality reductions than non-students during the pandemic. It is hypothesized that screentime increased due to virtual learning and reduced in-person social interaction opportunities. However, researchers predict that added screen time further disrupts sleep (Ellakany et al., 2022).

Current research indicates increased mental health concerns for adolescents during the pandemic. Chen and Lucock (2022) conducted an online study on 1,173 university students in the United Kingdom to investigate mental health concerns during the COVID-19 pandemic. Results suggested that over 50% of students endorsed clinically significant depression and/or anxiety symptoms. Participants who identified as females reported significantly more distress than males. Increased impact of pandemic-related stressors, reduced exercise, and higher tobacco usage appeared to exacerbate mental health concerns (Chen & Lucock, 2022). Additionally, adolescents with increased cognitive-emotional arousal at bedtime and decreased sleep quality during the pandemic tended to experience higher levels of stress related to COVID-19 (Gruber et al., 2021).

Effects of Poor Sleep in Adolescents

Investigating the factors that exacerbate poor sleep and understanding the implications is necessary for developing assessment, prevention, and intervention efforts. As previously discussed, unhealthy sleep hygiene among adolescents substantially contributes to poor sleep quality, reduced sleep duration, and EDS (Tan et al., 2012; Bartel et al., 2015). Effects of poor sleep can lead to poor academic performance, worsened cognitive outcomes, elevated mental health concerns, and adverse physical health outcomes, which are discussed below.

Academic and Cognitive Outcomes

Across childhood and adolescence, sleep duration and quality play a considerable role in adolescents' academics and cognitive outcomes (Adelantado-Renau et al., 2019). A number of studies have emphasized that strong academic performance correlates with obtaining sufficient sleep durations, consistent sleep schedules, adequate sleep quality, and reduced technology use (Hysing et al., 2015). Based on data from the Spring 2009 American College Health Association National College Health Assessment II dataset (n = 55,322), university students experienced a 10% higher probability of dropping an academic course for each day they endorsed sleep problems (Hartmann & Prichard, 2018). Consistently obtaining the recommended amount of sleep may increase an adolescent's chance of graduating high school and attending college (Sabia et al., 2017).

Sleep duration appears to play an essential role in academic and cognitive outcomes. Research suggests that later bedtimes are correlated with reduced grades, even when controlling for the pubertal stage, gender, and cognitive scores (Urrila et al., 2017). In college students, sufficient sleep durations also appear to be predictors of higher grade point averages (GPAs) in college students (Gaultney, 2010). Inconsistent sleep schedules (e.g., bedtime varying between 10:00 pm and 2:00 am) are also associated with worse school performance in high school and college students (Lund et al., 2010). In particular, greater differences between weekend and school week bedtimes have been associated with increased academic challenges and worse academic performance (Sun et al., 2019). A population-based study conducted in Norway revealed that too little sleep and too much sleep can negatively affect GPAs for adolescents between the ages of 16 to 19 years old. Adolescents who slept between seven and nine hours had higher GPAs than those who slept more than nine hours or less than seven hours (Hysing et al., 2015). In an experimental study restricting adolescents' sleep, adolescents experienced five nights of sleep deprivation (6.5 hours in bed) and five nights with healthy sleep duration (10 hours in bed), in random order. After five days of sleep deprivation, students earned lower scores on a quiz about a 30-minute movie, exhibited elevated inattention during the movie, and displayed lower arousal (Beebe et al., 2010).

Inadequate sleep duration influences other factors contributing to academic difficulties (e.g., attendance; Shochat et al., 2013; Hysing et al., 2015). For example, previous research revealed reduced school enjoyment in adolescents with poor sleep durations than those receiving adequate sleep (Garmy & Ward, 2017). Increased school tardies and absences are correlated with inadequate sleep duration (Hysing et al., 2015). Research in the university setting suggests that 54% of students occasionally skip class due to sleep disruptions (Dautovich et al., 2021). Frequent school absences are linked to adverse academic outcomes (Hysing et al., 2015).

As previously discussed, due to school start times, adolescents have little control over their wake times during the school week. Research on middle and high school students indicates that early start times are widely associated with increased tardiness and absences (Wheaton et al., 2016). However, delaying start times leads to later wake times and longer sleep durations (Wheaton et al., 2016). Several studies have also revealed that sleeping later during the school week is associated with improved class attendance and less EDS (Onyper et al., 2012). Consistently, delaying start times by 50 minutes at the United States' Air Force Academy improved academic performance throughout the day (Carrell et al., 2011).

Similar to sleep duration and sleep schedules, sleep quality appears to influence academic outcomes. EDS and poor sleep quality were endorsed by 82% of college students as interfering with their educational outcomes (Hershner & Chervin, 2014). In a large-scale survey, 46% of college students reported falling asleep in class "on occasion" (Dautovich et al., 2021). Numerous factors also affect sleep quality, including technology use, sleep environment, and caffeine use (Hysing et al., 2015). High school students who reported spending less than 30 minutes texting after turning their lights off at bedtime endorsed significantly higher grades than students who texted for at least 30 minutes after lights out (Higuchi et al., 2005). Combined technology use at night and caffeine consumption increases the chance of youth falling asleep at school by 70% (Calamaro et al., 2009). Since sleep hygiene practices influence sleep quality, targeting sleep hygiene behaviors may improve academic performance.

A considerable amount of research indicates that poor sleep can impair cognitive skills frequently used in the classroom and everyday tasks, such as sustained attention, divided attention, working memory, and reasoning skills (Gradisa et al., 2008; Lund et al., 2010; Shochat et al., 2013; Hysing et al., 2015). Concentration appears to be worsened by poor sleep efficiency and more inconsistent sleep schedules (Albqoor & Shaheen, 2020; Kim et al., 2022). Sleep duration and quality are positively related to sustained attention during class and homework completion. However, these benefits decrease after nine hours of sleep (Sabia et al., 2017). Divided attention is the ability to simultaneously attend to multiple stimuli and respond to environmental demands, such as taking notes, listening to the teacher, and reading the board. Dewald-Kaufmann and colleagues (2013) investigated a gradual sleep extension intervention for adolescents with symptoms of chronic sleep reduction. Adolescents in the experimental group were asked to extend their bedtime by five additional minutes each school night for two weeks. School week and weekend wake times stayed within an hour of each other. At the end of the two-week intervention, participants in the experimental group displayed significantly faster response times on visuospatial processing and divided attention tasks than the control group.

Notably, both tasks also involved working memory (Dewald-Kaufmann et al., 2013). When poor sleep and inconsistent sleep schedules impact a student's visuospatial processing, it likely interferes with tasks like recognizing letters, visualizing the rotation of three-dimensional objects in math class, and reading a map (Dewald-Kaufmann et al., 2013).

Cognitive and academic deficits correlated with poor sleep may be explained by neurological factors. Smaller brain grey matter volumes in the frontal, anterior cingulate, and precuneus cortex regions are associated with decreased bedtime on school nights and later weekend wakeup times (Urrila et al., 2017). The precuneus cortex plays a crucial role in complex functions, such as visuospatial imagery and retrieval of episodic memory (Cavanna & Trimble, 2006). The anterior cingulate cortex facilitates communication between the limbic system and prefrontal cortex, and it plays a vital part in empathy, impulse control, and decision making (Stevens et al., 2011). The prefrontal cortex relates to executive functioning skills, such as attention, planning, and problem-solving. Weekend bedtimes, weekend wakeup times, and grades are inversely correlated with reduced grey matter volume in the medial prefrontal cortex region (Urrila et al., 2017). Due to the high prevalence of sleep problems associated with adverse cognitive and academic outcomes, the college environment is a practical setting to address this public health concern.

Behavioral and Mental Health Outcomes

Adolescents with sleep problems tend to experience symptoms often associated with common mental health disorders, including emotional dysregulation, higher rates of stress, elevated depression, and increased social challenges (Meijer et al., 2010; Schlarb et al., 2012; Cowie et al., 2014). Poor sleep efficiency, estimated to impact about 30.30% of college students, can worsen fatigue, reduce concentration, and elevate anxiety (Albqoor & Shaheen, 2020).

Increased differences between school week and weekend sleep schedules are associated with elevated aggression, increased social withdrawal, and lower life satisfaction (Kim et al., 2022).

Poor sleep quality and shorter time asleep are related to an elevated risk of delinquent behavior, aggressive behavior, anxiety, depressed mood, withdrawn behavior, and somatic complaints (Meijer et al., 2010). In adolescents, obtaining less than eight hours of sleep is also associated with higher EDS, reduced motivation, and increased feelings of moodiness and irritability (Gradisar et al., 2008). Consequently, due to the challenges associated with poor sleep, adolescents may be misdiagnosed with a mood or behavioral disorder (e.g., Major Depressive Disorder) and not provided the appropriate sleep intervention (Gradisar et al., 2008). Regrading Health-Related Quality of Life (HRQoL), research indicates that adolescents with poor sleep are more likely to report that their mental health impedes their daily activities. Sleep also appears to substantially interfere more with mental health HRQoL factors than physical health (Chen et al., 2014).

Internalizing Behavior Outcomes. As previously mentioned, internalizing mental health symptoms (e.g., anxiety, depression, suicidal ideation) are exacerbated by poor sleep (Roberts et al., 2008). College students with overall inconsistent sleep schedules and inadequate school week sleep durations are more likely to endorse symptoms of depression and anxiety than students receiving adequate sleep (Regestein et al., 2010; Wong et al., 2013). However, the relationship between poor sleep with anxiety and depression in adolescents is not fully understood. Poor sleep can lead to increased depression and anxiety; elevated depression and anxiety symptoms can exacerbate sleep challenges (Hershner & Chervin, 2014). For example, poor sleep may lead to increased rumination due to decreased problem-solving abilities. Increased rumination can lead to elevated anxiety and depression while exacerbating sleep onset problems (Russell et al., 2019). Nevertheless, preliminary research suggests that addressing sleep concerns enhances treatment outcomes for depression (Owens et al., 2014), suggesting that screening for sleep problems is essential for treatment planning.

Adolescents with poor sleep are at increased risk of experiencing loneliness, social isolation, non-suicidal self-injury, suicidal ideation, and suicidal attempts (Osman et al., 2001; Owens et al., 2014; Littlewood et al., 2016; Hayley et al., 2017; Russell et al., 2019). In 8,462 college athletes, insufficient sleep correlated with increased depression, loneliness, anxiety, anger, non-suicidal self-injury (NSSI) ideation, and suicidal ideation. These mental health symptoms increased by approximately 20% for insufficient sleep each subsequent night (Ramsey et al., 2019). Loneliness and social isolation have been shown to predict distress and suicidal behaviors (Russel et al., 2019). Therefore, poor sleep may exacerbate feelings of loneliness, possibly leading to increased suicidal ideation. Research posits that sleeping eight hours decreases adolescents' risk of suicidality compared to adolescents who sleep five or fewer hours and adolescents who sleep 10 or more hours (Fitzgerald et al., 2011). A systemic literature review demonstrated increased nightmares and distress related to nightmares correlated with increased NSSI. Nightmares and insomnia symptoms were also associated with increased suicidality in university students. (Russel et al., 2019). Based on the connection between poor sleep and mental health concerns, evaluating sleep concerns in students who experience internalizing symptoms seems warranted. Furthermore, given that poor sleep environments have been associated with increased sleep disruptions and that sleep disruptions are associated with increased depression, university-wide efforts to improve sleep environments may improve a wide range of health outcomes (Peltz et al., 2016).

Externalizing Behavior Outcomes. Sleep quality and duration are related to externalizing behavioral health concerns, including hyperactivity, aggression, delinquency, and aggressive behavior (Meijer et al., 2010). Impulsivity is associated with insufficient sleep, leading to adolescents engaging in more risky behaviors without considering the consequences (Roberts et al., 2008; Wheaton, 2016). Adolescents who report symptoms of depression are more likely to engage in risky injury-related behaviors than those without depression (Testa & Steinberg, 2010). However, when controlling for depression, symptoms of insomnia (e.g., trouble sleeping) are a predictor of risk-taking behaviors (e.g., drinking and driving) in adolescents (Catrett & Gaultney, 2009).

The Centers for Disease Control and Prevention (CDC) analyzed data from 50,370 high school students from the National Youth Risk Behavior Surveys to gain insight into the connection between sleep behaviors and injury risk. Sleeping seven or more hours was associated with less frequent risk-taking behaviors. Risky behaviors included inconsistent seatbelt usage, driving under the influence of alcohol, riding with a driver under the influence of alcohol, and texting while driving. Interestingly, compared to adolescents sleeping an average of nine hours, extended sleep durations of 10 or more hours were also associated with increased risky behavior. This study shows adolescents with too much or too little sleep appear to engage in more risk-taking behaviors. Considering hyposomnia and hypersomnia are symptoms of depression, both sleep problems and engagement in risky behaviors are likely exacerbated by depression (Wheaton, 2016). Sleep screening and intervention may be one method of decreasing risky behaviors in adolescents.

Substance Use Outcomes. Substance use can interfere with sleep, and poor sleep can worsen substance use (Owens et al., 2014). Adolescents with insufficient sleep are more likely to experience EDS, associated with increased substance use (Paule et al., 2016). Adolescents with self-reported sleep problems were more likely to report using illegal substances than their peers without sleep problems (Wong et al., 2014). In particular, college students are at an increased risk of using stimulants, marijuana, tobacco, and alcohol than their peers without sleep problems (Kloss et al., 2016; Taylor et al., 2013). Initial research suggests that brief interventions addressing sleep hygiene can reduce alcohol consumption in university students self-reporting heavy drinking (Fucito et al., 2017).

Stimulants and alcohol tend to disrupt sleep cycles and cause EDS. Adolescents report consuming caffeine to enhance energy, counteract poor sleep, and improve mood (Owens et al., 2014). However, the sleep disruptions associated with caffeine usage may result in EDS and emotional dysregulation the following day due to more difficulty falling asleep, staying asleep, and obtaining deep sleep (Roehrs & Roth, 2008; Owens et al., 2014). Previous studies suggest that EDS may mediate the inverse relationship between academic performance and alcohol, caffeine, and nicotine usage (James et al., 2011; Hershner & Chervin, 2014).

Physical Health Outcomes

Poor sleep quantity and quality are associated with numerous health factors, including increased injury, obesity, hypertension, coronary heart disease, and strokes (Wong et al., 2014; Itani et al., 2017). Sleep is vital for boosting the immune system and regulating hormones (Besedovsky et al., 2012). Although most college students are healthy, the COVID-19 pandemic may have been challenging for the health of many students. Chronic poor sleep has been deemed a causal risk factor for contracting respiratory infections and the intensity of the infection (Jones et al., 2022); therefore, adequate sleep may be of particular importance to students hoping to avoid severe COVID-19 outcomes. Substantial research has demonstrated that some behavioral factors associated with poor sleep (e.g., self-control) also impact physical health outcomes (Taylor & Bramoweth, 2010). For example, inadequate sleep may lead to poor daily food choices due to reduced self-control and elevated impulsivity (Pilcher et al., 2021).

Sleep disruptions can also lead to worse HRQoL outcomes (Medic et al., 2017) but healthy sleep hygiene habits (e.g., consistent bedtime routines) are positively correlated with positive HRQoL outcomes (Billows et al., 2009; Storfer-Isser et al., 2013). For example, sleeping for extended periods during the school week has been associated with improved HRQoL. However, previous research suggests that going to bed later is correlated with increased EDS, mood challenges, and reduced HRQoL (Tzischinsky & Shochat, 2011).

Sleep disturbances predict pain severity for many health conditions, including sickle cell anemia, dysmenorrhea, and migraines (Miller et al., 2003; Valrie et al., 2013). For example, participants with lower amounts of sleep tend to report more intensified back and stomach pain than individuals who obtain adequate sleep (Haack & Mulligton, 2005). Like mental health concerns, pain and sleep quality likely have a bi-directional relationship. Sleep quantity is predictive of pain severity, which predicts sleep quality (Valrie et al., 2013). The link between mental health conditions, pain, and sleep remains uncertain, but research shows they influence each other (e.g., depressive symptoms influence sleep disruptions in adolescents with chronic pain; Miller et al., 2003). For example, compared to adolescents with only musculoskeletal pain, adolescents with comorbid musculoskeletal pain and sleep problems reported higher levels of pain and increased psychological problems (Harrison et al., 2016).

Injuries. Unintentional injuries may result in lifelong complications and are one of adolescents' leading causes of death (National Center for Statistics and Analysis, 2020). Injuries associated with poor sleep include athlete injuries, motor vehicle accidents, and wounds from risky behaviors (Watson et al., 2017). In the United States, about 100,000 motor vehicle accidents per year are connected to drowsy driving (National Center for Statistics and Analysis, 2020). Motor vehicle accidents encompass two-thirds of deaths related to unintentional injuries for adolescents. Adverse outcomes associated with poor sleep, such as reaction time reduction, attention difficulties, poor impulse control, and falling asleep at the wheel, also exacerbate injury risk (Wheaton, 2016; Beebe, 2011; Herman et al., 2012).

Research indicates that driving drowsy after being awake for 17 to 24 hours may cause similar driving impairment as drinking alcohol (Hershner & Chervin, 2014). About 40% of adult drivers report falling asleep at least once while driving (Teff, 2010). Poor sleep is a leading cause of motor vehicle accidents than alcohol use for college students (Taylor & Bramoweth, 2010). Consequently, efforts to increase sleep duration may reduce motor vehicle accidents. For example, two years after a county in Kentucky delayed school start times by one hour, there were 16.5% fewer motor-vehicle accidents for 17- and 18-year-old students, despite a 7.8% increase in motor-vehicle accidents at the state level (Danner & Phillips, 2008).

Healthy Weight Outcomes. Sleep is essential for regulating and producing hormones related to appetite, so inadequate sleep can lead to the body interpreting hunger cues and overeating (Dodor et al., 2010). Youth and adults with poor sleep tend to drink excess calories, consume a higher portion of calories from fats, and exercise less than individuals with adequate sleep (Cappuccio et al., 2008). Consequently, poor sleep quality and quantity can lead to weight gain (Wang & Biro, 2021). In addition, poor sleep is a factor in some people developing Type 2 Diabetes. Metabolic perturbations (e.g., insulin resistance) resulting from inadequate sleep are risk factors for Type 2 Diabetes (Owens et al., 2014). Hypertension is another outcome of poor sleep (King et al., 2008). In a study of 4,000 adolescents from Canada, cardiovascular risk correlated with higher sleep disturbance scores on a self-reported measure, the Pittsburg Sleep Quality Index (Narang et al., 2012).

