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Recovery Sleepers: A Pilot Study of a Sleep Health Intervention for College Students in Recovery from Substance Use Disorder

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RECOVERY SLEEPERS: A PILOT STUDY OF A SLEEP HEALTH INTERVENTION FOR COLLEGE STUDENTS IN RECOVERY FROM SUBSTANCE USE DISORDER

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

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I did not plan for my dissertation to be written during the most difficult two years of my life, but life has a funny way of knocking you down (literally) and showing you what is important. This document is a testament to all of the people who have supported me over the past 31 years. They say it takes a village, and I've got a pretty great one.

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In the words of Taylor Swift, who provided the soundtrack to this dissertation, "Long story short, I survived."

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Abstract

RECOVERY SLEEPERS: A PILOT STUDY OF A SLEEP HEALTH INTERVENTION FOR COLLEGE STUDENTS IN RECOVERY FROM SUBSTANCE USE DISORDER

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There is an increasing number of students in recovery from substance use disorder (SUD) on college campuses, and collegiate recovery programs have been designed to support students' recovery and global health needs. However, little research has focused on interventions that can promote health outcomes within this population. Chronic substance misuse can have lingering, negative effects on sleep even after sustained remission; thus, the present paper describes a pilot study of Recovery Sleepers, a sleep health promotion intervention rooted in self-determination theory for college students in recovery from SUD. Study aims were to examine the feasibility, acceptability, and fidelity of the intervention, as well as to explore preliminary data on effectiveness in improving objective and subjective sleep outcomes and other psychosocial variables. The intervention was found to be largely acceptable to participants, with evidence of clinically significant effectiveness for improving some sleep outcomes. Future studies should use a community-based approach to ensure community investment and alleviate challenges in recruitment.

Keywords: recovery, sleep, health behaviors, self-determination theory

Literature Review

Adequate, restful sleep is pivotal for physical, cognitive, and emotional health. Poor sleep can increase risk of mortality (Hublin et al., 2011), poor immune functioning (Besedovsky et al., 2019), impulsive decision-making (Brunet et al., 2020), impaired problem-solving and other executive functions (Nebes et al., 2009), and mood disorders (Zhai et al., 2015). On a societal level, poor sleep is associated with decreased productivity, accidents related to drowsiness, and healthcare costs for the treatment of sleep disorders and other medical conditions that may be exacerbated by inadequate sleep (Hillman & Lack, 2013). Obtaining healthy sleep is a challenge throughout the lifespan; however, college students are at especially high risk of poor sleep, with one study estimating that more than 60% of college students can be classified as poor sleepers (Lund et al., 2010). Sleep health promotion interventions tailored specifically to college students have demonstrated some success in increasing healthier sleep-related behaviors, promoting more accurate beliefs about sleep, and improving sleep quality (Brown et al., 2006; Kloss et al., 2016; Lamberti, 2012; Levenson et al., 2016). However, a growing subpopulation has not been represented in this body of literature: college students in recovery from substance use disorder.

Sleep and addiction are intricately linked at all stages of use, from initial misuse to sustained abstinence or recovery. Addictive substances themselves have powerful effects on sleep quality (Karam-Hage, 2004), and these effects do not immediately stop once the individual has decided to abstain. Sleep disturbance, such as sleep fragmentation and altered sleep architecture, is associated with both early and sustained remission from chronic substance use due to physiological and behavioral mechanisms (Brower, 2001). Moreover, poor sleep has been linked to higher likelihood of recurrent use (Brower et al., 1998). Therefore, poor sleep can have severe consequences for individuals in recovery.

In addition to the academic, social, and emotional pressures faced by all college students, students in recovery face unique challenges in maintaining both abstinence and their overall health. College campuses are often “abstinence-hostile environments,” where substance misuse is not only tolerated but encouraged (Harris et al., 2008; Perron et al., 2011). Moreover, traditional-aged college students are facing unique developmental challenges inherent to emerging adulthood (Arnett, 2015) that may impair the ongoing effort required to sustain recovery (Betty Ford Institute, 2007).

The population of students in recovery is growing on college campuses, and the number of registered collegiate recovery programs (CRPs) increased 77% over the past two years as institutions recognize the needs of this population (Association of Recovery in Higher Education [ARHE], 2022). These programs are designed not only to provide recovery support, but to support the global health and wellbeing of their students (Harris et al., 2014). Given the associations between sleep and substance misuse, it is important for campus programming to acknowledge sleep as a core pillar of student health and provide appropriate information and support.

The current paper describes a pilot study of Recovery Sleepers, a sleep health promotion intervention for college students in recovery from substance use disorder that is rooted in self-determination theory. The primary aim of this study was to assess the feasibility, acceptability, and fidelity of Recovery Sleepers. Additionally, preliminary analyses explored the effects of the intervention on sleep outcomes, as well as on secondary outcomes of improved sleep such as mental health.

Defining Sleep and its Role

Sleep is becoming increasingly recognized as critical to a healthy lifestyle (Matricciani et al., 2018). However, sleep and the parameters that can be used to determine sleep health are complex topics that elude simple definitions. Sleep is a multidimensional, recurring process with both behavioral and physiological characteristics. Behaviorally, sleep refers to disengagement from and unresponsiveness to environmental cues (Carskadon & Dement, 2011). This disengagement is accompanied by physiological changes in the functional organization of the brain (National Institute of Mental Health [NIMH], 2012) and is regulated by homeostatic and circadian processes at the hormonal, cellular, and genetic levels (Buysse, 2014). Because sleep is such a complex process, determining what classifies sleep as "healthy" is similarly multidimensional. Time spent sleeping (duration), ease of falling and staying asleep (efficiency), the placement of sleep within the 24-hour day (timing), the ability to maintain wakefulness (alertness), and one's subjective assessment of perceived sleep quality are all indicators of sleep health (Buysse, 2014). Sleep health can also be determined in part by sleep architecture, or the percentage of time one spends in the various stages of sleep (Mongrain et al., 2005). Research suggests that maintaining a regular sleep/wake schedule is also important for healthy sleep (Murray et al., 2019).

Regardless of how sleep health is defined, the importance of sleep is abundantly clear. Poor sleep has been associated with numerous negative physical health outcomes. Men who are classified as poor sleepers have a 55% increase in the odds of mortality over good sleepers after controlling for smoking status, body mass index, and depression; for women, the increase in odds of mortality is even higher (63% Hublin et al., 2011). Poor sleep has been associated with impaired or altered metabolic processes which contribute to diabetes (Knutson et al., 2011), obesity, and cardiovascular disease (Buxton et al., 2012). Sleep is also bidirectionally associated with immunity, and healthy sleep reduces infection risk, improves infection outcomes, and enhances vaccination responses (Besedovsky et al., 2019).

In addition to physical health, sleep is closely associated with mental health. Evidence suggests a bidirectional association between sleep and depression—poor sleep is a risk factor for depression, and depression also leads to disturbed sleep (Riemann et al., 2001). Depression has been associated with numerous components of poor sleep, including both long and short sleep duration (Zhai et al., 2015). Additionally, sleep disturbance is a symptom of many anxiety disorders, including post-traumatic stress disorder, generalized anxiety disorder, and panic disorder (Mellman, 2006). Among college students with depression, those who also reported sleep disturbance were at a higher risk of comorbid anxiety, cognitive deficits, and physical impairment than were depressed students with adequate sleep (Nyer et al., 2013).

Cognition can be affected by poor sleep as well. Sleep plays an important role in learning and memory consolidation (Lewis, 2014), and sleep disturbance has been associated with impairments in working memory, attentional set shifting, problem solving (Nebes et al., 2009), inference, and deduction (Curcio et al., 2006). Impulsivity and risky decision-making have also been associated with poor sleep. Young adults whose rapid eye movement (REM) sleep was restricted on the previous night made riskier decisions on the Iowa Gambling Task than did those who received adequate sleep (Brunet et al., 2020). Given the widespread ramifications of poor sleep, it is important to design sleep health interventions that target populations who may be at heightened risk of sleep disturbance to prevent physiological, psychiatric, and cognitive consequences.

Sleep in the College Student Population

College students are at particularly high risk for sleep disturbance. Using the generally accepted clinical cutoff of the Pittsburgh Quality Sleep Index (PSQI), more than 60% of students at a large, public university were classified as poor sleepers (Lund et al., 2010). In another sample of college students, the average PSQI score was above the clinical cutoff, suggesting that poor sleep is less of an exception and more of the norm (Orzech et al., 2011). An estimated 10.6% of students meet clinical criteria for insomnia, defined as a score of 14 or greater on the Insomnia Severity Index (ISI; Choueiry et al., 2016). This finding aligns with the estimated prevalence of clinical insomnia in adults (10-15%; Schutte-Rodin et al., 2008). Thus, while only one-tenth of students may struggle with clinically diagnosable sleep disturbance, many more report subclinical sleep quality concerns. The recent COVID-19 pandemic has only heightened this problem. Prior to the pandemic, 48% of students in a sample of over 1,000 scored $\geq$10 on the ISI. Following the onset of the pandemic, that proportion had risen to 54% (Benham, 2020).

There are several factors specific to the developmental phase of traditional-aged college students, emerging adulthood, that contribute to poor sleep. Emerging adulthood is characterized by identity exploration, instability, and the formation of deeper interpersonal connections (Arnett, 2000). As emerging adults are granted greater independence and responsibility, they are also tasked with making their own health decisions, often for the first time. Longitudinal studies suggest that college students increasingly focus on health throughout the college years, perhaps as they become better adjusted to independently making health decisions (Salmelo-Aro et al., 2007). Although emerging adults are beginning to form a more coherent sense of themselves than in adolescence, the social network still holds a great deal of both positive and negative influence on behavior (Hawkins et al., 2009). Peer influence has been shown to promote healthy eating and exercise, but also to reinforce substance misuse, unhealthy eating, and lack of exercise

(Calamidas & Crowell, 2018). Additionally, emerging adults may not engage in healthy behaviors due to low self-efficacy or a lack of related knowledge (Von Ah et al., 2004). Students often overestimate their sleep health and downplay the importance of sleep when measured via self-report (Barber & Cucalon, 2017; Orzech et al., 2011), suggesting a lack of knowledge about sleep and its consequences. Along with these developmental challenges, the campus environment also poses unique barriers to healthy sleep. When asked to identify causes of their poor sleep, students most commonly listed the academic and emotional stress that accompanies the college experience, as well as light/noise disruptions in shared living environments (Lund et al., 2010).

In addition to the negative physiological, psychiatric, and cognitive effects of sleep disturbance previously described, poor sleep can have specific, detrimental effects on college students. Over half of students (54%) reported skipping class due to poor sleep, and 46% of students reported falling asleep in class on at least one occasion (Orzech et al., 2011). In addition to academic consequences, poor sleep can lead to behavioral concerns as well, with poor sleep predicting binge drinking and alcohol-related consequences in young adults (Wong et al., 2015).

College Students in Recovery

One group of college students who may be particularly at risk of sleep disturbance is students in recovery from addiction to alcohol or other substances. Students in recovery face the same stressors as the general college student, while also enduring added pressures unique to the journey of recovery. Substance misuse and abstinence are also associated with sleep disturbance, and poor sleep has been associated with increased risk of recurrent use. The following sections address definitions of addiction and recovery, the prevalence of recovery on college campuses, and the links between substance misuse and sleep health.

Addiction

The American Society of Addiction Medicine (2019) defines addiction as a "treatable, chronic medical disease involving complex interactions among brain circuits, genetics, the environment, and an individual's life experiences" (n.p.), emphasizing the biopsychosocial factors that are implicated in the development, maintenance, and treatment of addiction. The *Diagnostic and Statistical Manual-5th Edition* (DSM-5) provides criteria for diagnosing an individual with substance use disorder (SUD), which requires a constellation of behavioral, physical, and cognitive symptoms (American Psychiatric Association [APA], 2013; see Table 1). Severity of the diagnosis is determined by the number of criteria met, with a minimum of two symptoms occurring within a 12-month period required for diagnosis.

Table 1

DSM-5 Criteria for SUD (APA, 2013)

Theme	Symptom
Impaired Control	• Substance is often taken in larger amounts or over a longer period than was intended. • There is a persistent desire or unsuccessful efforts to cut down or control substance use. • A great deal of time is spent in activities necessary to obtain the substance, use the substance, or recover from its effects. • Craving, or a strong desire or urge to use the substance.
Social Impairment	• Recurrent substance use resulting in a failure to fulfill major role obligations at work, school, or home. • Continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance. • Important social, occupational, or recreational activities are given up or reduced because of substance use.
Risky Use	• Recurrent substance use in situations in which it is physically hazardous • Substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance.
Pharmacological Criteria	• Tolerance, as defined by either of the following: o A need for markedly increased amounts of the substance to achieve intoxication or desired effect o A markedly diminished effect with continued use of the same amount of the substance • Withdrawal, as manifested by either of the following: o The characteristic withdrawal syndrome for the substance o The substance (or a closely related substance) is taken to relieve or avoid withdrawal symptoms

According to the National Survey of Drug Use and Health, 16.5% of Americans aged 12 or older met DSM-5 criteria for SUD within the past year (Substance Abuse and Mental Health Services Administration, 2022). Evidence suggests that individuals may also become addicted to particular behaviors that activate the brain reward system, such as gambling, compulsive buying, and Internet use (Grant & Chamberlain, 2016). Due to the current lack of consensus in the field regarding definitions and criteria of behavioral addictions (Grant & Chamberlain, 2016), the proposed study will focus solely on SUD.

Recovery

With appropriate medical, psychological, and formal and informal support networks, some individuals are able to achieve sustained remission from substance misuse, and an estimated 9.1% of American adults have resolved a significant substance misuse concern (Kelly et al., 2017). To be clinically determined as in remission, the *DSM-5* specifies that an individual must not meet any SUD criteria except the presence of cravings for 3-12 months (early remission) or longer than 12 months (sustained remission; APA, 2013). It is important to note, however, that remission is added as a specifier to the SUD diagnosis—the diagnosis itself is never removed.

In recent years, there has been a paradigm shift in which clinicians and individuals with SUD have moved away from the term “remission,” which connotes pathology, to a model of recovery. Recovery can be defined as:

> the experience (a process and a sustained status) through which individuals, families, and communities impacted by severe alcohol and other drug (AOD) problems utilize internal and external resources to voluntarily resolve these problems, heal the wounds inflicted by

> AOD-related problems, actively manage their continued vulnerability to such problems, and develop a healthy, productive, and meaningful life (White, 2007, p. 236).

Similarly, the Betty Ford Institute Consensus Panel (2007) defined recovery as “a voluntarily maintained lifestyle characterized by sobriety, personal health, and citizenship” (p. 221). Both of these definitions emphasize that recovery is not a temporary phase, but rather a lifestyle choice that requires sustained effort.

College Students in Recovery

College students in recovery are working to maintain a lifestyle of sobriety in an especially challenging environment (Perron et al., 2011). There are no precise estimates of the number of college students currently in recovery, as national college surveys typically focus on current substance use rather than abstinence (Perron et al., 2011). From these surveys, it is estimated that 18% of college students currently have significant alcohol-related problems (Perron et al., 2011). Prevalence of SUD nearly triples from adolescence (7%) to young adulthood (20%; Laudet et al., 2015), suggesting that traditional-aged college students are particularly likely to be diagnosed with SUD and begin to seek treatment. In 2009, 374,000 people between the ages of 18 and 24 entered SUD treatment in the United States, although it is unknown how many of those individuals were concurrently pursuing higher education (Substance Abuse and Mental Health Services Administration [SAMHSA], 2012). Interviews of a national sample of 230 emerging adults between the ages of 18 and 24 revealed that 4% consider themselves to be in recovery from SUD (Smith et al., 2011). Further underscoring the growing number of students in recovery, membership in the Association of Recovery in Higher Education (ARHE), an organization dedicated to the establishment of collegiate recovery programs (CRPs), saw a 77% increase from 2018 to 2019 and currently consists of 139 institutions (ARHE, 2022).

College campuses are considered "abstinence-hostile" environments due to the pervasive use and misuse of substances (Harris et al., 2014). The need to "fit in" is still high in emerging adulthood (Laudet et al., 2015), and students in recovery may feel as though they have to choose between their recovery community and their peers (Harris et al., 2014). Additionally, students in recovery may see their peers successfully managing significant substance use along with their academic obligations and begin to question some of the principles learned in treatment (Harris et al., 2014).

The inconsistent sleep schedules often seen among college students may also increase vulnerability to SUD. Genes that are implicated in regulating circadian rhythms, such as the sleep-wake cycle, are directly related to the dopaminergic pathway; thus, circadian disruptions may co-occur with changes in the reward value and motivation for addictive substances (Logan et al., 2014). Furthermore, those with disrupted social rhythms due to non-genetic factors are also susceptible to dysregulated dopaminergic responses (Falco & McClung, 2009). Therefore, people with disrupted circadian rhythms are more vulnerable to addictive disorders. Researchers hypothesize that prolonged social jetlag, or inconsistent sleep schedules on workdays and free days, may lead to disruption of the circadian rhythm, which then further increases vulnerability to SUD (Logan et al., 2014).

SUD and Sleep

As the number of students in recovery grows on college campuses, CRPs are increasingly focusing not only on providing students recovery-specific support, but information and resources that target holistic health and wellbeing (Harris et al., 2008). Sleep is a health behavior that is uniquely impacted by active substance use, immediate withdrawal, and sustained remission, and yet often remains overlooked in the curriculum of CRPs and other support services for students in recovery (Harris et al., 2008). Given the academic, physical, and psychological effects of poor sleep for college students (Nyer et al., 2013; Orzech et al., 2011), and the implications of sleep disturbance for recurrent use (Brower et al., 1998), sleep is an especially critical target of intervention for students in recovery.

Sleep and Active Use. The use of nearly all addictive substances is associated with poor sleep outcomes, including increased sleep-onset latency (SOL), frequent wake after sleep onset (WASO), and decreased sleep quality (Karam-Hage, 2004). The specific dimensions of sleep that are most strongly impacted differ by substance and frequency of use. When low doses of ethanol are administered to healthy controls, sleep initially seems to improve, as SOL decreases and total sleep time (TST) increases (Roehrs & Roth, 2001). However, when sleep architecture is examined, ethanol is associated with suppressed REM sleep in the first half of the sleep period and lighter sleep in the second half (Williams et al., 1983), changes that are known to increase daytime fatigue (Roehrs & Roth, 2001). Similarly, when opioids are administered to healthy controls, deep sleep and REM are significantly reduced, while efficiency, TST, SOL, and WASO are unaffected (Tripathi et al., 2020).

Sleep and Chronic Misuse. Chronic substance misuse has cumulative, negative effects on sleep health. For chronic alcohol misusers, sleep onset may be rapid after bouts of heavy drinking, leading to the belief that alcohol is necessary for sleep and further perpetuating both alcohol misuse and sleep disturbance (Roehrs & Roth, 2001). However, sleep in the chronic alcohol misuser is polyphasic, consisting of short, light, irregular bursts of sleep throughout the 24-hour day (Roehrs & Roth, 2001). Although advocates of polyphasic sleep claim that this irregular sleep schedule promotes increased work productivity without detrimental effects, a systematic review of the empirical literature suggests that polyphasic sleep is associated with decreased TST and circadian misalignment, factors that are both linked with adverse health outcomes (Weaver et al., 2021). Thus, although alcohol use may help chronic misusers initially fall asleep, they are not able to access the full benefits of restorative sleep. Chronic marijuana users have lower TST, worse sleep efficiency, longer SOL, and shorter REM latency than non-users (Bolla et al., 2008). Those who are dependent on opioids also have chronic sleep problems, with 80.6% of opioid-dependent participants scoring above the clinical cutoff for poor sleep on the PSQI compared to 8.8% of healthy controls, with sleep efficiency, SOL, and WASO negatively affected in chronic users (Hartwell et al., 2014).

Evidence suggests a reciprocal association between chronic substance misuse and sleep, in which those with poor sleep increase their substance use, which then worsens sleep outcomes (Logan et al., 2014). This reciprocal association has physiological, cognitive, and affective underpinnings. Circadian rhythm disruption can lead to changes in the reward value and motivation for addictive substances (Logan et al., 2014); thus, individuals who are predisposed to circadian dysregulation, and thus sleep disturbance, may be more likely to continue misusing substances. Adolescents with a delayed sleep phase, and subsequent circadian irregularity, were 2.2 times more likely to use alcohol, tobacco, and/or marijuana in emerging adulthood than adolescents without circadian irregularity (Calhoun et al., 2021).

