Investigating the Predictors of Sleep Paralysis Frequency Within the University Population: Hierarchical Regression Model

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Abstract

Sleep Paralysis (SP) is disproportionally present in the student population and a common symptom of SP is fear, this study examined the predictors of SP in the university student population. Based on pervious findings, there is a large disparity between SP experienced in the general population and the university student population and limited research on sleep paralysis predictors in students. This study planned to close the gap as to what student-related behaviors and environmental factors are causing this dissimilarity in SP. This large disparity in SP experience was hypothesized to be related to substance use, irregular sleeping behaviors, poor sleep environments and other lifestyle variables. We investigated this by studying a) the group comparisons between high SP experiencers and low SP experiencers, b) correlations between common student behaviors and SP, c) and a hierarchical regression model to find what behaviors most predicted SP in university students, all while controlling for demographics and sleep quality. This study was a retrospective online survey with 145 university students around the country, recruited primary with Reddit and Facebook sleep and student-related groups. The results showed that napping and family history of SP were significant predictors of SP frequency when controlled by sleep quality and demographics. This suggests that the more a student naps, the more frequent SP experiences a student will have, and students that have a family history of SP are more prone to increased SP. The findings produce clinical implications for future studies on classifying recurrent sleep paralysis in the university student population.

Frontispiece

Henry Fuseli. (1781). *The Nightmare*. [oil painting]. Detroit Institute of Arts, Detroit, Michigan

Dedication

To my parents, who always believed in my dreams.

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Chapter I

Introduction

Sleep Paralysis (SP) is a sleep phenomenon of muscle atonia or paralysis while conscious, creating an in-between sensation of wakefulness during Rapid Eye Movement (REM) sleep (Hobson, 1995; Paradis et al., 2009). During this stage of sleep, the brain induces a state of paralysis preventing someone from acting out their dreams; thus, creating the SP experience (Brook & Peever, 2011, 2012). The onset of SP happens most commonly while falling asleep (hypnagogic), or waking up (hypnopompic) (Cheyne et al., 1999; Girard & Cheyne, 2006; Hobson et al., 1995).

This state of immobility usually lasts between 5.3 to 6 min on average (Hinton et al., 2005a, Hinton et al., 2005b; Spanos et al., 1995). The body position also matters in SP, as most studies show that sleeping on your back, in the supine position, correlates with increased SP frequency (Cheyne, 2002; Wrobel-Knybel et al., 2020). The SP experience often includes common psychosomatic symptoms such as chest pressure, heart palpitations, not being able to breathe, sweating, chest pain, feeling of choking, nausea, shaking and chills (Wrobel-Knybel et al., 2020).

Many people who experience SP have many odd sensations and hallucinations during the event. Three types of experiences have been categorized in SP as the "Intruder," "Incubus," and the "Unusual Bodily Experience." In the Intruder SP experience, the person feels a "sensed presence" and a mixture of fear, with auditory, and sometimes visual hallucinations, theorized to come from a hypervigilant state in the midbrain (Cheyne et al., 1999). In the Incubus, people feel a pressure of someone or

something on their chest, that is sometimes perceived as a demon/creature sitting on their chest (Mayer & Fuhrmann, 2022). In the Unusual Bodily Experience (UBE), people experience a variety of feelings from bliss (Denis & Poerio, 2017) to alien abductions (McNally & Clancy, 2005). Other feelings can include floating or being controlled by a ghost (Hinton et la., 2005). There are also different artistic depictions of these concepts, such as the famous artwork represented in this paper's Frontispiece by Henry Fuseli in the year 1781.

Significance of Study

Fear has been found to be an important prominent symptom of SP, especially in the student population. In the general population, Cheyne et al. (1999) found that 98% of their web-based sample experienced fear during SP. In a more recent study, Mayer & Fubrmann (2022) found that students described themselves as "fearful" because of SP, supporting these previous results.

According to one study, 6.2% of the general population have experienced SP at least once in a representative sample in Germany and Italy (N = 494; Ohayon & Pakpour, 2022). On the other hand, the college student population is estimated to have experienced SP at least once ranges from 21% (N = 387) to 31.89% (95% CI: 27.5-36.3%) (Spanos et al., 1995; Wrobel-Knybel et al., 2020). Since students experience SP more frequently than the general population, they will have more potential to experience fear and fearful hallucinations/dream imagery. Furthermore, there is a heightened importance in studying SP in students as it effects their overall well-being, due to this fear.

There has been a lack of research on the predictors of SP in university students, especially when controlling for demographics (e.g., age, education level, ethnicity) and

other sleep-related variables that are associated with sleep paralysis (i.e., sleep quality). Most studies that investigate the predictive variables of sleep paralysis in students only studied group comparisons rather than more advanced models (i.e., hierarchical regression models). This study sought to bridge the gap about which behaviors truly predict sleep paralysis in students while controlling for demographics and other sleep variables.

Isolated Sleep Paralysis

While some studies have specific definitions of sleep paralysis, this study used any general SP experience rather than the popular "isolated SP" because of limitations in sensitive data collection. For background, SP is known to be a common symptom of Narcolepsy with Cataplexy, a disorder in which patients fall asleep in response to strong emotional stimuli (Siegel & Boehmer, 2006). However, SP also happens to healthy individuals, in which case it is called "isolated" sleep paralysis, when SP is experienced without any other sleep parasomnias (e.g., Narcolepsy with Cataplexy, Idiopathic Hypersomnia, etc.) (Sawant et al., 2005). In addition, there is recent research on "recurrent isolated" SP, in which a heathy individual repeatedly experiences SP without any other sleep parasomnia more than several times a year (Sharpless, 2016). In the current study, in the interests of protecting participants' privacy, sensitive details (i.e., Narcolepsy diagnosis or any other sleep-related disorder) were omitted from the survey, thus "isolated" SP and SP were not differentiated in this study. Instead, frequent sleep paralysis (+SP) and non-frequent sleep paralysis (-SP) were used. This study distinguished these two SP groups using the definition of recurrent isolated sleep

paralysis in the International Classification of Sleep Disorders, which equals two episodes in the last 6 months (American Academy of Sleep Medicine, 2005).

Existing Theories of Sleep Paralysis

There are many perspectives of sleep paralysis that could help us understand the how this experience is provoked. The difference theories include neurological, psychological, and environmental factors.

Neurological

Understanding the neurology of sleep paralysis is important for elucidating its underlying mechanisms and potential behavioral implications. SP is caused by REM muscle atonia, whereby GABA and glycine neurotransmitters, produced by neurons in the pontine reticular formation, inhibit specific neurons of the ventromedial medulla and motoneurons in the spinal cord (Brooks & Peever, 2012; Jalal and Hinton, 2013). In addition, research has shown that, during REM, the central amygdala activates and promotes the paralysis (Mahoney et al., 2017), which could suggest why fear is a common factor of SP. More specifically, SP has been proposed to be associated with the serotonin 2A receptor (Jalal, 2018) and research showed that the receptor activation could induce hallucinations and “mysterious” subjective states (Huijzer & Treur, 2021; Jalal, 2018), furthering the idea that SP is a terrifying experience due to the hallucinations that are present.

In a normal sleep cycle, when a person falls asleep, they will enter non-REM sleep and then 90-120 minutes later will enter REM sleep (Dement & Kleitman, 1957; Singh et al., 2006). In some instances, a person may fall directly into REM sleep during

sleep onset, called sleep onset REM (SOREM) (American Academy of Sleep Medicine, 2014) which is considered a sleep abnormality suggestive of narcolepsy. SP has been shown to happen most often during REM sleep but more specifically during the first 10-25 minutes of REM (Hishikawa & Shimizu, 1995; Takeuchi et al., 2002). One study found that SP only happens within SOREM in narcoleptic patients (Hishikawa et al., 1965 & Hishikawa et al. 1978). Additionally, researchers were able to elicit SP through SOREM with sleep interruption (Takeuchi et al., 1992) and a multi-phasic sleep wake cycle (Takeuchi et al., 2002). This research implies that sleep paralysis is correlated with sleep interruption and a multi-phasic sleep wake cycle, which are both frequent behaviors in the university student population.

There may also be a genetic component of SP. Denis et al. (2015) used a twin study to find associations between sleep paralysis and other potential risk factors and how they relate to genetic and environmental variables. With a univariate twin model, Denis et al. (2015) found that monozygotic (identical) twins were significantly more concordant for SP than dizygotic (fraternal) twins, indicating SP has a high genetic component. However, Denis et al. (2015) did not find associations of SP and previously genotyped single nucleotide polymorphisms (SNPs) when Bonferroni correction was applied, therefore more research is needed. In addition, two studies showed clustering of SP incidence within families (Bell et al., 1986; Dahlitz & Parkes, 1993). Mehwish Riaz et al. (2022) found that 24.6% of their student sample had a positive family history of sleep paralysis but did not test if family history was related to a higher SP frequency; thus, more research is needed.

Psychological

The most viewed explanation of SP is the Panic-Hallucination (PH) Model of Sleep Paralysis (Jalal, 2016) which states that an individual who enters a SP experience may set themselves in a feedback loop of negative emotions. During the experience, a person may have somatic and psychological symptoms (e.g., inability to speak or move, chest pressure, muscle spasms, fear, racing thought) and hallucinations resulting from those symptoms, which may seem real to the person. This may result in catastrophic cognitions such as "I am paralyzed for life" which increase the fear of the experience. (Jalal, 2016). This model explains why fear is associated with SP and how it could be so terrifying for individuals, adding to the significance of the research.

There is a large variety of clinical SP theories among a vast assortment of studies, which reveals the clinical importance of SP. Most significantly, SP has been associated with panic disorder, especially in the African American population, even when controlling for other demographics and clinical disorders (Paradis et al., 1997; Ramsawh et al., 2008). Additionally, panic attacks have been related to SP in Cambodian refugees (Hinton et al., 2005a, Hinton et al., 2005b). PTSD has also been correlated with SP in many studies (Sharpless et al., 2010; Paradis et al., 2009), especially in the firefighter population where individuals were most likely to experience SP if they had PTSD (Wrobel-Knybel et al., 2021) also implying that a firefighter's sleep schedule could influence SP. For anxiety, research has shown its association with sleep paralysis (Simard & Nielsen, 2005), especially in high stress exposed professions (e.g., nurses) (Wrobel-Knybel et al., 2022), similarly suggesting jobs with irregular sleep scheduled correlate highly with SP. In a community sample, Szklo-Coxe (2007) found that severe depression

increased the odds of SP after adjusted by anxiety. Other hypotheses showed a correlation between SP and past histories of childhood sexual abuse (McNally et al., 2006). These studies describe the clinical side of SP and the potential implications it may have on the student population.

Environmental

Environmental factors may influence the frequency of SP. Ma et al. (2014) found a significant odds ratio between students living in rural areas compared to urban areas, showing that rural students experienced more SP than urban students, which is paradoxical compared to studies on sleep interruption. Research has shown that SP can be elicited by sleep interruption when sleep researchers wake up participants in the middle of the night (Takeuchi et al. 1992, 2002) and sound could negatively influence someone's sleep quality (Meng et al., 2019), however there has been a lack of research into how sound correlates with SP in the university student population. In addition to these variables, other environmental student factors, such as the number of roommates, have not been studied with SP in university students.

General Behaviors Related to Sleep Paralysis

In the field of SP research there have been many behaviors that have been shown to influence SP. This chapter goes through the different behaviors and the main fundings that reveal them. These behaviors will be categorized as sleeping behaviors (i.e., napping, sleep duration, and bedtime), substance use (i.e., caffeine use, alcohol use, and nicotine use), and technology use (i.e., general phone use and social media use).

Sleep Behaviors

Irregular napping is one such behavior that is associated with SP. Ma et al. (2014) investigated the prevalence of sleep paralysis and its correlated factors among a Chinese adolescent population. The researchers used a cross-sectional epidemiological survey to study a large sample of juniors and seniors in high school (N=12,367). The authors adapted two sleep and lifestyle related questionnaires from Wing et al. (1989) and Munezawa et al. (2011), in which SP was measured by asking, "Have you experienced ghost oppression in which your hands, feet, and body cannot move when waking up or falling asleep during the previous month?" The results showed that participants who took naps longer than 2 hours were at twice the risk of experiencing SP compared to participants who did not take naps at all (12.4% vs. 5.3%). Thus, this study suggests that long naps during the day could increase SP, as well as suggesting napping is a potential consequence of SP-related sleep disruption. As napping behavior may influence SP, other sleeping behaviors could also affect its frequency.