Obesity is linked to other health complications, such as OSA, cardiovascular concerns, asthma, and joint pain. Cross-sectional and prospective studies suggest that inadequate sleep duration intensifies the risk of obesity in youth and adults (Leproult & Van Cauter, 2010). In adolescents completing a weight loss intervention, increased sleep duration on weekends and large sleep debts correlated with more minor changes in Body Mass Index z -scores (zBMI) and waist circumference (Valrie et al., 2015). Therefore, complications from poor sleep that lead to obesity can further complicate aversive health outcomes (Owens et al., 2014). Other predictors of obesity in adolescents are elevated symptoms of depression, sedentary behaviors, and technology use, both factors correlated with inadequate sleep (Shochat et al., 2010; Liou et al., 2010).

Excessive Daytime Sleepiness (EDS). Inadequate sleep duration, poor sleep quality, and unstable sleep schedules contribute to EDS (Onyper et al., 2012). Poor sleep environments, which often lead to disrupted sleep, have been associated with negative sleep factors, including EDS (Storfer-Isser et al., 2013; National Sleep Foundation, 2019). Previous research suggests that adolescents, elderly individuals, and people who work night shifts have the highest prevalence rates of EDS. Approximately one in five adults report experiencing EDS that interferes with everyday functioning (Pagel, 2009). About one-third (35%) of adolescents not enrolled in school experience continuous EDS. However, approximately 50% to 60% of college students endorse continuous EDS (Hershner & Chervin, 2014; American College Health Association, 2019). These findings suggest that adolescent college students are more at-risk for EDS than adults and same-aged peers not attending school.

EDS can interfere with numerous aspects of daily living and is associated with lower grades, worse job performance, lower productivity, diminished cognitive performance, and higher rates of motor vehicle accidents (Danner & Phillips, 2008). For example, EDS and poor sleep quality were endorsed by 82% of college students as interfering with their academic outcomes (Hershner & Chervin, 2014). Increased mental and behavioral health concerns (e.g., anxiety, reduced motivation, impulsivity) have been correlated with stronger EDS (Pagel et al., 2009; Dagnew et al., 2020; Sameer et al., 2020). Worse HRQoL can be related to more intense EDS (Sforza et al., 2002; Dagnew et al., 2020). As previously mentioned, research has demonstrated that adolescents with EDS are more likely to consume drugs and alcohol than peers without EDS (Owens et al., 2014). Several studies have shown that delayed start times for adolescents are linked to reduced EDS and more stable sleep schedules (Crowley & Carskadon, 2010; Garmy & Ward, 2017).

Prevention Science Framework

The high prevalence of sleep problems and poor outcomes associated with sleep problems are considerable public health concerns across the lifespan. Both the American Medical Association (AMA) and the American Academy of Sleep Medicine (AASM) consider poor sleep in adolescents a severe health risk (Owens et al., 2014). Systemic prevention efforts to gather nationwide prevalence data and reduce sleep problems are emerging. For example, the CDC has partnered with AASM and the National Association of Chronic Disease Directors (NACDD) to establish the Sleep and Sleep Disorders Team. The team's goal is to increase surveillance efforts to gather data about the prevalence rates of sleep problems and to evaluate the necessity of public health efforts related to sleep health (Owens et al., 2014).

Furthermore, the Healthy People 2030 initiative, a nationwide effort focused on improving health and well-being, recognized the large-scale problem of insufficient sleep for children and adults. Specifically, goals include increasing the number of children, high schoolers, and adults who obtain adequate sleep. For adolescents, Health People 2030 aims to decrease motor vehicle accidents related to drowsy driving and grow the number of middle schools starting at 8:30 am or later. Adult goals include increasing the percentage of individuals with symptoms associated with OSA who are further evaluated (Office of Disease Prevention and Health Promotion, n.d.).

The goal of universal screening is to catch individuals at-risk for certain conditions to provide further assessment and guide intervention (Shepardson & Funderburk, 2014). In the K-12 school setting, universal screening for academic, behavioral, and emotional challenges is becoming increasingly prevalent to assist in making data-driven decisions at the school, grade, classroom, and individual level (Eagle et al., 2015). Primary care offices have increased the implementation of regular screening in recent years. For young children, these screeners often are related to developmental skills. For individuals ages 12 and up, the Patient Health Questionnaire (PHQ-9) is a standard screener used in primary care offices, behavioral health settings, and emergency departments to screen for depression and suicidal ideation (Shepardson & Funderburk, 2014).

Universities may be a convenient and logical setting to deliver primary prevention efforts and universal screening (Shepardson & Funderburk, 2014). University systems may have a vested interest in positive sleep habits, given the links to academic, cognitive, behavioral, and health outcomes reviewed above. Universal screeners may allow students to engage in brief, effective interventions before the challenges become problematic. For example, if a student only vapes a few times a week, early preventative interventions may help reduce the vaping behavior and prevent long-term use (Mackenzie et al., 2011).

To date, limited research exists on universal screening implementation, feasibility, and effectiveness in the university setting. A 90% compliance rate with depression screenings conducted at university primary care centers suggests that it may be feasible to catch students who may not receive preventative treatment and connect students with intensive resources as needed (Mackenzie et al., 2011). Similarly, universal screening for alcohol misuse has led to increased identification of college students at-risk for future complications compared with relying on the patient or primary care provider to initiate a conversation about alcohol misuse (Baldwin et al., 2006).

Worldwide and nationwide epidemiology studies have repeatedly revealed the widespread prevalence and adverse outcomes of adolescent sleep problems (Owens et al., 2014). Prevention science frameworks can identify sleep problems, monitor sleep problems and interventions, and continuously evaluate goals based on data (Herman et al., 2012). Research indicates that early intervention improves outcomes (McGorry et al., 2011). Constant surveillance monitoring of public health concerns is an essential part of the prevention framework and involves gathering and interpreting ongoing data to assess current prevalence rates and identify causes (Herman et al., 2012).

Continued surveillance of the increasing prevalence of sleep problems and determining the causes are vital to establishing meaningful preventative interventions. For example, outdated sleep hygiene educational efforts (e.g., a curriculum that does not discuss the use of multiple interactive forms of technology at bedtime) may not be as effective (Owens et al., 2014). Understanding the unique challenges college students face is essential. For example, in the

United States, about 48.20% of women and 41.80% of men ages 18 to 24 years old report living outside of their parent or caregiver's home. Helping healthcare providers understand how these traditions and other biological, psychological, and environmental factors impact sleep is necessary (Owens et al., 2017). Surveillance methods in the university setting may involve collecting data on sleep problems during University 101 courses, residence hall gatherings, medical appointments, or behavioral health appointments. Collecting large-scale data throughout the school year (e.g., fall and spring) can assist in determining the effectiveness of prevention and intervention efforts (e.g., later start times) and identify common trends (e.g., sleep patterns change after school breaks).

Addressing sleep problems may be a practical first step in college counseling and health centers, as preliminary research suggests that sleep problems may moderate the effectiveness of behavioral interventions (Acosta et al., 2019). However, given the number of barriers that universities, healthcare facilities, and counseling centers must address (e.g., appointment time limits), any screening tool must be feasible and efficient. To properly screen and intervene, a brief scale needs to be developed and validated for the university setting.

Screening for Sleep Problems

The American Academy of Pediatrics (AAP) advocates that healthcare professionals (e.g., pediatricians, social workers, psychologists) screen all adolescents for sleep problems and intervene as needed (Sevecke & Meadows, 2018). Shepardson and Funderburk (2014) recommend universal screening for sleep in the university healthcare setting, along with depression, suicidal ideation, alcohol misuse, and tobacco use. Conversely, screening efforts have been focused on depression and risk-taking behaviors, such as alcohol use and sexual activity, and may not consider sleep's role in these behaviors and the high prevalence of sleep problems (Gilbert & Weaver, 2010). Additionally, it has been hypothesized that sleep screening may lead to increased conversations about sleep and other behavioral health concerns (Shepardson & Funderburk, 2014). Some researchers recommend assessing for sleep problems if the individual is positive for mental health concerns and vice-versa (Roberts, 2018). However, this may lead to some students being overlooked, as not all students with sleep problems will exhibit depression or engage in risk-taking behaviors (Shepardson & Funderburk, 2014).

Despite recommendations to screen for sleep problems and awareness that sleep problems are a public health concern, system-wide efforts to screen and treat sleep problems are scarce. Existing research suggests that 79% of Primary Care Providers (PCPs) have at least one patient presenting with sleep concerns per week (Luik et al., 2019). Discussed related to sleep problems and screening for sleep problems rarely occur during medical visits, mental health interventions, or psychological assessments (Everhart, 2011; Gilbert & Weaver, 2010; Lund et al., 2010). For example, Honaker and Saunders (2018) found that only 28% of youth with sleep problems had related documentation in their health records. During a recent study of 100 school psychologists, 77% did have experience implementing sleep screeners. Consistently, 79% of school psychologists endorsed not including an assessment for sleep problems in evaluations for special education (Drapeau et al.,2021).

When sleep screening does occur as part of standard practice, it is unclear if adequate screening methods are utilized (Honaker & Meltzer, 2016). Screening only appears to occur for adults when sleep problems are brought up during the appointment, and only 8% of PCPs report using validated sleep questionnaires or sleep diaries (Luik et al., 2019). Results from two studies indicated that about 70 to 90% of PCPs reported screening for sleep problems, but studies suggest that 25% to 70% PCPs only ask one question to screen for sleep problems (Faruqui et al., 2011; Owens, 2001). Contrary to PCPs' recall of screening for sleep problems, parents reported that only 52% of PCPs inquired about the sleep habits of children ages 10 and younger. Therefore, there appears to be a discrepancy between the PCP report and parents' reports of pediatric sleep screening (Honaker & Meltzer, 2016).

The lack of screening and intervention for sleep problems may be related to medical and behavioral healthcare providers' limited training on sleep (Mindell et al., 2011; Luik et al., 2019). Data suggests that the mean duration of sleep education throughout medical school is 2.5 hours (Mindell et al., 2011). In an international study of 152 pediatric residency programs, a mean of 4.4 hours was spent on sleep education. No sleep education training occurred in 27% of medical schools and 23% of pediatric residency programs (Mindell et al., 2011; Mindell et al., 2013). Regarding psychology graduate programs, initial research suggests that only 6% of clinical psychology doctoral and predoctoral internship programs offer courses on sleep (Meltzer et al., 2009). In a survey of school psychologists, only 20% reported receiving any form of classroom instruction on behavioral sleep medicine (Drapeau et al.,2021). Some form of behavioral sleep medicine training was endorsed in 31% of clinician psychology programs and 8.5% of school psychology graduate programs (Meltzer et al., 2009; Drapeau et al.,2021).

Previous studies have found that Primary Care Providers (PCPs) tend to recognize the importance of sleep; however, less than 50% of PCPs feel comfortable treating sleep concerns (Klingman et al., 2020), leading many people without adequate treatment. For example, in a three-year analysis of pediatric primary care visits of 750 patients, only 5.2% of youth experiencing sleep problems or sleep disorders received sleep-related treatment (Meltzer et al., 2014). To help increase sleep assessment and intervention, Sevecke and Meadows (2018) propose guidelines for sleep-related psychoeducation by PCPs, behavioral health providers, childcare and school personnel, dentists, and otolaryngologists. During prenatal visits, it is recommended that families are provided psychoeducation about infant sleep. Monitoring of sleep problems should continue throughout development. Behavioral healthcare providers can provide more extensive psychoeducation, screening, progress monitoring, assessment, and intervention recommendations while improving adherence to medical treatments for sleep problems and disorders (e.g., continuous positive airway pressure [CPAP] machines). Dentists and otolaryngologists can uniquely contribute to sleep screening problems by screening for OSA or bruxism (Sevecke & Meadows, 2018). Johansson and colleagues (2016) also suggest that nurses in primary care and other outpatient clinics should screen for adolescent sleep problems and provide education to families. Recommendations include asking about sleep quality, sleep hygiene, and technology use at bedtime (Johansson et al., 2016)

Sleep Screening in the University Setting

The university setting may be ideal for screening for sleep problems and providing prevention and intervention programs to groups of students (Chung et al., 2017). University medical centers are likely one of the most practical options, as they are used more frequently than counseling centers. However, feasible screening locations (e.g., university courses, healthcare facility, counseling center) may vary depending on the university's unique resources. (Shepardson & Funderburk, 2014).

Although screening for sleep problems in university students has not been investigated, sleep problems are a large-scale issue among adolescents that impact academics, behavior, and health outcomes. Therefore, this study will examine a commonly used sleep hygiene scale to validate and develop a brief screener for adolescent sleep hygiene that could feasibly be used within the university setting.

Measurement of Sleep Problems

There are various ways to assess sleep, including interviews, sleep logs, and objective measures. Simply asking if sleep problems are present is insufficient for sleep screening. When comparing parent reports with adolescent self-reports, adolescents are more likely to report sleep problems. For example, out of 308 families, 23.1% of adolescents self-reported sleep problems, but only 14.3% of parents endorsed sleep problems for their children. However, 66.6% of adolescents endorsed at least one clinical predictor of sleep problems (e.g., sleep onset latency of more than 30 minutes per night; Short et al., 2013).

Interviews may reveal various factors impacting sleep, such as developmental history, family history of sleep disorders, typical evening routine, dietary habits, weekend schedules, and sleep behaviors (Mindell & Owens, 2010; Meltzer et al., 2015). The *BEARS Sleep Screening Tool* is a commonly used semi-structured interview tool for youth ages 2 through 18 years old. It assesses five domains- Bedtime Issues, EDS, Night Awakenings, Regularity and Duration of Sleep, and Snoring (Owens & Dalzell, 2005). Sleep logs provide another subjective way to measure sleep. Healthcare professionals may use these logs to gain insight into individual sleep trends (e.g., bedtime, wake time, sleep onset latency time of night awakenings, schedule consistency) or as a progress monitoring tool (Meltzer et al., 2012).

To obtain objective sleep data, individuals wear actigraphy devices, a watch-type device, to measure sleep-wake patterns via activity levels (Meltzer et al., 2015). Polysomnography often occurs when healthcare providers suspect medical sleep disorders, particularly a sleep-related breathing disorder. Polysomnography, commonly referred to as a sleep study, is considered the gold standard in objective sleep assessment and measures physiological changes (e.g., heart rate, brain function, muscle movements) during sleep (Marcus, 2000). Importantly, objective measures of sleep do not generally provide information about behavioral habits or challenges contributing to sleep problems (e.g., sleep hygiene; Lewandowski et al., 2011).

The above methods (interviews, sleep logs, actigraphy) are diagnostic in nature and not feasible for screening purposes. Conversely, self-reported questionnaires provide a viable option to screen for sleep problems to prevent further problems. If an adolescent is at risk for sleep problems based on a self-report screener, additional self-report questionnaires, interviews, sleep logs, and objective measures of sleep may be necessary (Meltzer et al., 2013). The current study aimed to identify a brief, effective, and feasible universal screener for sleep hygiene within the university setting. Currently, the only validated way to measure multiple sleep hygiene behaviors is through self-report questionnaires. Therefore, self-report sleep questionnaires were deemed the most reasonable option for assessing a large group of students.

A variety of self-report and parent-report questionnaires exist to measure sleep in youth. Based on a review of 21 sleep measures, which included measures of EDS, sleep habit/hygiene, sleep-related attitudes/cognitions, sleep initiation/maintenance, and multidimensional sleep measures, only six out of 21 of the scales met the criteria as "well-established" (Lewandowski et al., 2011). An overview of commonly used scales is provided below.

Adolescent Sleep-Wake Scale (ASWS). The ASWS is a 28-item self-report measure of subjective sleep quality for adolescents ages 12 to 18 and is approaching well-established (LeBourgeois et al., 2001; Harsh, 2005; Lewandowski et al., 2011). This scale is adapted from the *Children's Sleep-Wake Scale* and encompasses five subscales: going to bed, falling asleep, awakening, reinitiating sleep, and wakefulness. Adolescents report on their last month of sleep and rate their responses on a six-point scale, ranging from "never" to "always" (LeBourgeois et al., 2001).

The ASWS total scale reveals good internal consistency. Across subscales, poor to good internal consistency has been demonstrated (Essner et al., 2015). Correlations with the *Adolescent Sleep Hygiene Scale* revealed concurrent validity (LeBourgeois et al., 2005). A comparison of scores between adolescents with pain to healthy adolescents without pain demonstrated construct validity. Consistent with previous research, adolescents with chronic pain endorsed significantly more challenges with falling asleep, reinitiating sleep, returning to wakefulness, and poorer overall sleep (Essner et al., 2015).

Adolescent Sleep Hygiene Scale (ASHS). The ASHS is the only self-report sleep hygiene scale validated for adolescents ages 12 to 18 (Lewandowski et al., 2011). Based on the *Children's Sleep Hygiene Scale*, the ASHS includes 33 items (LeBourgeois et al., 2001; Harsh et al., 2002). On the original scale, 27 quantitative items contributed to the eight subscales: Physiological, Behavioral Arousal, Cognitive/Emotional, Sleep Environment, Sleep Stability, Daytime Sleep), Substance Use, and Bedtime Routine. Five items included in the original ASHS remain on the current scale but never contributed to the subscales or total scores based on exploratory and confirmatory factor analysis data. The adolescent's ratings are based on the past month using a six-point scale, ranging from "never" to "always." The mean of each subscale is averaged to calculate the total score. In addition, four qualitative items ask about typical bedtimes and wake times on weekdays and weekends (LeBourgeois et al., 2001). Concurrent validity of the ASHS has been demonstrated through correlations with the ASWS (LeBourgeois et al., 2005).