Cognitively, poor sleep has also been associated with riskier decision-making and poorer performance on problem solving tasks (Brunet et al., 2020; Wilckens et al., 2014); thus, sleep disturbance may lead people to make more impulsive, riskier choices regarding substance use. Inadequate sleep can also negatively impact functioning in the amygdala and medial prefrontal cortex, as well as the connections between these two brain structures (Vanderkerckhove & Wang, 2017). When these connections are impaired, individuals may have difficulty engaging in the executive process (medial prefrontal cortex) of emotion regulation (amygdala). Adolescents with high levels of emotion dysregulation are more likely to report externalizing (disobedience, destructiveness, arguing) and internalizing (loneliness, anxiety, sadness) symptomatology, major risk factors for the development of SUD (Wills et al., 2017). Therefore, not only is substance use contributing to poor sleep, but those with poor sleep may be more likely to continue to misuse substances.

Sleep and Immediate Withdrawal. Sleep is likely to worsen before it improves for chronic misusers withdrawing from their primary substance. Withdrawal from addictive substances is associated with insomnia and shortened slow-wave sleep (SWS; Karam-Hage, 2004). In addition to decreased SWS, acute discontinuation of chronic alcohol use is associated with more frequent REM episodes but without increasing REM duration; thus, REM sleep comes in short, frequent bursts (Roehrs & Roth, 2001). Some individuals experience hallucinations during withdrawal, believed to be the product of the intrusion of these short, frequent bursts of REM sleep into wakefulness (Roehrs & Roth, 2001). Similarly, immediate withdrawal from opioid use is associated with TST suppression, particularly of REM sleep (Tripathi et al., 2020). Moreover, sleep disturbance was still present even for patients whose withdrawal symptoms were managed with methadone. For chronic marijuana users, immediate withdrawal is associated with longer SOL, decreased TST, and poorer sleep efficiency (Conroy & Arnedt, 2014).

Sleep and Recovery. Although some aspects of sleep improve with time in recovery, other aspects of sleep disturbance linger. Over half (62.9%) of patients with SUD in one treatment recovery program met clinical criteria for insomnia one month after abstinence; in fact, sleep disturbance was the most common health-related concern in this sample (Zhabenko et al., 2012). Studies of alcohol misusers in recovery indicate that SOL and TST tend to normalize in 9-12 months after abstinence; however, there is evidence of sleep fragmentation, awakenings, and REM sleep disruption for up to two years after abstinence (Brower, 2001; Roehrs & Roth, 2001). For opioid users, sleep concerns may persist despite medical management. At initiation of methadone treatment, 60.5% of opioid-dependent patients endorsed clinically significant sleep disturbance (Nordmann et al., 2016). The proportion of patients endorsing sleep disturbance only decreased to 55.4% following one year of treatment. For cocaine-dependent patients, sleep architecture was still disrupted after other withdrawal symptoms had abated (Irwin et al., 2016). In the first several months of abstinence from chronic cannabis use, strange, vivid dreams and difficulty initiating sleep may persist (Lee et al., 2014). It is important to note that the cited studies on sleep in recovery focus on the general population of treatment seekers; there is a dearth of research specific to college students' experiences of sleep and recovery.

There are two potential explanations for lingering sleep disturbances in recovery. As previously stated, individuals with genetic predispositions for irregular circadian rhythms may be more likely to develop addiction due to heightened sensitivity of the dopaminergic pathway (Logan et al., 2014). As chronic users continue to misuse substances, their sleep becomes more irregular throughout the 24-hour day, further dysregulating the internal circadian clock (Roehrs & Roth, 2001). Individuals who achieve abstinence may thus struggle with the dual effects of a genetic predisposition towards circadian rhythm disruption and substance-induced disruption (Logan et al., 2014). Another explanation is that, rather than the substances themselves worsening sleep problems, the substances were actually concealing preexisting sleep concerns

(Lee et al., 2014). Individuals often begin using substances to treat insomnia (Lee et al., 2014); thus, once the substances are removed, the underlying insomnia reappears.

Age is a significant factor affecting the course of sleep problems during recovery. Overall, sleep improved over the course of a one-month residential treatment setting in a sample of individuals with alcohol misuse (Kolla et al., 2014). However, younger patients had greater sleep disturbances at treatment admission and less improvement over time. Similarly, younger age predicted worse sleep disturbance and less improvement over time in a sample of cocaine misusers (Irwin et al., 2016). The causes of this age-related effect are unknown; however, researchers have posited that older patients may have fewer psychiatric comorbidities that moderate the association between age and sleep outcomes (Kolla et al., 2014).

In sum, evidence suggests that sleep often immediately worsens during the withdrawal period that follows acute discontinuation of use (Karam-Hage, 2004). After the withdrawal period, many aspects of sleep begin to steadily improve over time in recovery (Brower, 2001). However, other facets of sleep may take up to two years to improve (Brower, 2001), and sleep disturbance may persist longer and with greater severity for younger people (Kolla et al., 2014). For those whose substance use began as a means of treating preexisting sleep concerns, sleep symptoms may not abate organically and may require further treatment (Lee et al., 2014).

Sleep and Recurrence. There is some evidence that poor sleep has implications for recurrence of substance misuse. In one study of patients with a history of alcohol misuse, self-reported and polysomnographic indicators of poor sleep significantly predicted which patients had a recurrence, with 1% increase in SOL associated with a 2.4% increase in likelihood of recurrence (Brower et al., 1998). Similarly, patients who had higher levels of REM sleep pressure (i.e., shortened REM latency, higher REM percentages, and higher REM density) upon entry into an inpatient treatment facility were more likely to have resumed misuse three months after release (Gillin et al., 1994). More recent research has been less clear about the associations between sleep disturbance and recurrence. Lifetime history of insomnia and/or hypersomnia has been associated with higher cocaine use following substance use treatment, although not with alcohol or heroin use (Dolsen & Harvey, 2017). In another study of 119 patients with alcohol use disorder (AUD) entering a residential treatment program, neither sleep disturbance at admission nor discharge predicted recurrence of alcohol use after 12 months (Kolla et al., 2017).

Despite these mixed findings, proponents of the association between sleep disturbance and recurrence of use hypothesize that there are several mechanisms underlying this association. Sleep disturbance is a symptom of withdrawal from most psychoactive substances; therefore, it has been proposed that sleep disturbance is part of a protracted withdrawal process but will eventually dissipate (Brower & Perron, 2010), which could explain the absence of an association between sleep disturbance and recurrence after 12 months of abstinence (Kolla et al., 2017). Other researchers have posited that classical conditioning may play a role in the association between poor sleep and recurrence. A primary goal of addiction treatment is to extinguish the classical conditioning that has linked the unconditioned drug stimulus to environmental cues (Berro et al., 2014). The drug itself produces dopaminergic neuroadaptations in the reward pathway. The contextual cues surrounding drug use (e.g., location, emotional state) become strongly associated with the drug itself, so that the contextual cues alone can lead to cravings. Through time in treatment, these cues are no longer associated with use and the conditioned response is extinguished. Sleep deprivation is associated with heightened sensitivity of dopaminergic postsynaptic receptors. It is thought that this sensitivity may mimic the effect of substances, thereby reversing extinction and "undoing" treatment progress (Berro et al., 2014).

As stated previously, sleep concerns tend to worsen before they improve upon immediate abstinence (Karam-Hage, 2004). Behaviorally, individuals who have been using substances in order to self-treat insomnia may notice their sleep worsening after abstinence and believe that they need to resume use in order to obtain improvement in their sleep (Lee et al., 2014). As previously noted, poor sleep is also associated with riskier decision-making and greater emotional dysregulation (Brunet et al., 2020; Vandekerckhove & Wang, 2017). A study of adults in an outpatient SUD treatment program found that worse emotion regulation predicted greater risk of recurrence (Clarke et al., 2020). Therefore, those who are obtaining poor sleep may have fewer cognitive and emotional resources available to meet the sustained effort required for recovery (White, 2007). Additionally, poor sleep quality has been associated with increased tonic cravings—a steady state of unprovoked craving—but not cue-induced cravings in individuals with AUD (Baskerville et al., 2022).

Recommended Treatments for Sleep in Recovery. Due to possible associations between sleep disturbance and recurrence, it is critical that people in recovery receive professional support regarding sleep. People in recovery who are struggling with sleep disturbance are encouraged to seek nonpharmacological treatment (Arnedt et al., 2007), due to the addictive potential of sleep medications. A systematic review of non-pharmacological treatments for sleep disturbance in individuals with AUD found that cognitive-behavioral therapy for insomnia (CBTI), a combination of cognitive therapy, psychoeducation, and behavioral interventions (e.g., sleep restriction, stimulus control; Qaseem et al., 2016) has been effectively used in this population (Arnedt et al., 2007). However, small sample sizes and methodological weaknesses limit the generalizability of these studies, prompting a need for mixed-methods research to explore the feasibility and acceptability of these programs (Brooks & Wallen, 2014).

Other nonpharmacological treatments include a mindfulness meditation intervention, which yielded a significant increase in TST and sleep self-efficacy in an outpatient sample of adolescents with SUD (Britton et al., 2010), and progressive relaxation training, which yielded improved sleep quality in an inpatient sample of adult men with AUD (Greeff & Conradie, 1998).

The majority of the research into sleep treatment for those in recovery has taken place within the substance use treatment setting in the first 90 days of abstinence (Arnedt et al., 2011; Britton et al., 2010). Therefore, little is known about effective treatments for those who are farther along in recovery, as well as how treatments may differ when administered in non-clinical, supportive settings such as CRPs. Moreover, most studies of sleep interventions for those in recovery take a pathological perspective, with only those who meet clinical criteria for insomnia eligible to participate (Arnedt et al., 2011). Buysse (2014) advocates for a shift from sleep medicine, which focuses on the identification and treatment of sleep disorders, towards sleep health, a more positivistic view of sleep health promotion that can benefit all sleepers.

Sleep Health Interventions

Although there is a lack of research on sleep health promotion interventions for college students in recovery, researchers have developed interventions for the general college student population with mixed success. A systematic review of college sleep health interventions in 2018 identified 27 published non-pharmacological interventions to improve sleep in college students (Friedrich & Schlarb, 2018). These interventions fell into four categories: 1) sleep hygiene, 2) cognitive-behavioral (CBT), 3) relaxation, mindfulness, and hypnotherapy, and 4) other psychotherapeutic approaches. These interventions varied widely in duration, delivery strategy, length of follow-up, and treatment effect size.

Sleep hygiene interventions primarily consisted of psychoeducation and sleep tracking. These yielded moderate effects on healthy sleep behaviors (*d* = .48) and dysfunctional sleep-related beliefs (*d* = .58), as well as small-to-moderate effects on sleep parameters such as duration and SOL (*d* = .32-.61; Brown et al., 2006; Kloss et al., 2016). Effects on sleep parameters were commonly weaker than effects on beliefs and behaviors, suggesting that changes in sleep outcomes may take longer than six weeks—the average length of follow-up in the reported studies—to be measurable with sleep hygiene interventions (Brown et al., 2006). More structured CBT interventions yielded large effects on sleep-related beliefs (*d* = 1.27), sleep hygiene (*d* = 1.16), and actual sleep outcomes (*d* = 1.06-1.77) within a six-week period (Friedrich & Schlarb, 2018), suggesting that cognitive and behavioral intervention may be necessary in addition to the simple provision of psychoeducation. Relaxation interventions, including a mindfulness program (Greeson et al., 2014), yielded small-to-moderate changes in sleep efficiency (*d* = .45) and WASO (*d* = .51; Friedrich & Schlarb, 2018).

In addition to sleep-related outcomes, some studies also measured the effect of the intervention on mental health, as, theoretically, better sleep should positively impact mood (Nyer et al., 2013). Sleep hygiene and CBT interventions demonstrated small-to-moderate effects on mental health (*d* = .40 and .59, respectively), while relaxation interventions had a large effect on mental health (*d* = .93; Friedrich & Schlarb, 2018). The most common effects were improved stress, anxiety (Mairs & Mullan, 2015), and general mental health (Asano et al., 2015). There were no significant effects on depression in several studies (Ball & Bax, 2002; Taylor et al., 2014).

There are several limitations to the literature on sleep health interventions for college students. The studies mentioned above primarily used self-report measures and/or sleep diaries to capture sleep outcomes. Researchers have suggested that sleep health interventions should include more objective measures (i.e., actigraphy) to measure sleep parameters and provide a more comprehensive picture of sleep (Kloss et al., 2016). More individualized tailoring may also improve the effectiveness of these programs (Kloss et al., 2016; Trockel et al., 2011), as in one intervention in which participants received a graphical summary of their sleep data, comparison between their data and age-related norms, and sleep hygiene recommendations (Levenson et al., 2016). This intervention yielded moderate effects (d = .22-.46) on sleep-related beliefs and knowledge, SOL, and sleep efficiency. Lastly, reporting of intervention effects on health outcomes that may be affected by changes in sleep, including anxiety, depression, and general wellbeing, has been variable and inconclusive.

Although these existing sleep interventions have demonstrated some effectiveness in the general college student population, they did not provide demographic information on the recovery status of their participants, leaving the effectiveness with this subpopulation of students unknown. Students in recovery may benefit from psychoeducation that specifically addresses the role of chronic substance use, withdrawal, and recovery in sleep health. The general sleep health interventions described above were also lacking a psychosocial theoretical foundation. Given the fact that recovery requires sustained effort to make healthy choices and avoid relapse (White, 2007), sleep interventions that focus on motivational factors for both maintaining recovery and improving sleep may be valuable for this population.

Self-Determination Theory

Self-determination theory (SDT) is a theory of human motivation that examines the factors that foster an individual's innate tendencies to grow and develop (Ryan & Deci, 2000). The theory uses an organismic approach, assuming that people take an active role in personal development. However, the theory also addresses the role of social context, suggesting that environmental factors can either promote or thwart these innate tendencies (Ryan & Deci, 2000). Individuals are more likely to strive for self-growth if their environments satisfy their basic psychological needs (Deci & Ryan, 2008).

According to SDT, all humans have three basic psychological needs: autonomy, competence, and relatedness (Ryan & Deci, 2000). Each need exists on a spectrum ranging from need satisfaction to need frustration. Autonomy refers to the need to feel responsible for one's behavior and the freedom and ability to make choices (Ryan & Deci, 2000). For example, a college student whose parents dictate their academic major would likely experience some need frustration. Competence refers to a feeling of mastery over one's environment and outcomes (Ryan & Deci, 2000). A college student who feels that they are learning and retaining skills relevant to their career goals might place themselves closer to satisfaction on the competence spectrum. Lastly, relatedness refers to a sense of belonging and connection to others and is usually satisfied by close personal relationships or working with others towards a common goal (Ryan & Deci, 2000). In order for an individual to achieve optimal growth and personal wellbeing, the three needs must be sufficiently met (Tang et al., 2020). Cross-cultural research has supported the claims that these three needs are universal and have predicted wellbeing in cultures with diverse values (Deci & Ryan, 2008).

Basic Psychological Need Satisfaction and Health

In addition to benefits for overall wellbeing, satisfaction of basic psychological needs has been linked more specifically to health behaviors. College students with greater psychological need satisfaction are more future-oriented and more likely to engage in positive health behaviors (Visser & Hirsch, 2014). In a qualitative study of members of a health facility, factors that increase autonomy (e.g., self-selecting activities, creating a routine workout program), competence (e.g., setting and accomplishing goals, using developmentally appropriate exercise modalities), and relatedness (e.g., getting encouragement from others, having workout partners) promoted more physical activity (Springer et al., 2013). Similarly, psychological need satisfaction was positively related to exercise behavior in a sample of community adults (Sylvester et al., 2018). Regarding sleep, basic psychological need satisfaction is associated with better sleep quality, less daytime fatigue, and greater TST (Campbell et al., 2015), and these associations are mediated by sleep hygiene behaviors (Reid & Dautovich, 2021). Thus, individuals who are more psychologically satisfied are more likely to engage in healthy sleep-related behaviors, and these behaviors predict better sleep outcomes.

According to SDT, the associations between basic psychological need satisfaction and the performance of health behaviors are explained by differences in motivation (Ryan & Deci, 2000). Motivation to self-regulate, or perform a behavior, exists on a spectrum from controlled self-regulation—behavior that is controlled by external factors—to autonomous self-regulation (see Figure 1). On the far extreme of the spectrum is amotivation, where an individual perceives a particular behavior change as beyond their intentional control and thus does not attempt to change. Next, someone who is externally regulated may make a certain behavior change in order to attain a reward or avoid a negative consequence (Ryan & Deci, 2000). In the context of substance misuse, someone may enter treatment in order to avoid incarceration. The next level of regulation is introjection, in which in individual is motivated by internal pressures such as shame or guilt (Ryan & Deci, 2000). A mother may enter substance use treatment because of extreme guilt about the impact of her addiction on her children (Klag et al., 2010). A form of regulation that approaches autonomous self-regulation is identification. Identification occurs when someone makes a behavior change because they recognize and accept the underlying value of that behavior (Ryan & Deci, 2000); they still may not enjoy or desire the behavior, but they can acknowledge its importance. Further approaching autonomous self-regulation is integration, the process by which an individual incorporates identified behaviors with other aspects of the self (Ryan & Deci, 2000). For example, someone who continues to seek psychotherapy in recovery is most likely in the integration stage, as not only have they recognized the value of abstinence, but they have integrated recovery into their self-concept and future behaviors (Klag et al., 2010). The ultimate form of autonomous self-regulation is intrinsic motivation, in which a behavior is performed solely due to inherent pleasure or satisfaction (Ryan & Deci, 2000).

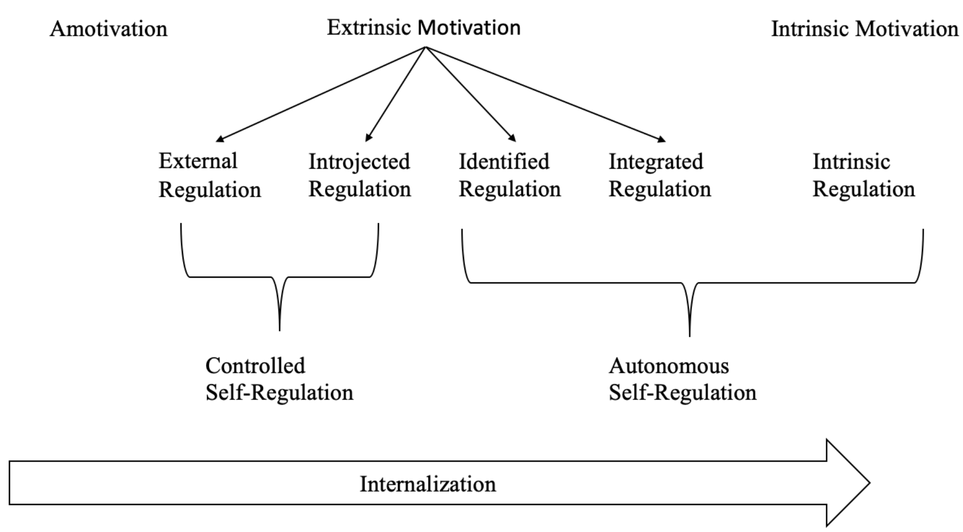

Figure 1. The Spectrum of Motivation in SDT. Adapted from Ryan & Deci, 2000

Behaviors are rarely intrinsically motivated at their onset; however, in need-satisfying environments, individuals will gradually move towards the autonomous end of the self-regulation spectrum through the process of internalization (Ryan & Deci, 2000). If someone experiences a lack of autonomy, they will be performing behaviors for external reasons and thus be unable to internalize motivation. People are more motivated to perform behaviors for which they feel equipped; thus, competence is also a critical mechanism for internalization (Ryan & Deci, 2000). Lastly, individuals are more motivated to perform behaviors that are modeled, valued, or prompted by others in their social network; thus, a sense of relatedness is essential for behavior change.

Behaviors are more likely to be consistently performed when they are autonomously self-regulated, so facilitating the process of internalization is essential for any health behavior change (Froiland et al., 2014). Behavioral health interventions can be designed to support basic psychological need satisfaction in several ways. In order to support participant autonomy, interventionists can provide a list of health behaviors from which participants can choose personally relevant options, explore how particular health behaviors relate to participants' goals, and provide a rationale for all advice (Patrick & Williams, 2012). To support participants' needs for competence, interventionists can help participants develop relevant skills, identify barriers, and problem solve. Lastly, relatedness can be facilitated by providing unconditional positive regard, empathy, and a warm interpersonal environment (Patrick & Williams, 2012). In a weight loss intervention that followed these guidelines, autonomous self-regulation for treatment mediated the association between perceived need support and reduced BMI at follow-up (Williams et al., 1996). Thus, those who felt greater need support were more likely to be autonomously self-regulated, which was then associated with more lasting changes and better health outcomes. Similarly, those who participated in a tobacco cessation intervention that specifically supported the three basic psychological needs moved towards autonomous self-regulation at a faster pace and were able to abstain for longer periods of time than those who received standard-of-care treatment (Williams et al., 2006).