In addition to napping, the time an individual falls asleep could also influence SP. Ma et al. (2014) reported that participants were at an increased risk of SP if they went to bed after 2:00 AM compared to before 10:00 PM (15.1% vs. 5.87%). This result suggests that the later an individual goes to bed, the more likely they are to experience SP. Translational issues limit strictly equating frequency of "ghost oppression" and SP. In the same study, Ma et al. (2014) also found that participants who slept less than 5 hours per night had greater SP prevalence than those who slept 7-8 hours per night (12.7% vs 4.52%). These results suggest that the less someone sleeps during the night the higher the chance they will experience SP. On the other hand, Munezawa et al. (2011) found that

participants who slept longer than 9 hours per night also reported a higher prevalence of SP compared to the rest of the sample. Both studies suggest that sleeping too little or too much may both increase SP. In addition to the objective sleeping behavior, other more subjective qualities of sleep may be a predictor of SP.

Substance Use

Studies have shown that SP frequency is positively correlated with use of substances such as alcohol, tobacco, and caffeine. In a nationally representative survey, Munezawa et al. (2011) investigated SP prevalence and associated factors in Japan's junior and senior high school students (a similar sample and study model to Ma et al., 2014). These researchers used three cross-sectional surveys of lifestyle habits (i.e., alcohol, smoking, eating, and sleeping), reaching 90,081 students across the country. The study showed that those "drinking alcohol in the past month" reported higher frequencies of SP compared to non-alcoholic drinkers (12.2% - 7.1%). Additionally, Munezawa et al. (2011) found that participants who "smoked at least once in the past month" had a 15.3% SP prevalence, while non-smokers had a 7.8% SP prevalence, which aligns that the idea that nicotine is cholinergic and has been shown to increase REM dream vividness (Page et al., 2006). However, the questions in the Munezawa et al. (2011) questionnaire were dichotomous. Students who answered "yes" to drinking alcohol or smoking once in the past month were considered as "drinking alcohol" or "smoking," making it hard to know if drinking or smoking makes the likelihood of SP higher or lower.

Rather than dichotomous questions, another study used a correlation-based approach to again find that smoking is associated with SP. Wrobel-Knybel et al. (2022) studied SP prevalence and frequency and associated lifestyle variables (e.g., smoking,

alcohol consumption, cups of coffee or other caffeinated beverages, physical activity). The researchers focused on four professional groups (nurses/midwives, policemen, teachers, and "other") and used an online questionnaire that included the SP-EPQ (Jalal & Hinton, 2013) to assess frequency, characteristics, and level of knowledge of the SP experience. The results showed a positive correlation between the number of years smoking cigarettes and the number of SP episodes in the last month. These researchers also found relationships between other lifestyle variables with SP.

Drinking caffeinated beverages is indirectly associated with rates of SP. Kerpersheok et al. (2018) studied how the timing of caffeine use could affect sleep quality in a large student sample (N = 880). The researchers measured the caffeine consumption frequency per week at different times of day (i.e., morning, afternoon, evening, and night). The results showed an interaction effect between evening caffeine use and lower sleep quality, suggesting that participants who drink coffee in the evening have lower sleep quality. Since lower sleep quality is linked to SP, participants who drink caffeine in the evening may also experience higher rates of SP. Thus, as SP is accompanied by certain risk variables, this paper will discuss how students display these risks. There is also limited research on when an individual uses a substance in a certain time in the day and how that would correlate of SP frequency.

Technology Use

There has been a lack of research regarding technology use and SP, although many studies have shown that technology and social media use could cause sleep disturbances and a reduction in sleep quality (Gradisar et al., 2013; Levenson et al., 2017), that, in turn, has been shown to increase SP frequency (Denis et al., 2018; Szklo-

Coxe et al., 2007). Research has shown that the use of technology before bed may influence sleep issues. Gradisar et al. (2013), using a US-based sample from random digit dialing (N = 750) and the Internet (N = 758), found that interactive devices (i.e., computers, smartphones, etc.) used before bed were positively associated with difficulties falling asleep ($\beta = 9.4$, $p < 0.0001$) and unrefreshing sleep ($\beta = 6.4$, $p < 0.04$). Compared to older adults, younger adults were more prone to use interactive technological devices. These results indicate that smartphones and other interactive technologies commonly used by college students (i.e., gaming consoles, computers etc.) could cause sleep disturbances, which, in turn, have been shown to influence SP (Szklo-Coxe et al., 2007). However, Gradisar et al. (2013) did not specify whether the content on the devices could influence sleep disturbances (e.g., social media).

Social media

Studies have shown that social media increases sleep disturbances (An et al., 2014; Levenson et al., 2016, 2017; Vernon et al., 2015), but have lacked in research related to SP. In one study, Levenson et al. (2017) surveyed a nationally representative US-based student sample (N = 1763) using a questionnaire measuring problems with sleep patterns and quality and found that the frequency of checking social media 30 minutes before bed had a significant effect on the odds ratio of sleep disturbance ($p = .007$). In another study, an Australian student sample (N = 1886) showed a significant correlation between problematic social networking use and increased sleep disturbances (Vernon et al., 2015). These two studies suggest that the use of social media in the student population may influence sleep disturbance, which would indirectly influence SP frequency (Denis et al., 2018; Szklo-Coxe et al., 2007).

Unstudied Student Variables

Some student behaviors could not be investigated in this study. One of these behaviors was use of illicit drug, such as psychedelics, stimulants, depressants, or prescribed psychotropic medications (e.g., anti-depressants). Another variable out of this study's reach is any clinical diagnosis of respondents, as this would provide more evidence on clinical aspects of SP in students. This study also did not study symptoms of anxiety, depression or suicidality which would have added to clinical information relating to SP in university students. Due to its sensitivity, this information was not included so as to not dissuade a participant from continuing the survey.

Sleep Paralysis in Certain Demographics

Research studying SP details the effects that it has on certain demographics and populations (i.e., age, gender, ethnicity, student status). Some studies have shown significant effects of SP in specific populations, although it comes with other conflicting research.

Age

Even through there is a significant difference between the rate of students experiencing SP compared to the general population (Sharpless et al., 2011), there has been no significant association between age and SP. In two systemic reviews of SP, both Denis et al. (2018) and Sharpless et al. (2011) did not find any study suggesting the association between age and SP. Most recently, Wróbel-Knybel et al. (2020) used a self-reported online survey of Polish students in Lublin (N = 439) and did not find any

association. As there are some conflicting theories, this study investigated whether age is the reason for the difference in frequency of SP.

Gender

There have been studies that showed a significant difference between women and men in the frequency of experiencing SP with some conflicting studies, along with a lack of research in the non-binary and transgender population. In one study, Ma et al. (2014) showed a differing rate of SP in female (7.4%) versus male Chinese adolescents (6.1%). In contrast, Sharpless et al. (2011) found that males are more likely to experience SP than females in a clinical outpatient population. Denis et al (2018) found that there were more studies showing no association between gender and SP than studies showing an association, although there have been no studies in the transgender and non-binary population that test for SP. In one study of sleep health among sexual minority individuals using data from The Behavioral Risk Factor Surveillance System (BRFSS) of the Centers of Disease Control and Prevention, Dai & Hao (2017) found that sexual minority individuals have a higher prevalence of sleep deprivation compared to their cisgender peers. Sexual minorities are more prone to sleep less than 5 hours per day, even as high as 35.5% greater than cisgender peers among the non-confirming transgender population. In addition, other studies have found a correlation between gender identity and sleep-related issues (Duncan et al., 2018; Harry-Hernandez et al., 2020). The current study is the first to research gender identity and sleep paralysis.

Ethnicity

Minority populations have been shown to have a higher percentage of SP experience specifically when combined with other variables such as being a student or having a clinical disorder (Paradis et al., 1997: Sharpless & Barber, 2011). Paradis et al. (1997) found that African Americans had a significantly higher rate of ISP with panic disorder than the white sample (59.6% to 7.5%, respectively). In addition, Hinton et al. (2005) showed that 65% of Cambodian refugees with PTSD had monthly SP experiences while non-PTSD refugees had 14.85%. Overall, studies have associated sleep paralysis and related experiences (e.g., ghost oppression, demon visits) to ethnicities across the world from Italy (Jalal et al., 2015) to China (Ma et al., 2014). Although one study showed no significant difference when comparing races with their respected sleep paralysis frequencies (Sharpless & Kliková, 2019), this study only compared non-white and white participants. Therefore, there is still a lack of research comparing SP experiences between races, especially in the university student population.

Study Aims and Hypotheses

This study aimed to address the current gap in scientific research on sleep paralysis predictors in the university student population by focusing on three aims and multiple hypotheses:

Study Aim 1:

First, we investigated the demographic variables related to SP frequency.

Study Aim 2:

Second, we determined the behavioral and environmental variables related the SP frequency.

Study Aim 3:

Finally, we analyzed the predicters of SP as controlled by demographics and the control (i.e., sleep quality).

Hypotheses

This study hypothesizes that a) females and the minority population (i.e., Black, Asian, etc.) will experience higher SP frequency, b) student-related and environmental factors (napping, bedtime, sleep duration, substance use, etc.) will correlate with higher frequencies of SP and c) student-related and environmental factors will predict SP frequency even when controlled by demographics and control (i.e., sleep quality).

Chapter II

Method

The study was conducted using an online self-report questionnaire administrated via Qualtrics and approved by the Committee on the Use of Human Subjects at Harvard University. The target sample was 200 participants with an equal representation of male and females, in addition to a small percentage of transgender and non-binary participants. Recruitment for this study included inviting members of sleep and student-related Reddit, GroupMe, and Facebook groups to participate. In addition, two Facebook ads that targeted students with SP and other general personal networks also were used.

This study received an Exempt Review from the Committee on the Use of Human Subjects (CUHS), which serves as the University-area Institutional Review Board (IRB). Harvard's Exempt Review is for research investigations with less than minimal risk to subjects with de-identified data (i.e., anonymous survey) and does not require a convened IRB review. There was no compensation for completing this study. This study stated that participants would not benefit from this study, nor would they receive any harm from participating.

Participants

This study investigated all levels of university students (undergraduate, graduate, medical, etc.). For the main analysis, each participant had to be at least 18 years or older, English speaking, and currently enrolled in a university. This study verified active student

status by asking “Are you currently a student at a university?” and “What is the highest level of education you have completed?” Participants who were younger than 18 years old and who could not speak English were not allowed to continue the study. The participants who were not students were allowed to continue the study, but their data was excluded from the analysis. Participants with psychiatric or medical disorders were not excluded from this study, nor did the researchers ask about such disorders due to the safety of participants’ sensitive data. 336 participants completed the self-report questionnaire, drawn from more than 30 online groups in Reddit and 5 Facebook groups (See Table 1). In addition, the survey was also sent out in many online groups from Iona University and Harvard Extension School (i.e., Harvard Extension School International Relations Club and Harvard Extension School Psychology Student Society).

This study implemented two Facebook Ad campaigns. First, in California from ages 18-30 (63.9% female & 36.1% male) with people who matched interests: “Sleep,” “Student,” “Dream,” and “School,” “Sleeping” that reached over 2,603 people and received 50 link clicks to the survey in 7 days. Second, people living anywhere in the United States from ages 18-65+ (79.7% female & 20.3% male) with interests: “Sleep,” “Student,” or “Dream” that reached over 1541 people and received 74 link clicks to the survey in a week. The researcher tried to reach a representative sample with the targeted ads of California because most of the recruitment was in the Northeast region of the United States.

Measures

The study protocol included measures of SP prevalence and frequency, sleep quality, alcohol use, caffeine use, nicotine use, sleeping environment, bedtime, napping behaviors, and technology use.

Prevalence and Frequency of Sleep Paralysis: This study used a measurement studying the presence, frequency, and duration of SP, modeled after The Unusual Sleep Experiences Questionnaire (USEQ; Paradis et al., 2009). The measurement evaluated SP by asking, "Some people have had the experience upon going to sleep or awakening when they were unable to move their arms or legs or speak even though they wanted to do so, have you ever had this experience?" When a participant answered "yes" to this question, the participant was asked to describe the experience to validate that it was sleep paralysis (Paradis et al., 2009). The questionnaire asked how many times a participant experienced SP, answers including "Once, Several, Several times a year, Monthly, Weekly, Several times a week" (modeled by Cheyne, 2005 and Denis & Poerio, 2017).