Cleveland Adolescent Sleepiness Questionnaire (CASQ). The CASQ is a free self-report scale assessing EDS in adolescents 11 to 17 years old (Spilsbury et al., 2007). Individuals report the frequency of the listed behavior during a usual week on a five-point Likert scale, ranging from "never" to "almost every day." The scale consists of 16 items, and the two domains include daytime sleepiness and day and nighttime alertness (Spilsbury et al., 2007).

The CASQ is a promising scale (Lewandowski et al., 2011). Good internal consistency of the total score demonstrates reliability. Correlations with the *Pediatric Daytime Sleepiness Scale* (PDSS) and the *School Sleep Habits Survey* (SSHS), both measures of daytime sleepiness, yielded convergent validity (Drake et al., 2003). In an evaluation of construct validity, elevated CASQ scores correlated with lower sleep duration in a sleep disorders sample and a normative sample (Spilsbury et al., 2007).

Pittsburg Sleep Quality Index (PSQI). The PSQI is a free self-report scale that measures sleep quality and sleep disturbances over the past month (Buysee et al., 1989). The scale consists of 19 items and utilizes a four-point Likert scale. An overall global score is calculated, along with a score for the seven domains, subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, sleep medication, and daytime dysfunction (Buysee et al., 1989). Higher scores are suggestive of more sleep problems. A cut-off score of five in adults classifies poor sleepers versus good sleepers. Adolescent cut-scores are not established (Grandner et al., 2006; Raniti et al., 2018). However, preliminary research suggests a cut-score of six should be used when screening college students for insomnia (Dietch et al., 2016).

The PSQI demonstrates adequate psychometric properties to measure adult sleep quality and disturbances. Sensitivity and specificity research shows the PSQI to be an appropriate measure to distinguish between "good" and "poor" sleepers in adults (John et al., 2016). Although utilized in research studies with adolescents, limited research on psychometrics properties in adolescents exists. However, the PSQI total score demonstrated good convergent validity with the *Center for Epidemiologic Studies-Depression Scale* and the *Spence Children's Anxiety Scale* for adolescents (Raniti et al., 2018). Research indicates good internal consistency (α = 0.77 – 0.83) and good concurrent validity, based on moderate correlation (r = 0.54) with a questionnaire about general health (Farrahi Moghaddam et al., 2012).

School Sleep Habits Survey (SSHS). The SSHS contains 63 items and is considered approaching well-established (Lewandowski et al., 2011). The scale focuses on bedtimes and wake times, school performance, daytime sleepiness, and sleep behavior problems for high schoolers (Wolfson & Caskadon, 1998; Wolfson & Caskadon, 2003). The SSHS entails three subscales: sleepiness, sleep/wake problems behaviors, and depressive mood. The SSHS includes items associated with trauma and traumatic injury (e.g., "In the past 6 months, were you injured by a gun, BB gun, or pellet gun?"). The rationale for including these items is unclear. Consequently, the SSHS scale is not an ideal screener for most school and university settings due to ethical concerns about screening for trauma without immediate follow-up (Erwin & Bashore, 2017). The ASHS subscales demonstrate adequate internal consistency. Regarding validity, the SSHS scores correlate with sleep diaries and actigraphy data (Wolfson & Caskadon, 2003).

Medically Specific Sleep Questionnaires. Specific sleep questionnaires may be necessary based on information collected during a clinical interview, results of a multidimensional rating scale or screener, or the nature of the presenting sleep concern. For example, the *Sleep Disorder Inventory for Students- Children and Adolescents* form is a screener for OSA, EDS, periodic limb movement disorder, delayed sleep phase syndrome, and narcolepsy disorders (Luginbuehl et al., 2008). Another example of a specific sleep screener is the *Pediatric Sleep Questionnaire* (PSQ; Chervin et al., 2000). The PSQ contains 22 items that screen for sleep-related breathing disorders, including snoring, sleepiness, and behavior subscales (Chervin et al., 2000). Scales assessing specific medical sleep concerns are not ideal for broad sleep screeners in the university setting. Sleep behavior and hygiene scales provide wide-ranging information to guide further screening and intervention.

Sleep Interventions in the University Setting

The transition to college often leads to changes that impact sleep, including inconsistent daily schedules, increased social activities, and less control over sleep environments (e.g., bright hallway lights in dorms; Owens et al., 2017). System-wide inventions may help university students improve their sleep hygiene. Research on systematic changes to improve sleep outcomes in the university setting is limited. Based on prior research, delaying class start times would likely improve sleep outcomes and enhance academic performance (Wheaton et al., 2016; Hershner & Chervin, 2014). Qin and Brown (2017) also suggested modifying the dormitory environment to encourage healthy sleep hygiene habits. Recommendations included moving vending machines away from bedrooms, posting information to gradually increase students' sleep hygiene awareness (e.g., fact flyers near the elevator), and allowing students to provide feedback on things like temperature (Qin & Brown, 2017).

Universities can provide widespread psychoeducation on sleep hygiene to large groups to help address public health concerns related to poor sleep and increase awareness of the unique sleep challenges students face (Levenson et al., 2016). Universal efforts to increase knowledge related to sleep hygiene could be accomplished by including education in University 101 courses or required training modules. Class assignments can offer students the opportunity to receive extra motivation (e.g., GPA) to learn about sleep hygiene (Hershner & O'Brien, 2018a). For example, the "Sleep 101" computerized sleep hygiene intervention is tailored to teach first-year college students about sleep and ways to improve their sleep hygiene behaviors. Across four universities, participants who completed the ”Sleep 101” intervention (*n* = 804) demonstrated enhanced knowledge about sleep and the impacts of using caffeine. Participants who completed the intervention reported being less likely to engage in drowsy driving and stay awake all night (Quan & Ziporyn, 2017).

Importantly, research indicates that only providing psychoeducation on sleep may not produce lasting behavior change. For example, several research studies on sleep hygiene education programs in high school demonstrate significant increases in sleep hygiene knowledge but trivial behavior change (Brown et al., 2002; Hershner & O’Brien, 2018a). Consistently, university students engaged in an eight-module online course demonstrated increased knowledge about sleep and improved attitudes related to sleep, but no significant behavioral changes were observed (Semsarian et al., 2021). However, other research suggests that college students may benefit more from sleep hygiene education than others (e.g., older adults). Researchers theorize that this may be due to college students' poorer overall sleep hygiene; thus, they are more responsive to sleep hygiene changes. Additionally, university students tend to demonstrate above-average cognitive flexibility, which may enhance intervention outcomes (Saruhanjan et al., 2021).

Combining sleep hygiene education with practical ways for students to implement healthy sleep hygiene behaviors may be a promising intervention (Cassoff et al., 2013). In one study, university students were required to select one sleep-related behavior (e.g., caffeine use) to focus on improving during exams. The assignment included creating a behavior change plan, three weekly progress reports, and one reflection assignment. As a result of this brief intervention, students reported significant improvement in sleep quality (Carter et al., 2017). Another program focused on small changes (e.g., ending electronic use 30 minutes before bed) demonstrated positive results in the university setting. Eight weeks after the intervention, the intervention group (n = 254) demonstrated improved sleep duration, sleep quality, and sleep hygiene behaviors, including ending electronic use earlier and more consistent sleep schedules than the control group (n = 295). Self-report measures also revealed more significant reductions in depressive symptoms and chances of inadequate sleep duration before examinations for the intervention group (Hershner & O'Brien, 2018b). These preliminary findings suggest that computerized sleep hygiene education programs that include behavioral modification strategies may be beneficial and feasible for college students.

Further assessment and intervention could occur as needed for students who are identified as at-risk on sleep hygiene screeners. Initial research suggests that individual and group treatments could be utilized for students requiring more intensive interventions. Cognitive-Behavioral Therapy for Insomnia (CBT-I) and Brief Behavioral Therapy for Insomnia (BBTI) may be effective in the university setting for improving sleep quality (Schlarb et al., 2017; Buysse et al., 2011). Both methods are well-established treatment options for insomnia and generally vary from four to eight sessions (Buysse et al., 2011). These modalities provide psychoeducation about sleep and help participants problem-solve ways to implement healthy sleep hygiene behaviors (Edinger & Sampson, 2003). CBT-I includes additional treatment sessions on cognitive restructuring to challenge negative thoughts and beliefs about sleep. Although these interventions are well-established, delivering them to all students with sleep problems is not feasible. University counseling centers may also have treatment session limits that prevent these modalities from being fully implemented (Iarovici, 2014). Therefore, large-scale interventions may be a practical first step in supporting students with sleep problems.

Given that most students do not exhibit clinically significant sleep problems, brief interventions in the medical setting may generate meaningful changes. Addressing sleep hygiene concerns in the medical setting may also increase the effectiveness of other medical treatments (Owens et al., 2014; Milojevich & Lukowski, 2016). However, many healthcare professionals lack training on brief sleep hygiene interventions. Consequently, university-wide interventions may include training health professionals on available brief, evidence-based tools (Hershner & O'Brien, 2018b). Mindfulness strategies may be a practical intervention for healthcare providers to suggest. For example, Bartel and colleagues (2018) investigated a universal mindfulness intervention for adolescents in high school. For adolescents who took over 30 minutes to fall asleep, listening to 15-minute body-scan audio for three or more nights per week reduced sleep onset latency (Bartel et al., 2018). Given that research suggests increased emotional regulation at bedtime can lead to worse sleep for university students, including ways to implement mindfulness may be a reasonable sleep intervention component (Peltz et al., 2016).

Statement of the Problem

Adolescents with poor sleep quantity and quality are at-risk for various academic, behavioral, and medical problems. The use of universal behavior screeners is becoming increasingly prevalent in K-12 schools, behavioral health practices, and medical settings. The purpose of these screeners is to identify at-risk concerns early and provide the necessary intervention supports to prevent future problems. Although the ASHSr is a reliable and valid method to assess sleep behaviors, it is not feasible for students to complete the full scale and for the healthcare providers to interpret the results, in addition to myriad concerns addressed during appointments. Consequently, universities and healthcare providers may find it advantageous to use a brief version of this scale to supplement current questionaries and follow up with additional sleep screeners when warranted. Therefore, university student self-ratings on the ASHS were used to assess the current factor validity of the ASHS, modify the scale as needed for the college setting, and develop a shortened version of the scale for screening purposes. Self-reported ratings on the newly established ASHS for college students (ASHS-College) and screener (ASHS-Screener) were compared to self-ratings on the *Epworth Sleepiness Scale for Children and Adolescents* (ESS-CHAD) to determine if the newly established scales correctly identified children with EDS and cut-off scores were generated. The newly established ASHS scales were compared with differences in the school week and weekend sleep factors, measurements of EDS, and HRQoL factors to assess validity.

CHAPTER 2: METHODS

Participants

The Institutional Review Board (IRB) granted permission for the research study (See Appendix A). Students enrolled at East Carolina University were recruited to participate in the current study through their undergraduate psychology courses. Those who consented to engage in the present study completed the *Adolescent Sleep Hygiene Scale*, *Revised* (ASHSr), *Epworth Sleepiness Scale for Children and Adolescents* **(**ESS-CHAD), and portions of the *RAND 36-Item Short-Form Health Survey* (SF-36) through a Qualtrics survey. In addition, demographic information was collected by each participant, including race, ethnicity, gender identity, academic year (e.g., sophomore), and age. Validity checks were randomly presented throughout the survey (e.g., please answer "mostly true" for this item). Participation and successful completion of the validity checks awarded students with partial credit toward a course research activities requirement. A sample size of 300 students is recommended for factor analysis (Hair, 2006).

Demographics

A total of 338 individuals completed the study. The original participant age range included individuals ranging from 15 to 46 years old. However, 24 participants were excluded due to falling outside the American Academy of Pediatrics's (AAP) definition of adolescence from age 11 to 21. Due to being under 18 years old and unable to obtain appropriate consent through the university's Experimentrak system, an additional 15 students were excluded. Three participants were eliminated due to providing no variability in their answers on Likert scale items, and two other participants were removed as they were outliers across multiple scales.

Table 2 presents the number and percentage of participants for each age, gender, race, ethnicity, and academic class (e.g., freshman). The study included 292 participants, ranging from ages 18 to 21 (M = 18.88, SD = .84), with 80.14% of the sample being 18 or 19 years old.

Table 2

Demographic Information

Variable	*n* = 292	%
Age		
18	108	36.99
19	126	43.15
20	43	14.73
21	15	5.14
Gender		
Male	119	40.75
Female	172	58.90
Other	1	0.34
Race		
American Indian or Alaska Native	1	0.34
Asian	6	2.05
Black or African American	67	22.95
Native Hawaiian or Other Pacific Islander	1	0.34
White	202	69.18
Other	4	1.37
Multiracial	11	3.77
Ethnicity		
Hispanic or Latino	28	9.59
Not Hispanic or Latino	264	90.41
Academic Class		
Freshman	226	77.40
Sophomore	47	16.10
Junior	18	6.16
Senior	1	0.34

Measures

Adolescent Sleep Hygiene Scale (ASHS)

A sleep hygiene scale is appropriate for the university setting, where behavioral sleep concerns can be addressed and guide interventions for individuals or groups. The *Adolescent Sleep Hygiene Scale, revised* (ASHSr) assesses sleep hygiene behaviors theoretically associated with sleep and is the only adolescent self-report sleep hygiene scale considered approaching well-establish.

The ASHS consists of 33 items and eight domains. Excluding one item, all items are reverse coded. Higher scores indicate healthier behavioral and environmental sleep hygiene factors. Subscale scores were calculated by determining the mean of relevant items, and the total sleep hygiene score is the mean of the eight subscale scores (LeBourgeois et al., 2005). To complete the ASHS, participants used a six-point ordinal scale (N = *Never,* O = *Once in a while*, S = *Sometimes*, Q = *Quite often*, F = F*requently, if not always,* A = *Always*) to answer the items, except for self-report bedtime and wake time items.

Based on confirmatory factor analysis (CFA), a revised version of the ASHS, coined ASHSr, was created to include six domains: Physiological, Behavioral Arousal, Sleep Stability, Sleep Environment, Cognitive/Emotional, and Daytime Sleep (Storfer-Isasser et al., 2013). Previous studies have confirmed internal consistency for the ASHSr. In a sample from the United States, the ASHSr’s total score demonstrated good internal consistency ($\alpha = .84$) and poor to good ($\alpha = .60$ - .81) internal reliability on the subscales. The ASHSr demonstrated fair to acceptable internal consistency on the Persian ($\alpha = .68$ to .80) and ($\alpha = .67$) and Dutch versions (Chehri et al., 2017; de Bruin et al., 2014). Test-test reliability was determined to be good (r =

.85) for the total score and good (*r* = .82 to .87) for the subscales in the Farsi version of the ASHSr (Chehri et al., 2017).

The validity of the ASHS and ASHSr is well-researched. The ASHS factors exhibited moderate to strong correlations with daily sleep quality through a questionnaire, sleep duration based on sleep logs, and a chronic sleep reduction scale (de Bruin et al., 2014). Correlation with actigraphy data and the *Child Behavioral Checklist* suggests concurrent validity for the ASHSr (Storfer-Isser et al., 2013). CFA and Rasch analyses supported the six-factor model in the Persian ASHSr (Lin et al., 2018b). The Farsi ASHS and *Pittsburg Sleep Quality Index* (PSQI) total scores correlated, suggesting a positive association between sleep hygiene habits and sleep quality (Chehri et al., 2017). The Dutch version of the ASHS discriminated between the clinical sample with insomnia and a normative sample (de Bruin et al., 2014).

The wording of two items was altered to adapt to modern adolescent behaviors for the current study. Item six changed from "After 6:00 in the evening, I smoke or chew tobacco" to "After 6:00 in the evening, I smoke or chew tobacco, or use e-cigarettes or vape." Item 22 changed from "I fall asleep while watching TV" to "I fall asleep while using screens (e.g., TV, cellphone, tablet)." In addition, the ASHS substance use subscale was included in the CFA due to recommendations from the researchers who established the ASHSr (Storfer-Isser et al., 2013).

Waketimes, Bedtimes, and Sleep Durations. As part of the ASHS, each participant recorded an estimate of their "usual" bedtimes and wake times during the school week and weekends. Based on the original format of the ASHS, participants entered their bedtimes and wake times in a 12-hour form (e.g., 11:15 pm). For 13 students, it was assumed that the am and pm should be reversed for their bedtimes. For example, a student indicated a bedtime of 12:00 pm and a wake time of 8:00 am. Four students' bedtime and wake time data were eliminated due be outliers with uncertain errors (e.g., one student indicated a bedtime at 1:00 pm and a wake time at 3:30 pm).

Using Excel, times were converted to a 24-hour format (e.g., 23:15). For bedtimes and wake times later than 11:59 pm, which is also 23:59, 24:00 was added. For example, a bedtime of 1:00 am converted to 25:00. SPSS (version 23) software was utilized to assess outliers, calculate sleep durations, and compute the differences in bedtimes, wake times, and sleep durations. The difference in school week and weekend bedtimes, noted as ΔBedtime, were calculated by determining the absolute value of their weekend bedtime minus their school week bedtime, ΔBedtime = |weekends bedtime – school week bedtime|. Consistently, differences in the school week and weekend wake time, noted by ΔWake times, were calculated using the following formula ΔWaketimes = |Weekend Waketime – School Week Waketime|. Changes in the school week and weekend sleep durations, noted as ΔSleep Duration, were calculated using the following formula: ΔSleepDuration = |Weekend Sleep Duration – School Week Sleep Duration|.

Epworth Sleepiness Scale for Children and Adolescents **(ESS-CHAD)**

The *Epworth Sleepiness Scale for Children and Adolescents* (ESS-CHAD) is based on the adult version of the ESS (Johns, 1992). The ESS-CHAD is a self-report scale and measures EDS in children and adolescents. The scale consists of eight scenarios for the participants to rank how likely they would fall asleep over the past month. The ESS-CHAD uses a 4-point ordinal response scale (0 = *would never fall asleep*, 1 = *slight chance of falling asleep*, *2 = moderate chance of falling asleep,* 3 = *high chance of falling asleep*). The items are added together to create the total ESS-CHAD Score. Higher scores indicate more problematics EDS. Scores ≤ 10 are considered ‘Normal.’ Scores between 11 and 15 indicate ‘Excessive Daytime Sleepiness,’ and scores ≥ 16 suggest 'High Levels of Sleepiness Suggestive of Significant Sleep Disorder' (Johns, 1992). The unidimensional structure of the pediatric scale has been verified through exploratory factor analysis and Rasch analysis (Janssen et al., 2017). In previous research, the ESS-CHAD demonstrated validity by distinguishing between children with chronic kidney disease engaging in dialysis, individuals considered pre-dialysis, and those who previously received a transplant (Davis et al., 2012).