The concept of basic psychological need satisfaction has particular relevance to substance misuse and recurrence. Common reasons for initial substance use and recurrence are feeling controlled by others (low autonomy), lack of life goals and unemployment (low competence), and loss of significant relationships (low relatedness; Chan et al., 2019). By incorporating basic psychological need support into health interventions for individuals in recovery, these interventions can tap into factors that are strongly related to both the sustained effort of recovery and motivation for health behavior change in other domains. Moreover, motivational interviewing, a set of techniques often used in SUD treatment, mirrors the principles of SDT as the practitioner attempts to promote client autonomy, competence, and relatedness (Vansteenkiste & Sheldon, 2006).

Purpose and Aims

Sleep is a significant health concern for college students. Research suggests that the majority of students can be classified as poor sleepers using established clinical cutoffs (Lund et al., 2010; Orzech et al., 2011), and poor sleep is associated with negative physical, psychological, and academic consequences (Hublin et al., 2011; Lewis, 2014; Orzech et al., 2011; Zhai et al., 2015). Students who are in recovery from substance misuse represent a growing population on college campuses (ARHE, 2022) and may be at particular risk of sleep disturbance. Sleep disturbance is implicated at all phases of addiction, including chronic misuse, immediate withdrawal, and recovery (Karam-Hage, 2004). Addictive substances are often used to mask sleep concerns and thus, when the individual decides to abstain, sleep may become a predominant concern for the individual in recovery (Lee et al., 2014). Moreover, poor sleep is a predictor of recurrence of use (Brower et al., 1998). Thus, for the college student in recovery, healthy sleep is crucial for general health and for the sustained effort required for ongoing recovery.

Although sleep health interventions have been designed for the broader college student population, none of these programs have specifically addressed the needs of students in recovery. Prior interventions in the fields of substance use and other health behaviors have used Self-Determination Theory (SDT) as a framework (Patrick & Williams, 2012). SDT posits that individuals have three basic psychological needs (i.e., autonomy, competence, relatedness; Ryan & Deci, 2000) and that, by addressing these needs, interventionists can help move participants towards autonomous self-regulation and thus make behavior change more likely and lasting (Patrick & Williams, 2012). Given the relevance of basic psychological need satisfaction to both addiction and sleep (Campbell et al., 2015; Chan et al., 2019), sleep health promotion interventions for individuals in recovery may benefit from including this framework and focusing on the three basic psychological needs.

The primary aim of the current study was to assess the feasibility and acceptability of Recovery Sleepers, an original sleep health promotion intervention for college students in recovery rooted in SDT. Pilot studies are recommended when new interventions are developed or adapted to target a novel population. Pilot studies are small-scale studies that allow the researcher to assess the feasibility of the study protocol, recruitment and consent procedures, acceptability of the intervention among participants, ease of interventionist fidelity, and preliminary effect sizes which may assist in the design of future, larger studies (In, 2017). This "piloting" ensures that study procedures are in optimal condition prior to applying them to a larger sample. Thus, the present study served to pilot Recovery Sleepers with a small sample of college students in recovery from SUD in order to inform future applications of this intervention.

As previously stated, the primary aim of the study was to **1) Assess the feasibility, acceptability, perceived effectiveness, and fidelity of Recovery Sleepers.** Feasibility was assessed via participant metrics (e.g., recruitment rate, study retention, discussion group attendance, completion of study materials). Acceptability and perceived effectiveness were measured via a participant exit questionnaire. Lastly, treatment fidelity was measured via interventionist checklists. Specific hypotheses were as follows:

Hypothesis 1.1: Feasibility. It was hypothesized that Recovery Sleepers would be deemed feasible. Feasibility was operationally defined as 1) the ability to meet the desired sample size (n = 10 per group), 2) $\geq$80% study retention, 3) >75% group discussion attendance, and 4) $\geq$80% completion of study materials.

Hypothesis 1.2: Acceptability and Perceived Effectiveness. It was hypothesized that Recovery Sleepers would be perceived by participants as an acceptable and effective intervention. Acceptability and perceived effectiveness were operationally defined as a mean $\geq$4.0 on all quantitative items on the participant exit questionnaire, supported by data from qualitative items (see "Measures" section for additional detail).

Hypothesis 1.3: Fidelity. It was hypothesized that co-interventionists would demonstrate treatment fidelity, defined as $\geq$90% adherence to the treatment protocol.

In addition to assessing feasibility, acceptability, and fidelity of the study protocol, pilot studies can also be used to examine preliminary outcomes of the intervention. Due to small sample sizes, pilot studies are typically underpowered to determine statistical significance; however, the analyses of effect sizes and confidence intervals can inform whether the researcher should proceed with a confirmatory trial (Lee et al., 2014). Thus, the study's second aim was to **2) explore the magnitude of intervention effects on sleep-related outcomes.** As previously described, prior sleep health promotion interventions have demonstrated moderate effects on sleep-related beliefs and behaviors, as well as small-to-moderate effects on actual sleep outcomes (Brown et al., 2006; Dietrich et al., 2016; Friedrich & Schlarb, 2018; Kloss et al., 2016). These findings have informed the following hypotheses:

Hypothesis 2.1: Self-Reported Global Sleep. It was hypothesized that Recovery Sleepers would have a small, positive effect on self-reported global sleep quality and sleep health compared to controls.

Hypothesis 2.2: Specific Sleep Outcomes. It was hypothesized that Recovery Sleepers would have a small effect on sleep parameters (i.e., total sleep time, sleep-onset latency, sleep efficiency, wake after sleep onset, and sleep quality) as measured by sleep diary and actigraphy compared to controls.

Hypothesis 2.3: Sleep Beliefs. It was hypothesized that Recovery Sleepers would have a moderate, positive effect on sleep beliefs compared to controls.

Hypothesis 2.4: Sleep Behaviors. It was hypothesized that Recovery Sleepers would have a moderate, positive effect on healthy sleep behaviors compared to controls.

Additionally, a tertiary aim of the study was to **3) explore the magnitude of intervention effects on basic psychological need satisfaction and autonomous self-regulation.** The basis for this aim was the inclusion of the principles of Self-Determination Theory (SDT) in the present intervention; namely, it was hypothesized that by enhancing satisfaction of the three basic psychological needs within the context of the intervention, participants would be more internally motivated to improve their sleep behaviors and thus have greater health outcomes. This hypothesis was mainly exploratory, as previous intervention studies rooted in SDT have not reported effect sizes (Patrick & Williams, 2012; Williams & Deci, 2001). Thus, the following exploratory hypotheses were developed:

Hypothesis 3.1: It was hypothesized that Recovery Sleepers would have a positive effect on basic psychological need satisfaction compared to controls.

Hypothesis 3.2: It was hypothesized that Recovery Sleepers would have a positive effect on autonomous self-regulation compared to controls.

The final aim of the study was to **4) explore the magnitude of intervention effects on related psychosocial variables.** Evidence regarding the effect of participation in a sleep health promotion intervention on mental health is mixed, with some studies reporting small-to-moderate effects on anxiety and negative affect (Farias, 2012; Mairs & Mullan, 2015) and others reporting no significant changes in anxiety or depression (Ball & Bax, 2002; Morris et al., 2015). Thus, the following exploratory hypothesis was developed:

Hypothesis 4.1: It was hypothesized that Recovery Sleepers would have a positive effect on mental health and wellbeing compared to controls.

Additional variables that may be particularly important for students in recovery, including recovery capital—the psychological, social, and cultural resources that one has to support their ongoing recovery (Vilsaint et al., 2017)—have not been captured in prior sleep health promotion interventions. Given the known associations between sleep disturbance and impulsivity (Brunet et al., 2020) and cravings (Baskerville et al., 2022), as well as the role that impulsivity and cravings play in recurrence (Sliedricht et al., 2021), these variables were also examined. Therefore, the following exploratory hypotheses were developed:

Hypothesis 4.2: It was hypothesized that Recovery Sleepers would have a positive effect on recovery capital compared to controls.

Hypothesis 4.3: It was hypothesized that Recovery Sleepers would have a negative effect on cravings compared to controls.

Hypothesis 4.4: It was hypothesized that Recovery Sleepers would have a negative effect on impulsivity compared to controls.

Method

Participants

Recommendations for appropriate sample size for pilot studies vary widely, with anywhere from 12 to 30 participants per condition suggested (Browne, 1995; Julious, 2005). Some researchers suggest that the sample size of a pilot study need not be determined by the power necessary for hypothesis testing, but by estimating the number of participants needed to understand the feasibility and acceptability of the intervention (In, 2017); thus, the recruitment goal for the present study was set at 10 per condition.

Participants were recruited via several strategies over the course of two semesters (Fall 2021 and Fall 2022). The study PI attended seven meetings of the collegiate recovery program (CRP) at Virginia Commonwealth University (VCU), Rams in Recovery, to provide study information and answer questions. Additionally, study information was distributed via the VCU student bulletin, TeleGRAM. Lastly, study information was sent via email to the point of contact for all CRPs in the mid-Atlantic region per the Association of Recovery in Higher Education database (ARHE, 2022). In order to be eligible to participate, individuals needed to be at least 18 years old and currently enrolled (full- or part-time) in a college or university. Additionally, because the intervention is designed for students in recovery, individuals had to have been continuously abstinent from their primary substance of use for at least three months, aligning with the *DSM-5* criteria for remission (Hasin et al., 2013). Lastly, individuals could not have been currently receiving sleep treatment from a healthcare provider in order to avoid conflicting care/recommendations.

Demographic Characteristics

A total of 14 participants were randomized into the study (see Table 2). Participants were 31.21 years old on average (*SD* = 9.94, range = 18–44), with a majority (64.3%) older than the traditional college age range of 18–23. Participants were mostly white (71.4%) and women (71.4). Relationship status varied, with "single" most commonly endorsed (28.6%). Most

Table 2

Demographic Characteristics of Study Participants

	n	%		*n*	%
Age			Housing		
18-25	5	35.2	On-campus residence hall	2	14.3
26-30	2	14.3	Off-campus apartment	3	21.4
31-35	2	14.3	Off-campus house	7	50.0
36-40	0	0.0	Other	2	14.3
41-45	5	35.2	Co-habitation		
Gender			Lives alone	3	21.4
Men	3	21.4	Lives with roommate(s)	3	21.4
Women	10	71.4	Lives with romantic partner(s)	4	28.6
Non-binary/non-conforming	1	7.1	Lives with family	4	28.6
Race			Paid Work		
White/Caucasian	10	71.4	0 hours per week	4	28.6
Hispanic/Latinx	2	14.3	1-10 hours per week	0	0.0
Multiracial/Biracial	2	14.3	11-20 hours per week	1	7.1
Relationship Status			21-30 hours per week	4	28.6
Single	4	28.6	31-40 hours per week	1	7.1
In a committed relationship	3	21.4	41-50 hours per week	4	28.6
Married	3	21.4	Caregiver Status		
Other	1	7.1	Yes	2	14.3
Missing response	*3*	*21.4*	No	12	85.7
University/College Type			Currently Enrolled Credits		
Four-year college/university	12	85.7	0-5	1	7.1
Community college	2	14.3	6-10	2	14.3
Class Standing			11-15	6	42.9
First-Year	1	7.1	16-20	1	7.1
Sophomore	2	14.3	More than 20	1	7.1
Junior	3	21.4	*Missing response*	*3*	*21.4*
Senior	7	50.0	Grade Point Average		
Graduate student	1	7.1	2.50-3.00	2	14.3
			3.01-3.50	1	7.1
			3.51-4.00	8	57.1
			Missing response	*3*	*21.4*

participants were enrolled in four-year colleges/universities (85.7%), with two participants enrolled in community colleges. Half of all participants were seniors. Participants were enrolled in 12.82 (*SD* = 4.81) credits on average in the semester of their participation, with an average GPA of 3.66 (*SD* = .47). Participants most commonly reported living in an off-campus house (50.0%) with a romantic partner (28.6%) or family member (28.6%). Regarding paid work, an equal number of participants reported engaging in 0, 21–30, and 41–50 hours per week (28.6% per category). Only two participants (14.3%) reported caregiving for a dependent.

Substance Use Characteristics

Alcohol was the most commonly identified primary substance of use (50.0%). Participants had been abstinent from their primary substance of use for 1342.23 days (*SD* = 1445.85) on average, with a wide range of duration of abstinence from 118 days (approximately 4 months) to 4583 days (approximately 12 years and 10 months; median = 433 days). Most participants endorsed using their primary substance more than six times per day (50.0%) every day (57.1%) as their typical use prior to entering recovery; moreover, most participants also endorsed using their primary substance more than six times per day (71.4%) every day (78.6%) at the time of their heaviest use. All participants who completed the questionnaire indicated a second drug of use, most commonly hallucinogens (21.4%).

Regarding substance use treatment, the majority of participants had not engaged in inpatient treatment (57.1%) or medically assisted treatment (64.3%). Most participants had engaged in a CRP (85.7%), other support group (85.7%), and outpatient treatment (71.4%). All participants who provided data indicated that they identify as a person in recovery. Most participants reported currently using nicotine/tobacco (57.1%), with some reporting current use of alcohol (14.3%), and marijuana (7.1%).

Table 3

Substance Use Characteristics of Study Participants

	n	%		*n*	%
Primary Substance of Use			Duration of Abstinence from Primary Substance (days)		
Alcohol	7	50.0	0-364 (<1 year)	4	28.6
Cocaine	1	7.1	365-729 (1 year)	3	21.4
Heroin	3	21.4	730-1094 (2 years)	1	7.1
Marijuana	1	7.1	1095-1459 (3 years)	0	0.0
Prescription opioids	1	7.1	1460-1824 (4 years)	1	7.1
Missing response	*1*	*7.1*	More than 1824 (at least 5 years)	4	28.6
Average Use- Frequency Per Week			*Missing response*	*1*	*7.1*
Every day	8	57.1	Secondary Substance of Use		
Nearly every day	3	21.4	Alcohol	1	7.1
1-2 times/week	2	14.3	CNS Depressants	1	7.1
Missing response	*1*	*7.1*	Cocaine	2	14.3
Average Use- Frequency Per Day			Hallucinogens	3	21.4
Once per day	1	7.1	Heroin	1	7.1
Twice per day	1	7.1	Prescription opioids	2	14.3
3-4 times per day	3	21.4	Prescription stimulants	1	7.1
5-6 times per day	1	7.1	Nicotine/tobacco	2	14.3
More than 6 times per day	7	50.0	*Missing response*	1	7.1
Missing response	*1*	*7.1*			

Sleep Circumstances

Of the thirteen participants who responded to items regarding sleep circumstances, 11 reported having at least 5 hours per night to devote to sleep. All participants reported having a consistent place to sleep; however, one participant denied having a comfortable place to sleep. One participant indicated having chronic pain that impacts sleep, and two participants endorsed engaging in shift work that requires them to work past 12:00AM. Participants reported co-sleeping with another person 2.64 nights per week on average (*SD* = 3.04, range = 0–7) and with a pet 2.55 nights per week (*SD* = 2.70, range = 0–7).

Procedure

The host institution granted ethics approval (IRB #HM20022646) prior to recruitment and data collection. A Certificate of Confidentiality was also obtained from the National Institute of Health (CC-OD-21-2543). Interested participants were directed to a screening questionnaire via REDCap, an online data management system (Harris et al., 2009; see Figure 2). Eligible individuals were then contacted by either study PI or an undergraduate research assistant and consented. After consenting to the study, participants were asked to provide their evening availability in order to schedule the Recovery Sleepers discussion groups. Approximately three days prior to the start date of the intervention, participants received an actigraph via postal mail, along with instructions for use and a pre-stamped, pre-addressed envelope for return. Participants also received a link via email to the baseline survey on REDCap.

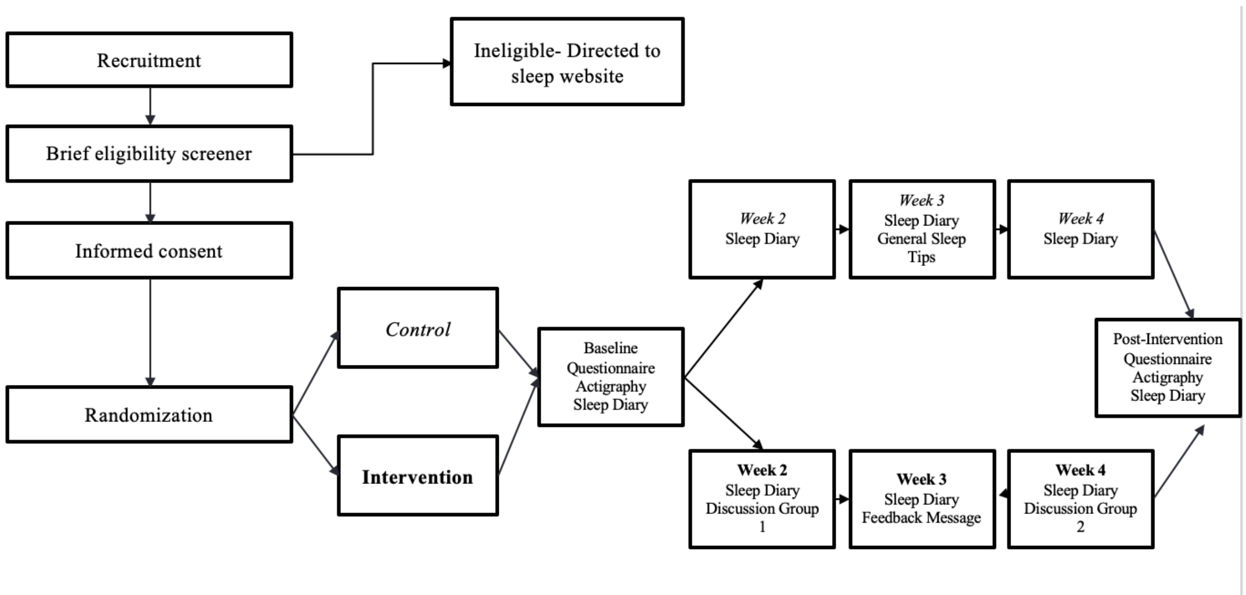

Figure 2. Study Procedures Overview

It was originally proposed that participants would be sorted into conditions by random assignment using an online randomizer. However, the evening availability reported by consented participants was highly variable, presumably due to the irregularity of college student schedules even outside of traditional business hours. Thus, the study PI blinded participants' identifying information and assigned to conditions based on availability (i.e., the participants with availability on the same evening were assigned to the experimental group, while those who were not available were assigned to the control condition).

Once randomized, participants completed the procedures of their designated treatment arm (see "Intervention Overview" and "Control Group Overview" sections for further details). All participants received a daily text message containing a link to a sleep diary via REDCap for the duration of the study. Additionally, prior to the last week of the study, participants again received an actigraph with instructions for use and return. They also received a link to the post-intervention survey via email. Participants received a $15 Amazon gift card for completing sleep tracking via actigraphy for four days (i.e., >50% of the requested seven days of tracking) at baseline, and an additional $15 Amazon gift card for completing four days of sleep tracking via actigraph at six-week follow-up.

Intervention Overview

Participants assigned to the intervention group participated in Recovery Sleepers, an intervention designed to promote sleep health while also incorporating elements that foster autonomy, competence, and relatedness in an effort to encourage autonomous self-regulation for healthy sleep behaviors (see Table 4). Interventionists were the study PI and a fellow counseling psychology graduate student, both of whom are familiar with sleep health promotion and behavioral health group interventions. Interventionists met at the start and midpoint of the intervention to discuss the study protocol.

Table 4

Recovery Sleepers Overview

Component of the Intervention	Timing	Psychological Need Addressed
Daily sleep tracking	Weeks 1-6	Competence
Discussion groups (psychoeducation, discussion, goal-setting)	Weeks 2 and 4	Competence, Relatedness, Autonomy
Individualized feedback messages	Week 3	Competence

Discussion Groups. In Weeks 2 and 4 of the intervention, participants attended two, 90-minute discussion groups via the Zoom teleconference platform. These groups were based largely on Brief Behavioral Treatment of Insomnia (BBTI; Troxel et al., 2012), a brief intervention that uses cognitive-behavioral principles to treat clinical insomnia. BBTI has successfully reduced insomnia in samples of community adults, older adults, and veterans (Chambers & Alexander, 1992; Maguen et al., 2021; McCrae et al., 2018). Although there have been prior trials of CBTI on college students (Azar & Asadnia, 2013; Morris et al., 2015), there have not been trials of its briefer counterpart in this population. BBTI is intended to be delivered to patients with clinical insomnia (Troxel et al., 2012), whereas the current intervention takes the more positivistic view that all college students can benefit from sleep health promotion. Thus, only elements of BBTI that have previously demonstrated efficacy in nonclinical samples (i.e., psychoeducation, sleep hygiene, stimulus control, sleep-related cognitive restructuring; Brown et al., 2006; Kloss et al., 2016; Lamberti, 2012) were incorporated into the intervention. Elements that are more specific to insomnia patients, such as sleep restriction/compression (Troxel et al., 2012), were not included in this intervention.