Sleep Quality: This study measured retrospective sleep quality with The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). This assessment included 19 items and was completed in about 5-10 minutes. Items asked about sleep quality, disturbance, latency, efficiency, bedtime, and daytime dysfunction. The items were put into 7 groups and scored between 0-3 points, then these points were added up to between 0-21, in which 21 represented the least sleep quality and 0 represented the most sleep quality. PSQI had an internal consistency of 0.83 (Cronbach's alpha) (Buysse et al., 1989). In a recent study, this questionnaire had a high content validity score using the content validate index (CVI; Polit et al., 2007; Wang et al., 2022). For reliability, the item reliability index was 0.99

and the person reliability index was 0.70, suggesting that the questionnaire was consistent and stable among different participants.

Napping Behavior: The questions asked about the average of napping frequency and duration of each nap were modeled by the questionnaire from Foley et al. (2007) which measured napping behaviors in a nationally representative poll. The question stated, "How many times do you usually nap?" which the participants answered, "Never, Less than once a month, 1-3 times per month, 1-3 times per week, 4-7 times per week." For napping duration, the study used a single item questionnaire based on Ma et al. (2014) which assessed napping behavior and sleep paralysis in a high school student population. The question stated, "How long was your nap on average during the previous month?" which participants answered, "None, Less than 15 minutes, 15-30 minutes, 30 minutes to 1 hours, 1-2 hours, 2 hours or more."

Number of Occupants: This study assessed sleeping environment by first asking about the number of occupants in a participant's room. This study based their question off a single item from Meng et al. (2019) which found that the number of occupants in a room predicted sleep issues in a college student sample. The question stated, "How many *other* occupants sleep in your room on average?" The researchers added the work "other" from the question to reduce confusion if that included the participant themselves. Based on that question the participants selected an answer from one of the following, "None, 1, 2-3, 4-5, 6 or more."

Background Noise: This study researched how background noise could affect a participant's sleep by asking a single item, yes or no question that stated, "Would you say

you live in a noisy area?" where the participant answered, "Yes, No or Unsure." This variable tried to assess the participant's sound environment.

Nicotine Use: This study assessed for nicotine use by asking about the frequency per day and week in addition to the type of nicotine use, time of nicotine use, and if nicotine increases SP. The questionnaire asked the participants to provide a number for daily and weekly nicotine use. The researchers asked for the type of nicotine use by listing "Cigarettes, Cigars or Pipes, E-Vapes, Nicotine Pouches, Smoking cessation products (Patches, Chantix, Gum) or Other." For time of nicotine use, the questionnaire asked, "What time do you usually use nicotine products?" with the answers, "During the day, In the Evening, or During the Night." The researchers also directly assessed the association between SP and nicotine use by asking a yes-or-no question, "Would you say that you experience sleep paralysis more after using nicotine?"

Alcohol Use: This study measured alcohol consumption by assessing the number of drinks per week, drinks at one time, number of nights per week, and if alcohol increases SP frequency. The number of drinks per week, drinks at one time, and number of nights drinking per week were recorded on a continuous scale; the participant provided their own self-prediction for each variable. The survey assessed for binge-drinking by asking, "How much do you drink at one time?" and "How many nights per week?". The researchers directly assessed the association between SP and alcohol use by asking, "Would you say that you experience sleep paralysis more after using alcohol?"

Caffeine Use: This study investigated caffeine intake by asking the daily and weekly frequency and time of usual caffeine intake. For questions related to daily and weekly frequency of caffeine, participants were given the ability to choose their own number on

a continuous scale, in the same manner as alcohol use. This survey assessed if the time of caffeine use could impact SP frequency by asking "What time do you usually drink caffeine?" and the participants answered "Morning, Afternoon, and/or Night." The researchers directly investigated the association between SP and caffeine use by asking, "Would you say that you experience sleep paralysis more after using caffeine?"

Family with Sleep Paralysis: For studying the familial association of sleep paralysis, this study used two main questions. First, the participants were asked "Do you have any family members that have or have had sleep paralysis?" which was a "Yes" or "No" question. If the respondent answered "Yes," there were directed to answer "How many family members have had sleep paralysis?" to measure the number of the relatives with sleep paralysis. The questionnaire asked which type of family member (e.g., sibling, parent, "other"). The participants were also given the opportunity to describe their "other" family relative with SP.

Technology Use: The participants were also asked about technology use in this questionnaire. This study primarily assessed whether technology use, screentime, or social media had any correlation with SP frequency. This study investigated technology use by measuring the hours of phone use, "How many hours do you use your phone per day?" and social media use, "How many hours do you use social media per day?" The participant had the chance to answer between "Less than 1 hour" and "10+ hours" per day. The survey also asked, "Do you ever use technology before bed?"

Student Status: This study tested the student's status by simply asking "Are you currently a student at a university?" If the participant was a student, the survey asked if the participant was in a university in the United States. In assessing for education level, the

researchers asked, “What is your highest level of education?” with the participant answering either “Some high school or less, High school diploma or GED, Some college but no degree, Associates or technical degree, Bachelor’s degree, or Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.)”

Procedures

The study was conducted using three main protocols – a data collection protocol, the study protocol, and the data cleaning protocol.

Data Collection

Most of the data was collected through Reddit groups as the study was advertised to over 3 million Reddit non-unique users. The researchers first emailed each administrator of the group to gain approval to post the survey in the respected Reddit group. The researcher sent over 40 requests and received 30 approvals (See Table 1). The post was titled “HARVARD SLEEP PARALYSIS STUDY” and included the IRB-approved message that described the study, with the link to the study’s survey. The Reddit posts were a free and easy option for recruitment as many of the groups shared the post on their own, creating a snowball recruitment effect. The Facebook groups used a similar protocol whereby the survey was posted in 5 sleep paralysis-related groups with the same message as above (Table 1). For student related groups, recruitment was done through Harvard Extension School GroupMe groups (i.e., HES students, HES IRB, and HES PSS). The data was also collected through two weeklong Facebook ad campaigns where participants were targeted with the interest of the study (i.e., “sleep,” “student,” “dream,” and “school”). Additionally, recruitment was done through the researcher’s own

personal network and social media (i.e., Instagram, Facebook, Snapchat, and LinkedIn). Overall, over 300 responses were collected, although after excluding outliers (z score > 4), 145 university student respondents were used for the main analysis (See Figure 1).

Study Protocol

Individuals who were interested in participating saw the general information of the study through one of the different recruitment channels (see Figure 1). After reading the study advertisement, the participant clicked the survey link which redirected them to the consent form that included a detail explanation of the study. After looking through and consenting to the study, the participant was forwarded to the study questionnaire. If the participant did not agree to the terms of the consent form, was under 18 years old or was not proficient in English, the participant was automatically sent to the end of the survey. If none of those exclusion criteria were met, the participant was then moved to a questionnaire and answered questions about demographics, including age, gender, ethnicity, student status, in addition to sleep paralysis-related questions, sleep behaviors, substance use, sleep quality, and technology use. After the completion of the study, the participant was thanked for participating in a message at the end of the study.

Data Cleaning Protocol

After the data were collected, the researchers used the following steps to clean the data for analysis. First, any respondent who did not agree to the term of the consent form, was under 18, and/or not proficient in the English language were automatically sent to the "End of the Survey." This included 1 participant who did not agree to the study, 12 participants who were under 18 years old, and 5 participants who were not proficient in

the English language. To remove outliers, this study performed a z-score analysis on any continuous variable of the study (e.g., caffeine use per week, nicotine use per day) and all z scores that were greater than 4 were removed from the study (N=9). Out of the (145) university students, 111 of respondents (76.55%) were students in American universities.

Table 1: Recruitment Table for Reddit and Facebook Groups

Reddit Groups	**# of Members**
r/horror	2.8m
r/luciddreaming	510k
r/mentalhealth	422k
r/dreams	340k
r/samplesize	211k
r/dreaminterpretation	74k
r/sleepparalysis	57k
r/Favors	50k
r/CPAP	30k
r/narcolepsy	26k
r/surveyexchange	18k
r/nightmares	15k
r/takemysurvey	15k
r/polyphasic	13k
r/idiopathichypersomnia	7k
r/SurveyCircle	4k
r/Weird_Dreams	3k
r/sexomnia	2k
r/ExplodingHeadSyndrome	1.6k
r/sleeptripping	1.4k
r/SleepParalysisStories	1.1k
Facebook Groups	**# of Members**
Sleep Paralysis	25k
Sleep Science	4.7k
Sleep Paralysis and Astral Travel	4.5k
Sleep Paralysis Facebook	2.3k
This is my sleep paralysis DEMON	466

Note: This table shows the Reddit and Facebook groups used in recruitment for this study, as well as the associated member count of each group.

All types of students remained in the analysis since the study aim was directed towards university students, although our sample was more representative of college students in the United States. The analysis excluded a handful of respondents (N = 2) due to inconclusive responses when answering the questions "What time do you usually go to bed?" and "What time do you usually wake up?" These participants had answers to these

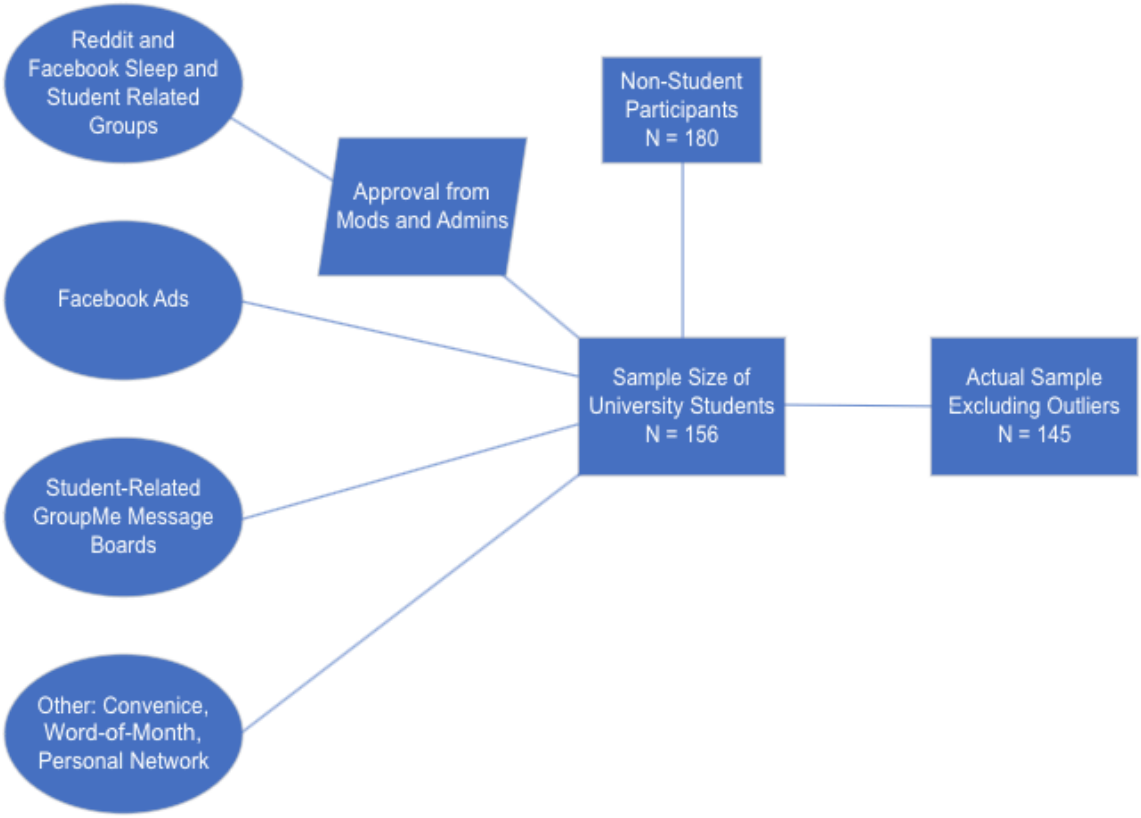

Figure 1: Graphic of Study Recruitment Process.

Note: This graphic describes each aspect of the recruitment process in this study. The first four circles on the left are the data sources and the last box on the right is the final sample size. Some participants (N = 11) were excluded because of outliers and inaccurate data.

questions that included "…from 8pm to 8am" and "not sure how to answer this question."

After examining the data to be sure all statistical assumptions were met, most of the variables had an acceptable skewness and kurtosis. However, the nicotine factor, which included different aspects of nicotine use, was excluded from the main analysis due to an extremely high skewness (1.842) and kurtosis (2.54). Given this information, the hierarchical regression analysis was based on the large sample size. The Inflation Variance Factor (VIFs) ranged between 1.040 and 1.808 indicating that the assumption of non-collinearity was met.

Data Analysis

The data analysis was conducted separately for each aim and hypothesis. The study first conducted descriptive analysis of each variable. All statistical tests were made using the R-Programming Language (R-Markdown, Version 4.2.2, 2022).