RAND 36-Item Short-Form Health Survey (SF-36)

The SF-36 was created as part of the Medical Outcomes Study (Ware & Sherbourne, 1992). It is a self-report measure of health-related quality of life (Hays et al., 1993). The eight domains of the scale include Physical Functioning, Role Limitations due to Physical Health Problems (RL (Physical)), Role Limitations due to Emotional Problems (RL (Emotional)), Energy/Fatigue, Emotional Well-Being, Social Functioning, Pain, and General Health. In this study, students completed all domains except Physical Functioning and Pain. Scores for each domain range from 0 to 100. Lower scores indicate worsened health-related quality of life (Ware & Sherbourne, 1992), and a score of 50 is considered average (Ware et al., 1994).

The SF-36 is available in 120 languages (Burholt & Nash, 2011). The subscales have demonstrated good internal consistency (α > .70) across studies (Traino et al., 2019). Validity has been demonstrated with the *Health Assessment Questionnaire*. In individuals with arthritis, lower scores on the scales correlate with higher pain and increased physical limitations (Matcham et al., 2014). Worse scores across all domains of the SF-36 have been associated with increased EDS (Sforza et al., 2002). For children and adolescents, the SF-36 has been able to discriminate in lower quality of life related to medical conditions, such as epilepsy and chronic migraines (Wang et al., 2012; Paschoal et al., 2013).

Statistical Analysis Procedures

Data from self-reported sleep schedules and rating scales were analyzed for normality. Analyses, including independent sample t-tests and one-way analysis of variance (ANOVA) tests, were conducted to assess differences among demographic groups. Internal consistencies were calculated to investigate reliability among scales and subscales.

Confirmatory Factor Analysis (CFA)

Goetz et al. (2013) proposed that researchers follow rigorous guidelines to maintain the scale's psychometrics when reducing items on a scale. Therefore, a calibration sample was created for the current study using the randomization function in SPSS, which consisted of approximately 75% of random participants. The validation sample included the remaining approximately 25% of participants.

Using JASP (Version 0.14.1; JASP Team, 2021), a first-order CFA was conducted on the calibration sample to examine the factor structure of the ASHSr. The additional substance use factor from the original ASHSr was re-introduced into the ASHSr based on previous researchers' recommendations (Storfer-Isser et al., 2013). For parameter estimation, robust maximum likelihood estimation was applied to account for skewed distributions on the ASHS items (McDonald & Ho, 2002).

Based on the first-order CFA results for the calibration sample, items were removed one by one when standardized factor loadings were lower than 0.40. A second-order CFA was then conducted to investigate the contribution of the total sleep hygiene construct on each factor. Modification indices (MI) were examined to evaluate if any items were strongly correlated with other items or factors and should be removed or moved to another factor (Hair, 2006).

Based on recommendations from Hu and Bentler (1999), multiple methods were used to establish the final model. The Root Mean Square Error of Approximation (RMSEA) was calculated, with values ≤ .06 indicating a good fit. Additionally, standardized root mean residuals (SRMR) values < 0.08 suggest a good fit (Hu & Bentler, 1999). Relative fit measures included the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI), which both indicated good fit with scores ≥ 0.95.

Repeated research on various medical and behavioral health concerns has demonstrated that screeners with three to five items can sufficiently discriminate between individuals who are at-risk versus not at-risk (Walton et al., 2020). Therefore, items were re-examined on the ASHS-College to create a screener with fewer items. The goal of the screener includes maintaining an adequate fit. Additionally, a theoretical review was conducted to eliminate items and to ensure retained items theoretically measure the same construct as the ASHS-College (Walton et al., 2020). To verify the stability of the model, cross-validation with a tight strategy was conducted with the validity sample for the ASHS-College and ASHS-Screener (MacCallum et al., 1994).

Subscale scores for the newly developed ASHS-College and ASHS-Screener were calculated by averaging the items for each subscale. Then, the total scores were calculated by averaging the subscale means. Using McDonald's ω, the internal consistencies of the ASHS-College and ASHS-Screener were examined. Coefficients of at least 0.60 were questionable, greater than 0.70 were acceptable, and 0.80 and above are considered good (Boateng et al., 2018).

Classification Accuracy

To determine if the established ASHS-College and ASHS-Screener have similar classification accuracy to the ESS-CHAD, a receiver operator characteristic (ROC) curve analysis was used. The ESS-CHAD was the criterion measure. Participants were dichotomized into two groups, ‘not at-risk’ and ‘at-risk,’ based on their scores on the ESS-CHAD.

Area Under the Curve (AUC) was calculated to measure the probability that an individual identified as at-risk on one screener would be classified as more at-risk on another (Lasko et al., 2005). In ROC curve analyses, AUC ranges from 0 to 1.00. An AUC value < 0.50 yields unacceptable accuracy, values between 0.50 and 0.69 suggest low accuracy, values between 0.70 and 0.89 indicate moderate accuracy, and values between 0.90 and 1.00 suggest high accuracy (Streiner & Cairney, 2007).

To determine a cut-score on the ASHS-College and ASHS-Screener, sensitivity and specificity were calculated as part of a ROC curve analysis. Sensitivity, also known as the true positive (TP) rate, is the proportion of truly ‘at-risk’ students identified as ‘at-risk’ by the screener (Streiner, 2003). Specificity, also known as the true negative (TN) rate, refers to the students correctly identified as ‘not at-risk’ by the screener (Streiner, 2003). Using the rationale provided by Cicchetti and colleagues (1995), sensitivity and specificity scores ≥ 0.70 were classified as fair, ≥ 0.80 as good, and scores ≥ 0.90 as optimal.

The false positive (FP) rate is the rate of individuals who are truly ‘not at-risk’ but falsely identified as ‘at-risk’ by the screener. FP is equal to (1 – specificity). The false negative (FN) rate is the rate of individuals who are truly ‘at-risk’ but identified as ‘not at-risk’ by the screener. The sum of the TP rate and FN rate is always one; consequently, the FN rate decreases as the TP rate increases. Similarly, the sum of the TN and FP rates equals one. Thus, sensitivity and specificity have a reciprocal relationship. When determining a cut-sore for a universal screener, over-identification is considered acceptable (Streiner & Cairney, 2007).

Validity

Factorial validity was assessed through the CFA. Criterion and concurrent validity were assessed by comparing the ASHS-College and ASHS-Screener to data derived from estimates of bedtimes and wake times, the ESS-CHAD total score, and factors on the SF-36 (Boateng et al., 2018). Significant correlations (r_s) between .10 and .30 were considered small, .30 to .50 medium, and greater than .50 was interpreted as large (Cohen, 1988).

CHAPTER 3: RESULTS

All planned statistical analyses are presented in this chapter. A combination of statistical software was used to complete these analyses, including IMB Statistical Package for the Social Sciences (SPSS) version 27, JASP 0.14.1, and Jamovi 1.6 (JASP Team, 2021; The Jamovi Project, 2021). Descriptive data from each measure is described initially. The Confirmatory Factor Analysis (CFA) is then described, followed by validation procedures.

Measures

Adolescent Sleep Hygiene **(ASHS)**

Each participant completed the ASHS as a measure of sleep hygiene. Means (*M*) and standard deviations (*SD*) were calculated for each quantitative item, subscale, and the total score on the ASHS and are presented in Table 3. The most highly endorsed items were "I use my bed for things other than sleep" (*M* = 2.18; *SD* = 1.01), "On weekends, I stay up more than 1 hour past my usual bedtime" (*M* = 2.29; *SD* = 1.02), and "During the school week, I stay up more than 1 hour past my usual bedtime" (*M* = 2.59; *SD* = 1.01). The least endorsed items were "I fall asleep while listening to loud music" (*M* = 4.30; *SD* = .98), "I fall asleep in a brightly lit room (e.g., the overhead light is on)" (*M* = 4.29; *SD* = 1.00), and "After 6:00 in the evening, I smoke or chew tobacco, or use e-cigarettes or vape." (*M* = 2.29; *SD* = 1.0). As presented in Table 3, internal consistency on the ASHSr (ω = 0.82) was in the good range and ranged from unacceptable to acceptable on the factors (ω = 0.54 to 0.77).

Table 3

Descriptive Statistics for Rating Scales Items and Subscales on the ASHSr

ASHSr Factors and Items	M (SD)
Physiological Factor (*ω* = .54)	**3.41 (.64)**
3. After 6:00 in the evening, I have drinks with caffeine	2.97 (1.15)
10. During the 1 hour before bedtime, I am very active.	3.4 (1.27)
12. During the 1 hour before bedtime, I drink more than 4 glasses of water.	3.07 (1.25)
18. I go to bed with a stomachache	4.04 (.93)
19. got to bed feeling hungry	3.56 (.96)
Behavioral Arousal Factor (*ω* = .59)	**3.06 (.46)**
11. During the 1 hour before bedtime, I do things that make me feel very awake^	2.72 (.96)
13. I go to bed and do things in my bed that keep me awake	2.82 (1.30)
28. I use my bed for things other than sleep	2.18 (1.01)
Cognitive/Emotional (*ω* = .73)	3.12 (.63)
9. During the 1 hour before bedtime, things happen that make me feel strong emotions	3.28 (.88)
14. I go to bed and think about things I need to do	3.48 (.88)
15. I go to bed feeling upset	3.48 (.88)
16. I go to bed and replay the day's events over and over in my mind	3.01 (.92)
17. I go to bed and worry about things happening at home or at school	3.12 (1.08)
29. I check my clock several times during the night	3.38 (1.06)
Sleep Environment (*ω* = .68)	3.84 (.73)
20. I fall asleep while listening to loud music	4.30 (.98)
21. I fall asleep while using screens (e.g., TV, cellphone, tablet)	3.09 (1.23)
22. I fall asleep in a brightly lit room (e.g., the overhead light is on)	4.29 (1.00)
23. I fall asleep in one place and then move to another place during the night	4.16 (1.18)
24. I fall asleep in a room that feels too hot or too cold	3.37 (1.11)
Sleep Stability (*ω* = .77)	**2.45 (.81)**
30. During the school week, I stay up more than 1 hour past my usual bedtime	2.59 (1.01)
32. On weekends, I stay up more than 1 hour past my usual bedtime	2.29 (1.02)
33. On weekends, I "sleep in" more than 1 hour past my usual wake time	2.63 (1.13)
Daytime Sleep (*ω* = .74)	**3.36 (.97)**
1. During the day, I take a nap that lasts more than 1 hour	3.27 (1.10)
4. After 6:00 in the evening, I take a nap	3.47 (1.05)
Substance Use (*ω* = .70)	**4.05 (1.07)**
6. After 6:00 in the evening, I smoke or chew tobacco, or use e-cigarettes or vape	4.17 (1.30)
7. After 6:00 in the evening, I drink beer (or some other drinks with alcohol)	3.99 (1.08)
ASHSr Total (*ω* = .82)	**3.31 (.36)**

Note. ASHSr = *Adolescent Sleep Hygiene Scale, Revised*; *ω* = McDonald's omega

Based on the ASHSr total score, there was no significant correlation between age and overall sleep hygiene, r_s = .03, *p* = .62. Likewise, there were no significant differences between men and women for overall sleep hygiene, *U* = 11,354.50, *p* = .11. Regarding race, independent one-way ANOVA showed a significant effect of the race on ASHSr (*F* (4, 287) = 2.80, *p* = .01, ω^2 = 0.02). Post-hoc testing using Tukey's correction revealed that Black or African American participants (*M* = 3.09; *SD* = 0.43) reported significantly worse sleep hygiene (*p* = .03) than White participants (*M* = 3.26; *SD* = 0.47). However, the p-value was small, and Cohen's d (-0.41) suggests this is a small effect. Regarding ethnicity, there was no significant difference observed in the ASHSr scores between participants who identified as 'Hispanic or Latino' (*M* = 3.25, *SD* = .45) and students who identified as 'Not Hispanic or Latino' (*M* = 3.21, *SD* = .41), based on an independent t-test, *t* (290) = .48, *p* = .63. As determined by an one-way ANOVA tests, there were no statistically significant differences between group means for academic class, *F*(2,288) = 1.66, *p* = .19.

Wake Times, Bedtimes, and Sleep Durations. Based on students' estimation of bedtimes and wake times, the average amount of sleep obtained was 8.76 hours (*SD* = 1.58) on school nights and 8.97 hours (*SD* = 1.55) on weekends. The mode bedtime was 12:00 am during the school week and 3:00 am on weekends. Concerning wake times, the mode was 9:00 am during the school week and 10:00 am on weekends. The mean variability between the school week and weekend bedtimes was 1.38 hours (*SD* = 1.20), 1.82 hours (*SD* = 1.72) for wake times, and 1.14 hours (*SD* = 1.35).

Spearman's correlation (r_s) was computed to assess the relationship between sleep duration and the variability in the school week and weekend bedtimes, wake times, and sleep durations. Results are presented in Table 4.

Table 4

Correlations Among School Week to Weekend Difference (Δ) and Sleep Durations

	Differences			Sleep Duration	
	ΔBedtimes	ΔWaketimes	ΔSleep Duration	School Week	Weekend
Differences					
ΔBedtimes	-				
ΔWaketimes	.37**	-			
ΔSleep Duration	.25**	.28**			
Sleep Durations			-		
School Week	.01	-.32**	-.16**	-	
Weekend	-.18**	.18**	.06	.47**	-

Note. ΔBedtime = |Weekend Bedtime - School Week Bedtime|; ΔWaketime = |Weekend Waketime - School Week Waketime|; ΔSleep Duration = |Weekend Sleep Duration - School Week Sleep Duration| ; * p < .05, ** p < .01

There were no significant correlations between age and ΔBedtimes (r_s = -.04, p = .50), ΔWaketimes (r_s = -.04, p = .52), ΔSleep Duraitons (r_s = -.06, p = .32), school week sleep duraitons (r_s = .05, p = .38), and wekeend sleep duraitnon (r_s = .05 p = .37). Based on a Mann-Whitney test, no signficnat differences were observed beetween men and women for ΔBedtimes (U = 10,370.50, p = .84), ΔWaketimes (U = 11,019.00, p = .26), ΔSleep Duraitons (U = 10,361.50, p = .86), and weekend sleep durations (U = 9,051.00, p = .09). However, women (*Mdn* = 9.00 hours) slept signficiantly longer during the school week than men (*Mdn* = 8.50), U = 7,862.00, p <.01. Regarding race, a one-way ANOVA revealed that there was not a statistically significant difference between groups for ΔBedtimes (F(4, 286) = 0.77, p = .54), ΔSleep Duraitons (F(4, 286) = 1.85, p = .12), and school week sleep durations (F(4, 286) = 1.93, p = .11). Race did not significnalty impact ΔWaketimes (H(4) = 3.88, p = .42) or weekend sleep durations (H(4) = 1.90, p = .75) based on Kruskal-Wallis tests. For ethnicity, there were no significant differences were observed between groups for ΔBedtimes (*U* = 3,102, *p* = .17), ΔWaketimes (*U* = 3,824.50, *p* = .74), ΔSleep Duraitons (*U* = 4,103.00, *p* = .32), school week sleep durations (*U* = 3,317.00, *p* = .39), and weekend sleep durations (*U* = 33,882.00, *p* = .64). Concerning academic class (e.g., freshman), one-way ANOVA tests revealed that there was not a statistically significant difference groups for ΔBedtimes (*F*(2, 287) = 1.40, *p* = .24), ΔWaketimes (*F*(2, 287) = 0.60, *p* = .55), ΔSleep Duraitons (*F*(2, 287) = 2.05, *p* = .13), and weekend sleep durations (*F*(2, 287) = 0.39, *p* = .67). There were also no significant differences in academic classes for school week sleep durations based on a Kruskal-Wallis test, *H*(2) = 0.51, *p* = .78.

***Epworth Sleepiness Scale for Children and Adolescents* (ESS-CHAD)**

Each participant completed the *Epworth Sleepiness Scale for Children and Adolescents* (ESS-CHAD) as a measure of EDS. Internal consistency was questionable (ω = 0.64) and did not increase with the removal of items.

To calculate the total score for the ESS-CHAD, the item scores were summed. Scores ≤ 10 are considered 'Normal.' Scores between 11 and 15 indicate 'Excessive Daytime Sleepiness' (EDS), and scores ≥ 16 suggest 'High Levels of Sleepiness Suggestive of Significant Sleep Disorder.' As seen in Table 5, of the 292 participants, 200 (68.49%) ratings indicate they are experiencing 'Normal Levels of Sleepiness.' The EDS group contained 88 participants (30.14%), and four (1.37%) participants' scores suggested a 'High Level of Sleepiness Suggestive of Significant Sleep Disorder.'

Table 5

Frequency of Categories of Daytime Sleepiness based on ESS-CHAD Scoring

Category of Daytime Sleepiness	N	%	Cumulative %
Normal Levels of Sleepiness	200	68.49	68.49
Excessive Daytime Sleepiness	88	30.14	98.63
High Level of Sleepiness Suggestive of Significant Sleep Disorder	4	1.37	100.00

Note. ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*

Means and standard deviations for each item and the ESS-CHAD item and total scores are presented in Table 6. The most commonly endorsed item was related to falling asleep in the afternoon if ‘lying down to rest or nap,’ with an overwhelming majority (85.25%) indicating a ‘moderate’ or ‘high’ to high chance of falling asleep. A ‘moderate’ or ‘high’ chance of falling asleep was endorsed by approximately half (53.42%) while ‘sitting and watching TV or a show,’ slightly less than half (46.57%) for ‘sitting and while reading,’ and less than half (42.12%) while ‘sitting in a classroom at school during the morning.’ During a 30-minute car or bus ride, over one-third (39.38%) of participants endorsed a ‘moderate’ or ‘high’ chance of falling asleep. Furthermore, a ‘moderate’ or ‘high’ chance of falling asleep by slightly over one-tenth (11.64%) while ‘sitting quietly by themselves at lunch,’ less than one-fifth (3.09%) while ‘sitting and eating a meal’ (3.09%), and very few (2.73%) endorsed falling asleep while ‘sitting and talking to someone.’