A significant portion of the discussion groups was comprised of psychoeducation (see Appendix A for discussion group interventionist manual). Topics included the benefits of healthy sleep (Buysse, 2014), the physiology of sleep, the two-process model of sleep regulation (Borbely, 1982), the intersection of sleep and substance misuse/recovery (Brower et al., 1998; Dolsen & Harvey, 2017; Karam-Hage et al., 2004), stimulus control, sleep hygiene (Mastin et al., 2006), maladaptive sleep-related cognitions, and relaxation techniques (Troxel et al., 2012). In addition to psychoeducation, participants also set sleep-related goals. They were introduced to the SMART framework of goal-setting, which has been consistently effective for health behavior change (Bailey, 2019), and encouraged to set specific, attainable, personally relevant goals (Patrick & Williams, 2012). In order to foster a sense of relatedness, participants engaged in both larger group (*n* = 6–8) and smaller, breakout group (*n* = 2–4) discussion. Discussion focused on participants' current sleep concerns and healthy sleep practices, experiences of sleep during active use and recovery, and progress on sleep-related goals.

Feedback Messages. In the third week of the intervention, participants received emailed feedback messages that featured summaries of their individual sleep diary data compared to recommendations by the National Sleep Foundation (Hirshkowitz et al., 2015), a technique used in previous sleep health promotion interventions to help participants gauge their sleep needs (Levenson et al., 2016; see Appendix B for sample feedback message). Feedback messages also contained tailored suggestions based on participants' sleep data and the goals set during the first discussion group. These suggestions reflected common sleep hygiene recommendations, including limiting nighttime screen usage, avoiding large meals before bedtime, limiting caffeine intake before bedtime, exercising regularly, and decreasing light/noise disruption (Drake et al., 2013; Hale et al., 2018; Laskowski, 2019; Lund et al., 2010; Nakajima, 2018; Singh et al., 1997), as well as behavioral suggestions around stimulus control and maintaining a consistent sleep schedule (Troxel et al., 2012). These suggestions were meant to increase perceived competence by providing concrete tools with which to achieve mastery of sleep health (Patrick & Williams, 2012).

Control Group Overview

Participants assigned to the control group continued to track their sleep via daily sleep diary; however, they neither attended discussion groups nor received personalized feedback messages. In the third week of the intervention, control participants received an emailed handout of sleep hygiene recommendations (see Appendix C). By providing control participants with sleep hygiene tips, we could analyze whether the elements specific to Recovery Sleepers (i.e., group discussion, goal-setting, personalized feedback) enhanced outcomes above and beyond the provision of general sleep health information and daily sleep tracking.

Measures

All self-report measures were administered online via REDCap. See Table 5 for an overview of included measures.

Table 5

Main Outcome Measures

Constructs	Measures and Key Variables	B	T	P
Demographics	Age, gender identity, relationship status, race, university, academic credits, GPA, caregiving, paid work, residence information	X		
Substance Use History	Substance(s) of choice, frequency of past use, past treatment modalities, length of sustained remission	X		
Sleep- Self-Report	Sleep circumstances, insomnia (Insomnia Symptom Questionnaire), sleep health (RU SATED), sleep disturbance (PSQI), sleep cognitions (DBAS-16), sleep hygiene (SHI)	X		X
Sleep diary	Total sleep time, sleep efficiency, sleep-onset latency, wake after sleep onset, sleep quality	X	X	X
Actigraphy	Total sleep time, sleep efficiency, sleep-onset latency, wake after sleep onset			
Self-Determination	Basic psychological need satisfaction (autonomy, competence, relatedness; BPNSFS), motivation (TSRQ)	X		X
Health and Well-Being	Positive well-being (MHC-SF), anxiety (GAD-7), depression (CES-D), health-related quality of life (RAND-36)	X		X
Recovery-related psychosocial characteristics	Recovery capital (BARC-10), cravings (BSCS), trait impulsiveness (BIS)*, impulsiveness (MCQ)	X		X

Note: B = Baseline; Week 1, T = Continuously throughout intervention, P = Post-Intervention; Week 6 *BIS only administered at baseline

Participant Characteristics

Demographics. Relevant demographic information was collected at baseline. Participants were asked to provide their age, gender identity (man, woman, non-binary/non-confirming, transgender, other), relationship status (single, in a committed relationship, married, divorced, other), and race (American Indian/Alaskan Native, Asian, Black/African American, Hispanic/Latinx, Native Hawaiian/Other Pacific Islander, white, multiracial/biracial). Participants reported the college/university in which they were currently enrolled; these responses were then either coded as "four-year college/university" or "community college." Participants reported the number of academic credits in which they were currently enrolled, their current grade point average, the number of weekly hours spent engaging in paid work, and whether or not they served as a caregiver for a dependent. Additionally, they reported their current residence (on-campus residence hall, off-campus apartment, off-campus house, other) and co-habitants (none, roommate(s), romantic partner(s), family). Lastly, height and weight were collected to best calibrate the actigraphs; however, these data were not used in analyses.

Substance Use History. At baseline, participants identified their primary substance of use [alcohol, central nervous system depressants (e.g., Xanax, Valium, Ativan), cocaine, hallucinogens, heroin, marijuana, methamphetamines, prescription opioids, prescription stimulants, nicotine/tobacco] along with the estimated date of their most recent use of this substance. Participants reported the weekly and daily frequency with which they engaged in use both on average and at their period of heaviest use. Participants could also identify a secondary substance of use. Regarding substance use treatments, participants indicated the number of months in which they engaged in particular treatment modalities (inpatient treatment, outpatient treatment, CRP, other support groups). Participants also reported whether or not they identify as a "person in recovery." Lastly, participants were asked to indicate which of the aforementioned substances they had used within the previous three months.

Feasibility, Acceptability, and Fidelity

Post-Intervention Questionnaire. Participants completed a post-intervention questionnaire regarding the feasibility, acceptability, and perceived effectiveness of the intervention (see Appendix D), which differed based on assigned condition. Participants responded to several quantitative items assessing the enjoyability, helpfulness, and acceptability of the intervention. Additionally, they rated the enjoyability and helpfulness of each component of the intervention. All quantitative items were on a scale ranging from 1–5. Participants also responded to open-ended questions regarding what they liked about the intervention, whether/how their sleep had changed, how this change impacted their daily functioning, and possible changes that they would make to the intervention.

Fidelity Checklists. Following each discussion group, both interventionists completed a checklist indicating whether the major themes and activities had been covered (see Appendix E).

Sleep

Sleep Circumstances. Participants were asked several items related to biopsychosocial circumstances that may affect their sleep (adapted from Martin et al., 2017). Specifically, they were asked about sleep opportunity (i.e., whether they have at least 5 hours per night to devote to sleep) and whether they had a consistent and/or comfortable place to sleep. Participants were asked whether they experience chronic pain that impacts their sleep as well as whether they engage in shift work that requires working past 12:00AM. Additionally, participants reported how many nights per week they co-sleep with another person and/or a pet. These responses were used solely for descriptive purposes and were not included in statistical analyses.

Insomnia. The Insomnia Symptom Questionnaire (ISQ; Okun et al., 2009) is a 13-item questionnaire designed to identify respondents who meet clinical criteria for insomnia. Participants report the weekly frequency that they experience several insomnia symptoms (e.g., difficulty falling asleep) on a scale from 0 (*never*) to 5 (*always, 5-7 times per week*). Participants then report how long each of these symptoms have been present. Participants also rate their degree of sleep-related impairment in various domains (e.g., "have your sleep difficulties affected your work?") on a scale from 0 (*not at all*) to 4 (*extremely*). To meet criteria for insomnia, a respondent must indicate difficulty falling asleep, difficulty staying asleep, or unrefreshing sleep frequently or always for at least four weeks. They must also indicate at least "quite a bit" impairment in one domain. Using these criteria, the ISQ demonstrates high specificity (>90%) but variable sensitivity, possibly due to its multidimensional representation of sleep (Okun et al., 2009). In the current study, the ISQ was used as a dichotomous variable (insomnia/no insomnia) for descriptive purposes and not included in statistical analysis.

Sleep Health. The RU SATED scale assesses six dimensions of sleep health (i.e., regularity, satisfaction, alertness, timing, efficiency, and duration) from a positivistic, nonclinical perspective (Buysse, 2014). Participants responded to six items (e.g., "Are you satisfied with your sleep?") on a scale ranging from 0 (*rarely/never*) to 2 (*usually/always*). A total score was derived by summing all items (range: 0–2), with higher scores indicating healthier sleep. Although previous studies have demonstrated suboptimal internal consistency (∝ = .62-.64; Ravyts et al., 2021; Reid & Dautovich, 2021), the RU SATED has strong concurrent validity with the Insomnia Severity Index, Pittsburgh Sleep Quality Index, and Sleep Self-Efficacy Scale. In the current study, the measure also yielded suboptimal internal consistency (∝ = .65); thus, results should be interpreted with caution.

Sleep Quality. The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) is a 19-item measure of sleep quality and disturbance over the past month. A global score (range: 0–21) can be derived by summing the following subscales, or component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of medications, and daytime dysfunction, with higher scores representing greater sleep disturbance.

The PSQI can be used to differentiate "good" and "poor" sleepers, with poor sleepers scoring 5 or greater (Buysse et al., 1989). The PSQI demonstrates moderate convergent validity with the Insomnia Severity Index (*r* = .63; Buysse et al., 1989) and acceptable internal reliability in college student samples (∝ = .73; Lund et al., 2010). In the present sample, the PSQI also yielded acceptable internal consistency (∝ = .71).

Sleep Diary. The Consensus Sleep Diary is a valid, standardized sleep diary (Carney et al., 2012) that was administered daily throughout the intervention via a link sent by text message. Prior to administration, participants were provided a set of standardized instructions regarding how to complete the diary and were encouraged to complete the diary within one hour of getting out of bed each morning. They recorded 1) the time that they got into bed the previous night, 2) the time that they tried to go to sleep, 3) how long it took them to fall asleep, 4) how many times they woke throughout the night, 5) how long these awakenings lasted in total, 6) the time of their final awakening, 7) the time that they got out of bed for the day and 8) a sleep quality rating on a scale from 1 (*very poor*) to 5 (*very good*). The following daily variables were computed: total sleep time (TST), sleep efficiency, sleep-onset latency (SOL), wake after sleep onset (WASO), and sleep quality.

Actigraphy. Participants wore the ActiGraph GT9X-BT on their non-dominant wrist for seven consecutive 24-hour periods at baseline and follow-up. Actigraphs contain a built-in accelerometer that records movements in order to estimate sleep parameters. Actigraphy is a valid method of collecting sleep data with relatively little participant burden (Martin & Hakim, 2011) and is highly correlated with polysomnography (*r* = .80; Ancoli-Israel et al., 2003). Actigraphy data were analyzed using the ActiLife 6.0 data analysis software platform (ActiGraph, 2012). Bedtime and waketime were verified via sleep diary-reported data. The Cole-

Kripke algorithm was used to distinguish sleep from wakefulness; this algorithm has been demonstrated to effectively differentiate sleep from wakefulness 88% of the time (Cole et al., 1992). The following variables were calculated: TST, sleep efficiency, SOL, and WASO.

Sleep Cognitions. The Dysfunctional Beliefs and Attitudes about Sleep-16 (DBAS-16; Morin et al., 2007) assesses the extent to which participants agree with statements that represent maladaptive beliefs about sleep (e.g., "I need eight hours of sleep to feel refreshed and function well during the day"). Participants rate their level of agreement with each statement on a scale from 0 (*strongly disagree*) to 10 (*strongly agree*). A total score is derived by averaging responses across all items (range: 0–10), with higher scores indicating more dysfunctional beliefs. The DBAS-16 has demonstrated good internal reliability (∝ = .79) in non-clinical samples (Morin et al., 2007); similarly, it yielded good internal consistency in the present sample (∝ = .85).

Sleep Hygiene Behaviors. The Sleep Hygiene Index (SHI; Mastin et al., 2006) is a 13-item scale in which participants indicate how frequently they engage in specific behaviors (e.g., "I take daytime naps lasting two or more hours") that have been derived from the diagnostic criteria for hygiene in the American Sleep Disorders Association's International Classification of Sleep Disorders. Participants respond on a scale from 1 (*always*) to 5 (*never*), with higher total scores indicating healthier sleep hygiene (range: 13–65). Scores on the SHI have been positively correlated with the PSQI and Epsworth Sleepiness Scale in nonclinical samples (Mastin et al., 2006) and demonstrated acceptable internal consistency (∝ = .70) in the present sample.

Self-Determination

Basic Psychological Need Satisfaction. The Basic Psychological Need Satisfaction and Need Frustration Scale (BPNSNFS; Chen et al., 2015) consists of three subscales corresponding to the three basic psychological needs according to SDT: autonomy, competence, and relatedness

(Deci & Ryan, 2008). Each subscale consists of eight statements (e.g., "I feel a sense of choice and freedom in the things I undertake") to which participants rate their degree agreement on a scale from 1 (*not true at all*) to 5 (*completely true*). Negatively-worded items are reverse-coded such that higher subscale scores (range: 8–40) indicate greater need satisfaction. Previous research with adults has yielded good internal consistency for all three subscales (∝ = .70–.88; Campbell et al., 2015). In the current study, the autonomy and competence subscales demonstrated good internal consistency (∝ = .86 and .94, respectively), with the relatedness subscale yielding only suboptimal internal consistency (∝ = .68).

Motivation. The Treatment Self-Regulation Questionnaire (TSRQ; Ryan & Connell, 1989) assesses motivations to participate in a particular health behavior. Using the stem, "The reason I would engage in healthy sleep behaviors is…," participants rated the degree to which 15 statements reflect their motivations on a scale from 1 (*not at all true*) to 7 (*very true*). Three subscale scores are derived: autonomous regulation (e.g., "Because I feel that I want to take responsibility for my own health;" range: 6–42), controlled regulation (e.g., "Because I want others to approve of me;" range: 6–42), and amotivation (e.g., "I really don't think about it;" range: 3–21). The autonomous and controlled regulation subscales have demonstrated good psychometric properties across several health behaviors, including tobacco use, diet, and exercise (Levesque et al., 2007); however, there is little research on the amotivation scale. Thus, amotivation was not included in statistical analyses in the present study. The autonomous and controlled regulation subscales yielded good internal consistency in the current sample (∝ = .84 and .85, respectively).

Health and Wellbeing

Positive Wellbeing. The Mental Health Continuum-Short Form (MHC-SF; Keyes et al., 2008) is a briefer, 14-item version of the Mental Health Continuum (Keyes, 2007). Participants rated the frequency with which they experience positive examples of psychological (e.g., "that you liked parts of your personality"), emotional (e.g., "happy"), and social (e.g., "that people are basically good") wellbeing in the past month on a scale from 0 (*never*) to 5 (*every day*). A higher total score (range: 0–70) indicates greater positive wellbeing. The MHC-SF has demonstrated good psychometric properties in both college student (Keyes et al., 2012) and recovery (Redmond et al., 2021) populations to represent mental health from a positivistic perspective rather than simply the absence of psychopathology. The MHC-SF yielded good internal consistency in the present sample ($\propto$ = .90).

Anxiety. The Generalized Anxiety Disorder-7 (GAD-7; Spitzer et al., 2006) is designed to screen for GAD according to *DSM-IV* criteria. Participants reported the extent to which seven anxiety symptoms (e.g., "feeling nervous, anxious, or on edge") have bothered them over the past two weeks on a scale from 0 (*not at all*) to 3 (*nearly all day*), with higher total scores (range: 0–21) indicating more severe anxiety. The total score has yielded good internal consistency in college samples ($\propto$ = .90; Byrd-Bredbenner et al., 2020). The GAD-7 demonstrated similarly good internal consistency in the present sample ($\propto$ = .91).

Depression. The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) was developed by the National Institute of Mental Health to assess subthreshold depression in the general population. Participants reported the frequency with which they experienced 20 symptoms (e.g., "I was bothered by things that didn't usually bother me") in the past week on a scale from 0 (*rarely/none of the time*) to 3 (*most or all of the time*). Positively-worded items were reverse-scored so that higher total scores (range: 0–60) represent greater depression. The CES-D has demonstrated good psychometric properties in previous university samples (Jiang et al., 2019) and yielded good internal consistency in the present sample (∝ = .95).

Health-Related Quality of Life. The RAND 36-Item Health Survey (RAND-36; Ware & Sherbourne, 1992) was designed to assess global physical and mental health. Two component scores are derived: the Physical Component Score (PCS) and Mental Component Score (MCS). The PCS represents physical functioning, role limitations due to physical health, pain, and general health, while the MCS represents emotional wellbeing, role limitations due to emotional wellbeing, energy/fatigue, and social functioning. Both the PCS and MCS range from 0 to 100, with higher scores indicating better health. The PCS and MCS have previously demonstrated good psychometric properties (Hays & Morales, 2001) and yielded good internal consistency in the current sample (∝ = .77 and .78, respectively).

Recovery-Related Psychosocial Variables

Recovery Capital. The Brief Assessment of Recovery Capital (BARC-10; Vilsaint et al., 2017) assesses the personal, social, environmental, and cultural resources that buffer against stress and support recovery. Participants rated their level of agreement with 10 statements (e.g., “My living space has helped to drive my recovery journey”) on a scale from 1 (*strongly disagree*) to 6 (*strongly agree*), with higher total scores (range: 10–60) indicating greater recovery capital. The BARC-10 has previously demonstrated good content validity, internal consistency, and predictive validity of sustained remission (Vilsaint et al., 2017); it yielded good internal consistency in the present sample (∝ = .83).

Cravings. The Brief Substance Cravings Scale (BSCS; Somoza et al., 1995) assesses the intensity, frequency, and duration of cravings within the past 24 hours. Although the original scale allows participants to respond based on both their primary and secondary substances of use, the present study adapted this measure so that responses only pertained to the primary substance, as it was unknown whether all participants would identify a secondary preferred substance. Items were assessed on a scale from 0 to 4, with higher total scores (range: 0–12) indicating cravings of greater frequency, intensity, and/or duration. This modified BSCS yielded good internal consistency in the current sample ($\propto$ = .86).

Trait Impulsivity. The Barratt Impulsiveness Scale (BIS-11; Barratt, 1959) measures impulsivity across the following subconstructs: attention, motor impulsiveness, self-control, cognitive complexity, perseverance, and cognitive instability. Researchers posit that the BIS-11 reflects an enduring personality trait, rather than behavioral measures which assess a more state-dependent impulsivity (Stanford et al., 2009); thus, scores on the BIS-11 were not expected to change over the course of six weeks, and the measure was only administered at baseline to depict trait impulsivity. Participants reported their level of agreement with 30 statements (e.g., "I do things without thinking") on a scale from 1 (*rarely/never*) to 4 (*almost always/always*), with certain items reverse-coded such that higher total scores (range: 30–120) indicate greater impulsivity. Although the total score of the BIS-11 has yielded good internal consistency in previous samples ($\propto$ = .83; Stanford et al., 2009), it only demonstrated suboptimal internal consistency in the current study ($\propto$ = .69).

Delay Discounting. State impulsivity was compared across timepoints via the 27-item Monetary Choice Questionnaire (MCQ; Kirby et al., 1999). Participants are provided 27 scenarios and must decide whether they would choose immediate, smaller monetary rewards or larger, delayed rewards (e.g., "Would you prefer $40 today, or $55 in 62 days?") This task assesses delay discounting, the concept that rewards decrease in perceived value as the delay of those rewards increases. Those with impulsive tendencies exhibit high delay discounting, preferring more immediate rewards, though they may be smaller in size. The MCQ correlates highly with self-reported impulsivity scales, including the BIS-11, with the additional benefit of having less face validity of questionnaires (Kirby et al., 1999). Individuals with a history of substance misuse demonstrate higher delay discounting on the MCQ than those who have not misused substances (Towe et al., 2015); however, there is some evidence of a ceiling effect, suggesting that the MCQ may not fully capture the upper limit of delay discounting within the recovery population. To score the MCQ, a delay-discounting rate (*k*-value) is calculated for each participant (range: .00016–.25), with higher *k* indicating greater delay discounting and thus greater impulsivity. Open-access software provided by researchers at the University of Kansas was used to score the MCQ (Kaplan et al., 2014).

Data Analysis

Qualitative analyses were conducted to assess participants' responses to open-ended questions regarding the acceptability and perceived effectiveness of the intervention. Due to the small sample size of the experimental condition and subsequent scarcity of data, it was unnecessary to have multiple coders; thus, responses were coded by the study PI using content analysis (Kyngas, 2020).