For the group comparisons, two groups were formed within the study, +SP group (N = 56) were participants that experienced SP "Several times a year" or more, on the other hand, the -SP group (N = 89) experienced SP overall "Several" times or less. This study used a Shapiro-Wilk normality test and found that SP frequency (dependent variable) was not normality distributed ($W = 0.907$, $p < 0.001$), thus researchers had to use a non-parametric alternative to investigate the comparisons. Because the dependent variable was not normally distributed, this study used a Mann-Whitney and report the U-statistics and p-value for the nominal variables. The researchers used a chi-squared ($X^{2)}$ test to investigate if the two groups were different from each other with a X^2 statistic and a p-value for categorical variables. Together, this study used all these statistical methods

to see the differences in variables between the non-frequent SP group (-SP) and the frequent SP group (+SP).

This study also performed a non-parametric correlation analysis using Spearman's R since variables were not normally distributed. Two sets of correlations were performed, one to investigate how the sample's demographics related to the rest of the study's variables, and the second was a correlation matrix of independent variables. Correlations were performed to determine whether the sample's demographics related to the student behavioral and environmental factors and to see if there were potential factors related to demographics and SP frequency. The correlation matrix was performed to see if any variables were associated with each other and how this might influence the hierarchical regression model.

A factor analysis was conducted with varimax rotation on each of the student factors (i.e., caffeine use, nicotine use, alcohol use, napping, and family) which tested for eigen values, factor loadings, and degree of fit. The researchers used the fa() function on R-Programming for an exploratory factor analysis using minimum residual which is best for hypothesis testing; this study also used varimax rotation to simplify the expression of factors (See Park et al., 2009). The analyses also included tests of internal consistency using Cronbach's *a* for each of the different factors. Factor analysis was performed to validate the behavioral and environmental constructs of university students, in addition to combining the questionnaire items into constructs used for more valid calculation of a hierarchical regression model.

To find the predictors of SP frequency in university students, this study conducted three hierarchical regressions (modeled from Park et al., 2009): one for overall sleep

paralysis frequency, one for the non-frequent SP group (-SP) and one for the frequent SP group (+SP). Each hierarchical regression analysis contained three models. The first model included demographics, the second added the sleep quality construct, then and the third added student variables. Researchers wanted to investigate what variables predicted SP frequency when controlling for demographics and a variable that was already related to SP (i.e., sleep quality). Due to the sample size of this study and the number of independent variables used, this study preformed 3 steps in each hierarchical regression model. The analysis first found that linear models of demographics and SP frequency, then demographics and sleep quality as related to SP, then demographics, sleep quality and student-related behavioral and environmental variables as related to SP. After, researchers found the ANOVA for each regression model and its summary. Results showed a R^2 statistic where researchers were able to analysis the change of R^2 to see how each model predicted SP frequency.

All processing scripts are available on: https://github.com/mikeyfresh102/student-sleep-paralysis

Chapter III

Results

The dependent variable in this study was SP frequency. In this sample, 77.93% of participants experienced SP at least once in their lifetime (N=113), while 22.07% have never experienced SP (N=32). From this data, 89 participants (61.38%) were placed in the -SP group as individuals who either never or rarely experienced SP, which is represented as blue in Figure 2. Out of the sample, 56 participants (38.62%) were placed in the +SP group as individuals who frequently experienced SP, which is represented as red in Figure 2. The data shows a right skewed dataset, suggesting that most of the

Table 2: Descriptive Statistics of Sleep Paralysis Frequency

SP Frequency	**N**	**%**
"Never"	32	22.07%
"Once"	16	11.03%
"Several"	41	28.28%
"Several times a year"	22	15.17%
"Monthly"	13	8.97%
"Weekly"	7	4.83%
"Several times a week"	10	6.90%
"Daily"	4	2.76%

Overall, even with the SP-centered recruitment process, most of the sample did not experience SP in high frequencies, sample tended to have sleep paralysis less frequently.

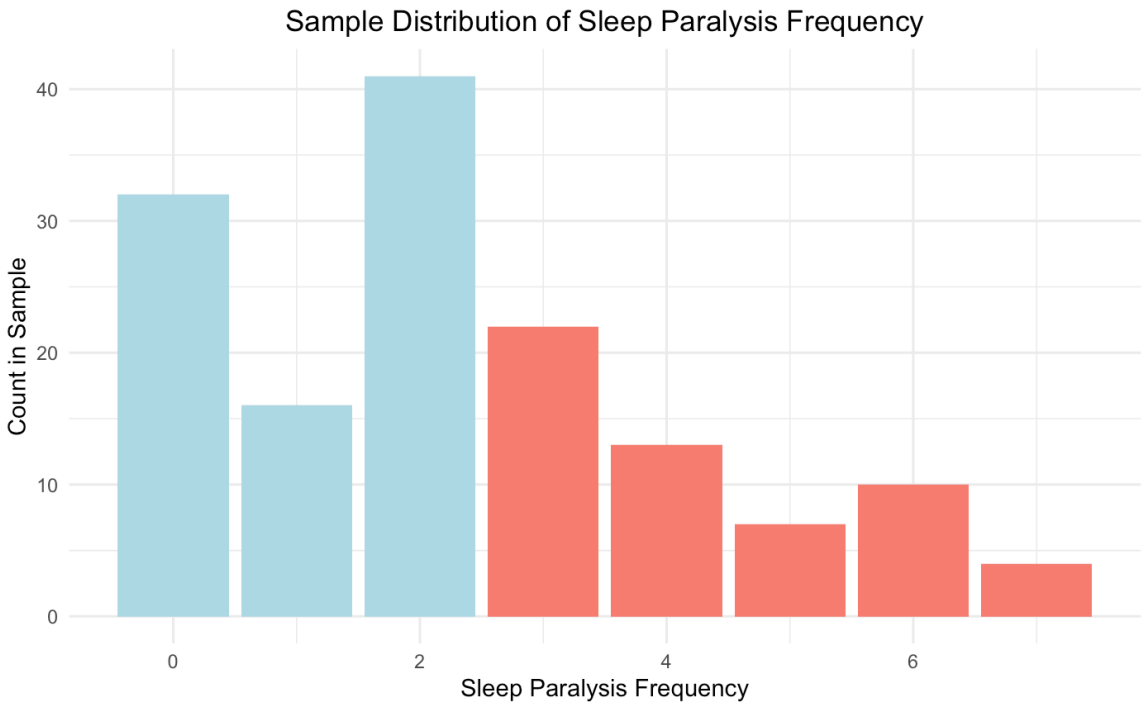

Figure 2: Bar Graph of Sleep Paralysis Frequency

Note: The -SP group (non-frequent experiencers) is represented as the blue bars and the +SP group (frequent experiencers) is represented as the red bars. The SP frequency is represented as 0 or "Never" to 7 or "Daily."

although a sufficient sample was received to statistically find the differences between these two groups and SP-related predictors.

Demographics

For the demographics in this study, Table 3 shows that most participants were white females (Female, N=96; White, N=107). Although there were more white individuals in the -SP group, the percentage of females was similar in the two groups. For

the questions on race and ethnicity, the respondents were given the opportunity to "Select all that apply," thus the percentages do not equal 100%. There were no significant ethnicity differences between the +SP group and -SP group. There was a higher

Table 3: Sample Demographics and Differences of +SP and -SP Groups

Demographics	**Total (%) (N = 145)**	**+SP % (N=56)**	**-SP % (N=89)**
Race			
White or Caucasian	104 (71.72%)	67.86%	74.16%
Black or African American	14 (9.66%)	8.93%	10.11%
Asian	24 (16.55%)	16.07%	16.85%
Other	16 (11.03%)	10.71%	11.24%
Multiple Races	14 (9.66%)	3.57%	13.48%
Prefer not to say	2 (1.3%)	0.006%	0.006%
Hispanic Origin			
Yes	26 (17.93%)	23.21%	14.61%
Gender			
Male	42 (28.97%)	25%	31.46%
Female	96 (66.21%)	67.86%	65.17%
Non-binary/third gender	7 (4.83%)	7.14%	3.37%
Age			
18-24 years old	81 (55.86%)	67.68%	48.31%
25-34 years old	36 (24.83%)	21.43%	26.97%
35-44 years old	20 (13.79%)	8.93%	16.85%
45-54 years old	7 (4.83%)	1.79%	6.74%
55-64 years old	1 (0.69%)	0%	1.12%
Highest Level of Education			
Some high school or less	2 (1.38%)	1.79%	1.12%
High school diploma or GED	12 (8.28%)	10.71%	6.74%
Some college, but no degree	39 (26.90%)	35.71%	21.35%
Associates or technical degree	13 (8.97%)	10.71%	7.87%
Bachelor's degree	53 (36.55%)	26.79%	42.70%
Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.)	26 (17.93%)	14.29%	20.22%

Table 4: Group Comparisons between +SP and -SP in Demographics

Demographics	**Statistic**	***p***
Race		
White or Caucasian	$X^2 = 0.4$	0.528
Black or African American	$X^2 = 0.00$	1
Asian	$X^2 = 0.00$	1
Other	$X^2 = 0.00$	1
Multiple Races	$X^2 = 2.82$	0.093
Hispanic Origin		
Yes	$X^2 = 1.2$	0.274
Gender		
Male	$X^2 = 0.42$	0.518
Female	$X^2 = 0.02$	0.878
Non-Binary / Third Gender	$X^2 = 0.40$	0.526
	Statistic	***p***
Age	U = 1934.5	0.012*
Highest Level of Education	U = 1951.5	0.023*

Note: For the Race, Hispanic Origin, and Gender a chi-squared test was used since they are categorical variables which showed the group differences between +SP and -SP. For Age and Highest Level of Education a Mann-Whitney U test showed the difference of medians between +SP and -SP groups since they are nominal variables.

percentage of Hispanic participants in the +SP group (23.21%) than the -SP (14.61%). Almost five percent of this sample was non-binary or third gender (N=7), in addition a larger percentage of non-binary participants were in the +SP group (7.14%) than the -SP group (3.37%), suggesting future investigations are needed (See Figure 3). For males and females, there was not a significant difference in SP groups, although males were higher in -SP (31.46%) than +SP (25%). The sample was also majority student-aged (18-24 years old, N=81), which was expected because of the study recruitment, in addition to one single participant who was between 55-65 years old. Participants that were between 18-24 years old were higher in +SP (67.68%) than the -SP (48.31%), while participants that were between 35-44 years old were higher in -SP (16.85%) than +SP (8.93%). There

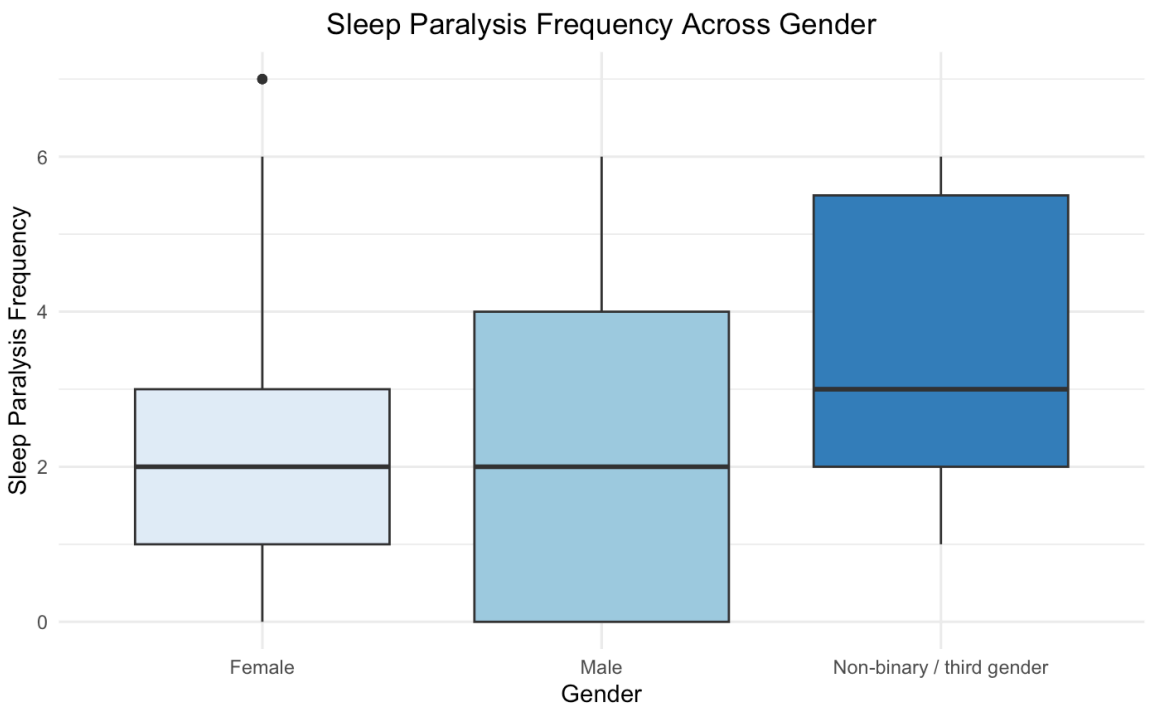

Figure 3: Sleep Paralysis Frequency Across Gender

Note: The sample here consists of the genders of the participants, including female, male and non-binary/third gender. The outcome variable represents the frequency of sleep paralysis.

was a significant difference between the age of participants in the +SP and -SP groups (U = 1934.5, $p = 0.012$), suggesting that the younger participants experience SP more frequently. For the participants' highest level of education, some variety of answers indicated that participants may have been confused about the question, since the whole sample responded "Yes" to "Are you a student at a university?", while some participants selected "Some high school or less" on the questions of education. Participants who graduated with a bachelor's degree or more represented 62.92% of the -SP group, while

only 41.08% in the +SP group. There was a significant group difference in the participants' highest level of education (U = 1951.5, $p = 0.023$) suggesting that participant early in their academic career experience more SP than other university students. Overall, it seems that there were no significant differences in ethnicity or gender, although there are differences in age and education.