Table 6

Means (M) and Standard Deviations (SD) for ESS-CHAD Items and Total Score

ESS-CHAD Items	M (SD)
1. Reading	1.46 (0.94)
2. Watching Screens	1.59 (0.87)
3. Classroom during the morning	1.32 (1.00)
4. Riding in a car or a bus	1.31 (1.01)
5. Lying down in the afternoon	2.36 (0.83)
6. Talking to someone	0.11 (0.42)
7. Alone after lunch	0.51 (0.73)
8. Eating a meal	0.16 (0.49)
9. Total	8.81 (3.40)

Note: Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD); *M* = Mean; *SD* = Standard Deviation

Correlations among items were assessed using Spearman's correlation (r_s) and presented in Table 7. When comparing item scores to the total score, all items showed moderate to strong associations (r_s = .33 to .64). Inter-item spearman correlation coefficients were primarily in the very weak to weak range (r_s = .13 to .38).

There was no significant correlation between age and EDS based on the ESS-CHAD total score (r_s = .02, p = .50). Regarding gender, a Mann-Whitney test showed there was not a significant difference for EDS between men and women, U = 9,929.00, p = .66, based on ESS-CHAD total scores. As determined by one-way ANOVA tests, EDS did not significantly differ between group means for each race (F(4, 287) = 1.64, p = .16) or academic class (F(2,288) = 0.05, p = .95). A Mann-Whitney test showed that there was not a significant difference in ESS-CHAD total scores between participants who identified as Hispanic or Latino and those who did not identify as Hispanic or Latino, U = 3519.00, p = .68.

Table 7

Correlations Among ESS-CHAD Items

ESS-CHAD Items	I	2	3	4	5	6	7	8
1. Reading	-							
2. Watching Screens	.25**	-						
3. Classroom during the morning	.29**	.23**	-					
4. Riding in a car or a bus	.15*	.18**	.28**	-				
5. Lying down in the afternoon	.13**	.11	.10	.32**	-			
6. Talking to someone	.17**	.12*	.29**	.08	.03	-		
7. Alone after lunch	.18**	.15*	.15**	.08	.15**	.16**	-	
8. Eating a meal	.18**	.12*	.17**	.11	.09	.24**	.38**	-
9. Total Score	.59**	.51**	.64**	.60**	.48**	.33**	.46**	.39**

Note. ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*; * $p < .05$, ** $p < .01$

RAND 36-Item Short-Form Health Survey **(SF-36)**

Students completed the following subscales on the SF-36: Role Limitations due to Physical Health Problems (RL (Physical), Role Limitations due to Emotional Problems (RL (Emotional)), Energy and Fatigue, Emotional Well-Being, Social Functioning, and General Health. Descriptive statistics for the items and subscales are presented in Table 8, along with internal consistencies. Each domain showed acceptable to good internal consistency (ω = .73 to .82). The RL (Physical), RL (Emotional), Energy and Fatigue, Social Functioning, and General

Health subscales were in the acceptable range (ω = .75 to .78). The Emotional Well-Being subscale revealed good internal consistency (ω = .82). Spearman correlations were compared among HRQoL factors. The results are presented in Table 9. All factors were significantly correlated with each other (r_s = .27 to .64).

Table 8

Means (M) and Standard Deviations (SD) for SF36 Items and Factors

SF-36 Factors/Items	M (SD)
RL (Physical) (ω = .75)	68.60 (37.11)
Cut down on time spent on work or other activities	72.44 (44.76)
Accomplished less than you would like	62.50 (48.49)
Were limited in the kind of work or other activities	70.51 (45.67)
Difficulty performing the work or other activities	69.87 (45.96)
RL (Emotional) (ω = .77)	54.83 (41.01)
Cut down on time spent on work or other activities	58.65 (49.32)
Accomplished less than you would like	49.36 (50.08)
Didn't do work or other activities as carefully as usual	56.41 (49.67)
Energy and Fatigue (ω = .73)	49.12 (19.29)
Amount of time you felt full of pep	49.81 (24.27)
Amount of time you had a lot of energy	57.12 (24.28)
Amount of time you felt worn out	48.78 (27.38)
Amount of time you felt tired	41.28 (27.33)
Emotional Well-Being (ω = .82)	63.05 (19.59)
Been a very nervous person	55.37 (28.31)
Felt so down in the dumps that nothing could cheer you up	69.65 (27.96)
Felt calm and peaceful	58.26 (22.68)
Felt downhearted and blue	65.08 (26.42)
Been a happy person	66.88 (23.61)
Social Functioning (ω = .78)	74.91 (25.15)
Extent that physical health or emotional problems interfered with normal social activities	76.62 (27.24)
Time that physical health or emotional problems interfered with social activities	73.21 (28.23)
General Health (ω = .75)	75.81(18.95)
In general, your health is:	72.98 (22.45)
I seem to get sick a little easier than other people.	78.23 (28.33)
I am as healthy as anybody I know.	72.18 (30.45)
I expect my health to get worse.	78.63 (30.53)
My health is excellent.	77.02 (26.79)

Note. SF-36 = *RAND 36-Item Short-Form Health Survey* (SF-36); RL = Role Limitations; ω = McDonald's omega

Concerning the Role Limitation (RL) domains, less than half of the participants (41.10%) endorsed “yes” to their emotional health leading to a decrease in the amount of time spent doing work activities or other activities. In comparison, about one-fourth (27.70%) endorsed “yes,” indicating that their physical health challenges lead to reduced work or engagement in other activities. Difficulty performing work or other activities due to physical health was denied (i.e., answered “no”) by most participants (69.70%). Around half (50.60%) endorsed “yes” for emotional health getting in the way of desired accomplishments, but only about one-third (30.30%) of participants indicated interference of physical health in accomplishing daily goals. About one-third (34.90%) indicated “yes” for their emotional health impacting how carefully they complete activities. Physical or emotional health was reported to influence social activities ‘most of the time’ or ‘all of the time’ for about one-seventh participants (14.01%). For about one-tenth of participants (10.43%), the degree to which physical health or emotional problems interfered with typical social activities was endorsed as “quite a bit” or “extremely.”

Regarding the Energy and Fatigue subscale, almost two-thirds (64.70%) of students endorsed having a lot of energy as occurring ‘a good bit of the time,’ ‘most of the time,’ or ‘a good bit of the time.’ Feeling tired at least ‘a good bit of the time’ occurred for more than half (58.10%) of the participants; however, slightly more than half (53.70%) reported feeling ‘full of pep’ at least ‘a good bit of the time.’ Consistently, less than half (47.50%) reported feeling ‘worn out’ for a ‘good bit of the time,’ ‘most of the time,’ or ‘a good bit of time.’

Concerning the Emotional Well-Being scale, being a happy person was indicated by about three-fourths of participants (75.80%) as occurring ‘a good bit of the time,’ ‘most of the time,’ or ‘all of the time.’ On the other hand, about one-fourth (25.50%) of the participants reported feeling down and having trouble making themselves feel better at least ‘most of the time.' Consistently, feeling downhearted and blue was endorsed by approximately one-fourth (26.10%) of participants at least 'a good bit of the time.' Related to anxiety and emotional arousal symptoms, feeling calm and peaceful at least 'most of the time' was indicated by slightly less than two-thirds (63.90%). Less than half (41.10%) reported feeling nervous at least 'a good bit of the time.'

As part of the General Health subscale, most participants (85.5%) supported the statement 'My Health is Excellent' as 'definitely true' or 'mostly true.' Over three-fourths (77.90%) of participants endorsed that they do not get sick more easily than others. Consistently, 'I am as healthy as anybody I know' was endorsed as 'definitely true' or 'mostly true' for over three-fourths (77.50%). Expecting their health to get worse was indicated as 'definitely true' or 'mostly true' by less than one-fifth (15.00%) of participants. Overall health was classified as 'Poor' by 0.60% of participants, 'Fair' by 8.30% of participants, 'Good' by 36.30% of participants, 'Very Good' by 36.00% of participants, and 'Excellent' by 18.50% of participants.

Table 9

Correlations Among SF-36 Domains

SF-36	RL (Physical)	RL (Emotional)	Energy/ Fatigue	Emotional Well-Being	Social Functioning	General Health
RL (Physical)	-					
RL (Emotional)	.55**	-				
Energy/Fatigue	.29**	.48**	-			
Emotional Well-Being	.35**	.57**	.64**	-		
Social Functioning	.46**	.58**	.56**	.64**	-	
General Health	.27**	.36**	.31**	.24*	.39**	-

Note. SF-36 = *RAND 36-Item Short-Form Health Survey* (SF-36); RL = Role Limitations; * $p < .05$, ** $p < .01$

There was no significant correlation between age and RL (Physical; r_s = -.02, p = .75), RL (Emotional; r_s = .06, p = .33), Energy and Fatigue (r_s = .01, p = .87), Emotional Well-Being (r_s = -.05, p = .42), Social Functioning (r_s = -.01, p = .98), and General Health (r_s = .09, p = .32). A Mann-Whitney U test showed that there was not a significant difference in between ethnicity groups on the RL (Physical), U = 3598.50, p = .86, RL (Emotional), U = 3654.50, p = .95, Energy/Fatigue, U = 3224.00, p = .29, Emotional Well-Being, U = 3110.00, p = .30, Social Functioning, U = 3143.00, p = .30, and General Health, U = 679.50, p = .53.

Men (*Mdn* = 100.00) experienced lower interference of physical health in their daily activities, noted RL (Physical), than women (*Mdn* = 75.00) based on a Mann-Whitney U test, U = 11,937.00, $p < .01$. Women (*Mdn* = 33.33) also experience significanlty more frequent restrictions in their daily activites due to emotinal health, noted as RL (Emotional), compared to men (*Mdn* = 66.67), U = 12,354.50, $p < .01$. Concerting Social Functioning, women (*Mdn* = 75.00) endorsed expeirencing signifcianlty more intense and frequent interference of physical health and emotional health on social activities than men (*Mdn* = 87.50), U = 11,653.50, $p < .01$. Concerning fatigue, women (*Mdn* = 50.00) experienced higher amounts fatigue and reduced energy more than men (*Mdn* = 55.00), U = 12,342.50, $p < .01$. Emotional Well-Being was significnalty healthier in men (*Mdn* = 72.00) than in women (*Mdn* = 64.00), U = 12,791.50, $p < .01$. On the General Health scale, there was no signficnat difference between men (*Mdn* = 80.00) and women’s (*Mdn* = 80.00) scores, U =1585.50, p = .83. In summary, women’s eomotinal and pshsycal health significanlty impacted their daily activites and social activies more than men. Women also endorsed significantly higher symptoms of fatigue and worse emotional well-being than men. However, no statistical differences in general health were observed.

No statistically significant differences between aacademic classes groups or race groups were observed on the RL (Physical; $F(2, 288) = 0.24$, $p = .98$; $F(4, 287) = 1.21$, $p = .31$), RL (Emotional; $F(2,288) = 1.10$, $p = .60$; $F(4, 287) = 1.31$, $p = .27$), Energy/Fatigue ($F(2,288) = 0.73$, $p = .74$; $F(4, 287) = 0.39$, $p = .82$), Emotional Well-Being ($F(2,288) = 0.82$, $p = .80$; $F(4, 287) = 0.49$, $p = .74$), Social Fucntioning $F(2,288) = 0.20$, $p = .99$; $F(4, 287) = 0.35$, $p = .84$), and General Health ($F(2,288) = 0.98$, $p = .64$; $F(4, 287) = 1.11$, $p = .35$), based on one-way ANOVAs.

Statistical Analysis Results

Confirmatory Factor Analysis (CFA)

Using SPSS, a calibration sample was created using the randomization function, which consisted of approximately 75% of random participants. The validation sample included the remaining approximately 25%. Based on a Mann-Whitney U test, there were no significant differences between the ages of the calibration and validation groups, $U = 7796.50$, $p = .15$. Chi-square tests of independence showed there was not a statistically significant difference between the calibration and validation samples for gender, (χ^2 (2, $N = 292$) = 3.31 $p = .19$), race (χ^2 (6, $N = 292$) = 2.03, $p = .92$), ethnicity (χ^2 (1, $N = 292$) = 3.45, $p = .06$), and academic class (χ^2 (3, $N = 292$) = 0.39, $p = .94$).

JASP was used to conduct the confirmatory factor analysis using the calibration sample first (JASP Team, 2021). The ASHSr was then established with six latent constructions and 24 items. The substance use factor from the original ASHS was included in this study due to the high prevalence among college students, creating seven latent constructs and 26 items. The first-order model did not have minimally adequate fit using the calibration sample ($\chi^2 = 688.57$, $df = 278$, $p < .01$; $CFI = 0.79$; $TLI = 0.75$; $RMSEA = 0.07$; $SRMR = 0.09$). Therefore, items with standardized estimates (λ) below 0.40 were removed one at a time, including all items on the Physiological and Behavioral Arousal factor subscales. The model was then examined as a second-order model. One item was then eliminated from the Sleep Environment subscale due to non-convergence.

As seen in Table 10, the second-order model then had adequate fit, (χ^2 = 222.64, *df* = 114, p < .01; *CFI* = .98; *TLI* = .95; *RMSEA* = 0.06; *SRMR* = 0.08) with the calibration sample. When the model was assessed with the validation sample, it also had adequate fit, (χ^2 = 113.90, *df* = 114, p = .10; *CFI* = .98; *TLI* = .98; *RMSEA* = .06; *SRMR* = .09). Therefore, the ASHS-College consisted of five domains and 17 items. As shown in Table 11, internal consistency for the ASHS-College was acceptable (ω = .75) and ranged from questionable to acceptable on the factors (ω = .60 to .75). Table 11 displays the descriptive statistics for the total sample and inter-factor correlations for the ASHS-College. Domain scores were calculated by averaging the item scores, and total scores were calculated by averaging the domain scores.

Table 10

Fit Statistics for ASHS-College and ASHS-Screener

	χ^2	df	p	CFI	TLI	RMSEA	SRMR
ASHS-College (Calibration Sample)	222.64	114	<.01	.96	.95	.06	.08
ASHS-College (Validation Sample)	113.90	114	.10	.98	.98	.05	.09
ASHS-Screener (Calibration Sample)	3.49	6	.74	1.00	1.00	>.01	.03
ASHS-Screener (Validation Sample)	4.53	6	.61	1.00	1.00	>.01	.06

Note. ASHS = *Adolescent Sleep Hygiene Scale*; χ^2 = Chi-square; df = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Squared Residual

Table 11

Inter-Factor Correlations, Internal Consistency, Means, and Standard Deviations of the ASHS-College

ASHS-College Domains	M (SD)	1	2	3	4	5
1. Cognitive/ Emotional (ω = .74)	3.14 (.60)	-				
2. Sleep Environment (ω = .60)	3.71 (.74)	.34**	-			
3. Sleep Stability (ω = .65)	2.50 (.85)	.19*	.22**	-		
4. Daytime Sleep (ω = .75)	3.35 (.92)	.25**	.31**	.28**	-	
5. Substance Use (ω = .70)	4.06 (1.30)	.10	.15*	-.04	.04	-
6. College Total (ω = .75)	3.14 (.60)	.53**	.64**	.56**	.64**	.48**

Note. ASHS = *Adolescent Sleep Hygiene* Scale; ω = McDonald's omega; * $p < .05$, ** $p < .01$

To create the ASHS-Screener, standardized estimates and factor loadings continued to be monitored. MI was examined in the second-order model to assess possible ways to improve fit. Theoretical review assisted in the removal of items. For example, Item 14 ('I go to bed and think about things I need to do') and Item 16 ('I go to bed and replay the day's events over and over again in my mind') theoretically measure the same concept related to the Cognitive/Emotional factor (e.g., rumination, worry, anxiety). Therefore, Item 14 was removed due to redundancy and lower standardized factor loadings. Upon reviewing MI, Item 1 ('During the day, I take a nap that lasts more than 1 hour past my usual bedtime.') on the Daytime Sleep scale was highly correlated with the Sleep Stability factor. Given that napping theoretically plays a prominent role in maintaining consistent sleep stability (Ye et al., 2015), Item 1 was moved to the Sleep Stability factor. Consequently, Item 4 ('After 6:00 in the evening, I take a nap') was eliminated due to redundancy, which led to removing the Daytime Sleep Factor.

After eliminating inadequately fit items one by one and re-examining the model, the second-order CFA for the newly established ASHS-Screener demonstrated adequate fit, (χ^2 =

3.49, *df* = 6, *p* = .74; *CFI* = 1.00; *TLI* = 1.00; *RMSEA* = >.01; *SRMR* = .03). As seen in Table 10, the model also had an adequate fit for the validation sample, (χ^2 = 4.53, *df* = 6, *p* = .61; *CFI* = 1.00; *TLI* = 1.00; *RMSEA* > .01; *SRMR* = .06). The ASHS-Screener consisted of three domains and six items. Table 12 displays descriptive statics for the domain scores and total score, along with the inter-factor correlations, for the ASHS-Screener. Domain scores were calculated by taking the mean of each item score, and the total score was calculated by configuring the mean of the domain scores. As seen in Table 12, based on the total sample, internal consistency for the ASHS-Screener was acceptable (ω = .75) and ranged from unacceptable to questionable for the factor scores (ω = .41 to .64).

For both the ASHS-College and ASHS-Screener, the validation and calibration samples also had acceptable first-order standardized factor loadings ranging from (γ = .45 to .87) and second-order standardized factor loadings (λ = .50 to .96). First-orders standardized factor loadings were acceptable for the calibration (γ = .50 to .94) and validation (γ = .52 to .83) samples, as shown in Table 13. Consistently, second-order standardized factor loadings were acceptable for the calibration (λ = .61 to .81) and validation (λ = .74 to .77) samples.