All quantitative analyses were conducted using SPSS version 26. Prior to analyses, data were cleaned. Missing data were less than 5% of all data among treatment completers; thus, mean substitution was used. For treatment non-completers, an intent-to-treat (ITT) approach was used. ITT analysis includes all randomized participants in analyses regardless of their deviation from the intervention protocol or withdrawal from treatment, and it has been recommended for use in randomized controlled trials, in which noncompliance and missing outcomes are common to final analyses (Gupta, 2011). In cases where post-intervention data were missing, the last observation carried forward approach, in which the last available measurement for a particular individual prior to withdrawal is carried forward to post-intervention (Streiner & Geddes, 2001), was used. All variables were normally distributed (skewness and kurtosis <2), with the exception of delay discounting as measured by the MCQ; thus, a logarithmic transformation was applied as suggested by prior researchers (Kaplan et al., 2014; Towe et al., 2015).

Due to the small sample size inherent to pilot studies, interpreting statistical significance should be avoided; rather, effect sizes should be used to estimate the strength of the intervention and inform future research trials (Browne, 1995). In order to counteract the impact of low power, researchers conducting pilot studies may consider widening confidence intervals from the traditional 95% to 75–85% (Bell et al., 2018). The present study takes a moderate approach by analyzing 85% confidence intervals. This approach heightens the possibility of a Type I error, so results should be interpreted with caution. To discourage overinterpretation of statistical significance, only effect sizes are discussed in the main paper, with statistical significance (*p*-values) presented in tabled format.

To assess baseline differences between groups, Fisher's exact tests were conducted between the experimental and control groups on categorical variables (i.e., gender, race, primary substance of use, dichotomous insomnia status). Fisher's exact test is preferred over chi-square analysis for smaller samples (Kim, 2017). Student's *t*-tests were used to determine baseline differences between groups on continuous variables.

In order to assess the size of the effect of time on a particular variable from baseline to post-intervention, separate paired-sample *t*-tests were conducted for each condition on each group of variables [self-reported sleep (RU SATED, PSQI, DBAS-16, SHI), sleep diary (TST, sleep efficiency, SOL, WASO, sleep quality), actigraphy (TST, sleep efficiency, SOL, WASO), self-determination (BPNSFS, TSRQ), health and wellbeing (MHC-SF, GAD-7, CES-D, RAND-36) and recovery-related psychosocial variables (BARC-10, BSCS, MCQ). The magnitudes of these changes are represented by Hedges' *g*, which has been shown to correct for bias in small samples (Hedges & Olkin, 1983; Lakens, 2013). Lakens' (2013) qualitative labels are used: $g \leq .19$ is a negligible effect, .20–.49 is a small effect, .50–.79 is a moderate effect, and $\geq .80$ is a large effect. As previously stated, 85% confidence intervals are presented for all Hedges' *g* statistics (Bell et al., 2018). Significance may be interpreted wherein the confidence interval does not include zero (Lakens, 2013).

Intervention effects on sleep, self-determination, and other psychosocial variables were examined via Analyses of Covariance (ANCOVAs). Condition was the independent variable in these analyses, with the post-intervention variable of interested entered as the dependent variable. The corresponding baseline variable of interest was entered as a covariate. Through this method, the effect of the intervention after controlling for baseline characteristics was yielded. All variables were entered in separate analyses. The sizes of the intervention effects are represented via partial eta-squared (η^2) and interpreted via Cohen's (1988) ranges: $\eta^2 \leq .009$ is a negligible effect, .01–.059 is a small effect, .06–.139 is a medium effect, and $\geq .14$ is characterized as a large effect.

Results

Aim 1: Feasibility, Acceptability, and Fidelity

Feasibility of Recruitment

As previously stated, the following recruitment strategies were used: presenting to Rams in Recovery, the local collegiate recovery program (CRP), members; posting in the university online bulletin, and sending study information to CRP personnel in the mid-Atlantic region. Most individuals who completed the eligibility screener (79.3%) were recruited through Rams in Recovery. The remaining 45% of individuals screened were recruited via the university bulletin. There were no individuals recruited from other CRP; moreover, the study PI received feedback from several contacted CRP personnel who stated that a) the study required too much of their students without adequate compensation, or b) their students did not have time to participate.

Eligibility and Consent

Of the 29 individuals who completed the eligibility screener, 21 (72.4%) were found eligible (see Figure 3). The most common reason for ineligibility was lack of three months of continuous abstinence from the primary substance of use (62.5% of ineligible individuals). Of note, all individuals who were reported less than three months of abstinence had been recruited via university bulletin rather than through a CRP. Of the 21 individuals deemed eligible, 16 provided informed consent, with study personnel unable to contact the remaining five eligible individuals. Two of the consented participants did not respond to further communication following the provision of consent; thus, they were not randomized into the study.

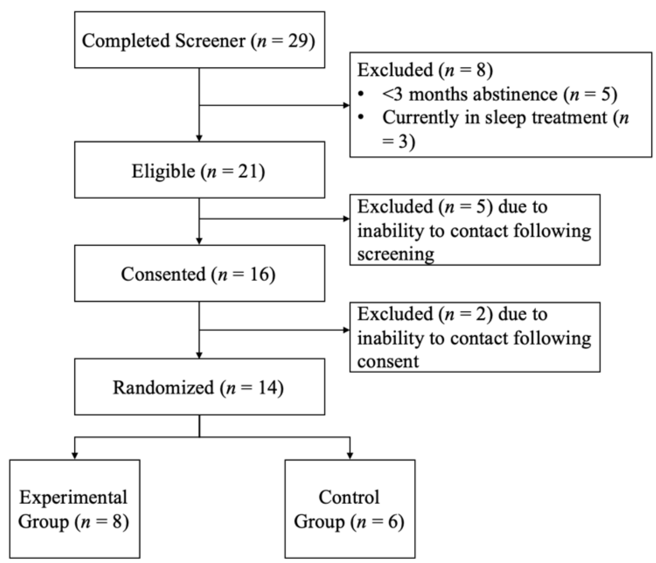

Figure 3. CONSORT Flow Diagram

Randomization Success

Eight participants were randomized to the intervention group and six to the control group. Using an alpha level of .15, Fisher's exact tests demonstrated a significant difference between groups in gender (p = .13), with men disproportionately assigned to the experimental group (n = 3) rather than the control (n = 0). There were no significant differences in race (p = .39), primary substance of use (p = .59), or insomnia status (p = .59). Student's t-test demonstrated a difference

Table 6

Baseline Differences Between Conditions on Continuous Variables

	Experimental Mean (SD)	Control Mean (SD)	*t*	*p*	*g* [85% CI]
Age	31.75 (9.81)	30.50 (11.00)	-.22	.42	-.11 [-.84, .62]
Duration of Abstinence from Primary Substance	1089.75 (1003.86)	1746.20 (2064.83)	.66	.27	.41 [-.37, 1.18]
Sleep Health (RU SATED)	6.75 (3.01)	7.50 (2.26)	.53	.30	.26 [-.48, .98]
Sleep Disturbance (PSQI)	8.63 (2.45)	8.00 (5.66)	-.25	.40	-.14 [-.87, .59]
TST (mins)- Diary	430.19 (43.52)	450.12 (27.21)	.95	.18	-.51 [-.57, 1.56]
Sleep Efficiency (%)- Diary	78.11 (6.65)	75.74 (5.93)	-.65	.27	-.35 [-1.39, .72]
SOL (mins)- Diary	32.19 (23.62)	31.64 (14.76)	-.05	.48	-.03 [-1.07, 1.02]
WASO (mins)- Diary	26.31 (14.22)	21.09 (10.49)	-.72	.24	-.39 [-1.43, .68]
Sleep Quality Rating- Diary	3.48 (.54)	3.23 (.31)	-.98	.18	-.52 [-1.58, .56]
TST (mins)- Actigraphy	385.31 (79.03)	456.13 (54.89)	1.80	.05	**.96 [.11, 1.76]**
Sleep Efficiency (%)- Actigraphy	73.10 (5.58)	76.96 (5.90)	1.17	.36	.62 [-.19, 1.40]
SOL (mins)- Actigraphy	20.79 (18.61)	17.27 (13.39)	-.38	.28	-.20 [-.97, .58]
WASO (mins)- Actigraphy	122.74 (20.27)	113.42 (31.11)	-.61	.14	-.37 [-1.09, .46]
Sleep Cognitions (DBAS-16)	4.31 (1.50)	4.94 (1.77)	.70	.25	.36 [-.38, 1.09]
Sleep Behaviors (SHI)	25.50 (8.94)	25.50 (4.72)	.00	.50	.00 [-.73, .73]
Autonomy (BPNSNFS)	28.13 (5.57)	25.93 (5.48)	-.74	.24	-.37 [-1.10, .37]
Competence (BPNSNFS)	31.25 (4.62)	28.67 (9.75)	-.60	.28	-.34 [-1.06, .41]
Relatedness (BPNSNFS)	34.88 (2.95)	34.33 (4.59)	-.25	.40	-.14 [-.86, .600]
Autonomous Regulation (TSRQ)	30.13 (10.33)	32.50 (3.15)	.61	.28	.27 [-.47, 1.00]
Controlled Regulation (TSRQ)	11.75 (7.52)	13.17 (5.60)	.40	.35	.20 [-.54, .92]
Positive Well-Being (MHC-SF)	47.70 (10.32)	41.67 (14.49)	-.87	.20	-.46 [-1.19, .29]
Anxiety (GAD-7)	9.68 (6.10)	8.00 (4.56)	-.59	.28	-.29 [-1.10, .45]
Depression (CES-D)	17.13 (11.54)	22.17 (16.41)	.64	.27	.34 [-.400, 1.07]
Physical Health (PCS; RAND-36)	72.97 (20.25)	81.38 (16.76)	.81	.22	.41 [-.37, 1.17]
Mental Health (MCS; Rand-36)	55.24 (21.93)	47.44 (30.48)	-.50	.32	-.29 [-1.05, .49]
Recovery Capital (BARC-10)	50.25 (9.04)	48.20 (5.12)	-.52	.31	-.24 [-1.04, .61]
Cravings (BSCS)	2.88 (4.01)	4.00 (3.08)	.57	.29	.28 [-.49, 1.04]
Trait Impulsivity	68.85 (4.67)	66.83 (11.75)	-.398	.35	-.23 [-.95, .51]
Delay Discounting (MCQ)	.0125 (.0078)	.0079 (.0062)	-.56	.30	-.25 [-.97, .490]

between conditions in total sleep time (TST) as measured by actigraphy at baseline, $g = .96$, 85% CI [.11, 1.76], with the experimental group reporting fewer minutes of TST ($M = 385.31$) than the control ($M = 456.13$; see Table 6). There were no other significant differences between the experimental and control group at baseline. Thus, randomization appeared to be primarily successful, although the noted differences in gender and TST as measured by actigraphy should be taken into consideration when interpreting results.

Feasibility of Intervention

Feasibility was assessed by ability to meet the desired sample size, study retention, discussion group attendance, and completion of study materials.

Sample Size. The desired sample size ($n = 10$ per condition) was not met, as only eight participants were randomized to the treatment condition and six to the control. Inadequate sample size is likely attributable to recruitment difficulties, as no randomized participants were recruited outside of Rams in Recovery. As stated, other CRP personnel either did not respond or voiced concern about study burden and inadequate compensation; moreover, individuals recruited via university bulletin did not meet eligibility criteria regarding abstinence from substance use.

Study Retention and Attendance. Of the eight participants randomized to the intervention condition, six (75.0%) completed the study. Two participants were lost to follow-up after Week 1 of the study (i.e., completion of the baseline questionnaire and a week of sleep tracking). Five participants attended the first discussion group (83.0%) and four attended the second (66.7%), yielding an average attendance rate of 5%.

Regarding study materials, all intervention participants fully completed the baseline questionnaire, with the six participants retained to completion (75.0%) completing the post-intervention questionnaire. Among intervention participants, 64.6% of sleep diaries were completed and the actigraphs worn on 89.3% of the required days. Thus, 82.2% of study materials were completed.

Acceptability and Perceived Effectiveness

Acceptability. Three quantitative items assessed the acceptability of the intervention as a whole, and acceptability was operationally defined as an average score of $\geq$4.0 on each of these items. Each of these items met this criterion, as participants agreed that they enjoyed the intervention (M = 4.33), that other college students could benefit from the intervention (M = 4.67), and that the intervention did not require too much time/energy (M = 4.33). Additional items asked about specific components of the intervention. Participants reported that the daily sleep diary was manageable (M = 4.33) and gave them insight into their sleep (M = 4.33). They reported that the actigraph was only somewhat easy to wear (M = 3.83) but that the provided instructions for use were adequate (M = 4.17). Participants strongly endorsed enjoying the discussion groups (M = 4.50), and all participants indicated that they thoroughly read their personalized feedback messages.

Perceived Effectiveness. Mean level of agreement with the item “Recovery Sleepers helped me improve my sleep” was lower than hypothesized (M = 3.83). Regarding specific components of the intervention, group discussion was rated as most highly impactful on sleep (M = 4.17), followed by feedback messages (M = 4.00), psychoeducation (M = 3.67), sleep tracking via daily diary (M = 3.00), and sleep tracking via actigraphy (M = 2.83). When asked what they enjoyed about the intervention, four participants mentioned the receipt of personalized sleep data and feedback, while two participants enjoyed setting goals in the discussion groups. Additionally, two participants described satisfaction from contributing to scientific research.

All participants who provided qualitative responses reported positive changes to their sleep outcomes and/or sleep hygiene behaviors. Behavioral changes noted including decreasing time spent awake in bed, limiting non-sleep activities in bed, and reducing nighttime screen usage and caffeine intake. Participants did not identify specific changes to their sleep, but rather made vague statements like, "It is changing a little every day." Participants stated that these changes have given them more energy, reduced daytime fatigue, and facilitated better health choices overall, with one participant writing, "Better sleep has helped in all areas of life!"

Participants were also asked to identify changes that they would make to the intervention in the future. Two participants expressed concerns about the actigraphs, with one stating that the band was too short for comfortable wear and another stating that they already wear a FitBit and would have preferred to use their personal device. A third participant suggesting adding more discussion groups.

Fidelity to Intervention

The study PI reported 100% fidelity on fidelity checklists. The co-interventionist reported 94% fidelity, as she reported the inability to collect SMART goals from all participants in the first discussion group due to technological difficulties with the Zoom platform. Thus, total fidelity was 97%.

Aim 2: Intervention Effects on Sleep

Self-Reported Sleep Outcomes

Four participants in the experimental group (50.0%) and two in the control group (33.3%) met clinical criteria for insomnia at baseline. Participants had a mean baseline PSQI score of 8.36 (*SD* = 3.95), higher than the cutoff score of 5.00 that is used to determine clinically significant sleep disturbance (Buysse et al., 1989).

Insomnia, Sleep Health, and Global Sleep Disturbance. Two of the four intervention participants who originally met criteria for insomnia no longer reported diagnosable symptoms (50.0%). The two participants in the control who reported insomnia at baseline maintained the criteria, while an additional control participant also met criteria at follow-up.

Sleep health for the intervention group as measured by the RU SATED moderately improved from baseline (M = 6.75) to post-intervention (M = 8.75), g = -.59, 85% CI [-1.07, -.07] (see Table 7); the control group also moderately improved over time (M_{pre} = 7.50, M_{post} = 8.83, g = -.64, 85% CI [-1.18, -.04]. Condition had a negligible effect on sleep health at follow-up after controlling for baseline scores, η^2 = .001. Sleep disturbance as measured by the PSQI also moderately improved from baseline (M = 8.63) to post-intervention (M = 6.88) among the intervention group, g = .73, 85% CI [.18, 1.24], while there was only a negligible effect of time for the control group, g = .04, 85% CI [-.45, .54]. Condition had a moderate, positive effect on global sleep disturbance after controlling for baseline scores, η^2 = .109.

Table 7

Self-Reported Sleep Outcomes

	Change from Baseline-Experimental Group			Change from Baseline-Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*p*	η^2
Sleep Health	-1.87	.05	**-.59 [-1.07, -.07]**	-1.87	.06	**-.64 [-1.18, -.04]**	.02	.90	.001
Sleep Disturb.	2.33	.03	**.73 [.18, 1.24]**	.12	.45	.04 [-.45, .54]	1.35	.27	**.109**

Note: Boldness represents moderate-to-large effect sizes.

Sleep Diary

At baseline, participants reported average total sleep time (TST) of 440.15 minutes (approximately 7 hours and 20 minutes; SD = 36.14) and an average sleep efficiency percentage of 76.93 (SD = 6.14; see Figure 4). Average sleep-onset latency (SOL) was 31.91 minutes (SD =

18.78) and wake after sleep onset (WASO) was 23.70 minutes (*SD* = 12.22). Participants rated their sleep quality at 3.35 (*SD* = .44) on a scale from 1 to 5 on average, indicating fair sleep.

Among participants in the experimental group, there were large changes in sleep efficiency, *g* = -1.69, 85% CI [-2.60, -.64] and SOL, *g* = .82, 85% CI [.13. 1.43] from baseline to post-intervention, with participants reporting greater sleep efficiency (M_{pre} = 77.80%, M_{post} = 85.54%) and shorter SOL (M_{pre} = 33.40 minutes, M_{post} = 20.00 minutes) at follow-up (see Table 8). There was a moderate change in WASO over time, *g* = .68, 85% CI [.03, 1.26], with participants reporting fewer minutes of WASO post-intervention (*M* = 17.20) than at baseline (*M* = 29.29). There were only negligible changes in TST, *g* = -.10, 85% CI [-.61, .42] and sleep quality, *g* = -.18, 85% CI [-.69, .56].

In the control group, there were small changes in all sleep diary variables from baseline to follow-up. Most of these changes were positive, with control participants reporting slightly improved sleep efficiency (M_{pre} = 74.94%, M_{post} = 79.12%), shorter SOL (M_{pre} = 31.13 minutes, M_{post} = 20.67 minutes), shorter WASO (M_{pre} = 20.98 minutes, M_{post} = 17.48 minutes), and better sleep quality (M_{pre} = 3.22, M_{post} = 3.37) post-intervention. However, they also reported less TST (M_{pre} = 439.38 minutes, M_{post} = 421.42 minutes) at follow-up.

Table 8

Sleep Diary Outcomes

	Change from Baseline- Experimental Group			Change from Baseline- Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*p*	η^2
TST	-.28	.40	-.10 [-.61, .42]	.82	.23	.29 [-.26, .81]	1.08	.33	**.134**
Efficiency	-4.74	.01	**-1.69 [-2.96, -.64]**	-1.21	.15	-.43 [-.96, .15]	2.81	.14	**.286**
SOL	2.29	.04	**.82 [.13, 1.43]**	1.27	.14	.45 [-.13, .99]	.06	.82	.008
WASO	1.91	.06	**.68 [.03, 1.26]**	1.12	.16	.40 [-.17, .93]	.45	.52	**.060**
Quality	-.49	.32	-.18 [-.69, .36]	-.93	.20	-.33 [-.85, .23]	.19	.68	.026

Note: Boldness represents moderate-to-large effect sizes.

After controlling for baseline scores, the intervention had a large, positive effect on sleep efficiency, $\eta^2 = .286$ and a moderate, positive effect on WASO, $\eta^2 = .060$. There was a moderate effect of intervention on TST, $\eta^2 = .134$; however, this effect represents a decrease in TST among the control group rather than improvement among the intervention group. Condition had a small effect on sleep quality, $\eta^2 = .026$, wherein the control group reported slightly higher quality at follow-up. There was only a negligible effect of condition on SOL, $\eta^2 = .008$.

Actigraphy

As measured by actigraphy, participants reported average TST of 420.72 minutes (approximately 7 hours; *SD* = 74.68) and an average sleep efficiency percentage of 75.03 (*SD* = 5.83). Average SOL was 19.03 minutes (*SD* = 15.57) and average WASO was 118.08 minutes (*SD* = 22.50).

Among participants in the experimental group, there were large changes in sleep efficiency, *g* -1.00, 85% CI [-1.62, -.30] and WASO, *g* = 1.17, 85% CI [.41, 1.84] over time, with participants reporting better efficiency (M_{pre} = 73.10%, M_{post} = 82.98%) and shorter WASO (M_{pre} = 122.74 minutes, M_{post} = 75.39 minutes) at follow-up (see Table 9). There was a small change in SOL, *g* = .47, 85% CI [-.09, .95], with participants reporting shorter SOL (M_{pre} = 20.79 minutes, M_{post} = 9.31 minutes) at follow-up. There was negligible change in TST over time.

Among participants in the control group, there was a large change in TST over time, *g* = .84, 85% CI [.19, 1.43), with participants reporting shorter TST post-intervention (M_{pre} = 456.13 minutes, M_{post} = 418.38 minutes). There was a small change in SOL, *g* = -.28, 85% CI [-.78, .24], with control participants reporting longer SOL at follow-up (M_{pre} = 17.27 minutes, M_{post} = 25.78 minutes). There were negligible changes in sleep efficiency.