Napping Behavior

When analyzing the napping behavior results, participants in the +SP group were significantly different than the -SP groups in every item. According to the descriptive data, Table 4 showed that 23.6% of -SP never napped, while that is only 3.57% of the +SP group. Among the +SP group, 55.36% napped once or more per week, on the other hand in the -SP group that percentage was 29.22%. For the usual length of naps in the sample 39.31% of respondents napped for more than 1 hour; in +SP, that percentage increased to 55.35% and in -SP that percentage decreased to 32.59%. For the question about what time respondents took naps, 78.62% of the overall sample took naps in the afternoon, although 62.5% of +SP took naps either in the morning or at night compared to only 13.49% in the -SP group. For the total sample, 21.38% stated that they experience SP more than napping, while that was increased in the +SP group (39.29%) and decreased in the -SP group (10.11%).

For the question, "Have many times do you usually nap?" there was a strong significant difference between +SP and -SP (U = 3347.5, $p < 0.000$). For the length of these naps, the +SP group took significantly longer naps than the -SP group (U = 3198.5,

Table 5: Descriptive Statistics of Napping Behavior

Napping Items	**Total (%) (N = 145)**	**+SP % (N=56)**	**-SP % (N=89)**
"How many times do you usually nap?"			
Never	23 (15.86%)	3.57%	23.60%
Less than once a month	28 (19.31%)	19.64%	19.10%
1-3 times per month	37 (25.52%)	21.43%	28.09%
1-3 times per week	32 (22.07%)	28.57%	17.98%
4-7 times per week	25 (17.24%)	26.79%	11.24%
"How long are your naps on average during the previous month?"			
Never	23 (15.86%)	3.57%	23.60%
Less than 15 minutes	6 (4.14%)	3.57%	4.49%
15-30 minutes	23 (15.86%)	25%	10.11%
30 minutes to 1 hour	33 (22.76%)	12.5%	29.21%
1 hour to 2 hours	40 (27.59%)	32.14%	24.72%
2 hours or more	20 (13.79%)	23.21%	7.87%
"When do you usually take naps?"			
Naps in the morning	23 (15.86%)	32.14%	5.62%
Naps in the afternoon	114 (78.62%)	89.29%	71.91%
Naps at night	24 (16.55%)	30.36%	7.87%
"Would you say that you experience sleep paralysis more form napping?"			
Yes	31 (21.38%)	39.29%	10.11%

Table 6: Group Comparisons between +SP and -SP in Napping Behaviors

Napping Items	**Statistic**	***p***
"How many times do you usually nap?"	U = 3347.5	0.000*
"How long are your naps on average during the previous month?"	U = 3198.5	0.003*
	Statistic	***p***
Naps in the morning	$X^2 = 16.19$	0.000*
Naps in the afternoon	$X^2 = 5.18$	0.023*
Naps at night	$X^2 = 11.01$	0.000*
SP more from napping	$X^2 = 15.71$	0.000*

Note: Mann-Whitney U test developed the U statistic and p value to show the differences in medians between the +SP and -SP groups. A Chi-Squared test developed the X^2 statistic, showing the difference between napping in the morning, afternoon, or night and if participants' experienced SP more from napping.

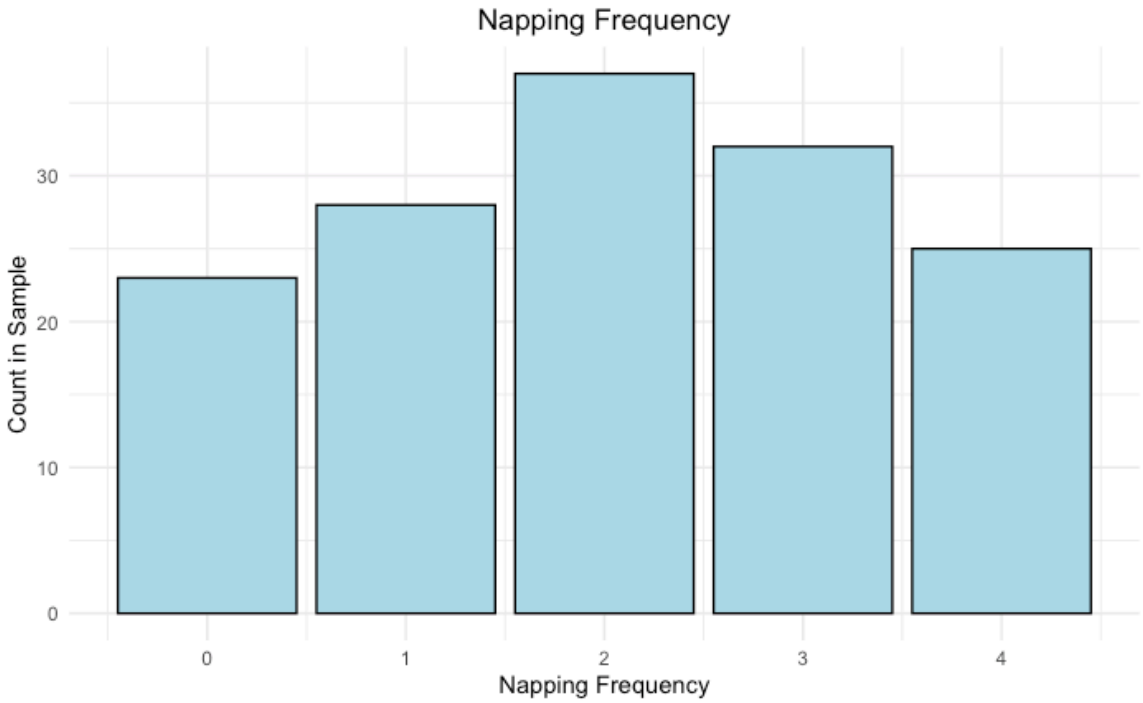

Figure 4: Bar Graph of Napping Frequency

Note: Frequency of napping in this sample from 0 or "Never" to 4 or "4-7 times per week."

$p = 0.003$) When the participants took these naps, the +SP group was significantly different between than the -SP group in frequency of naps taken in the morning ($X^2 = 16.19$, $p < 0.000$) and naps taken at night ($X^2 = 11.01$, $p < 0.000$). In comparison to -SP, +SP group showed significantly more naps in the afternoon ($X^2 = 5.18$, $p = 0.023$). Finally, the +SP group experienced SP from napping more frequently than the -SP group ($X^2 = 15.71$, $p < 0.000$). Overall, there were significant group differences in all napping variables, suggesting that napping frequency influenced SP frequency.

Environmental Variables

The results tell us about the distribution of other sleeping occupants in the room of the students as well as if the participant lives in a noisy area (see Table 6). Most respondents did not have any other occupants sleeping in their room on average, suggesting that 60.69% of our sample do not have roommates. Within the two groups 33.93% of +SP had more than 1 person sleeping in the same room than the -SP group (42.7%), which is the opposite of the hypothesis, although it was not significant. In our total sample, 6.9 percent had 2 or more people sleeping in their room on average (N=10), while that percentage did not variety between +SP (5.36%) and -SP (7.87%).

Table 7: Descriptive Statistics of Environmental Variables

Environmental Items	**Total (%) (N = 145)**	**+SP (N=56)**	**-SP (N=89)**
"How many other occupants sleep in your room on average?"			
None	88 (60.69%)	66.07%	57.30%
1	47 (32.41%)	28.57%	34.83%
2 – 3	10 (6.9%)	5.36%	7.87%
"Would you say you live in a noisy area?"			
No	105 (72.41%)	83.93%	65.17%
Yes	33 (22.76%)	7.14%	32.58%
Unsure	7 (4.83%)	8.93%	2.25%

For background noise, a large majority did not live in a noisy area (72.41%), suggesting that most of our sample did not have background noise while they slept, while 7 respondents (4.83%) were unsure if they lived in a noisy area. The +SP group responded "Yes" to living in a noisy area 7.14% of the time while the -SP group responded "Yes"

Table 8: Group Comparisons between +SP and -SP in Environmental Variables

Environmental Items	**Statistic**	***p***
"How many other occupants sleep in your room on average?"	U = 2264	0.284
"Would you say you live in a noisy area?"	$X^2 = 11.25$	0.000*

Note: For the number of occupants sleeping in a participants' room a Mann-Whitney U test showed the differences in medians between +SP and -SP and presented a U-statistic and p value. For if a participant lived in a noisy area a Chi-Squared test showed the difference between the sleeping environment item and +SP and -SP.

32.58% of the time The -SP group had a significantly higher number of participants who lived in a noisy area compared to the -SP group ($X^2 = 11.25$, $p < 0.000$). This suggests that people who experienced SP more were less likely to live in a noisy area. There were no significant differences in the number of other occupants living in the same room as the participant. Overall, these results showed that background noise could negativity correlate with SP frequency, suggesting future research be done on sound environment and SP.

Nicotine Use

The results showed that almost a quarter of our sample used nicotine products (N=35, 24.14%), while the +SP group had 28.57% nicotine users and the -SP group had 21.35% (Table 8). The total nicotine users smoked an average of 3.17 times per week (± 11.29) suggesting a high variability of uses of nicotine, while the +SP group used nicotine an average of 3.02 (± 7.25) and the -SP group an average of 3.26 (± 13.26). For daily nicotine use, the sample used nicotine an average of 1.65 per day (± 5.15), while the two groups showed similar statistics of daily nicotine use. There was no significant group difference between general nicotine use, nor nicotine per week nor nicotine per day. For

Table 9: Descriptive Statistics of Nicotine Use

Nicotine Items	**Total (%) (N = 145)**	**+SP (N=56)**	**-SP (N=89)**
"Do you use nicotine products?"	35 (24.14)	28.57%	21.35%
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
"How many times per week?"	3.17 (11.29)	3.02 (7.25)	3.26 (13.26)
"How many times per day?"	1.65 (5.15)	1.64 (4.5)	1.65 (5.55)
"What time do you usually use nicotine products?"			
Nicotine during the day	26 (17.93%)	21.43%	15.73%
Nicotine in the evening	19 (13.1%)	19.64%	8.99%
Nicotine at night	19 (13.1%)	17.86%	10.11%

Note: The time to smoke nicotine was a "Select all that apply" question, thus the percentage will not equal 100.

Table 10: Group Comparisons between +SP and -SP in Nicotine Use

Nicotine Items	**Statistic**	***p***
"Do you use nicotine products?"	$X^2 = 0.625$	0.430
"How many times per week?"	U = 2705	0.25
"How many times per day?"	U = 2746	0.151
Nicotine during the day	$X^2 = 0.42$	0.520
Nicotine in the evening	$X^2 = 2.55$	0.110
Nicotine at night	$X^2 = 1.19$	0.274

Note: For the number of nicotine used per day and week, a Mann-Whitney U test developed a U-statistic and p value to show the differences in medians between +SP and -SP. For general nicotine users, nicotine during the day, evening and night, a Chi-Squared test developed the X2 statistic, showing the difference between each nicotine use item and the two groups.

the type of nicotine use, most of the participants used E-Vapes as their source of nicotine (N=19), while 3 participants used nicotine pouches as their main source. This data also

showed the difference in use of E-Vapes (N=19) compared to cigarettes (N=13) among university students, although these results were not significant. Time of nicotine use suggested that most participants used nicotine products during the day (17.93%). Between the two groups, the +SP (37.5%) smoked nicotine more during the evening and night compared to the -SP group (19.1%), although the comparison was not significant. For the question, "Would you say that you experience sleep paralysis more after using nicotine?" all the participants selected "No", so the statistics were not included in the results. Overall, nicotine does not seem to impact SP frequency.