Table 12

Inter-Factor Correlations, Internal Consistency, Means, and Standard Deviations of the ASHS-Screener

	M (SD)	1	2	3
1. Cognitive/ Emotional (ω = .60)	3.26 (.74)	-		
2. Sleep Environment (ω = .52)	3.66 (.90)	.23**	-	
3. Sleep Schedule (ω = .41)	2.92 (.82)	.31**	.24**	-
4. Screener Total (ω = .64)	**3.27 (.59)**	.67**	.72**	.71**

Note. ASHS = *Adolescent Sleep Hygiene* Scale; ω = McDonald's omega; * $p < .05$, ** $p < .01$

Table 13

Factor Structure of ASHS-College and ASHS-Screener from the Second-Order Confirmatory Factor Analysis (CFA)

ASHS-College	Calibration Sample λ γ	Validation Sample λ γ
Cognitive/Emotional	**.53**	**.83**
9. During the 1 hour before bedtime, things happen that make me feel strong emotions	.50	.46
14. I go to bed and think about things I need to do	.50	.69
15. I go to bed feeling upset	.70	.73
16. I go to bed and replay the day's events over and over in my mind	.75	.91
17. I go to bed and worry about things happening at home or at school	.71	.45
29. I check my clock several times during the night	.49	.46
Sleep Environment	**.94**	**.96**
21. I fall asleep while using screens (e.g., TV, cellphone, tablet)	.51	.50
22. I fall asleep in a brightly lit room (e.g., the overhead light is on)	.70	.71
23. I fall asleep in one place and then move to another place during the night	.73	.53
24. I fall asleep in a room that feels too hot or too cold	.49	.66
Sleep Stability	**.45**	**.82**
30. During the school week, I stay up more than 1 hour past my usual bedtime	.66	.71
32. On weekends, I stay up more than 1 hour past my usual bedtime	.86	.75
33. On weekends, I "sleep in" more than 1 hour past my usual wake time	.76	.63
Daytime Sleep	**.60**	**.82**
1. During the day, I take a nap that lasts more than 1 hour	.72	.92
4. After 6:00 in the evening, I take a nap	.85	.86
Substance Use	**.41**	**.50**
6. After 6:00 in the evening, I smoke or chew tobacco, or use e-cigarettes or vape.	.80	.66
7. After 6:00 in the evening, I drink beer (or some other drinks with alcohol)	.75	.87
ASHS- Screener		
Cognitive/Emotional	**.61**	**.77**
15. I go to bed feeling upset	.62	.79
16. I go to bed and replay the day's events over and over in my mind	.71	.83
Sleep Environment	**.64**	**.80**
21. I fall asleep while using screens (e.g., TV, cellphone, tablet)	.51	.52
22. I fall asleep in a brightly lit room (e.g., the overhead light is on)	.94	.78
Sleep Schedule	**.81**	**.74**
30. During the school week, I stay up more than 1 hour past my usual bedtime	.53	.73
1. During the day, I take a nap that lasts more than 1 hour	.50	.56

Note. ASHS = *Adolescent Sleep Hygiene* Scale γ = second-order standardized factor loadings**;** λ = first-order standardized factor loadings

There was no significant correlation between age and sleep hygiene based on total scores on the ASHS-College (r_s = .02, *p* = .75) and ASHS-Screener (r_s = .07, *p* = .21). There were no significant differences in overall sleep hygiene for women and men based on the ASHS-College, *U* = 11,461.50, *p* = 08 and the ASHS-Screener, *U* = 11,706.50, *p* = .04. Regarding race, there were no statistically significant differences between group means on the ASHS-College as determined by one-way ANOVA (*F*(4,287) = 1.03, *p* = 0.39). Independent one-way ANOVA showed a significant effect of the race on ASHS-Screener (*F* (4, 287) = 3.97, *p* < .001, ω^2 = 0.04). Consistent with ASHSr, post-hoc testing using Tukey's correction revealed that White participants (*M* = 3.36; *SD* = 0.54) reported significantly better sleep hygiene than Black participants (*M* = 3.06; *SD* = 0.68), *p* > .01. Cohen's d (-0.50) suggests that this is a medium effect. Based on a Mann-Whitney test, there were no significant differences between the two ethnicity groups on the ASHS-College total score, *U* = 3741.50, *p* = .92, and the ASHS-Screener, *U* = 3726.00, *p* = .94. One-way ANOVAs demonstrated no significant differences between the means for academic class on the total scores for the ASHS-College (*F*(2,28) = 0.88, *p* = .42) and ASHS-Screener (*F*(2,28) = 0.92, *p* = .40).

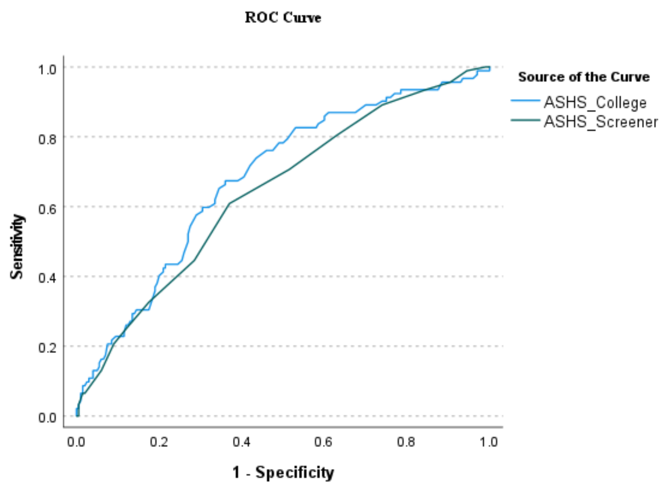
Classification Accuracy

ROC curve analyses were used to determine if the ASHS-College and the ASHS-Screener accurately predict EDS based on the ESS-CHAD. In the first analyses, ESS-CHAD scores ≤ 10, indicating 'Normal Levels of Sleepiness' were classified as 'not at-risk.' Both 'Excessive Daytime Sleepiness' and 'High Level of Sleepiness Suggestive of Significant Sleep Disorder' were grouped as 'at-risk,' which includes scores ≥ 11. Figure 1 displays a graph of the ROC curve results. As seen in Table 14, the AUC is below .80 for total samples, equaling 0.68

(*SE* = 0.03, CI-95 = 0.2 - 0.75) for the ASHS-College scale and 0.64 (*SE* = 0.03, CI-95 = 0.57 - 0.71) for the ASHS-Screener. Therefore, moderate classification accuracy was not achieved.

Figure 1

Comparison of ROC Curves (Excessive and High-Level Groups Classified as At-Risk)



Note. ASHS = *Adolescent Sleep Hygiene Scale*

Table 14

Areas under the receiver operating characteristic curves (AUC) for ASHS scales and ESS-CHAD (Excessive and High-Level Groups Classified as At-Risk)

	AUC	SE	p[1]	95% CI
ASHS-College	.68	.03	<.01	.62 - .75
ASHS-Screener	.64	.03	<.01	.57 - .71

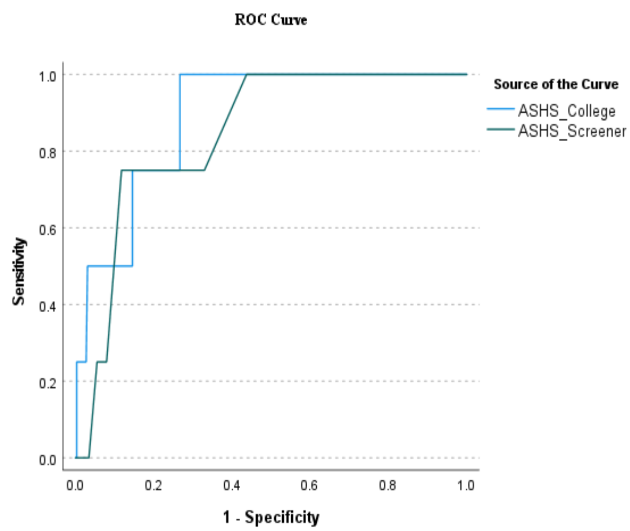
Note: [1] = Comparison of observed AUC and the null hypothesis (AUC=.50); AUC = Area Under the Receiver Operating Characteristic Curve; SE = Standard Error; CI = Confidence Interval; ASHS = *Adolescent Sleep Hygiene Scale*; ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*

To conduct an additional ROC curve analysis, ESS-CHAD scores ≤ 15, indicating ‘Normal Levels of Sleepiness’ and ‘Excessive Daytime Sleepiness,’ were classified as ‘not at-risk.’ Scores ≥ 16, indicating ‘High Level of Sleepiness Suggestive of Significant Sleep

Disorder,' were classified as 'at-risk.' Figure 2 displays a graph of the results. As seen in Table 15, the AUC for both the ASHS-College and ASHS-Screener suggested high accuracy equaling .89 (SE = .05, CI-95 .78 - 0.99) and 84 (SE = .07, CI-95 .71 - 0.98), respectively.

Figure 2

Comparison of ROC Curves (Excessive Group Classified as At-Risk)



Note. ASHS = *Adolescent Sleep Hygiene Scale*

Table 15

Areas Under the Receiver Operating Characteristic Curves (AUC) for ASHS Scales and ESS-CHAD (Excessive Group Classified as At-Risk)

	AUC	SE	p[1]	95% CI
ASHS-College	.89	.05	<.01	.78 - .99
ASHS-Screener	.84	.07	.02	.71 - .98

Note. [1] = Comparison of observed AUC and the null hypothesis (AUC=.50); AUC = Area Under the Receiver Operating Characteristic Curve; SE = Standard Error; CI = Confidence Interval; ASHS = *Adolescent Sleep Hygiene Scale*; ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*

Table 16 demonstrates possible cut-scores, along with their corresponding sensitivities and specificities. As presented in Table 17, the ASHS-College, a cut score of 3.07 yielded optimal sensitivity (1.00) and acceptable specificity (.73). There was a disproportionate balance of PPP (.05) and NPP (1.00). For the ASHS-Screener, a cut score of 2.50 yielded acceptable sensitivity (.75) and acceptable specificity (.88). Consistent with other results, there was a disproportionate balance of PPP (.08) and NPP (1.00).

Table 16

Predictive Accuracy of ASHS-College and ASHS-College Cut Scores with the ESS-CHAD

	Positive if Less Than or Equal To	Sensitivity	1 – Specificity
ASHS-College	3.04	0.75	0.25
	3.06	0.75	0.26
	3.07	1.00	0.27
	3.08	1.00	0.27
	3.09	1.00	0.27
	3.11	1.00	0.29
ASHS-Screener	2.08	0.00	0.03
	2.25	0.25	0.06
	2.42	0.25	0.08
	2.58	0.75	0.12
	2.75	0.75	0.15
	2.92	0.75	0.22

Note. ASHS = *Adolescent Sleep Hygiene Scale*; ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*

Table 17

Sensitivity, Specificity, PPP, and NPP

	Sensitivity	Specificity	PPP	NPP
ASHS-College (Cut Score = 3.07)	1.00	.73	.05	1.00
ASHS-Screener (Cut-Score of 2.50)	0.75	.88	.08	1.00

Note. PPP = Positive Predictive Power, NPP = Negative Predictive Power; ASHS = *Adolescent Sleep Hygiene Scale*

Validity

Spearman's rank-order correlations were calculated to evaluate concurrent and convergent validity. Specifically, correlations were assessed between the newly established ASHS scale with the ESS-CHAD and SF-36. As another measure of validity, correlations were determined for sleep hygiene factors with sleep duration and differences in the school week and weekend bedtimes, wake times, and sleep durations. Results are presented in Table 18. Furthermore, EDS and HRQoL factors were compared with sleep duration and differences in the school week and weekend bedtimes, wake times, and sleep durations. Results are presented in Table 19.

Table 18

Concurrent and Convergent Validity of the ASHS-College and ASHS-Screener

ASHS-College	Cognitive/ Emotional	Daytime Sleep	Sleep Environment	Sleep Stability	Substance Use	ASHS-College Total
Differences						
ΔBedtimes	-.09	-.05	-.08	-.13*	-.19**	-.18*
ΔWaketimes	-.07	-.25**	.01	-.15*	-.06	-.20**
ΔSleep Duration	-.12*	-.23**	-.06	-.04	-.02	-.16**
Sleep Durations						
School Week	.13*	.04	-.01	.04	.01	.06
Weekend	.08	-.21**	.01	.04	.04	-.04
ESS-CHAD						
Daytime Sleepiness	-.18**	-.29**	-.35**	-.14*	-.05	-.34**
SF-36						
RL (Physical)	.25**	.19**	-.35**	.11	.02	-.34**
RL (Emotional)	.34**	.16**	.15**	.10	.07	.23**
Energy/Fatigue	.40**	.29**	.20**	.20**	.04	.22**
Emotional Well-Being	.47**	.16**	.15**	.13*	.07	.23**
Social Functioning	.36**	.21**	.13**	.17**	.03	.30**
General Health	.10	.16	.10	.06	.27**	.26**

ASHS-Screener	Cognitive/ Emotional	Sleep Environment	Sleep Schedule	ASHS-Screener Total
Differences				
ΔBedtimes	-.02	-.08	-.09	-.08
ΔWaketimes	-.07	.02	-.18*	-.10
ΔSleep Duration	-.11	-.04	-.16*	-.13*
Sleep Durations				
School Week	.09	.03	.14*	.11
Weekend	.01	.04	-.06	.01
ESS-CHAD				
EDS	-.17**	-.25**	-.26**	-.32**
SF-36				
RL (Physical)	.19**	.16**	.17**	.24**
RL (Emotional)	.31**	.09	.13**	.24**
Energy/Fatigue	.41**	.09	.30**	.35**
Emotional Well-Being	.50**	.03	.21**	.30**
Social Functioning	.35**	.01	.21**	.25**
General Health	.11	.20**	.12	.23**

Note. ASHS = *Adolescent Sleep Hygiene Scale*; ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*; EDS = Excessive Daytime Sleepiness; SF-36 = *RAND 36-Item Short-Form Health Survey*; RL = Role Limitations; ΔBedtime = |Weekend Bedtime - School Week Bedtime|; ΔWaketime = |Weekend Waketime - School Week Waketime|; ΔSleep Duration = |Weekend Sleep Duration - School Week Sleep Duration|; * $p < .05$, ** $p < .01$

Table 19

Correlations between the EDS and SF-26 with Sleep Duration and Change (Δ) in Bedtimes, Wakes, and Sleep Durations

	Differences			Sleep Duration	
	ΔBedtimes	ΔWaketimes	ΔSleep Duration	School Week	Weekend
ESS-CHAD					
EDS	-.04	.01	.04	-.09	.01
SF-36					
RL (Physical)	-.08	-.14*	-.09	-.01	-.04
RL (Emotional)	-.04	-.16*	-.04	.10	.03
Energy/Fatigue	.03	-.12*	-.08	.14*	-.04
Emotional Well-Being	-.09	-.07	-.04	.06	-.01
Social Functioning	-.03	-.11	.05	.05	-.02
General Health	.02	-.13	-.13	.15	.15

Note. Δ = Differences in School Week to Weekend; ASHS = *Adolescent Sleep Hygiene Scale*; ESS-CHAD = *Epworth Sleepiness Scale for Children and Adolescents*; EDS = Excessive Daytime Sleepiness; SF-36 = *RAND 36-Item Short-Form Health Survey*; RL = Role Limitations; ΔBedtime = |Weekend Bedtime - School Week Bedtime|; ΔWaketime = |Weekend Waketime - School Week Waketime|; ΔSleep Duration = |Weekend Sleep Duration - School Week Sleep Duration; * $p < .05$, ** $p < .01$

CHAPTER 4: DISCUSSION

Poor sleep is a public health concern for children, adolescents, and adults. National organizations, including the American Medical Association (AMA), the American Academy of Sleep Medicine (AASM), and the Centers for Disease Control and Prevention (CDC), have recognized the necessity of addressing the widespread prevalence of poor sleep (Owens et al., 2014). However, screening for sleep problems rarely occurs in primary care practices, university settings, or as part of psychological evaluations or interventions (Everhart, 2011; Klingman et al., 2020). Consequently, developing and validating feasible screeners and interventions are essential to address widespread public health concerns related to inadequate sleep. The current study focuses on the development of a screener for adolescents in the university setting.

The factor structure of the *Adolescent Sleep Hygiene Scale*, *Revised* (ASHSr) was investigated to establish an adequate sleep hygiene assessment and screener in a university sample. Internal consistency, convergent validity, and concurrent validity were assessed for the newly established college assessment (ASHS-College) and screener (ASHS-Screener). Internal consistency was adequate for the ASHS-College total score. On the ASHS-College, all subscales had questionable to acceptable internal consistency. The internal consistency was questionable for the total score on the ASHS-Screener. On the subscales, internal consistency ranged from unacceptable to questionable. The lower reliability on the newly established ASHS scales is consistent with previous research on the psychometrics of the ASHS and is expected when using a screener with a wide range of content items that may be independent of each other (de Bruin et al., 2014; Streiner et al., 2003).

Internal consistency was considered questionable on the *Epworth Sleepiness Scale for Children and Adolescents* (ESS-CHAD). The questionable internal consistency of the ESS-

CHAD may also be attributed to items that measure distinct activities that are independent of each other (Streiner et al., 2003). For example, as expected, more students endorsed falling asleep for an afternoon nap than while talking to someone else. On the *RAND 36-Item Short-Form Health Survey* (SF-36) subscales, internal consistencies ranged from acceptable to good.

A strength of the current study is the implementation of calibration and validation samples to conduct the confirmatory factor analysis (CFA). The empirical structure of the ASHSr was modified for this university sample due to inadequate fit. Specifically, one item from the Sleep Environment factor was removed, along with the Behavioral Arousal and Physiological factors. The newly established ASHS-College consists of 17 items and five factors. To establish the ASHS-Screener, adequate fit and modification indices were further examined. A theoretical review was also prioritized when establishing the screener to ensure items measured the same sleep hygiene constructs as the ASHS-College. The ASHS-Screener contains three factors and six items. Both the ASHS-College and ASHS-Screener demonstrated adequate fit for the calibration and validation samples.