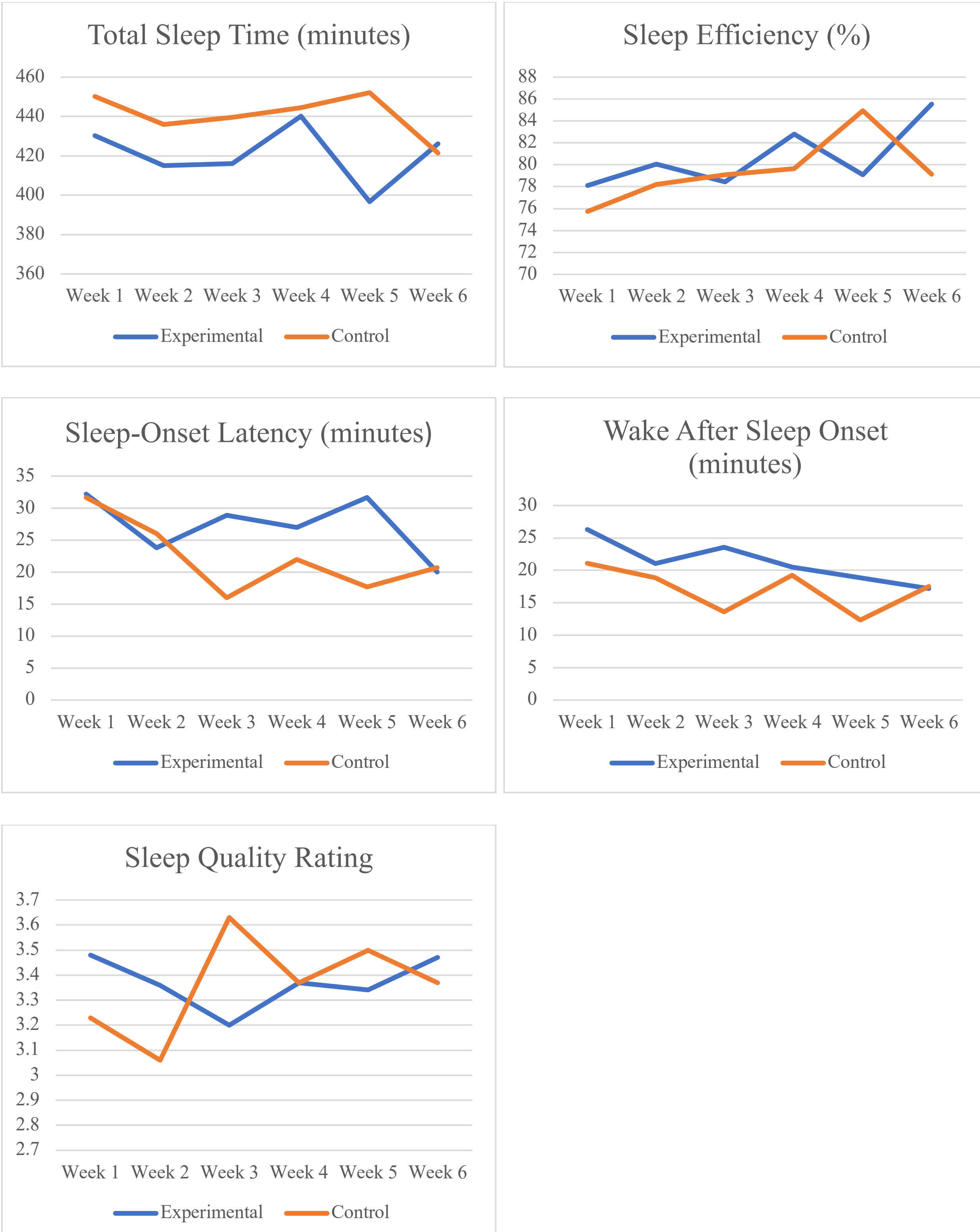

Figure 4. Sleep Diary Variables over Time

After controlling for baseline scores, the intervention had a large, positive effect on SOL, $\eta^2 = .196$ and moderate, positive effects on sleep efficiency, $\eta^2 = .125$ and WASO, $\eta^2 = .080$. There was a negligible effect of condition on TST, $\eta^2 = .007$.

Table 9

Actigraphy Outcomes

	Change from Baseline- Experimental Group			Change from Baseline- Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*P*	η^2
TST	-.11	.458	-.04 [-.53, .46]	2.45	.029	**.84 [.19, 1.43]**	.07	.804	.007
Efficiency	-2.91	.017	**-1.00 [-1.62, -.30]**	-.08	.471	-.03 [-.52, .47]	1.28	.287	**.125**
SOL	1.36	.116	.47 [-.09, .98]	-.81	.227	-.28 [-.78, .24]	2.20	.172	**.196**
WASO	3.41	.010	**1.17 [.41, 1.84]**	.56	.299	.19 [-.32, .69]	.78	.399	**.080**

Note: Boldness represents moderate-to-large effect sizes.

Sleep-Related Beliefs and Behaviors. Time had a negligible effect on dysfunctional sleep-related beliefs for both the intervention, $g = .13$, 85% CI [-.33, .58] and control, $g = -.04$, 85% CI [-.54, .45] groups (see Table 10). The intervention had a small, positive effect on dysfunctional beliefs about sleep after controlling for baseline scores, $\eta^2 = .034$.

There was a large effect of time on sleep hygiene behaviors among the intervention group, $g = .88$, 85% CI [.29, 1.41], with participants reporting better sleep hygiene at post-intervention ($M = 25.50$) than baseline ($M = 21.13$). The effect of time on sleep hygiene was also large among the control group, $g = .93$, 85% CI [.25, 1.54]. The intervention had a small, positive effect on sleep hygiene, $\eta^2 = .051$.

Table 10

Effects on Sleep Beliefs and Behaviors

	Change from Baseline- Experimental Group			Change from Baseline- Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*p*	η^2
Sleep Cognitions	.41	.35	.13 [-.33, .58]	-.12	.45	-.04 [-.54, .45]	.39	.55	.034
Sleep Hygiene	2.79	.01	**.88 [.29, 1.41]**	2.71	.02	**.93 [.25, 1.54]**	.59	.46	.051

Note: Boldness represents moderate-to-large effect sizes.

Aim 3: Self-Determination Outcomes

Basic Psychological Needs. At baseline, participants reported highest satisfaction in relatedness (*M* = 34.64), followed by competence (*M* = 30.86), and autonomy (*M* = 27.18). From baseline to follow-up, participants in the experimental group increased in autonomy (M_{pre} = 28.13, M_{post} = 31.00, a large effect, *g* = -.87, 85% CI [-1.40, -.28] and competence (M_{pre} = 31.25, M_{post} = 32.65), a moderate effect, *g* = -.61, 85% CI [-1.10, -.09] (see Table 11). There was a small decrease in relatedness over time (M_{pre} = 34.88, M_{post} = 33.50), *g* = .44, 85% CI [-.06, .91]. Among participants in the control group, there was a large increase in autonomy, *g* = -.97, 85% CI [-1.58, -.27], a small increase in competence, *g* = -.27, 85% CI [-.76, .26], and a small decrease in relatedness, *g* = .37, 85% CI [-.17, .88]. The intervention had a negligible effect on autonomy ($\eta^2 < .000$), competence ($\eta^2 = .001$), and relatedness ($\eta^2 < .000$) after controlling for baseline differences.

Table 11.

Self-Determination Outcomes

	Change from Baseline-Experimental Group			Change from Baseline-Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*p*	η^2
Autonomy	-2.76	.01	**-.87 [-1.40, -.28]**	-2.82	.02	-.97 **[-1.58, -.27]**	.00	.97	.000
Competence	-1.95	.05	**-.61 [-1.10, -.09]**	-.77	.24	-.27 [-.76, .26]	.02	.91	.001
Relatedness	1.40	.10	.44 [-.06, .91]	1.08	.16	.37 [-.17, .88]	.00	.98	.000
Autonomous Self-Reg.	-1.21	.13	-.38 [-.84, .11]	.41	.35	.14 [-.36, 63]	.53	.48	.046
Controlled Self-Reg.	.43	.34	.135 [-.33, .59]	-.71	.26	-.24 [-.74, .27]	1.54	.24	**.123**

Note: Boldness represents moderate-to-large effect sizes.

Motivation. Regarding motivation for sleep changes, the intervention group had a small increase in autonomous self-regulation from baseline (*M* = 30.13) to post-intervention (*M* = 31.50), *g* = -.38, 85% CI [-.84, .11] and a negligible change in controlled self-regulation (M_{pre} = 11.75, M_{post} = 11.25), *g* = .135, 85% CI [-.325, .585]. Conversely, among the control group, there was a negligible change in autonomous self-regulation, *g* = .141, 85% CI [-.364, .632] and a small increase in controlled self-regulation, *g* = -.244, 85% CI [-.738, .273]. After controlling for baseline scores, the intervention had a small, positive effect on autonomous self-regulation, η^2 = .046. Condition had a moderate effect on controlled self-regulation, η^2 = .123; however, this is due to an increase in controlled self-regulation among the control group rather than change in the intervention group.

Aim 4: Psychosocial Outcomes

At baseline, participants reported a mean positive wellbeing score of 45.11 (*SD* = 12.15). Mean anxiety was 8.96 (*SD* = 5.36), suggestive of mild anxiety (Spitzer et al., 2006). Participants also reported a mean depression score of 19.29 (*SD* = 13.49), greater than the cutoff score of 16 that is traditionally used to determine risk of clinical depression (Radloff, 1977). Average physical (*M* = 76.20, *SD* = 18.73) and mental health (*M* = 52.24, *SD* = 24.61) as measured by the RAND-36 were both greater than the normative mean of 50 (Ware & Sherbourne, 1992), suggesting good global health in both domains.

There was only negligible change in positive wellbeing from baseline to follow-up in both the experimental (M_{pre} = 47.70, M_{post} = 48.75. g = -.15, 85% CI [-.60, .31]) and control (M_{pre} = 41.67, M_{post} = 42.83, *g* = -.18, 85% CI [-.68, .33]) groups (see Table 12). Intervention effects on positive wellbeing were also negligible, $\eta^2 < .000$.

Change in anxiety among the intervention group from baseline (*M* = 9.68) to follow-up (*M* = 10.25) was negligible, *g* = -.18, 85% CI [-.64, .28]; among the control group, there was a moderate decrease in anxiety from baseline (*M* = 8.00) to follow-up (*M* = 7.00), *g* = .27, 85% CI [-.25, .77]. The intervention had a moderate, positive effect on anxiety after controlling for baseline scores, η^2 = .061.

Table 12.

Psychosocial Outcomes

	Change from Baseline- Experimental Group			Change from Baseline- Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*p*	η^2
Positive Well-Being	-.49	.32	-.15 [-.60, .31]	-.54	.31	-.18 [-.68, .33]	.00	.96	.000
Anxiety	-.59	.29	-.18 [-.64, .28]	.79	.23	.27 [-.25, .77]	.71	.42	**.061**
Depression	-2.63	.02	**-.83 [-.1.35, -.25]**	-.07	.47	-.03 [-.52, .47]	.55	.48	.047
Physical Health	.41	.35	.13 [-.33, .58]	-2.31	.04	**-.83 [-1.44, -.13]**	12.91	.01	**.563**
Mental Health	1.29	.12	.41 [-.09, .87]	-2.44	.04	**-.87 [-1.49, -.16]**	4.91	.05	**.329**

Note: Boldness represents moderate-to-large effect sizes.

Time had a large effect on depression in the experimental group, *g* = -.83, 85% CI [-1.35, -.25]; however, this was in the opposite direction than desired (M_{pre} = 17.13, M_{post} = 22.00). There was negligible change in depression in the control group, *g* = -.03, 85% CI [-.52, .47]. The intervention had a small, negative effect on depression, η^2 = .047.

The intervention group demonstrated negligible change in physical health over time, *g* = .13, 85% CI [-.33, .58], while the control group demonstrated a large improvement in physical health over time, M_{pre} = 81.38, M_{post} = 88.38, *g* = -.83, 85% CI [-1.44, -.13]. Time had a small effect on mental health in the intervention group, M_{pre} = 55.24, M_{post} = 48.48, with mental health actually declining over the span of the intervention. Mental health improved from baseline (*M* = 47.44) to follow-up (*M* = 59.28) in the control group, a large effect, *g* = -.87, 85% CI [-1.49, -.16]. Condition had a large effect on physical health, η^2 = .563; however, this effect is attributable to a large improvement in physical health among the control group rather than change in the experimental group. The intervention had a large, negative effect on mental health, η^2 = .329.

Recovery-Specific Outcomes

At baseline, participants reported an average recovery capital score of 49.46 (SD = 7.58). This mean score is higher than the cutoff score of 47 that has been demonstrated to predict sustained remission (Vilsaint et al., 2017), suggesting that participants in the sample had good psychosocial resources to support recovery. Participants' average craving score at baseline was 3.31 (SD = 3.59). Nine participants (64.3%) reported either no or slight cravings over the past 24 hours, one participant (7.1%) reported moderate cravings, and two (14.3%) reported extreme cravings.

There was a small increase in recovery capital over time among the experimental group, M_{pre} = 50.25, M_{post} = 52.79, g = -.35, 85% CI [-.81, .13] (see Table 13). The control group had a larger increase in recovery capital over time, M_{pre} = 48.20, M_{post} = 50.60, g = -1.26, 85% CI [-2.01, -.40]. There was a small, positive effect of condition on recovery capital, η^2 = .037, with the control condition associated with better outcomes. The intervention group reported decreased cravings over time (M_{pre} = 2.88, M_{post} = .50), a moderate effect, g = .51, 85% CI [.01, .99]. The control group also reported a decrease in cravings (M_{pre} = 4.40, M_{post} = 2.20), a small effect, g = .37, 85% CI [-.19, .90]. There was a large positive effect of the intervention on cravings, η^2 = .210.

Table 13.

Recovery Specific Outcomes

	Change from Baseline- Experimental Group			Change from Baseline- Control Group			Intervention Effects		
	t	*p*	*g* [85% CI]	*t*	*p*	*g* [85% CI]	*F*	*p*	η^2
Recovery Capital	-1.13	.15	-.35 [-.81, .130]	-3.54	.01	**-1.26 [-2.01, -.40]**	.39	.55	.037
Cravings	1.64	.07	**.51 [.01, .989]**	1.04	.18	.37 [-.19, .90]	2.66	.13	**.210**
Delay Discounting	-.23	.41	-.07 [-.52, .383]	-2.15	.04	**-.74 [-.1.30, -.11]**	.88	.37	**.074**

Note: Boldness represents moderate-to-large effect sizes.

Participants' average trait impulsivity score (M = 67.99, SD = 8.12) was higher than found in a community sample (M = 59.18; Reise et al., 2013) but similar to means found among substance misusers (*M* = 64.05–72.05; Cicolini et al., 2011). The average score on the delay discounting task following transformation was -2.32 (*SD* = .57), suggesting greater delay discounting than in a prior sample of individuals in inpatient SUD treatment (*M* = -3.28; Mulhauser et al., 2019). There was little change in delay discounting in the experimental group from baseline (*M* = -2.40) to follow-up (*M* = -2.38), *g* = -.07, 85% CI [-.52, .38]. The control group demonstrated increased delay discounting from baseline (*M* = -2.22) to follow-up (*M* = -2.05), a moderate effect, *g* = -.74, 85% CI [-1.30, -.11]. There was a moderate effect of intervention on delay discounting, η^2 = .074, in which the control group reported greater delay discounting.

Discussion

Sleep is a key component to a healthy lifestyle (Matricciani et al., 2018), and poor sleep has been associated with negative physical (Besedovsky et al., 2019), cognitive (Nebes et al., 2009), and emotional (Zhai et al., 2015) outcomes. A wide base of research demonstrates that college students are at particularly high risk of poor sleep (Lund et al., 2010; Orzech et al., 2015), presumably due to aspects of the campus environment (i.e., light/noise disruptions, academic and emotional stress, lack of clear boundaries around business hours; Lund et al., 2010) and developmental trends in autonomy over health-related behaviors and peer influence (Calamidas & Crowell, 2018; Salmela-Aro et al., 2007). Several sleep health promotion interventions have effectively demonstrated improvement in healthy sleep-related behaviors, more accurate beliefs about sleep, and better sleep quality among college students (Friedrich & Schlarb, 2018). However, these interventions have neglected college students in recovery from substance use disorders (SUD), a growing subpopulation (Harris et al., 2014) that is particularly at risk for sleep disturbance due to the lingering impact of substance misuse on sleep after abstinence (Brower & Perron, 2010; Kolla et al., 2014). As collegiate recovery programs (CRPs) seek to support the holistic wellbeing of students in recovery (Harris et al., 2014), there is a need to investigate how sleep health can be feasibly and effectively promoted within this subpopulation.

The purpose of this study was to determine the feasibility, acceptability, and preliminary efficacy of Recovery Sleepers, a sleep health promotion intervention designed for the current study for college students in recovery from SUD. Recovery Sleepers is largely based on Brief Behavioral Treatment for Insomnia (BBTI; Troxel et al., 2012), with the addition of self-determination theory (SDT) as a framework. SDT posits that students whose basic psychological needs (i.e., autonomy, competence, and relatedness) are more satisfied are more likely to be autonomously self-regulated, or intrinsically motivated, to perform healthy behaviors (Ryan & Deci, 2000). Thus, Recovery Sleepers incorporates specific aspects (i.e., goal-setting, psychoeducation, group discussion, personalized feedback messages) that target these basic psychological needs in an effort to bolster intrinsic motivation.

As Recovery Sleepers is a novel intervention, the current study piloted the intervention to explore its feasibility, acceptability, and fidelity with a small sample prior to future implementation in a larger sample (In, 2017). Additionally, the study aimed to provide preliminary data on the magnitude of the effect of the intervention on subjective and objective sleep parameters and sleep-related cognitions and behaviors. Lastly, preliminary data on secondary, psychosocial variables (i.e., basic psychological need satisfaction, motivation, mental health and wellbeing, recovery capital, cravings, and impulsivity) that may also be affected by participation in a sleep health promotion intervention were gathered. The following sections summarize the findings for each study aim.

Study Feasibility, Acceptability, and Fidelity

Overall, there were some significant challenges to feasibility of the intervention, particularly regarding recruitment and inability to meet the desired sample size. In order to increase the sample size in future iterations of this study, changes to recruitment procedures should be considered. Rams in Recovery, the CRP with which the research team had previously collaborated, was an effective source of participants; however, contacting CRP personnel at other universities yielded either no response or negative feedback about the demands of the study and low compensation. Thus, it seems that a prior relationship between the researcher and CRP personnel is likely to boost recruitment. This idea aligns with the core tenets of community-based participatory research, which posits that, by building partnerships and collaborations with key stakeholders and community members, the power differential and inherent mistrust between researchers and participants are ameliorated (Collins et al., 2018). Future research may benefit from collaborating with CRP personnel and other members of the recovery community to a) improve the intervention by discussing with community members the particular aspects of sleep health promotion that they find most salient and b) enhance trust between the researchers and the recovery community, thereby facilitating recruitment. Additionally, advertising the study in the university bulletin proved largely unsuccessful, as students recruited via this strategy did not meet the eligibility criterion for abstinence from substance use. Thus, a more targeted, community-based approach would ensure that participants are both appropriate for and invested in the study.

Student availability also posed a challenge for both recruitment and discussion group attendance. As previously stated, the originally planned randomization strategy could not be implemented due to difficulty scheduling discussion groups around student availability. Rather, assignment to conditions was determined by student availability at the predetermined discussion group time, with those unavailable assigned to the control group. This strategy was mostly successful, as there were few significant differences between the intervention and control groups at baseline, with the exception of gender and total sleep time (TST) as measured by actigraphy. However, this strategy is not fully random, as students who are at available at particular times of day may differ in key variables (i.e., chronotype and preferred timing of daily activities) from students who are not. Future research should consider using a less biased condition assignment strategy and offering discussion groups at several different times to best capture students with varied schedules.

Furthermore, discussion group attendance was lower than expected. Groups were held in the first and third weeks of November, likely a month of high stress for students (Baghurst & Kelly, 2014). Thus, future studies should consider conducting discussion groups earlier in the semester to increase attendance. Discussion groups were also conducted via Zoom rather than in-person. The online format allowed for greater access to students from different universities and locations; however, research on online class attendance during the COVID-19 pandemic demonstrated a decline in attendance when compared to face-to-face classes (Meeter et al., 2020). The authors posit that, in online settings, a lack of social integration or feelings of disconnectedness could result in lower motivation to attend. Thus, future studies could assess whether in-person discussion groups foster a greater sense of social connectedness and thus better attendance. Other possible strategies to improve attendance include shortening the duration of the discussion groups (i.e., from 90 to 60 minutes) and offering compensation specifically for group attendance.

Participants did complete study materials at an acceptable rate (82.8% of materials completed). The sleep diary completion rate of 64.6% was consistent with other studies (van Eerde & Venus, 2018), and participants wore the actigraphs for 89% of the required nights. Thus, both daily sleep diary and actigraphy appear to be feasible methods for collecting sleep data among college students in recovery.