Alcohol Use

Most (53.79%) of our sample drank alcohol (N=78). On average, these respondents drank alcohol 2.31 (± 3.9) times per week, 1.52 (± 2.08) times at once and 0.86 (± 1.05) nights per week (See Table 11). In the +SP group, alcohol users drank on an average of 2.25 (± 3.65) per week, 1.46 (± 2.3) times at once and 0.86 (± 1.14) nights per week. In the -SP group, alcohol users drank on an average of 2.35 (± 4.08) times per week, 1.56 (± 1.94) times at once and 0.85 (± 1.01) nights per week. These results suggested that most of our sample drank alcohol moderately, drinking less than one night per week and that there was no difference between the +SP and -SP groups. The study did not find any evidence of binge drinking as the number of drinks an individual drank at once never reached more than 4 drinks and respondents drank less than 1 night per week; thus, binge drinking was not evident. For the question, "Would you say that you experience sleep paralysis more after drinking?" 10.71% of +SP alcohol drinkers responded "Yes" while 6.74% of -SP responded similarity. There were no significant differences in any of the alcohol-related item in this survey. Overall, these results

Table 11: Descriptive Statistics of Alcohol Use

Alcohol Items	**Total (%) (N = 145)**	**+SP (N = 56)**	**-SP (N = 89)**
"Do you drink alcohol?"			
Yes	78 (53.79%)	50%	56.18%
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
"How many drinks per week?"	2.31 (3.9)	2.25 (3.65)	2.35 (4.08)
"How much do you drink at one time?"	1.52 (2.08)	1.46 (2.3)	1.56 (1.94)
"How many nights per week?"	0.86 (1.05)	0.86 (1.14)	0.85 (1.01)
"Would you say that you experience sleep paralysis more after drinking?"			
Yes	12 (8.28%)	10.71%	6.74%

Table 12: Group Comparisons between +SP and -SP in Alcohol Use

Alcohol Items	**Statistic**	***p***
"Do you drink alcohol?"	$X^2 = 0.31$	0.579
"How many drinks per week?"	U = 2468	0.919
"How much do you drink at one time?"	U = 2299	0.408
"How many nights per week?"	U = 2424	0.769
"Would you say that you experience sleep paralysis more after drinking?"	$X^2 = 0.29$	0.592

Note: For the number of drinks per week, drinks at one time, and the number of nights drinking per week, a Mann-Whitney U test developed a U-statistic and p value to show the differences in medians between the groups. For general alcohol users and if participants experience SP more from drinking, a Chi-Squared test developed the X2 statistic, showing the difference between each alcohol use item and the SP groups.

suggested that alcohol does not influence SP frequency in university students, nor was there any relation between binge drinking and SP frequency.

Caffeine Use

The results showed the variables of caffeine consumption in our sample (See Table 12). Most of our participants drank caffeine at 75.86% (N=110) and that number does not variety depending on SP frequency (+SP, 75%; -SP, 76.4%). On average, our respondents drank caffeine 6.31 times per week (± 6.24), while the +SP group drank 4.61 (± 4.74) and the -SP group drank 7.39 (± 6.83) times per week. Our total sample of university students drank 1.08 (± 0.87) caffeinated drinks per day, while this statistic was less for the +SP group (mean = 0.88 ± 0.64) and was more for the -SP group (mean = 1.21 ± 0.96). For time of drinking caffeine, most of the sample drank caffeine in the morning (N=94, 64.83%). For the +SP group, 14.29% drank caffeine in the evening, while only 8.99% of the -SP group drank in the evening. For the question, "Would you say that you experience sleep paralysis more after drinking caffeine?" the total sample of caffeine drinkers answered "Yes" at 6.9% while for +SP this percentage was 12.5% and -SP was 3.37%.

There were some significant differences between the +SP and -SP groups for certain caffeine related variables. Table 13 did not show a difference in general caffeine use between the two groups, although there was a significant difference in the average use of caffeine per week (U = 1931.5, $p = 0.021$), suggesting that low SP experiencers drank more caffeine than high SP experiencers per week. Additionally, there was a non-significant difference in caffeine use per day between the groups (U = 2053.5, $p = 0.55$) furthering that notion. There was no difference between the specific time of drinking caffeine. The +SP group experienced more SP when drinking caffeine than the -SP group

Table 13: Descriptive Statistics of Caffeine Use

Caffeine Items	**Total (%) (N = 145)**	**+SP (N = 56)**	**-SP (N = 89)**
"Do you drink caffeine?"	110 (75.86%)	75%	76.4%
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
"How many caffeinated drinks per week?"	6.31 (6.24)	4.61 (4.74)	7.39 (6.83)
"How many caffeinated drinks per day?"	1.08 (0.87)	0.88 (0.64)	1.21 (0.96)
	N (%)	**%**	**%**
"What time do you usually drink caffeine?"			
Morning	94 (64.83%)	62.5%	66.29%
Afternoon	51 (35.17%)	35.71%	34.83%
Evening	16 (11.03%)	14.29%	8.99%
"Would you say that you experience sleep paralysis more after drinking caffeine?"			
Yes	10 (6.9%)	12.5%*	3.37%*

Table 14: Group Comparisons between +SP and -SP in Caffeine Use

Caffeine Items	**Statistic**	***p***
"Do you drink caffeine?"	$X^2 = 0.00$	1
"How many caffeinated drinks per week?"	U = 1931.5	0.021*
"How many caffeinated drinks per day?"	U = 2053.5	0.055
Caffeine in the morning	$X^2 = 0.08$	0.774
Caffeine in the afternoon	$X^2 = 0.00$	1
Caffeine in the evening	$X^2 = 0.52$	0.472
SP more from Caffeine	U = 2719.5	0.036*

Note: For the number of caffeinated drinks per week and day and if participants experience SP more from caffeine, a Mann-Whitney U test developed a U-statistic and p value to show the differences in medians between the groups. For the general caffeine use and the time of caffeine use, a Chi-Squared test developed the X2 statistic, showing the difference between each caffeine use item and the SP groups.

(U = 2719.5, $p = 0.036$), suggest that the +SP group are influenced more by caffeine than the -SP group when experiencing SP. Overall, the data implied that non-frequent SP

experiencers drank more caffeine than frequent SP experiencers, although caffeine influenced SP frequency more in the +SP group than in the -SP group, thus this suggested that the +SP group may have drank less caffeine to avoid SP.

Family Variables

As shown in Table 14, about 30 percent of the sample had a family member with SP (N=42, 28.97%), and that statistic was more for the +SP group (35.71%) and less for

Table 15: Descriptive Statistics of Family Variables

Family Items	**Total (%) (N = 145)**	**+SP (N = 56)**	**-SP (N = 89)**
"Do you have any family members that have or have had sleep paralysis?			
Yes	42 (28.97%)	35.71%	24.72%
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
"How many family members have had sleep paralysis?"	0.49 (0.9)	0.66 (1.05)	0.38 (0.79)

Table 16: Group Comparisons between +SP and -SP in Family Variables

Family Items	**Statistic**	***p***
"Do you have any family members that have or have had sleep paralysis?	$X^2 = 1.52$	0.22
"How many family members have had sleep paralysis?"	U = 2813.5	0.103

Note: For the number of family members with SP, a Mann-Whitney U test developed a U-statistic and p value to show the difference in the median between the groups. For if the participant had any family members with SP, a Chi-Squared test developed the X2 statistic, showing the difference between the family item and the SP groups.

the -SP group (24.72%). On the other hand, according to Table 15, there was no group difference in having a family member with SP influenced SP frequency. On average, the respondents had a mean of 0.49 (± 0.9) family members with SP, while the +SP group had a mean of 0.66 (± 1.05) and the -SP had 0.38 (± 0.79) on average. There was no significant group difference in the amount of family members with SP and SP frequency. Overall, there was no significant group difference in any family variable and SP in this sample.

Sleep Quality and Sleeping Behaviors

The average PSQI score (which is a sum of seven different sleep-related components, Buysse et al., 1989) was 7.99 (SD = 3.15), although in the +SP group, the PSQI score was 9.32 (± 3.23) and the -SP group was 7.15 (± 2.8). The average time to fall asleep in this sample was 31.42 (± 28.5) minutes with no variety in the +SP or -SP groups. The average hours of sleep of the total sample were 7.03 (± 1.41) hours, while there was a slight difference between the two groups (+SP, 6.95; -SP, 7.07). The average

Table 17: Descriptive Statistics of Sleep Quality and Sleeping Behaviors

Sleeping Items	**Mean (SD)**	**+SP (SD)**	**-SP (SD)**
PSQI Score	7.99 (3.15)	9.32 (3.23)	7.15 (2.8)
Average minutes it takes to fall asleep	31.42 (28.5)	31.80 (31.91)	31.18 (26.32)
Average hours of sleep	7.03 (1.41)	6.95 (1.80)	7.07 (1.11)
Average time to get up in the morning	7:50 AM (1:47)	8:05 AM (1:56)	7:41 AM (1:41)
	Mean (Median)	**Mean (Median)**	**Mean (Median)**
Average Bedtime	12:20 AM (9:00 PM)	11:22 PM (4:45 AM)	12:57 AM (9:30 PM)

Note: For the average bedtime the mean and the median were included, the rest of the table included a mean and standard deviation.

Table 18: Group Comparisons between +SP and -SP in Sleep Quality and Sleeping Behaviors

Sleeping Items	**Statistic**	***p***
PSQI Score	U = 3415.5	0.000*
Average minutes it takes to fall asleep	U = 2376	0.637
Average hours of sleep	U = 2219	0.260

Note: For each item, a Mann-Whitney U test developed a U-statistic and p value to show the differences in medians between the +SP and -SP groups.

awake time also varied slightly between +SP (8:05 AM) and -SP (7:41 AM), as the total sample recorded an average of 7:50 AM. For the analysis of the average bedtime, since the data was extremely varied the researchers calculated the input as a median rather than a mean. For the total sample, the mean bedtime was 12:20 AM with a median of 9:00 PM. While the +SP group had a mean of 11:22 PM and a median of 4:45 AM. In the -SP group, these participants had a mean bedtime of 12:57 AM with a median of 9:30 AM. This data further suggested the variability of bedtimes among frequent SP experiencers.

There was no significant difference in awake time, bedtime, total hours of sleep, or time to get up in the morning. On the other hand, there was significant difference in PSQI scores between the +SP group and the -SP group (U = 3415.5, $p > 0.000$). This suggested that frequent SP experiencers have less sleep quality than non-frequent SP experiencers. Overall, the PSQI score showed that sleep quality significantly influenced SP frequency, while bedtime could influence SP, but more research is needed.

Technology Use

The results to the technology use variables and will not be used for this study's main analysis. These variables were inputted into the survey just for a preview of

Table 19: Descriptive Statistics of Technology Use

Technology Items	**N**	**%**
"On average, how many hours do you use your phone per day?"		
Less than 1 hour	2	12.5%
1 – 2 hours	4	25%
2 – 4 hours	7	43.75%
4 – 6 hours	2	12.5%
6 – 8 hours	0	0%
8 – 10 hours	1	6.25%
	N	**%**
"On average, how many hours do you use social media per day?"		
Less than 1 hour	4	25%
1 – 2 hours	4	25%
2 – 4 hours	4	25%
4 – 6 hours	3	18.75%
6 – 8 hours	0	0%
8 – 10 hours	1	6.25%
	N	**%**
"Do you ever use technology before bed?"		
Never	1	6.25%
Somewhat Unlikely	2	12.5%
Somewhat Likely	7	43.75%
Always	6	37.5%

technology use and sleep paralysis. The primarily results show that most respondents used their phone about 2-4 hours per day (N=7, 43.75%), while most respondents used social media less than 2 hours a day (N=8, 50%). Additionally, a large majority of participants were likely to use technology before bed at 81.25% (N=13), which implies that future research is needed. There was not enough data to provide a significance difference of technology use between the +SP and -SP groups.