Using the ESS-CHAD as the criterion measure, a cut-score of 3.07 was established on the ASHS-College and 2.50 for the ASHS-Screener. The cut-score for the ASHS-College further adds to previous research on the cut-score for the ASHSr that demonstrated a cut-score of 3.80 based on the lowest quintile of sleep hygiene for adolescents ages 16 to 19 (Storfer-Isser et al., 2013). Students who were identified as 'at-risk’ on the ESS-CHAD had a high probability of being ‘at-risk’ on both ASHS scales, based on Receiver Operator Characteristic (ROC) curve analyses. Therefore, the ASHS-College did well in identifying true positives (TPs), suggesting the ASHS-Screener may be a valid universal screener for sleep hygiene problems. However, the Positive Predictive Power (PPP) of the ASHS-College and ASHS-Screener was relatively low, indicating that the scales would over-identify several students as 'at-risk' who were actually 'not at-risk' (i.e., FPs). Since using the ASHS-College is not diagnostic for EDS and the ASHS-Screener is a universal screener, over-identification is considered acceptable (Streiner & Cairney, 2007).

Concurrent Validity

Concurrent validity was demonstrated by correlations between ASHS-College and ASHS-Screener with other sleep-related factors, including sleep durations, changes in bedtimes and wake times, EDS, and fatigue.

Sleep Schedules

Maintaining stable bedtimes and wake times can be quite challenging for college students, who often have inconsistent daily schedules (Lund et al., 2010; Gilbert & Weaver, 2010). Most nights, staying up one hour past their usual bedtime was endorsed by 86.99% of participants during the school week. Similarly, 82.19% endorsed waking up an hour past their usual wake time on weekends most of the time. Participants with healthier sleep hygiene tended to have more stable bedtimes, wake times, and sleep durations. Based on ASHS factors related to sleep schedules (i.e., Daytime Sleep, Sleep Stability, Sleep Schedule), consistent sleep schedules and reduced napping were associated with less EDS, improved energy, enhanced emotional well-being, and better social functioning. Less stable sleep schedules and increased napping were associated with participants endorsing more limitations in daily activities due to physical and emotional health concerns.

Current research on the coronavirus disease 2019 (COVID-19) pandemic has demonstrated that adolescents were able to sleep later during quarantine than during previous in-person learning, suggesting later start times helps students more easily maintain consistent wakeup times and sleep durations (Kaditis et al., 2021). A pre-pandemic national survey suggested a mean wake time of 8:02 am for university students (Lund et al., 2010). In a study conducted at the start of the COVID-19 pandemic, university students demonstrated a mean waketime of 9:06 am for the school week during the COVID-19 pandemic (Wright et al., 2020). Consistently, participants in the current study had a mode wake time of 9:00 am during the school week. Regarding weakened wake times, a national survey conducted before the pandemic suggested a mean weekend wake time of 10:08 am for university students (Lund et al., 2010), and research on university students at the start of the COVID-19 pandemic revealed a weekend wake time of 10:0 0am (Wright et al., 2020). Consistent with pre-pandemic and pandemic research, participants in the current study had a mode weekend wake time of 10:00 am.

Concerning bedtimes, the current study corroborates previous research showing irregular sleep schedules in university students between the school week and weekend (Lund et al., 2010). In the current study, the mode school week bedtime was 12:00 am. Consistently, in a nationwide survey, university students had a mean bedtime of 12:17 am on school weeks (Lund et al., 2010), and the average school week bedtime was 12:48 am in a group of university students at the start of the COVID-19 pandemic (Lund et al., 2010; Wright et al., 2020). Regarding weekend bedtimes, the mean was 1:44 am in the national survey during the pandemic (Wright et al., 2020), whereas the mode weekend bedtime was 3:00 am in the current study. Despite the later weekend bedtime observed, the mean differences in the school week and weekend bedtimes and wake times were under two hours in the present study. These results suggest positive sleep hygiene based on researchers' recommendations to maintain consistent wake times within two hours (Crowley & Carskadon, 2010).

The later bedtime during the weekends may be exacerbated by the COVID-19 pandemic, as several studies demonstrated later bedtimes during increased social distancing recommendations for adolescents and university students (Smit et al., 2021). For example, a study conducted on high schoolers (*n* = 94) revealed mean bedtime delays of 1.5 hours and wake time delays of 2.0 hours when comparing pre-pandemic schedules and pandemic schedules (Genta et al., 2021). In an international study of 845 youth ages three to 17 years old, later bedtimes were noted for all ages during the pandemic. During the school week, 89.8% reported going to bed after 10:00 pm compared to 57.1% before the pandemic (Kaditis et al., 2021). The increased use of technology may also have led to delayed bedtimes since interactive technology use (e.g., engaging in social media conversations) around bedtime can cause amplify cognitive alertness and lead to delayed sleep onset (Liu et al., 2019a).

Along with challenges in maintaining consistent sleep schedules, naps are prevalent among college students, likely attributed to flexible schedules and poor sleep habits (Gilbert & Weaver, 2010; Calamaro et al., 2009). University students may be tempted to nap due to gaps in their daily schedule and the immediate relief from fatigue (Calamaro et al., 2009). In a nationwide survey conducted in the United States, 40% of adults reported taking a nap at least once in the past week (National Sleep Foundation, 2019). In the current study, over half of the students endorsed napping for one hour (58.90%) and napping after 6:00 pm (52.05%) on most days. An overwhelming majority of participants (85.25%) also endorsed a moderate to high chance of falling asleep while lying down in the afternoon.

Although naps are prevalent, research has consistently demonstrated that napping leads to disrupted sleep and inconsistent sleep schedules (Calamaro et al., 2009). In the current study, the Daytime Sleep factor was the only sleep hygiene factor associated with weekend sleep durations.

Participants who endorsed napping more frequently tended to have more inconsistent sleep schedules based on longer weekend sleep times and more unstable wake times and sleep durations. These results build on existing evidence suggesting that adolescents with poor sleep attempt to compensate by napping and sleeping for extended durations on the weekends (Calamaro et al., 2009). However, previous research suggests that napping is associated with increased EDS, indicating that naps are ineffective in compensating for poor sleep (Brown et al., 2002; Calamaro et al., 2009; Gilbert & Weaver, 2010). Consistently, in the current study, participants who napped less frequently tended to experience improved energy and lower EDS.

Sleep Durations

Several studies revelated that older adolescents and college students do not obtain the recommended seven to nine hours of sleep (Johansson et al., 2016; Donae et al., 2015). Previous studies indicate that college students sleep about 6.50 hours to 7.50 hours per night (Ferrara & De Gennaro, 2001; Lund et al., 2010; Taylor & Bramoweth, 2010; Kloss et al., 2011). Contrary to expectations, only 10.96% of participants obtained less than 7.00 hours of sleep during the school week, and 5.82% received less than 7.00 hours during the weekends. The average sleep duration was 8.76 hours during the school week and 8.97 hours on weekends. Similar to the current study, research conducted on university students during the pandemic revelated an average sleep duration of 8.4 hours during the school week and 8.8 hours on weekends (Wright et al., 2020). The ability to wake up later during school weeks due to virtual learning likely contributed to students' maintaining somewhat consistent sleep durations (Valenzuela et al., 2022).

During the COVID-19 pandemic, many students did not have to commute to class, likely had limited access to social events, and spent more time on electronics than before the pandemic.

Consequently, compared to pre-pandemic data, preliminary research performed suggests that adolescents and college students experienced increased sleep duration, later bedtimes, and delayed wake times during the start of the COVID-19 pandemic (Benham, 2020; Cellini et al., 2020; Gao & Scullin, 2020; Li et al., 2020; Wright et al., 2020). Thus, the extended sleep durations, later bedtimes, and delayed wake times reported in the current study are consistent with research conducted during the COVID-19 pandemic (Benham, 2020). The increase in sleep duration is consistent with previous research regarding extended sleep durations during school breaks and when school start times are delayed (Lufi et al., 2011). Therefore, findings from the current study, combined with previous research conducted during the pandemic, potentially support the theory that later start times lead to increased sleep durations due to delayed wake times during the school week (Onyper et al., 2012; Wheaton et al., 2016; Hershner & Chervin, 2014).

Prior research revealed that longer sleep durations are correlated with improved sleep hygiene (de Bruin et al., 2014). Inconsistently, school week sleep durations were not significantly associated with overall sleep hygiene but were linked with the Cognitive/Emotional factor on the ASHS-College and the Sleep Schedule factor on the ASHS-Screener. Thus, sleeping longer during the school week was correlated with less cognitive-emotional arousal at bedtime and more stable sleep schedules. Results are consistent with previous research suggesting that mental health challenges, including emotional dysregulation, mood instability, and anxiety, are often elevated in adolescents with poor sleep durations (Kaplan et al., 2014; Milojevich & Lukowski, 2016). Students may not meet the criteria for sleep or mental health disorder but still display these symptoms, suggesting that early identification and intervention may prevent future challenges (Milojevich & Lukowski, 2016).

Sleep Environment

Several studies have demonstrated that Sleep Environment factors (e.g., noise, lights, temperature) play an essential role in sleep outcomes, including sleep quality, bedtimes, and daytime sleepiness (Noland et al., 2009; Storfer-Isser et al., 2013; Hershner & Chervin, 2014). University students have historically identified disruptions from lights and noises as one of the top three contributors to poor sleep (Dautovich et al., 2021). Exposure to lights, including dorm lights and screens, can delay the circadian rhythm and suppress the release of melatonin (Cain & Gradisar, 2010). Slightly more than one-fifth of participants endorsed falling asleep in a brightly lit room (22.26%). Previous studies indicated that 33.00% to 42.50% of college students endorsed noise interfering with sleep (Lund et al., 2010; American College Health Association, 2019). When researching students in residence halls, Qin and Brown (2017) also observed that 12.2% listened to music 'always' and 26.9% listened to it 'often' to help them fall asleep. The current study's prevalence rates were consistent, with about one-fourth of students reporting falling asleep with loud music (23.61%) most nights. Modifying the wording of this item may provide additional insight into noise interference. Furthermore, participants' increased use of screens likely plays a role in sleep disruptions due to heightened light and sounds (Mireku et al., 2019; Fossum et al., 2014). About two-thirds (67.81%) of participants reported falling asleep using screens most nights, which generally increases disruptions due to noise and light. Consistent with previous research, healthier sleep environments in the current study were associated with lower EDS and improved energy (Storfer-Isser et al., 2013; National Sleep Foundation, 2019). Given that poor sleep environments have been associated with increased sleep disruptions and that sleep disruptions are associated with increased depression, university-wide efforts to improve sleep environments may improve a wide range of health outcomes (Peltz et al., 2016).

Substance Use

A strength of this study includes examining the factor structure of the ASHSr with the Substance Use factor using confirmatory analyses. Although the Substance Use factor was eliminated from the ASHSr, the researchers suggested re-examining Substance Use due to limited variability in responses from their study sample on these items (Storfer-Isser et al., 2013). In the current study, 26.75% of participants endorsed smoking, chewing tobacco, using e-cigarettes, or vaping after 6:00 pm most nights, and 37.26% reported consuming alcohol after 6:00 pm most nights. More inconsistent bedtimes correlated with higher rates of evening substance use, supplementing previous research indicating that more considerable differences between school week and weekend bedtimes are associated with increased substance use (Sun et al., 2019). In contrast to previous research, increased substance use in the evening was not significantly correlated with EDS or energy/fatigue (Owen et al., 2014; Arnedt et al., 2011; Paul et al., 2016). However, increased Substance Use was the only sleep hygiene factor on the ASHS-College correlated with worse General Health on the SF-36. It is also unclear how the COVID-19 pandemic impacted substance use among university students.

Cognitive/Emotional

It is unclear how the COVID-19 pandemic may have impacted cognitive and emotional outcomes. Preliminary research suggests that adolescents with increased cognitive-emotional arousal at bedtime and decreased sleep quality during the pandemic tended to experience higher levels of stress related to COVID-19 (Gruber et al., 2021). Based on a systemic review and meta-analyses, the prevalence of depression symptoms among university students is estimated to be about 33.6%. Depression symptoms were estimated to increase to 35.9% of students during the COVID-19 pandemic (Li et al., 2022). Somewhat consistent with previous findings, 36.10% of the current participants denied feeling calm and peaceful, about one-fourth (25.50%) of the participants endorsed feeling down, and about one-fourth (26.10%) reported feeling downhearted and blue a ‘good bit of the time’ over the past four weeks. Regarding anxiety, previous research indicates that 39.0% of university students endorse elevated symptoms. During the COVID-19 pandemic, prevalence estimates increased to 40.7% of students reporting increased anxiety symptoms (Li et al., 2022). Consistently, 40.10% of participants in the current study reported being nervous most of the time over the past four weeks.

Previous studies have demonstrated that elevated cognitive-emotional arousal (e.g., worrying) close to bed correlates with trouble falling asleep, obtaining enough sleep, and acquiring quality sleep (Henrich et al., 2021). When going to bed, 72.96% of participants in the current study endorsed repeatedly playing the day’s events in their minds on most nights. On most nights, 50.00% reported going to bed feeling upset.

Participants with higher cognitive-emotional arousal also experienced increased EDS, fatigue, and worse emotional well-being. Consistently, previous research has observed a connection between increased emotional regulation challenges at bedtime and heightened sleep disruptions, which increases the likelihood of experiencing symptoms of depression (Peltz et al., 2016). More specifically, elevated cognitive-emotion arousal may be predictive of depression (Henrich et al., 2021).

Participants with lower cognitive-emotional arousal at bedtime had more stable sleep durations. These results align with prior studies that suggest that college students with inconsistent sleep schedules are more likely to endorse symptoms of depression and anxiety than students with stable sleep schedules (Regestein et al., 2010; Wong et al., 2013). Previous research also suggests that college students with more internalizing mental health concerns slept less during the school week (Regestein et al., 2010; Wong et al., 2013). The current study builds on the previous research, as participants with higher cognitive-emotional arousal tended to obtain less sleep during the school week. Although the relationship between sleep problems, emotional regulation, and mood is not fully understood, these findings possibly support previous research indicating that sleep interventions may lead to lower depression and improve the effectiveness of other depression treatments (Owens et al., 2014).

Excessive Daytime Sleepiness (EDS) and Fatigue

EDS and energy/fatigue are theoretically related to sleep hygiene and were empirically examined by comparing scores on the ASHS scales to the ESS-CHAD and Energy/Fatigue subscale on the SF-36. Previous research across internal university samples suggests that EDS occurs in about 26% to 35% of students (Gaultney, 2010; Whittier et al., 2014; Dagnew et al., 2020; Li et al., 2020). Reliably, in the current study, 31.51% of participants endorsed elevated to high levels of EDS.

Regarding fatigue, around 50% to 60% of participants reported feeling tired and worn out most of the time over the past four weeks. These findings match observations in previous studies suggesting that 50% to 60% of college students report experiencing persistent fatigue (Hershner & Chervin, 2014; American College Health Association, 2019). Women reported significantly higher rates of fatigue and worse emotional well-being than men. Women also slept significantly longer than men during the school week; however, the time difference between genders was only 30 minutes. These results are consistent with previous research demonstrating that women tend to endorse more symptoms of depression, anxiety, sleep disruptions, and fatigue (Medic et al., 2017; Janssen et al., 2017). University research students have also confirmed this implication before and during the COVID-19 pandemic (Viselli et al., 2021).

In the current study, 42.21% of students reported a moderate to high chance of falling asleep when sitting in a morning class. This finding strengthens previous research revealing that about 46% of university students endorsed falling asleep during class “on occasion” (Dautovich et al., 2021). Consistent with previous research indicating that poor sleep hygiene is related to worse perceptions of EDS (Storfer-Isser et al., 2013), all sleep hygiene factors were significantly associated with EDS, except for Substance Use (Gradisar et al., 2008). Building on prior research, increased napping and more unstable sleep schedules lead to higher rates of EDS in the current study (Brown et al., 2002; Calamaro et al., 2009). Previous research suggests a link between shorter sleep duration and higher EDS (Calamaro et al., 2009). However, sleep duration was not associated with EDS based on the current study's self-reported bedtimes and wake times. Given the significant link between EDS and healthy sleep hygiene but not sleep duration, it is possible that self-reported bedtimes and waketimes are not valid measures for assessing sleep hygiene.

The current study further supports research investigating the role of the sleep environment in EDS. Participants who endorsed worse Sleep Environments also reported experiencing increased EDS and fatigue (Storfer-Isser et al., 2013; Grover et al., 2016). Research on sleep durations during the COVID-19 pandemic predicts that added screentime for adolescent lead to disrupted sleep (Ellakany et al., 2022). Therefore, increased screentime may have impacted students' sleep environments, which led to worse sleep outcomes and later bedtimes.

Convergent Validity

Sleep hygiene behaviors have previously been associated with improved HRQoL (Billows et al., 2009; Lawless et al., 2020). To assess validity, the data from self-reported bedtimes and wake times, the ASHS-College, and the ASHS-Screener were compared to the SF-36 domains. Higher scores on the ASHS scales indicate healthier sleep hygiene, and greater scores on the SF-36 suggest improved HRQoL.

Health-Related Quality of Life (HRQoL)

According to previous research, healthy sleep hygiene habits (e.g., reduced technology usage) are positively correlated with positive HRQoL outcomes (Billows et al., 2009; Storfer-Isser et al., 2013). In the current study, healthier overall sleep hygiene was associated with improvements in all SF-36 factors, supporting the connection between improved sleep hygiene and better HRQoL (Billows et al., 2009; Storfer-Isser et al., 2013; Medic et al., 2017). These findings align with previous studies suggesting that adolescents with worse sleep hygiene experience more intense physical and emotional health challenges (Miller et al., 2003; Harrison et al., 2016; Lewandowski et al., 2011). The limited correlations between Substance Use and HRQoL factors were unexpected and contradicted previous research indicating that substance use is often linked with emotional challenges (Bromber et al., 2020). A possible explanation may be that the Substance Use items on the ASHS measure substance use after 6:00 pm and should have a later cut-off time for university students.

In the current study, men demonstrated less interference of physical and emotional health in their everyday activities and social functioning. Consistent with previous research (Medic et al., 2017). women reported significantly higher rates of fatigue and worse emotional well-being than men.