Regarding acceptability, participants reported that the study burden was reasonable and that participation was both helpful and enjoyable. They endorsed particularly enjoying the discussion groups, which aligns with the Substance Abuse and Mental Health Administration's (2023) emphasis on community and relationships as vital parts of recovery. Moreover, several participants enjoyed contributing to the recovery community via participation in scientific research. Future research should continue to include group discussion in order to align with this population's desire to address individual health needs within the context of supportive relationships, as well as to emphasize participants' larger role in furthering research that will benefit the larger recovery community.

In addition to group discussion, participants identified personal feedback as helpful in improving their sleep outcomes and behaviors, further underlying the need for individualized tailoring within sleep health promotion interventions (Kloss et al., 2016). Goal-setting was also identified as a helpful and enjoyable aspect of the intervention. The co-interventionists made an observational note that, although participants enjoyed goal-setting, they often had difficulty doing so within the SMART framework, which emphasizes smaller, achievable objectives towards a larger goal (Bailey, 2019). Several participants stated that people in recovery see things in "extremes" or with an "all-or-nothing" mentality. For example, one participant wanted to set a goal to decrease the amount of time spent scrolling on his phone from bed. The co-interventionists suggested a goal to reduce the number of mornings spent scrolling from seven to four per week; rather, the participant wanted to completely eliminate use of his phone from bed and stated that this “cold turkey” approach was the most effective strategy for him to make behavioral changes. This anecdote reiterates the importance of including members of the recovery community in the future design and implementation of Recovery Sleepers to best incorporate attributes and values unique to the recovery community (Collins et al., 2018).

Participants perceived the intervention as generally effective in improving sleep; however, they had difficulty identifying specific ways in which their sleep had changed. More often, they cited sleep-related behavioral changes post-intervention (e.g., engaging in fewer non-sleep activities from bed, decreased caffeine use), which supports the concept often touted in sleep health intervention research that behavioral changes precede changes in actual sleep parameters (Friedrich & Schlarb, 2018).

Additionally, the study demonstrated good treatment fidelity. No changes to the manual or procedures were necessary for proper delivery. However, both interventionists were familiar with the development of this project; therefore, future studies should include interventionists who were not involved with intervention development to further ensure that protocol materials are clear and reasonable.

Intervention Effects on Sleep-Related Variables

Both college students and individuals in recovery are at higher risk of sleep disturbance than the general adult population (Karam-Hage, 2004; Lund et al., 2010); thus, it was hypothesized that college students in recovery would also report suboptimal sleep health. Indeed, at baseline, participants demonstrated some sleep disturbance through all three methods of data collection (i.e., self-report, daily sleep diary, and actigraphy), supporting the need for intervention in this population. The average baseline score on the PSQI was greater than the clinical cutoff score of 5 suggesting typically poor sleep quality (Buysse et al., 1989), as has been found in other college student samples (Lund et al., 2010). At baseline, both sleep diary and actigraphy indicated poorer sleep efficiency (75.03–76.93%) than recommended by the National Sleep Foundation (85%; Hirshkowitz et al., 2015); moreover, sleep-onset latency (SOL) was also longer (19.03–31.91 minutes) than the recommended 15 minutes (Hirshkowitz et al., 2015). Average total sleep time (TST) was around seven hours per night, at the lower end of the recommended range for adults (i.e., 7–9 hours per night; Hirshkowitz et al., 2015). There was a large discrepancy between wake after sleep onset (WASO) reported via sleep diary (M = 24 minutes/night) and actigraphy (M = 118 minutes/night), despite using participants' sleep diaries to set bed- and wake-times for actigraphic data collection, as recommended to alleviate discrepancies (Ancoli-Israel et al., 2003). Although prior research has demonstrated that participants may underreport WASO in sleep diary due to the role of retrograde amnesia associated with sleep onset (Lehrer et al., 2022; Perlis et al., 2001), the present discrepancy is much larger than in previous studies (Lehrer et al., 2022). The use of multiple methods of data collection allows for a more accurate depiction of sleep parameters (Dietch & Taylor, 2021) and should be continued in future studies.

In terms of the intervention effects, Recovery Sleepers had moderate effects on subjectively and objectively assessed sleep quality, sleep efficiency, and WASO, as well as SOL as measured by actigraphy. There was also a moderate change in sleep disturbance as measured by the PSQI, which aligns with other sleep health intervention studies in college samples (Brown et al., 2006; Kloss et al., 2016). However, the average PSQI score following the intervention still remained greater than the clinical cutoff, suggesting some lingering sleep disturbance. There was no significant change in sleep health as measured by the RU SATED; however, the poor internal consistency of the RU SATED in the current study ($\alpha = .65$) calls into question whether this scale reliably measures the concept of sleep health among students in recovery.

The intervention had larger effects on sleep efficiency, WASO, and SOL as measured by both sleep diaries and actigraphy than demonstrated in previous studies (Brown et al., 2006; Kloss et al., 2016). Changes in these particular sleep parameters could be related to the behavioral goals that participants set during group discussion. Most participants set goals related to stimulus control, including engaging in fewer non-sleep activities from bed and getting out of bed when unable to sleep, thus reducing time in bed (TIB). As sleep efficiency is calculated by dividing TIB by TST (Carney et al., 2012), it makes sense that sleep efficiency would improve as participants spent less time awake in bed. Changes in SOL and WASO could also result from these behavioral goals, as the brain begins to associate the bed more strongly with sleep, thus decreasing the frequency and duration of wake periods (Bootzin & Perlis, 2011). It is important to note that sleep efficiency as measured by actigraphy remained below the desired 85% post-intervention (82.98%; Hirshkowitz et al., 2015), suggesting a need for further intervention.

The intervention did not have an effect on either diary or actigraphy TST. This finding could be an artifact of study timing, as participants tracked their post-intervention data during final exam week, a time when students often forgo sleep for last-minute studying (Zeek et al., 2015). Moreover, participants reported receiving approximately seven hours of sleep per night at baseline, which, although at the lower end of the suggested range (Hirshkowitz et al., 2015), is still greater than observed in other college student samples (Creswell et al., 2023; Lund et al., 2010; Zeek et al., 2015). Thus, participants may have been more concerned with improving the quality, rather than quantity, of their sleep and may have had less “room for improvement” in sleep duration compared to other sleep parameters.

Although previous sleep health interventions have yielded moderate changes in sleep-related beliefs and behaviors (Kloss et al., 2016; Levenson et al., 2016), there were only small post-intervention differences between the experimental and control groups in dysfunctional beliefs about sleep and sleep hygiene behaviors. Nonetheless, there were large increases in sleep hygiene behaviors in both the experimental and control groups. The control group received a list of sleep hygiene behaviors in the third week of the intervention as a substitute for the personalized feedback messages received by experimental participants. This finding suggests that simply providing sleep hygiene information to students in recovery may be an effective strategy for improving sleep-related behavior; similarly, previous interventions that have focused simply on psychoeducation have yielded small-to-moderate effects on behavior change (Brown et al., 2006).

One possible rationale for the lack of change in sleep-related beliefs is the age of participants. Prior sleep health intervention studies have consisted primarily of traditional-aged, and particularly first-year, college students, who may have a lack of health-related knowledge (Barber & Cucalon, 2017; Von Ah et al., 2004). The present sample had an average age of 31.21 years, with five participants between the ages of 41 and 45 years. Thus, older students may be better-versed in basic health-related knowledge than prior, younger samples, suggesting that beliefs are not a key target for intervention among students in recovery.

Intervention Effects on Psychological Need Satisfaction and Self-Regulation

One possible explanation for the larger effects of the intervention on sleep outcomes than seen in previous studies is the inclusion of specific activities that target basic psychological needs. Self-determination theory posits that, by fulfilling satisfaction of the three basic psychological needs (i.e., autonomy, competence, and relatedness), one can move from controlled self-regulation (i.e., engaging in behavior as a response to external pressures) towards autonomous self-regulation (i.e., engaging in behavior due to an internal desire or value; Deci & Ryan, 2008). Autonomously self-regulated behaviors are more likely to be consistently performed (Williams et al., 2006); therefore, health behavior interventions have been designed to support the satisfaction of psychological needs and encourage autonomous self-regulation (Patrick & Williams, 2012). In Recovery Sleepers, autonomy was enhanced by participants setting their own, personally relevant goals; competence by providing psychoeducation, asking participants to identify their current healthy sleep behaviors, and providing personalized feedback messages; and relatedness by incorporating group discussion.

In order to assess the intervention's effectiveness in addressing basic psychological need satisfaction and self-regulation, we ran exploratory analyses of baseline characteristics and intervention effects. Participants' need satisfaction was lower at baseline than in previous samples of college students (Reid & Dautovich, 2021) and adults (Wei et al., 2005), suggesting possible frustration on the dimensions of autonomy, competence, and relatedness. The intervention did not have a significant effect on psychological need satisfaction. The present study used a global need satisfaction scale that assessed participants' sense of autonomy, competence, and relatedness in all aspects of life, which are unlikely to change due to a six-week intervention; thus, future research could adapt this scale to specifically target psychological need satisfaction related to health and health behaviors.

At baseline, participants reported higher autonomous self-regulation than controlled self-regulation for performing healthy sleep behaviors, indicating that they had already internalized motivation to care for their sleep health needs. This finding may be expected, as participants in the study have already made a significant, ongoing commitment to their health by choosing to maintain recovery and thus may be more likely to be intrinsically motivated to improve other aspects of their health. The intervention did not change self-regulation, and participants who received the intervention continued to be autonomously motivated at follow-up. Participants in the control group increased in controlled self-regulation over time, suggesting that they became more motivated by external forces to perform healthy sleep behavior. As previously stated, control participants received a list of sleep hygiene behaviors but no additional psychoeducation or group discussion; thus, they may have felt pressure to improve their sleep behavior due to demand characteristics of the study without understanding the rationale behind these recommendations, leading to greater extrinsic motivation.

Intervention Effects on Psychosocial Variables

The final aims of this study were to examine intervention effects on psychosocial variables that may be impacted by changes in sleep health, including mental health and recovery-specific variables (i.e., recovery capital, cravings, and impulsivity).

Mental Health and Wellbeing

The intervention did not have an effect on positive wellbeing or anxiety; however, it had negative effects on both depression and global mental health. Sleep and mental health are inextricably linked, as sleep disturbance is both a symptom and a result of mental health concerns (Alvaro et al., 2013). Poor sleep has been linked to greater depression and anxiety (Cox & Olatunji, 2016; Zhai et al., 2015) and poorer wellbeing (Chow, 2020). Research has been mixed regarding mental health outcomes following participation in a sleep health intervention, with some studies reporting small-to-moderate effects on anxiety and negative affect (Farias, 2012; Mairs & Mullan, 2015) and others reporting no significant changes in anxiety or depression (Ball & Bax, 2002; Morris et al., 2015). It is unclear why participation in the intervention would have contributed to worsening depression and global mental health. It is unlikely that the behavioral changes associated with the intervention would cause negative mood changes, as stimulus control and other aspects of BBTI have been associated with improved psychosocial functioning (Maguen et al., 2021). Moreover, although the shortened TST that often accompanies the sleep restriction/compression phase of BBTI has been linked to worsening mood (Kyle et al., 2011), participants in this intervention did not decrease their TST. As participants completed post-intervention measures at a much busier time of the semester than at baseline, it is possible that academic stress, along with the burden of the intervention, contributed to perceived declines in mental health. Future studies should further investigate mental health outcomes of sleep health interventions during different parts of the semester to assess the role of academic stress in these associations.

Recovery-Specific Outcomes

Additional psychosocial variables that are more specific to recovery were also assessed. Recovery capital refers to the psychological, social, and cultural resources that one has to support their ongoing recovery (Vilsaint et al., 2017). Healthy sleep has been associated with better social wellbeing (Ghose et al., 2022); thus, it was hypothesized that the intervention may have an effect on recovery capital. There was a small, positive change in recovery capital over time among the intervention group; interestingly, change in recovery capital over time was much larger in the control group. This difference may relate to the worsening depression among participants in the intervention group at follow-up. Depression is associated with a pessimistic cognitive style (Haeffel et al., 2008); thus, participants in the experimental group may have been less likely to recognize an increase in their psychosocial resources due to worsening mood.

Despite increasing depression, participants in the intervention group reported fewer cravings for their preferred substance at follow-up than baseline. Better sleep quality has been associated with decreased drug cravings, as mediated by positive affect (Lydon-Staley et al., 2017). Thus, sleep disturbance is associated with worse mood, which in turn leads to increased cravings. In the current sample, better sleep led to decreased cravings despite worsening mood. Another explanation for the association between sleep and cravings is the increased sensitivity of dopaminergic postsynaptic receptors that results from sleep deprivation (Berro et al., 2014). Better sleep following the intervention could have dampened the sensitivity of these receptors, thereby decreasing cravings.

Participants had similar impulsivity scores to prior samples of substance misusers (Cicolini et al., 2011) and higher than those found in community samples (Reise et al., 2013). It was hypothesized that the intervention would decrease impulsivity as measured by a delay discounting task, as poor sleep has been associated with more impulsive decision-making and impaired prefrontal cortex activity (Brunet et al., 2020; Nebes et al., 2009). This hypothesis was not supported, as there was not a sizable change in delay discounting over time in the experimental group. It is likely that six weeks is not an adequate period in which to see changes in delay discounting; moreover, greater changes in sleep parameters in general, or specifically increased TST, may be necessary to affect impulsivity in a population that is predisposed to have greater levels of this trait. The control group demonstrated moderately increased delay discounting, and thus greater impulsivity over time, although a rationale for this change is unclear. The appropriateness of the delay discounting task for samples with historical substance misuse has been questioned due to possible ceiling effects (Towe et al., 2015); thus, future research should continue to explore different behavioral measures of impulsivity that best capture possible sleep-related changes.

Study Strengths, Implications, and Limitations

This study makes several unique contributions to the literature on both sleep health promotion interventions and college students in recovery from SUD. It is the first sleep health intervention that specifically targets college students in recovery, an underutilized population in health research. Additionally, prior sleep health promotion intervention studies conducted with the college student population have primarily assessed sleep using sleep diary and/or self-report measures (Friedrich & Schlarb, 2018). By using actigraphy, the current study examined how cognitive-behavioral interventions may affect objective sleep parameters. Moreover, prior interventions have lacked a psychosocial or developmental framework (Friedrich & Schlarb, 2018). By framing the development of Recovery Sleepers within the context of self-determination theory, we were able to better analyze how basic psychological need satisfaction and self-regulation may serve as mechanisms of change within the context of sleep health interventions. Lastly, by using both objective (e.g., attendance, retention rates) and subjective (e.g., participant feedback) measures of feasibility and acceptability, we were able to obtain a wealth of data to inform future iterations of this intervention.

The study also had several limitations. As previously stated, the desired sample size for a pilot study was not met (In, 2017); thus, all statistical analyses are underpowered. Although we tried to correct for this lack of power by focusing on effect sizes and confidence intervals rather than probability values, these statistics are still somewhat affected by sample size (Lee et al., 2014). Additionally, widening confidence levels from the traditional 95% to 85% increased the probability of committing a Type I error, or asserting significance when there is none. Thus, it is possible that some of the effect sizes reported here are, in fact, smaller. Future pilot studies of Recovery Sleepers should aim for greater sample sizes to allow for more narrow confidence intervals and more accurate results.

Although students in this sample were enrolled at different universities, they all participated in Rams in Recovery, the CRP at Virginia Commonwealth University. To ensure broader generalizability of results, future samples should include students from a greater variety of universities and CRPs. The majority of participants were also white. As students of color are at especially greater risk of sleep disturbance (Dzierzewski et al., 2020), future studies should seek to include marginalized students to ensure that their health needs are met. This study was also conducted at a time of the semester that is associated with high stress and academic workload; thus, conducting the study at lighter times of the semester could improve recruitment, retention, and attendance rates. Lastly, changes in psychosocial variables may take longer than six weeks to manifest. Future studies should collect follow-up data at longer intervals to assess long-term changes associated with the intervention.

Conclusion

There are a growing number of students in recovery from substance use disorder on college campuses and, in turn, the presence of collegiate recovery programs has multiplied (Laudet et al., 2015). These programs seek not only to support student’s recovery journeys, but also to support their holistic health and wellbeing (Harris et al., 2014). Sleep is a critical component of wellbeing (Matricciani et al., 2018), and students in recovery may be at particular risk for sleep disturbance due to academic stress, the campus environment (Lund et al., 2010), and lingering effects of chronic substance misuse on sleep architecture (Brower, 2001).

Moreover, given the potential association between sleep disturbance and recurrence of use (Brower & Perron, 2010), ensuring healthy sleep is critical for this population.

Recovery Sleepers, an original sleep health promotion intervention rooted in self-determination theory, was demonstrated as an acceptable intervention, with some preliminary evidence of effectiveness in improving sleep quality and efficiency. However, recruitment proved to be challenging, suggesting that future studies should use a community-based participatory approach in which the research team and community members collaborate to better tailor the intervention to the population and increase trust and engagement (Collins et al., 2018). The group discussion unique to Recovery Sleepers aligned well with the emphasis on relationships within the recovery community (Kollath-Cattano et al., 2018) and should be replicated in future studies. Additionally, by using multiple methods of sleep data collection (i.e., self-report measures, sleep diary, actigraphy), we could more intricately analyze the role of sleep health interventions in affecting specific sleep parameters. Future studies should continue to use various data collection methods to triangulate findings.

Recovery from substance use disorder is a lifestyle choice “characterized by sobriety, personal health, and citizenship” (Betty Ford Institute, 2007, p. 221). Students in recovery should be supported in their physical and mental health needs so that they may continue to make the daily choice to commit to sustained abstinence. Incorporating brief health interventions, like Recovery Sleepers, into collegiate recovery programming can boost students’ internal resources to continue their recovery journeys while pursuing higher education.

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Appendix A

Discussion Group Interventionist Manual

Recovery Sleepers Group Manual

Recovery Sleepers Discussion Group #1

I. Welcome

Hello! Thank you to everyone for coming tonight to our first discussion group for Recovery Sleepers! *[Interventionists introduce themselves, asks participants to introduce themselves with icebreaker question; interventionist divides participants into 2 Zoom breakout rooms].*

We need to set a few group rules to make sure that everyone gets as much out of the group as possible! First of all, remember that you are free to withdraw participation at any time. One of the biggest rules here is confidentiality. We want you to share all of the great information about sleep that we will talk about tonight with others; however, we ask you not to share anything that others disclose. Of course, we also ask that everyone be respectful when others are sharing.

II. Small Group Discussion (5 mins)

First, we are going to divide into smaller groups so that we can have more in-depth discussions about our sleep. We've randomly divided everyone into breakout rooms. Once you get in your breakout room, we will ask you a few questions to frame your discussion.
[*Break out*]

Questions:

- Do you feel like you have healthy sleep? Do you feel rested in the morning?
- When do you notice that your sleep is better? When is it worse?
- What was your sleep like when you were actively using? What was it like when you first quit?
- What are some positive things that you are already doing to improve your sleep?

[*Re-enter large group]*
Does anyone want to share anything interesting that their group discussed?

III. **Importance of Sleep**

Before we talk about how to improve your sleep, we need to take a step back and discuss what sleep is and why it's so important. We still don't know precisely why we sleep, but we do know that sleep impacts every system of the body. Getting healthier sleep boosts your immune system, prevents obesity and diabetes by regulating hormones that help maintain weight, and can even help you live longer! Sleep helps your brain too—people who don't get enough sleep make riskier decisions and have more difficulty problem solving and doing complex tasks. Sleep also impacts emotional health- we tend to be less emotionally stable when we don't get enough sleep.

Psychological disorders like depression and anxiety can make it more difficult to sleep, but poor sleep can also worsen depression and anxiety- it's an unfortunate cycle.

<u>What have you all noticed when you don't get enough sleep?</u>

Your body goes through a lot of changes when you sleep. Your body temperature drops, your brain quiets down, and heart rate and respiration slow. But sleep isn't just one process- there are actually four stages of sleep.

The four stages are divided into two categories- REM (rapid eye movement) and NREM (non-REM). We start out the night in non-REM sleep. Stage 1 sleep is when you've just dozed off, but you could still be awakened pretty easily. We then transition to Stage 2, which is a little deeper, but you could still be awakened fairly easily. Stage 3 is the deepest part of NREM sleep, and your brain waves are much slower than when you are awake. We think that this stage is very important for a lot of the physical healing benefits of sleep. The last stage, Stage 4, is considered REM sleep. In REM sleep, brain activity picks up, but most of the body (except for the eyes and breathing muscles) experiences temporary paralysis. This is also when most of our dreams occur! REM sleep is very important for storing learning and memories.

Throughout the night, we are constantly cycling through these stages of sleep, with generally longer periods of REM throughout the night. The structure of our sleep cycles is referred to as sleep architecture, and research suggests that that all stages have an important role in sleep quality.