Factor Analysis

Factor analysis with varimax rotation revealed the following five student factors: Alcohol Use (MR1), Caffeine Use (MR2), Family with SP (MR3), Nicotine Use (MR4), and Napping (MR5). In factor analysis, each factor loading represented the correlation between the item (e.g., Caffeine Per Day) and the underlying construct (e.g., Caffeine Use), thus factor analysis combined multiple items to create an overall construct score for each factor. Each factor had an eigenvalue of at least 1 (Alcohol Use, 2.69; Caffeine Use, 2.32; Family, 1.74, Nicotine Use, 1.60; and Napping, 1.22), which meant that each created factor had a variance that was greater than the original items. The overall factor analysis represented 68% of the total variance of the sample, which was acceptable due to a common threshold of 60% in social sciences (Hair, 2014). The alcohol factor included general use (0.82), drinking per week (0.77), amount at once (0.78), and number of nights per week (0.81) and was 28% of the total variance explained in addition to having a high internal consistency ($\alpha = 0.89$). The caffeine factor included caffeine per day (0.99), caffeine per week (0.85), and general caffeine use (0.70) and was 24% of the total variance explained with a high internal consistency ($\alpha = 0.89$). The family factor included if a participant had a family member with SP (0.99) and the number of family members with SP (0.84) and was 18% of the total variance explained with an acceptable internal consistency ($\alpha = 0.74$). The nicotine factor included general nicotine use (0.80), nicotine per day (0.63), and nicotine per week (0.61), the factor represented 17% of the total variance explained and had a high internal consistency ($\alpha = 0.92$). The napping factor included the frequency of napping (0.78) and the usual length of naps (0.71), the factor

Table 20: Factor Analysis of University Students Variables

University Student Factors	**Factors**				
	1	2	3	4	5
Factor 1: Alcohol					
Alcohol Use	**0.82**	0.08	0.03	0.08	0.02
Alcohol Per Week	**0.77**	0.04	0.08	0.29	0.05
Alcohol at Once	**0.78**	0.09	0.05	0.28	0.08
Nights of Drinking Per Week	**0.81**	0.04	-0.01	0.08	-0.06
Factor 2: Caffeine					
Caffeine Use	0.22	**0.70**	-0.07	-0.04	0.01
Caffeine Per Week	-0.01	**0.85**	-0.08	-0.01	-0.26
Caffeine Per Day	0.01	**0.99**	-0.06	0.04	-0.15
Factor 3: Family					
Family Member with SP	0.06	-0.10	**0.99**	0.00	0.01
# of Family Members with SP	0.05	-0.08	**0.84**	-0.06	-0.01
Factor 4: Nicotine					
Nicotine Use	0.23	0.02	-0.08	**0.80**	0.03
Nicotine Per Week	0.11	0.04	0.09	**0.61**	0.05
Nicotine Per Day	0.16	-0.08	-0.10	**0.63**	0.00
Factor 5: Napping					
Napping Frequency	-0.02	-0.05	-0.02	0.00	**0.78**
Length of Naps	0.07	-0.27	0.01	0.09	**0.71**
Eigenvalue	**2.69**	**2.32**	**1.74**	**1.60**	**1.22**
Variance explained	**0.28**	**0.24**	**0.18**	**0.17**	**0.13**
Cronbach's α	**0.89**	**0.89**	**0.74**	**0.92**	**0.72**

Note: The loadings in bold are meeting the criterion for establishing existence of a factor. The factor loading was calculated from Pearson's correlation. As well as the eigenvalue which accounts for the total variance among individual variables for an underlying construct. The table also shows the variance explained which the total amount of variance explained for each factor. Finally, Cronbach's α reveals that internal consistency of the construct.

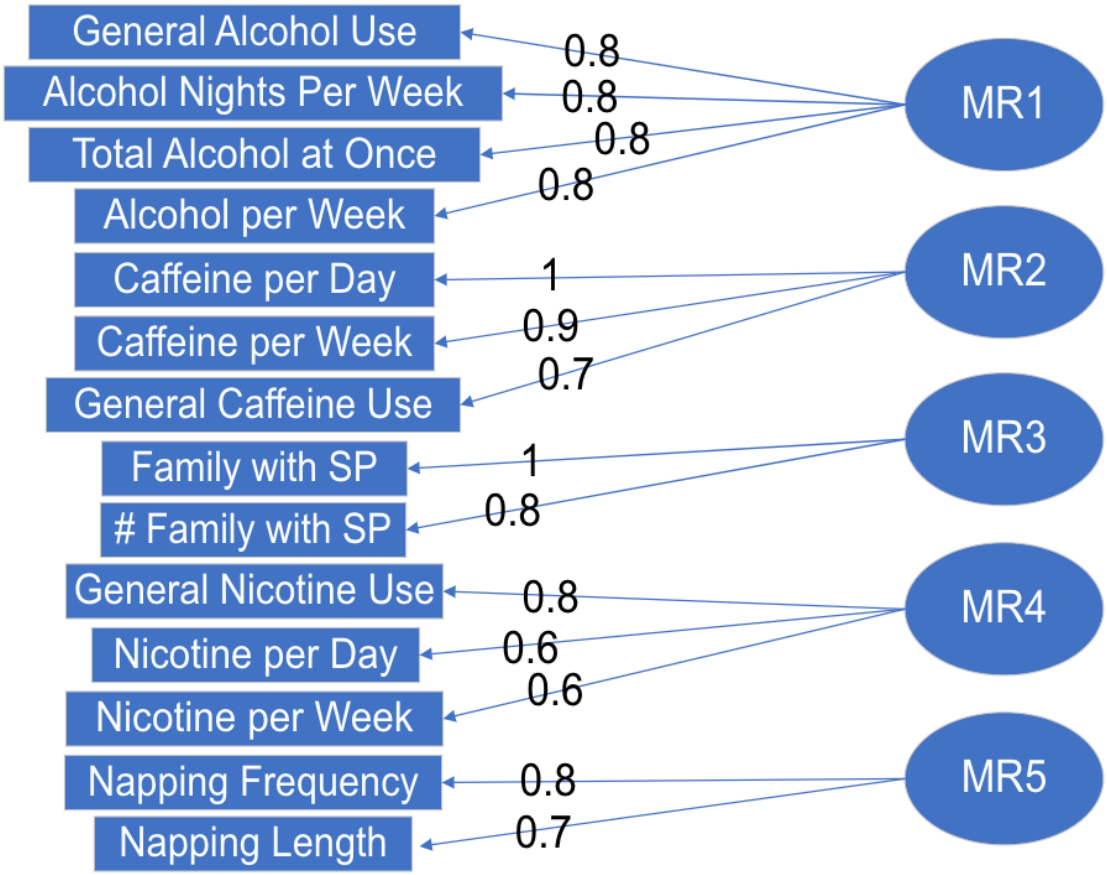

Figure 5: Factor Analysis of University Student Variables

Note: The boxes on the left represent the different items in the survey while the ovals on the right represent the underlying constructs where MR1 = Alcohol Use, MR2 = Caffeine Use, MR3 = Family with SP, MR4 = Nicotine Use and MR5 = Napping

was 13% of the total variance explained and had an acceptable internal consistency (α = 0.72). Although the nicotine factor was taken out of the main analysis as it did not assume normality since it had a skewness of 1.61 and kurtosis of 2.09 which are both extremely high; the nicotine factor's skewed distribution negatively impacted the results.

The rest of the factors had acceptable scores of skewness and kurtosis, implicating normal distribution.

Correlations of Variables

As illustrated in Table 20, there was a positive correlation in caffeine and age (r = 0.21; $p < 0.01$), in addition to education (r = 0.21; $p < 0.001$), suggesting that the older you are the more caffeine intake you have as a university student. Napping had a negative correlation with age (r = -0.30; $p < 0.001$) and education (r = -0.26; $p < 0.01$), indicating that the more you age the less naps you take. Female respondents were less likely to use nicotine (r = -0.28, $p < 0.01$) and more likely to use caffeine (r = 0.17, $p < 0.05$), meaning that university student females smoked less nicotine and drank more caffeine than males or non-binary individuals. For ethnicity, the black respondents in our sample were correlated with family-with-SP (r = 0.17, $p < 0.05$), suggesting that black students have more family members with SP. Asian respondents had a positive correlation of other family members with SP (r = 0.22, $p < 0.01$) and had a negative correlation of drinking alcohol (r = -0.28, $p < 0.001$), meaning that Asian participants drink less alcohol and have more family-with-SP than other ethnicities in this study. White participants were more likely to drink alcohol (r = 0.20, $p < 0.05$) and less likely to have a family member with SP (r = -0.28, $p < 0.001$). For participants who identity with multiple races were shown to negatively correlate with living in a noisy area (r = -0.20, $p < 0.05$), indicating

Table 21: Correlations between Variables and Demographics

Correlate (r)	**Nicotine**	**Caffeine**	**Alcohol**	**Family**	**Napping**	**Noisy**	**O**	**PSQI**	**SP**
Age	-0.11	0.21**	-0.14(*)	0.09	-0.30***	-0.20*	0.1	-0.04	-0.24**
Education	-0.14	0.21*	-0.02	0.15(*)	-0.26**	-0.16(*)	0.01	-0.02	-0.19*
Gender	-0.28**	0.17*	0.13	0.03	-0.06	-0.12	-0.04	0.06	0.01
Hispanic	0.16	-0.07	0.01	0.11	-0.04	0.07	-0.09	0.06	0.07
Black	0.01	0.04	-0.03	0.17*	0.13	0.06	0.08	0.64	0.09
White	0.03	0.04	0.20*	-0.28***	-0.1	-0.02	0.04	-0.01	-0.09
Asian	0.02	0.02	-0.29***	0.22**	0.09	0.11	-0.07	-0.1	0.03
Multiple	-0.05	0.02	-0.01	0.02	0.07	0.22***	0.01	-0.09	-0.08

*Note: This figure presents a table of correlations between the independent variables and the demographics of this study. This study calculated the correlation with Spearman's R analysis. $p < 0.001$= ***, $p < 0.01$ = **, $p < 0.05$ = *, $p < 0.1$ = (*)*

Table 22: Correlation Matrix of Independent Variables

Correlate (r)	**Napping**	**O**	**Noisy**	**Nicotine**	**Alcohol**	**Caffeine**	**Family**	**PSQI**
Napping	-							
O	-0.02	-						
Noisy	0.09	-0.01	-					
Nicotine	-0.07	0.05	-0.07	-				
Alcohol	-0.01	-0.04	-0.01	0.32***	-			
Caffeine	0.13	0.05	-0.07	-0.14	-0.04	-		
Family	-0.01	-0.03	-0.01	0.01	-0.29***	0.45***	-	
PSQI	0.17*	-0.05	-0.06	0.06	-0.02	-0.03	0.01	-

*Note: The results were calculated using Spearman's R. $p < 0.001$= ***, $p < 0.01$ = **, $p < 0.05$ = *, $p < 0.1$ = (*). This includes a correlation matrix of the independent variables. The variables of Napping, Nicotine, Alcohol, Caffeine, Family and PSQI are all constructs from a mix of different items. The "O" represents number of occupants. The "Noisy" represents if a participant lived in a noisy area.*

that multiple race participant lived in calm areas. Finally, SP frequency both correlated with age (r = -0.24, $p < 0.01$) and education (r = -0.19, $p < 0.05$), suggesting that age and lower completed levels of education are related to increased rates of SP frequency.

There were some correlations found between the independent variables of this study (Table 20). The use of nicotine was negatively related to alcohol use (r = -0.32, $p < 0.001$) suggesting that participants who smoked nicotine were less likely to drink alcohol. For alcohol use, participants who drank alcohol were less likely to have family-with-SP (r = -0.29, $p < 0.001$). For participants with higher amount of family-with-SP drank more caffeine (r = 0.45, $p < 0.001$). Finally, there was a significant correlation between sleep quality (PSQI) and napping behaviors within the participants (r = 0.17, $p < 0.05$). Overall, people with family-with-SP drink less alcohol, but more caffeine, as well as participant who smoked nicotine drank less alcohol. Lastly, respondents who naps longer and more frequent had less sleep quality. Overall, there were many correlations between variables, most importantly how the more naps a participants took, the less sleep quality they had.