Physical Health. Although the causality between sleep disturbances and medical symptoms is unclear (Hanson & Chen, 2008), studies suggest that improving sleep hygiene practices may enhance HRQoL factors for a variety of medical conditions, including asthma, obesity, and pain (Lawless et al., 2020; Valrie et al., 2015; Harrison et al., 2016). Improvements in all sleep hygiene factors were associated with less interference with physical health in everyday activities, except for Substance Use and Sleep Stability. These findings may support the implication that sleep disruptions can worsen medical symptoms (e.g., pain), leading to further interruption of daily activities (Friedrich & Schlarb, 2017; Lund et al., 2010). For example, for adolescents who experience pain, elevated cognitive-emotional arousal at night and poor sleep hygiene predict insomnia (Henrich et al., 2021). Therefore, poor sleep hygiene could lead to disrupted sleep, which may worsen medical symptoms and interfere with daily activities.

Prior research regarding the connection between sleep and HRQoL to General Health measures in adolescents has been mixed (Chen et al., 2014). Although a weak correlation, General Health was the only HRQoL factor significantly correlated with Substance Use. Some research is consistent with the current study showing no significant association between sleep duration and sleep hygiene with General Health (Chen et al., 2014). Inconsistent results may be due to adolescents generally being healthy. Findings may also be limited by the possibility that COVID-19 restrictions led to longer sleep durations, which helped maintain more positive HRQoL related to General Health.

Emotional Health. Out of the ASHS-College factors, the Cognitive/Emotional appeared to be the most strongly correlated with HRQoL factors. Therefore, participants who experienced more elevated and unpleasant emotions at bedtime tended to endorse worse mental and physical health perceptions compared to participants who reported less bedtime cognitive-emotional arousal. Research conducted by Gruber and colleagues (2021) broadly supports these findings with their data suggesting that elevated bedtime cognitive-emotional arousal and reduced sleep quality lead to higher rates of stress associated with COVID-19 for adolescents (Gruber et al., 2021). Based on previous studies, it is also possible that students with increased stressors related to the pandemic also had elevated mental health concerns (Chen & Lucock, 2022), which further worsened sleep and HRQoL outcomes. Although addressing sleep concerns will not reduce all stressors, findings suggest that interventions addressing sleep concerns and emotional regulation (e.g., mindfulness) may improve the quality of life for university students (Lawless et al., 2020).

Symptoms related to various mental health conditions (e.g., depression, loneliness, emotional dysregulation) are consistently linked to unhealthier sleep hygiene and are exacerbated by poor sleep (Gradisar et al., 2008; Meijer et al., 2010; Regestein et al., 2010; Schlarb et al., 2012; Cowie et al., 2014). Except for Substance Use, improvements in all sleep hygiene factors were related to enhanced Emotional Well-Being and better Social Functioning in the current study. Healthier sleep hygiene was also associated with reduced interference of emotional problems in daily activities. Frequent napping and irregular sleep schedules were also associated with worse emotional well-being and social functioning. These results align with previous studies suggesting that napping and trouble maintaining a consistent sleep schedule exacerbate sleep problems (e.g., difficulty falling asleep, night awakenings, daytime sleepiness) and mental health symptoms (Gilbert & Weaver, 2010; Hershner & Chervin, 2014). Further research has suggested that sleep disruptions intensify engagement in other unhealthy behaviors (e.g., caffeine use) and worsen stressors (e.g., academic problems; James et al., 2011; Hershner & Chervin, 2014).

Social activities tend to interfere with university students' sleep due to the timing of events and possible substance use. In the current study, elevated cognitive-emotional arousal at bedtime was correlated with more social functioning and emotional well-being problems. These results appear to partially support prior studies noting the connection between heightened loneliness and social isolation with poor sleep hygiene, depression, and suicidal ideation (Osman et al., 2001; Littlewood et al., 2016; Hayley et al., 2017; Russel et al., 2019). Nevertheless, the impact of COVID-19 on the current participants' social behaviors is unclear.

Implications and Future Directions

To our knowledge, this is the first study conducted solely on university students using the ASHSr. Therefore, further work is required to establish the validity in the university setting and determine the generalizability of the ASHS-College and ASHS-Screener. Replication of this study in other university settings is needed to re-examine the factor structure and cut scores while also determining the scale's validity in broader age groups of students attending universities. The current study should be replicated in community samples and/or healthcare settings to determine if the newly established scales generalize to adolescents who do not attend a university. Both externalizing behaviors (e.g., risky behaviors leading to motor vehicle accidents) and internalizing symptoms (e.g., depression) are widespread public health concerns for adolescents and college students (Wheaton et al., 2016; National Center for Statistics and Analysis, 2020). Therefore, it would be useful to extend the current findings by including more specific measures of externalizing and internalizing behaviors to further assess validity (Catrett & Gaultney, 2009; Wheaton, 2016). Collecting data on students' class schedules may also be valuable to determine possible systemic changes, such as later start times (Onyper et al., 2012). Other meaningful data collection could include information related to chronic health concerns (e.g., asthma, ADHD, OSA), academic factors (e.g., virtual or in-person courses, GPA, academic major), employment status, extracurricular activities, and environmental factors (e.g., type of residence, number of roommates or family members in the household, noise level).

Future researchers may explore ways to implement a feasible workflow for sleep screening and interventions in the university setting. Implementing universal screening and intervention procedures may be met with resistance due to fear of overwhelming healthcare and university professionals. Additionally, due to the high prevalence of sleep problems in adolescents, sleep disruptions may be viewed as "typical" without considering the impact of poor sleep (Qin & Brown, 2017). Advocacy efforts will likely need to include university officials, healthcare providers, and policymakers to address the importance of system-wide sleep prevention efforts (Russel et al., 2019).

Collaborating with university leaders and/or healthcare providers to determine where the screening will primarily occur is essential for universal screening efforts. Possibilities include University 101 courses, counseling centers, and university medical centers. However, University 101 professors may experience challenges finding time to score and provide individualized feedback on the screeners. Nonetheless, this method may be feasible for collecting and monitoring system-wide data. Counseling centers generally only treat a limited number of students; therefore, sleep screening could be incorporated into their treatment planning sessions, but other screening opportunities are needed to reach more students. University medical centers may be ideal as they are used more frequently than counseling centers (Shepardson & Funderburk, 2014).

Once the primary screening method is determined, it is crucial to investigate and research workflow considerations, including when (e.g., well-visits), where (e.g., waiting room), and how (e.g., tablet) the screener will be completed. Furthermore, the workflow procedures should encompass information about where the results will be stored (e.g., students' electronic health records). Additionally, it is essential to configure how the results will be communicated to the provider (e.g., autogenerated into the student's medical chart) and the student (e.g., discussion during the medical appointment). Future work on developing clear guidelines for the screener's interpretation and corresponding recommendations. When creating the workflow, it is essential to remember allotted appointment times and staff availability to intervene when scores are elevated (Klein et al., 2011). However, addressing sleep hygiene concerns may also save practitioners time in another area and increase the effectiveness of other treatments (Owens et al., 2014). For example, increasing exercise can improve sleep and help smoking cessation (Irish et al., 2015). Therefore, investigating if the cost-benefits of addressing sleep concerns may be valuable, as improving sleep may alleviate other challenges.

Previous research suggests that healthcare providers do not receive adequate training in assessing and treating sleep problems during their graduate training (Mindell et al., 2011; Mindell et al., 2013; Luik et al., 2019; Drapeau et al.,2021). Therefore, not only do university students need to receive psychoeducation on healthy sleep hygiene but exploring feasible and beneficial methods for training will be needed to ensure providers have adequate tools to address sleep problems (Hershner & O'Brien, 2018). Although sleep certifications are available for several healthcare professionals, these interventions are intended to be brief and do not require extensive training. For example, providers can briefly discuss turning off cellphone notifications, wearing earplugs in noisy environments, and implementing mindfulness strategies at bedtime for individuals having trouble falling asleep (Bartel et al., 2018). Consequently, investigating ways to deliver this psychoeducation to healthcare providers is a crucial area of future research.

Importantly, providing training on behavioral change is likely a needed component. For example, a student may need support in problem-solving ways to remember to start their bedtime routine.

Not only should behavioral health and medical professionals receive training on sleep hygiene, but it has been hypothesized that educating professors about ways to encourage healthy sleep habits can lead to positive large-scale changes. For example, professors may consider how the timing of their assignment deadlines could interfere with sleep. Late-night deadlines (e.g., 11:59 pm) encourage delayed bedtimes, and early morning deadlines (e.g., 8:00 am) may reinforce students staying up all night to complete the assignment. Therefore, Qin and Brown (2017) suggest setting assignment deadlines around 10:00 pm may be beneficial to help students go to bed earlier. Further work is needed to fully understand the implications of professors incorporating modifications to encourage healthy sleep.

Future research should also investigate the effectiveness of university-wide interventions to improve students' sleep outcomes since widespread interventions can increase access and benefit more extensive groups of students than individual therapy (Hershner & Chervin, 2014). Based on research conducted on high school students, delaying class start times would likely improve sleep outcomes and enhance academic performance (Hershner & Chervin, 2014). In the current study, participants with healthier sleep environments endorsed less impact on their physical and emotional health on daily activities, improved emotional well-being, and enhanced social functioning. Therefore, given that university students living in residence halls have limited control over their environment (Qin & Brown, 2017), evidence supports the need for universities to consider system-wide interventions to support healthy sleep environments (Noland et al., 2009). Interventions could include implementing quiet hours in dorms and reducing hallway lights after 10:00 pm (Hershner & O'Brien, 2018).

Further investigation into systemic barriers preventing adequate sleep hygiene should also be considered. For example, about one-half of the participants indicated that they go to bed hungry. It is unclear if this results from inadequate knowledge about healthy sleepy hygiene behaviors related to eating, reduced structure during the COVID-19 pandemic, lack of access to food, or something else (Lin et al., 2018a; Valenzuela et al., 2022). Therefore, researchers, university officials, community leaders, and other professionals may consider working with students to determine barriers and problem-solve solutions.

Given that most students do not exhibit clinically significant symptoms, brief interventions may be possible (Owens et al., 2017). A challenge posed in the research is that limited amounts of college students will not voluntarily engage in online sleep hygiene programs. As previously discussed, sleep is essential for various other health and academic outcomes. Consequently, future research may work with university administrators to investigate mandatory sleep hygiene education proposed by Quan and colleagues (2018). For example, required training modules could deliver sleep hygiene knowledge, similar to modules related to substance use and sexual assault often required (Quan et al., 2018). These programs may help students with no or minor sleep problems make positive behavior changes, thus preventing future problems (Hershner & Chervin, 2014). However, education on healthy sleep hygiene practices may not be enough for most students, as knowledge does not necessarily generate behavior change. Therefore, researching ways to incorporate practical behavioral modification strategies for the university setting is essential (Cassoff et al., 2013; Irish et al., 2015; Semsarian et al., 2021). In addition, clarifying which sleep hygiene behaviors are more feasible to implement (e.g., reducing technology usage versus caffeine usage) is an essential consideration for universities (Barber & Cucalon, 2017). Investigated recommendations could include strategic use of technology before and at bedtime (e.g., avoid video games, reduce brightness, silence technology notifications) and tools for coping with the urge to engage in unhealthy behaviors (Mireku et al., 2019; Fossum et al., 2014; Liu et al., 2019). When guiding students on changing one behavioral change at a time, researchers should consider including discussions about possible temporary negative consequences to avoid unintentional unhealthy behavioral changes (Irish et al., 2015). For example, students who reduce caffeine use may experience increased daytime sleepiness, leading to napping and decreased physical activity. Similarly, reduced naps in students may lead to increased caffeine usage (Juliano & Griffiths, 2004; Dhand & Sohal, 2007).

Initial research suggests that group treatments using CBT-I strategies may be effective in the university setting for improving sleep quality (Schlarb et al., 2017). Continued research is required to determine ways to break down evidence-based sleep interventions (e.g., CBT-I) into brief evidence-based components for addressing "at-risk" sleep problems (Bartel et al., 2018). For example, stimulus control techniques, such as using one's bed only for sleep (e.g., avoiding doing schoolwork in bed), are effective strategies for reducing sleep onset latency, improving sleep duration, and increasing sleep efficiency (Edinger & Sampson, 2003). Therefore, future research may investigate the implementation of these techniques in universal or group interventions. Then, students who need more extensive support could further engage in individual or small group sessions to problem-solve barriers to implementation and/or engage in the cognitive restructuring techniques used in CBT-I.

To help measure the effectiveness of sleep hygiene interventions, there is ample room for further research in investigating progress monitoring tools for sleep hygiene, including the ideal administration timeline. Notably, the impacts of sleep interventions may not be immediately observable in self-reported data. For example, as mentioned above, reducing caffeine usage may lead to increased fatigue (Dhand & Sohal, 2007). Therefore, future research should consider the appropriate timing of progress monitoring tools to best capture intervention effectiveness. Future researchers should also consider measuring whether interventions appropriately address sleep concerns across demographic graphic groups. The current study and previous research demonstrated differences in sleep hygiene among black and white students. Given that Black students did not endorse higher levels of problematic EDS or HRQoL factors than White students. A general weakness of sleep hygiene assessment and intervention research is that racial, ethnic, cultural, and gender differences have not always been evaluated or considered (Lubas & Szklo-Coxe1, 2018). Therefore, future researchers should be mindful of demographic factors that may impact sleep hygiene when further investigating screening tools and interventions.

Limitations

The current study encompasses several limitations to consider. First, although previously deemed reliable in many studies, the ESS-CHAD demonstrated questionable reliability (ω = 0.64) in the current study. However, the finding was consistent with previous research on the adult version of the ESS in university settings (α = .58; Prestwich et al., 2007). Second, replication of this work is needed to ensure the generalizability of the ASHS-College and ASHS-Screener to screen for sleep problems among university students of diverse demographics (e.g., age, academic class, geographical location). For example, the current study sample consisted primarily of first-year students, and most of the students were 18 to 19 years old. Therefore, results may not be generalizable to upper-level students. Third, considering the high association of poor sleep with externalizing behaviors (e.g., impulsivity, aggression, risk-taking behaviors;

Meijer et al. 2010), it may be helpful to assess the validity of the ASHS measures with an externalizing behavior measure. This may be particularly important given the public health efforts to decrease motor vehicle accidents due to drowsy driving and associated risk-taking behaviors (e.g., lower seatbelt use in students with poor sleep; Wheaton et al., 2016).

Fourth, the analyses in this study were subjective and dependent upon self-report; thus, the ratings may reflect some biases. Previous researchers have hypothesized that the decreased cognitive factors associated with sleep deprivation may lead to inaccurate reporting on self-report measures (Barber & Cucalon, 2017). In addition, research indicates that young adults tend to over-report sleep durations and may downplay their sleep problems (Lauderdale et al., 2008; Dautovich et al., 2021). However, limited research has demonstrated whether self-reported estimates of bedtimes and wake times are necessary or valuable for universal screening. Validity results from this study suggest that information on sleep hygiene behaviors is more valuable than self-reported estimates of bedtimes and wake times, as they were more significantly correlated with other measures. Collecting objective measures of sleep (e.g., actigraphy) is also not practical for universal screening. Nonetheless, future studies may be advantageous to investigate whether self-reported estimates of bedtimes and wake times are valid and beneficial for sleep screeners.

Fifth, another weakness in this study that could have affected the measurements of sleep hygiene is the wording of items on the ASHS. In the current study, the language of two items was altered to adapt to modern adolescent behaviors. Item six changed from “After 6:00 in the evening, I smoke or chew tobacco” to “After 6:00 in the evening, I smoke or chew tobacco, or use e-cigarettes or vape.” Item 22 changed from “I fall asleep while watching TV” to “I fall asleep while using screens (e.g., TV, cellphone, tablet).” Future research may consider updating the question about loud noises (i.e., “I fall asleep while listening to loud music”) that considers loud noises from other forms of technology and environmental noises (e.g., cars driving by). An example could be “I fall asleep in a room where there are loud noises,” similar to an item on the *Childhood Sleep Hygiene Scale*. The change would allow for consideration of a broader range of disruptive noises (e.g., cars driving by). Additionally, since university students often have delayed bedtimes, it may be beneficial to consider later times for items asking about behavior (e.g., “After 6:00 in the evening, I drink beer or some other drinks with alcohol”).

Likely a significant factor, the current study was unintentionally initiated during the start of the COVID-19 pandemic in the United States. Data were collected during an unusual time for college students, including quick transitions to virtual learning, changes in living circumstances and daily routines, and reduced social interactions. Therefore, it is unclear how these factors related to the COVID-19 pandemic impact the measures used in this study.

Conclusion

Sleep problems are highly prevalent for adolescents, particularly in the university setting. Research indicates that sleep problems are associated with various adverse factors, including poor academic performance, anxiety, depression, risky behaviors, and obesity. Developing screening tools and interventions to prevent, identify, and treat sleep problems may prevent adverse medical and mental health outcomes. The university setting may be ideal for widespread screening for sleep problems and intervention to promote healthy behaviors. Confirmatory factor analysis (CFA) was utilized in the current study to establish a sleep hygiene assessment (ASHS-College) and screener (ASHS-Screener) for the university setting. Concurrent and convergent validity was demonstrated by the adequate association between the newly established measures with measures related to excessive daytime sleepiness and health-related quality of life. Future research should investigate the feasibility of implementing the screener in the university setting and executing sleep hygiene interventions.

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APPENDIX A: IRB APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
rede.ecu.edu/umcirb/

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Erin Ezell
CC: Christy Walcott
Date: 12/9/2019
Re: UMCIRB 19-002955
An Online Survey to Develop and Validate a Sleep Screener for Adolescents

I am pleased to inform you that your research submission has been certified as exempt on 12/9/2019. This study is eligible for Exempt Certification under category # 2a.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

Document	Description
Consent (0.01)	Consent Forms
Proposal (0.01)	Study Protocol or Grant Application
Recruitment(0.01)	Recruitment Documents/Scripts
Study Scales(0.01)	Surveys and Questionnaires
Validity Check(0.01)	Additional Items

For research studies where a waiver of HIPAA Authorization has been approved, each of the waiver criteria in 45 CFR 164.512(i)(2)(ii) has been met. Additionally, the elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.