IV. Two-Process Model

So how do our bodies know when to sleep? There are two processes that help to regulate sleep. One process is called the sleep drive. It's kind of similar to hunger- Your sleep drive increases throughout the day, similar to how your hunger increases if you don't eat. So ideally, your sleep drive is at its peak right around your bedtime, and then it decreases as you sleep throughout the night.

If we just had our sleep drive, then as soon as we accumulated a little bit of sleep drive, we would fall asleep and continue that throughout the day. We also have what's called the circadian alerting signal, but we are going to call it the wake drive. This is controlled by a circadian rhythm, or an internal, 24-hour clock. This signal starts increasing early in the morning before we wake up, and gets stronger throughout the day, helping us fight any daytime sleepiness. That signal then starts decreasing around bedtime.

Everyone's wake drive is a little different, and people have what are called chronotypes. People with morning chronotypes prefer to wake up early and do activities earlier in the day, whereas those with evening chronotypes prefer to rise later and do activities later in the afternoon/evening. Most people are somewhere in the middle between those two extremes. It can be difficult when school and work schedules don't align with our wake drive. So, if I am a strong evening chronotype but my job makes me get up at 6 AM and start the day, my sleep drive is probably still pretty high, and my wake drive hasn't really kicked in yet.

V. Sleep and substance use

The reason that we wanted to start Recovery Sleepers, specifically, is because sleep is impacted at every stage of recovery- active use, immediate withdrawal, recovery. What did you notice about sleep when you were actively using?

Almost all addictive substances are associated with sleep disturbance in some way, although the aspect of sleep that is most affected differs by the drug. When people drink alcohol, sleep appears to improve- people usually fall asleep faster and sleep longer. But when we look at that sleep architecture, we see that more of their sleep is light (stages 1 and 2), and they aren't getting the deeper stages, like stage 3 and REM, that are necessary for restful sleep. Thus, people are usually more tired the next day after a night of drinking, even though they may have gotten an adequate amount of sleep. Chronic alcohol users will sometimes drink in order to fall asleep. However, they end up just having short, light bursts of sleep that are irregular throughout the 24-hour day. Again, it's not restful sleep. Similar patterns are seen with chronic opioid users.

So, we know that misusing substances leads to worse sleep, but there's actually some evidence for the other way around, that people who already have sleep problems may be more likely to develop addiction. Some people have genetic predispositions for circadian disruption- their sleep and wake drives aren't in sync. That disruption can also lead to changes in the brain's reward system, such that substances are more rewarding for those who have circadian dysregulation. So those who are already starting out with poor sleep issues may be more likely to continue using because the drugs are more rewarding than for other people.

As we said earlier, poor sleep can also lead people to make riskier decisions and have difficulty problem solving. So, people who aren't getting adequate sleep may not have the cognitive resources to notice their pattern of use and make healthier choices. Poor sleep also makes us more emotionally labile, and a lot of people use substances in order to cope with those emotions.

Do you remember whether there were any changes in your sleep when you first stopped using?

Unfortunately, sleep tends to get worse in withdrawal before it gets better. A lot of the time, people were using substances in order to fall asleep, even though their sleep wasn't actually restful. So, when those substances are taken away, the old insomnia returns. REM sleep usually comes in frequent, short bursts. The hallucinations that some people experience during withdrawal are thought to be a result of those bursts of REM sleep intruding into wakefulness.

What about now that you've all been in recovery? How would you rate your sleep compared to when you were actively using?

The good news is that a lot of aspects of sleep do improve over time in recovery. However, we still see some concerns with sleep architecture and insomnia up to 2 years after sobriety. Again, one explanation for that could be that people with addiction were more likely to have a genetic predisposition for circadian dysregulation, which disrupts sleep.

Poor sleep has also been tied to relapse, which we are going to call recurrence. People who have a recurrence are more likely to report sleep problems than those who do not have a recurrence. There are a few reasons for that. We talked about how poor sleep can lead us to make riskier decisions and have fewer cognitive and emotional resources. Additionally, sleep deprivation makes our reward pathways very fired up. In recovery, your brain has "unlearned" that feeling; however, when that reward pathway gets re-activated by sleep deprivation, your brain can go back to its former habit of trying to activate that pathway even more!

Because of all of this, it's really important to gather tools and learn skills to help ensure that you get healthy sleep. You all are dealing with a double whammy- not only are people with addiction at higher risk for sleep problems, but we know that more than half of college students are poor sleepers.

VI. Stimulus control

A lot of the components of sleep that we've talked about are controlled by genetic and hormonal processes that are outside of our control. However, there are some behaviors that we can control to make sure that we are getting adequate rest.

One factor that is within your control is something called stimulus control. Stimulus control is a fancy way of saying that our brain learns associations between things in the environment, or cues, and behaviors. You've probably heard a lot about this in terms of addiction with the phrases "people, places, and things." Certain people, places, and things serve as cues that our brain associates with drug use. We have to unlearn those associations in order to stay sober. A similar concept plays out with sleep. Our brain has to learn associations between certain cues and sleep.

It can be helpful to implement a bedtime routine, a set of behaviors that you perform every night before bed. This routine will allow your brain to form associations and know that when you are performing those behaviors, it's time for sleep! Does anyone have a bedtime routine?

It's also important that your brain makes the association between the bed/bedroom and sleep. Try not to do other activities- work, watching TV, playing on your phone- before bed. Even mental activities, like planning and worrying from bed, can cause the brain to associate the bed with wakefulness. Some of you probably live in dorms or other small spaces where it's difficult to separate your workspace from your sleep space. How can you get around this? What behaviors do you need to stop doing from bed?

Stimulus control is also the reason why it's so important that we get out of bed if we can't sleep and do something quiet and relaxing until we get tired. Lying there and worrying about our sleep only deepens our brain's associations between the bed and wakefulness! What activities might you do if you can't sleep?

VII. Sleep Hygiene

There are other behaviors that we can do to help improve our sleep. We refer to these behaviors as sleep hygiene- kind of like oral hygiene for your mouth! Here's a list of sleep hygiene behaviors that we know can improve our sleep [*show Sleep Hygiene handout*]. Take a look at these suggested behaviors- <u>which of these are you already doing?</u>

<u>Which of these behaviors do you think are things that you may need to adopt?</u>

Throughout discussion, interventionists explain/clarify each sleep hygiene tip further.

VIII. Explanation of SMART goals

Any time you are trying to make a behavior change, it's important to set goals that can help you get there. But sometimes we set goals that are so vague, or unrealistic, that we are setting ourselves up for failure! Tonight, we are going to set some goals for our sleep hygiene behaviors. But we want to make sure that we set goals that will help us be successful! <u>Has anyone heard of SMART goals? Can you explain them to us?</u>

SMART is an acronym.

- S stands for specific. We don't want to set goals that are ambiguous, like "I'm going to sleep better." What specifically do we want to do? Go to bed earlier? Change the bedroom environment?
- M stands for measurable. We have to know when we have attained our goal, so we have to be able to measure it somehow. By setting a goal like "I'm going to go to bed at 10:00 three nights this week," I am able to measure whether I have accomplished that or not.
- A stands for attainable. It has to be realistic! If I have never exercised in my life, it's probably not realistic to set a goal to exercise an hour every single day. Take baby steps that you can actually achieve!
- R stands for relevant. Your goal should be something that will directly improve your sleep.
- T stands for time oriented. It's important to specify an exact time frame. For example, instead of just saying "I'm going to go to bed at 10:00," I want to specify how many nights per week, and, if possible, which nights of the week!

IX. Small Group Discussion

We are going to break into our same small groups again and work on setting a sleep goal for the next two weeks. We will not return to the main group, so thank all of you for coming and participating in Recovery Sleepers! We will have one other group like this in two weeks, on [*insert date/time*]. *[Breakout Rooms]*

Let's all try to set one SMART goal related to sleep in the next two weeks. Try to focus on the behaviors that you can control. Once you've got your SMART goal, write it down on a sticky note or type it into the Notes app on your phone- somewhere where you can see it!

[Get everyone to share their goals and write them down along with their name! Walk them through identifying barriers to their goals and problem solving]

Recovery Sleepers Discussion Group #2

I. Intro/Agenda Setting

Hello, everyone! Thanks for coming back to our second and final Recovery Sleepers group! So last week we talked about favorite Halloween candies. Tonight, I want to know your LEAST favorite food, that one food that you just will not touch. [*can substitute any icebreaker question*]

Tonight, we are going to check in on how the goals we set last time went and if you all noticed any changes in your sleep. After we do that, we are going to talk a bit about the cognitive part of sleep, how our thoughts can impact sleep, and some techniques for changing those thoughts and getting into more of a relaxed state. Let's go ahead and break into the same small groups as last time and talk about how our goals went. *[Interventionists divide participants into same breakout rooms as in Discussion Group #1]*

II. Small Group Discussion (15 mins)

- Check in on goal progress.
  - If it went well- what factors allowed it to go well? Do you think you will continue doing that behavior?
  - If it did not go well- what were the barriers? Help problem solve
  - Noticed any changes to sleep?
  - Received personalized sleep data- any surprises?

III. Sleep-Related Cognitions

We've talked about the behaviors that can impact our sleep that are within our control. Our thoughts and beliefs about sleep can also strongly impact the quality of our sleep. Today, we are going to talk about some common thoughts that often stand in the way of sleep.

Let's say you are lying in bed, trying to fall asleep, and sleep just isn't happening. <u>What thoughts are usually going through your head in that moment?</u>

One common thought is some variation of this: If I don't get at least 8 hours of sleep, I won't be able to function tomorrow. Most people overestimate the effects of a poor night's sleep. Especially when we have trouble falling asleep, we tend to overestimate how poorly we will feel the next day. In reality, our bodies are fairly resilient, and one night of inadequate sleep will not severely impact our physical, cognitive, or emotional functioning. It's more the long-term, chronic effects of poor sleep that could impact you. <u>When you are having difficulty falling asleep and begin to worry about your functioning the next day, what are some ways that you can talk back to that thought?</u>

<u>Before we get to the next one, let me ask you- if you aren't able to fall asleep, do you think it's better to get up and take something [e.g., melatonin, OTC sleep meds]?</u> So, let's talk about

sleeping pills first. Well, we know that if you take a sleeping pill, whether it's prescription or OTC, whenever you can't fall asleep, your body will become accustomed to the drug, and your sleep and wake drives will no longer be regulated. Of course, you should discuss any medication with your doctor, because everyone's needs and bodies are different. But usually, it's better to try to change your sleep by changing behaviors rather than adding medication.

As for melatonin, melatonin is a natural hormone that is produced by the pineal gland in your brain and then released into the bloodstream. It's heavily influenced by daylight- darkness tells your brain to release it, daylight tells your brain to stop. Melatonin is the hormone that helps regulate our circadian rhythm and synchronizing those sleep and wake drives. So, the melatonin that you take in pill form is the same hormone, just synthetically made. We know that melatonin is particularly useful for people who have a diagnosable sleep condition called delayed phase sleep disorder, where their natural sleep drive is so delayed that it inhibits them from working a normal schedule. We are less sure about whether it helps people who just have more "normal" sleep problems. As of now, we don't know of any significant short- or long-term effects of regular melatonin use in adults, so there is no glaring reason why you shouldn't take it. However, you probably would only want to take it ahead of time rather than in the middle of the night so that it does not further disrupt your sleep/wake drives.

<u>Here's another question. If you don't get a good night's sleep, what should you do the next night?</u> A lot of people think that if they don't get a good night's sleep one night, they need to "catch up" by either napping or sleeping extra-long the next night. First off- sleep if you are tired. If you are so drowsy during the day that you cannot safely perform your responsibilities, definitely take a short nap (typically no longer than one hour!). However, the goal is to maintain your regular sleep schedule. If you try to nap a lot during the day, or sleep for a long time the next night, it actually increases your feelings of drowsiness and further disrupts those sleep-wake drives. So, it's better to just go about your regular sleep schedule!

IV. Relaxation

Sometimes when we can't sleep, we lay in bed stressing- about the things we have to do the next day, about the fact that we can't sleep, about anything that is bothering us. When we are feeling stressed or anxious, our sympathetic nervous systems, the fight-or-flight part of our brain and body, becomes activated, making sleep even harder to achieve! One way to handle this is by using relaxation techniques. When we relax our bodies, it sends a signal to our brains that it's time to calm down. <u>Has anyone ever done any type of relaxation exercise before?</u>

One easy technique is deep breathing. Typically, when we are stressing, we tend to take shorter, shallower breaths. What you want to do is take big deep breaths to help your body and mind relax. So, I want everyone to get as comfy as you can in your chair or wherever you are right now. Close your eyes. We are going to take a deep breath in through our noses… hold it… and then exhale through your mouth. *[Do this 3x]*

Another tool that can be helpful is progressive muscle relaxation. Progressive muscle relaxation also involves deep breathing, but while you are breathing, you are going to tighten different groups of muscles and then release the tension as you exhale. We are going to listen to a progressive muscle relaxation exercise. So that everyone feels more comfortable, why don't we all turn off our cameras as we do this exercise. *[Interventionist can either conduct PMR exercise verbally or play the following YouTube video:* https://www.youtube.com/watch?v=QkswdqpHqww*]*

What was it like to do that exercise?

Meditation and guided meditation are also great ways to relax. There are a ton of apps out there, like Calm and Headspace, that offer meditation and guided meditation exercises. Calm even has relaxing bedtime stories!

V. Goal Setting

Now we are going to get back into our breakout rooms and try to set some new SMART goals. Our goals can be related to the first goal you set last time, or it can be a brand-new behavior that you think you should target! It could also be based on the things we talked about this time- changing some of our thoughts around sleep or trying relaxation techniques.

We won't be going back to the bigger group, so let me just thank you for your participation so far in this study- it is so appreciated, and I hope it has helped you think about the importance of sleep in a different way! You will keep filling out your daily sleep survey until [*insert date/time*]. You will wear the actigraph one last time from [*insert dates*]. Additionally, you will receive a longer survey to fill out that week, similar to what you did at the very start of the study. And then you will be done! Any questions? Thank you SO MUCH again and it has been a pleasure to meet all of you! *[Divide into same breakout rooms]*

Let's all try to set one SMART goal related to sleep in the next two weeks. Try to focus on the behaviors that you can control. Once you've got your SMART goal, write it down on a sticky note or type it into the Notes app on your phone- somewhere where you can see it!

[Get everyone to share their goals and write them down along with their name! Walk them through identifying barriers to their goals and problem solving]

Appendix B

Sample Feedback Message

Hi XX,

We hope you are having a great week so far! We wanted to provide you with some information specific to your own sleep and how it compares to recommendations from the National Sleep Foundation, as well as suggestions for areas in which you might improve! This data comes from the first week of your daily sleep diary survey (10/24-10/30).

Duration: The National Sleep Foundation recommends that adults sleep **7-9 hours** on average. Your average for the week was approximately **7 hours and 29 minutes**. Well done!! You are doing a great job of dedicating enough time for sleep!

Efficiency: Sleep efficiency refers to the percentage of time you spend asleep in bed! It's calculated by taking the amount of time that you are sleeping and dividing it by the amount of time that you are spending in bed. The National Sleep Foundation recommends that people spend **75%** of their time in bed asleep. Your sleep efficiency was at **84%!** You are doing a great job of not spending too much waketime in bed, especially before you fall asleep.

It does look like you are waking up fairly frequently during the night (your average was 2.71 times, and you ranged from 1-4). Pay attention to the nights when you wake up frequently- what is different about those nights (some possibilities- caffeine, screen time, stress level)? How can you use that knowledge to help you decrease nighttime awakenings?

Regularity: As we talked about in the Recovery Sleepers group, it's important to sleep and wake around the same time each day. Social jetlag is calculated by looking at the difference in sleep times from weekdays to weekends. It is recommended that you don't have a difference greater than **1 hour**- in other words, that your sleep schedule does not shift by more than one hour when you switch from weekdays to weekends. Your social jetlag score was **19 minutes**! You are doing an excellent job of maintaining a regular sleep schedule!

Goal: This week in Recovery Sleepers, you set a goal to reduce your phone usage to 10-15 minutes in the mornings when you wake up. That is great! I know you also mentioned caffeine use during our meeting, you could consider creating a "caffeine curfew" or a time where you decide to no longer have caffeine. If you're already doing that, maybe you can move that caffeine curfew up sooner! This may be a small change that makes a big difference in reducing the number of times you're waking up during the night.

We look forward to seeing you next week for our second Recovery Sleepers group (Tuesday, 11/16 @ 6:00)!

Morgan & Ashley

Appendix C

Sleep Hygiene Handout

Sleep Hygiene

What is Sleep Hygiene?
Sleep hygiene is a set of behaviors that research suggests can improve your sleep. Not everyone may perform all of these behaviors- choose the ones that work best for you and your lifestyle!

1) ***Get Regular.*** One of the best ways to train your body to sleep well is to go to bed and wake up around the same time every day, even when you don't have work/school! This will help to regulate your internal clock!

2) ***Get Up and Try Again.*** If you haven't been able to fall asleep after about 20 minutes, get up and do something quiet and boring until you feel sleepy, then come back to bed and try again! Keep the lights dim and avoid screens (phone, TV, etc.).

3) ***Avoid caffeine and nicotine.*** It is best to avoid consuming caffeine (coffee, soda, tea, chocolate) or nicotine at least 4-6 hours before bedtime. These substances are stimulants and may prevent you from falling asleep!

4) ***Bed is for sleeping.*** Try not to use your bed for anything besides sleep and sex, so that your body comes to associate bed with sleep. Watching TV, working on your laptop, or eating in bed can disrupt this connection!

5) ***Limit naps.*** It is best to avoid taking naps during the day to make sure you are tired at bedtime. If you do nap, keep it to one hour or less and no later than mid-afternoon!

6) ***Sleep rituals.*** You can develop your own rituals to perform right before bedtime. This tells your body that it's time to go to sleep! Some people do relaxation exercises (deep breathing, meditation, etc.) before bed!

7) ***Limit clock-watching.*** Sometimes when we struggle with falling asleep, we find ourselves constantly watching the clock. Clock watching increases worry and makes it even harder to fall asleep! Try not to check the time when you can't fall asleep!

8) ***Bedroom environment.*** Our bedroom should set the stage for sleep. We want to make sure that the bedroom is cool, with blankets to stay warm. If light comes into your window, an

eye mask or blackout curtains can help! A white noise machine can help to block out any noise disruption!

9) ***Exercise.*** Regular exercise can help with sleep! Try not to do strenuous exercise in the four hours before bedtime, though!

Appendix D

Post-Intervention Questionnaire

Please indicate how strongly you agree with the following statements regarding the Recovery Sleepers program on the following scale:

1	2	3	4	5
Strongly Disagree				**Strongly Agree**

1. I enjoyed the Recovery Sleepers program.
2. The Recovery Sleepers program helped me improve my sleep.
3. Other college students in recovery would benefit from the Recovery Sleepers program.
4. The electronic daily sleep diary felt manageable along with my schoolwork.
5. The electronic daily sleep diary gave me insight into my sleep.
6. Recovery Sleepers required too much of my time/energy.
7. The actigraph was easy to wear.
8. I understood how to wear the actigraph.

Intervention participants only:

9. I enjoyed the Recovery Sleepers discussion groups.
10. I thoroughly read the feedback message that was emailed to me in Week 3.
11. Of the following components of RS, please select the activity that you think MOST contributed to positive changes in your sleep: Actigraph, daily sleep diary, psychoeducation, group discussion, feedback message
12. What did you like about Recovery Sleepers?
13. Describe your sleep before participating in Recovery Sleepers?
14. How has your sleep changed since participating in Recovery Sleepers?
15. If your sleep has changed, how do you think this change has impacted your functioning (academic, work, social, general health)?
16. Would you recommend Recovery Sleepers to a friend in recovery? Why or why not?
17. What would you change about Recovery Sleepers?

Control participants only:

18. Of the following components of RS, please select the activity that you think MOST contributed to positive changes in your sleep: Actigraph, daily sleep diary, sleep hygiene handout

Appendix E

Fidelity Checklist

Discussion Group #1

- ☐ Small group discussion about current state of sleep; sleep when actively using vs. sleep in recovery
- ☐ Importance of sleep
- ☐ Two-process model of sleep
- ☐ Sleep architecture
- ☐ Sleep and active use
- ☐ Sleep and recovery/relapse
- ☐ Sleep hygiene
- ☐ Stimulus control
- ☐ SMART goals
- ☐ Small group discussion about SMART goals
- ☐ Collected SMART goals from all participants

Feedback Messages/Control Emails

- ☐ Sent feedback message to all RS participants
    - Included sleep diary data for all participants
    - Included 2 suggestions for all participants
- ☐ Sent sleep hygiene tips to all control participants

Discussion Group #2

- ☐ Small group discussion about SMART goal progress
- ☐ Myths about sleep
- ☐ Relaxation Techniques
- ☐ Small group discussion about SMART goals
- ☐ Collected SMART goals from all participants

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