Hierarchical Regression Models

This study used hierarchical regression analysis to test the predictors of SP frequency in the university student population (Table 22). In the first regression model, there was a significant correlation at -0.41 ($p < 0.05$) for age and SP frequency while the other demographic variables did not show any correlation. When inputting the control (i.e., sleep quality) in regression 2, PSQI showed an increase of 0.10 R^2 variance and a significant correlation of 0.19 ($p < 0.001$) as well as age, keeping a significant positive correlation with SP (r = -0.35, $p < 0.05$). In regression 3, the large decrease of

Table 23: Hierarchical Regression Analysis of Sleep Paralysis Predictors in University Students

Predictor Variables	**Regression 1**	**Regression 2**	**Regression 3**
Age (0, 18-24 years old)	-0.41*	-0.35*	-0.19
Education (0, Some High School)	-0.19	-0.18	-0.17
Gender (1, Female)	0.29	0.17	0.19
PSQI		0.19***	0.16***
Caffeine			-0.08
Alcohol			-0.08
Napping			0.43*
Family			0.33*
R^2	**0.055****	**0.145*****	**0.185***
R^2 Change	**0.055****	**0.090*****	**0.040***

*Note: Table 20 demonstrates the three steps of the hierarchical regression model predicting SP frequency among university students, while controlling for demographics and sleep quality. The table shows the correlations between each variable and SP frequency, as well as the variance of each regression in addition to the change of variance for each model. $p < 0.001$= ***, $p < 0.01$ = **, $p < 0.05$ = *, $p < 0.1$ = (*)*

Table 24: ANOVA model summary–Sleep Paralysis Predictors in University Students

Model		**SS**	**df**	**F**	**Sig**
1.	Regression	39.368	3	4.42	0.005
	Residual	485.07	141		
	Total	524.44	144		
2.	Regression	49.165	4	16.56	0.000
	Residual	435.91	140		
	Total	524.44	144		
3.	Regression	32.078	8	2.70	0.033
	Residual	403.83	136		
	Total	524.44	144		

Note: The ANOVA analysis of variance, degrees of freedom, sum of squares, F-statistic, and p-value for the hierarchical regression model. It reveals the model summary of the three steps in hierarchical regression model predicting SP frequency in university students.

age in predicting sleep paralysis, suggested that student behaviors may mediate age's correlation on sleep paralysis. Within the student factors, napping showed correlation of 0.43 ($p < 0.01$) and the family factor showed a significant correlation at 0.33 ($p < 0.05$). These results suggested that napping and family-with-SP are significant predictors of sleep paralysis in university students. There was no significance in the other student behaviors (i.e., caffeine, alcohol). Model 1 was significant in predicting SP frequency with the age of the participant. Model 2 significantly improved the model ($p < 0.001$) with the addition of the PSQI as a predictor of SP. Model 3 also had a significant model, suggesting that napping and family-with-SP were significant predictors of SP, canceling out the significant correlation of age and SP, although sleep quality was still a significant predictor in this model.

Table 25: Hierarchical Regression Analysis of Sleep Paralysis Predictors in -SP Group

Predictor Variables	**Regression 1**	**Regression 2**	**Regression 3**
Age (0, 18-24 years old)	-0.18	-0.17	-0.16
Education (0, Some High School)	0.02	0.01	-0.01
Gender (1, Female)	0.13	0.13	0.09
PSQI		0.03	0.02
Caffeine			-0.02
Alcohol			-0.15
Napping			-0.11
Family			0.34***
R^2	**0.00**	**0.00**	**0.12****
R^2 Change	**0.00**	**0.00**	**0.12****

*Note: Table 22 demonstrates the three steps of the hierarchical regression model predicting SP frequency among university students, while controlling for demographics and sleep quality. The table shows the correlations between each variable and SP frequency, as well as the variance of each regression in addition to the change of variance for each model. $p < 0.001$= ***, $p < 0.01$ = ***

Table 26: ANOVA model summary–Sleep Paralysis Predictors in -SP Group

Model		SS	df	F	Sig
1.	Regression	2.53	3	1.17	0.326
	Residual	69.56	85		
	Total	72.09	88		
2.	Regression	0.45	4	0.629	0.430
	Residual	69.11	84		
	Total	72.09	88		
3.	Regression	11.59	8	4.031	0.005
	Residual	57.52	80		
	Total	72.09	88		

Note: Table 23 shows the ANOVA analysis of variance, degrees of freedom, sum of squares, F-statistic, and p-value for the hierarchical regression model on Table 22. It reveals that model summery of the three steps in hierarchical regression model predicting SP frequency in university students.

For this hierarchical regression model of the -SP group, Table 24 showed the predictor of SP frequency within university students with non-frequency SP experiences. In regression 1, the results did not find any significant predictors of age or other demographics. In regression 2, there was also no significance in sleep quality and SP in this group. Although in regression 3, family-with-SP was a significant predictor of SP when controlled by demographics and sleep quality, no other student-related variables were significant. According to Table 23, the ANOVA analysis of variance showed that only Model 3 significantly predicted SP in the -SP group with an F-statistic of 4.031 and a p-value less than 0.001. This model also showed a 0.12 variance of predicting SP with family-with-SP, suggesting that there are other variables besides napping, sleep quality and family-with-SP that predict SP frequency among university students. Overall, non-frequency SP experiencers were only predicted if they had family members with SP

rather than other sleep-related variables (i.e., napping, sleep quality), suggesting that this study's non-frequency SP group only had a genetic predictor of SP

Chapter IV

Discussion

The purpose of this study was to investigate the potential predictors of SP frequency in university students. After comparing the different students' behaviors and variables among frequent SP experiencers (+SP) and non-frequency SP experiencers (-SP), student behavior related variables were considered for further analysis. Student-related variables were then tested to determine how they correlated with SP frequency when controlling for demographics and sleep quality. Finally, this study examined whether predictors were different among frequent and non-frequent SP experiencers by performing the same analysis on the two groups. The results found that age and education correlate with higher SP frequency in the demographic analysis. It showed that napping, sleep quality, and some caffeine variables correlated with SP frequency in the correlation analysis. The main hierarchical regression analysis found that napping and family-with-SP predicted SP in university students when controlled by demographics and sleep quality. The findings from this study provided additional evidence on the predictors of SP in university students, as well as clinical screening implications when testing for Recurrent Isolated Sleep Paralysis (RISP) in students.

Student-Related Behaviors

This study analyzed student-related variables between frequency and non-frequency SP experiencers and found many significant differences. Within the

demographics of the study, no differences were found, although some correlation between age and education as younger individuals were shown to experience SP more frequently. Furthermore, the correlation between age/education and SP was seen to be influenced by the variables of napping, sleep quality, and family-with-SP, as that correlation lost its significance when adding the previous variables to the regression model. Within the napping behaviors of our sample, frequency SP experiencers napped more frequently, at greater lengths, and at more varying times of day than non-frequent experiencers, suggesting that napping is a strong predictor of SP among university students. For the sleeping environment of the students, there was no difference in the amount of other sleeping individuals in the same room, although this study showed that not living in a noisy area increased SP. This suggested that respondents who lived in a quiet area experienced more SP than a noisy area. More research is needed to see if some noise (or white noise) during sleep could help reduce SP frequency in students. This study created a valid construct of nicotine use with high internal constancy, although no difference between the two groups was found, suggesting that nicotine does not impact SP frequency, as shown in past studies, even when controlled by demographics and sleep quality. This research also created a construct of alcohol use with high validity and internal constancy, but alcohol did not impact SP frequency in any of the statistical test, furthering evidence that alcohol has no relation to SP frequency. Additional, binge-drinking also has no relation with SP frequency according to our research. For caffeine and SP frequency, this study suggested that individuals experience SP more when drinking caffeine, which is understandable as non-frequent SP experiencers drink more caffeine more frequent experiencers. Although the time of drinking caffeine did not

impact SP frequency, more research is needed to determine why frequent SP experiencers felt that they experience more SP with caffeine. Since there was conflicted research on the family relation to SP, researchers inputted a family factor into the main analysis for university students. This study showed that family did not show a difference between frequent and non-frequent SP experiencers in the Mann-Whitney U Test. Although when controlled by demographics and sleep quality, family, and the amount of family members with SP significantly impacted SP frequency in our overall student sample, as well as our non-frequent SP analysis. This suggested a strong genetic component to SP in university students, especially among non-frequent SP experiencers. According to our study, sleep quality significantly impacted SP frequency, adding to evidence of past studies, even when controlled by demographics. This study showed that frequent SP experiencers awaken later than non-frequent, as well as go to bed later, suggesting that SP either may cause irregular sleep schedules or vise-a-versa. Researchers found that hours of sleep and time to go to sleep did not impact SP in university students. For technology use, researchers did not find enough data for a significant test for technology use and SP, thus more research is needed, especially in technology before bed. When controlling for demographics and sleep quality, these results suggested that napping and family with SP are two predictors of SP frequency in university students, as well as sleep quality in the overall sample, suggesting that frequent SP experiencers were predisposed to SP through their family, and had frequent SP through their behaviors. Although, in the non-frequent SP sample, when adding sleep quality (control), only family with SP predicted SP frequency in university students. These results gave evidence that frequent SP may be predicted by behavioral and genetic factors, while non-frequent SP may be sufficiently

predicted by merely genetic factors. This provides addition evidence for SP in university students and that sleep quality's correlation with SP was influenced by the napping behaviors and family-with-SP. These results partially accepted our hypothesis, as evident with napping behavior, sleep quality, and family-with-SP. The results on living in a noisy area had an opposite effect of what was predicted.

Multiphasic Sleep Schedule Theory

This study showed that many individuals in the frequency SP group had irregular sleeping patterns as evident with their bedtime (Median = 4:45 AM), and napping behaviors. These variables displayed by frequent SP experiencers directly related to a multiphasic sleep schedule which could cause Sleep Onset REM, which has been correlate with SP (Takeuchi et al., 1992). This suggests that students may have increased Sleep Onset REM due to their irregular sleep schedule, thus causing frequent SP experiences. Future research is needed to confirm this relationship. Although, these results could assist with clinical treatments of SP and screening SP in university students; as well as helping students avoid irregular sleeping patterns to improve their sleep quality, reduce SP and reduce the potential fear related to SP.

Time of Substance Use

This paper researched how time of substance use could relate to SP frequency, with the variables of naps, caffeine, and nicotine use. This study theorized that napping during the evening would increase the chances of SP as this would affect circadian rhythm greater later in the day. This study also theorized that caffeine during the evening would influence SP since caffeinated drinks affect sleep quality and may cause Sleep

Onset REM. Lastly, it was theorized that nicotine during the evening could influence SP, although the results did not show significance. Overall, the specific time of substance use did not relate to SP frequency in this study.

Other Substance Use

This project did not have the opportunity to study more potent psychoactive substances (e.g., cocaine, psychedelics, cannabis). According to our SP theory of multiphasic sleep schedules, it can be hypothesized that cocaine, psychedelics, cannabis, and other stimulants could have a large impact on sleeping behaviors and sleep quality, thus suggesting a connection with SP. This study could not study these variables due to participant's privacy of sensitive data. Overall, more research is needed for these variables, to provide more evidence to reduce the use of these substances in university students.

Limitations

While the results showed that napping, sleep quality and family-with-SP are predictors of SP in university students, it is vital to understand the limitations of this study. First, this study did not control for psychopathology and other sleep-related disorders (e.g., insomnia, narcolepsy with cataplexy, etc.). Not inputting sleep-related disorders could have skewed the study as narcolepsy with cataplexy and insomnia involve naps and irregular sleeping patterns throughout the day, in addition to decreased sleep quality. Given that insomnia and narcolepsy with cataplexy are highly correlated with SP and since some of the Reddit groups were titled *r/insomnia* and *r/narcolepsy*, these results could have been influenced by participants with these disorders.

Additionally, this study recruited through a convenience sample of online groups which included Reddit, Facebook, Facebook ads, and other student-related groups. The sample was not representative of the general university student population since the participants were recruited purely from an online presence; thus, this study cannot validate that the results match the whole university student's population. Additionally, not all the student respondents went to a university in the United States, thus expanding the statistical noise of the targeted population. A larger more representative sample is needed to validate these findings, or a prospective study could investigate each frequent SP experiencer's behaviors more closely. Overall, this sample was not representative of the targeted population, thus more research is needed.

Another limitation of the study was that some participants had conflicting responses when it came to student status. Participants (N = 159) indicated that they are a student at a university, although 16 of those respondents stated that their highest level of education was either "Some high school or less" or "High school degree or GED." The respondents may have been confused on the question, so the researchers focused on the "Yes" or "No" response of "Are you currently a student at a university?", and the participants who answered "Yes" were included as university students.

For the PSQI (Sleep Quality) score, some of the respondents were a little vague when asked about bedtime, sleep duration, and awake time. The researchers found the average between the ranges that were inputted by the participants (e.g., "3-7 hours" was inputted as 5.5 hours). Thus, some of the data on bedtime, sleep duration and awake time may be incorrect due to incorrect input. This could have influenced the sleep quality scoring and the analysis on sleeping behaviors.

Conclusion

This study used a retrospective survey to investigate the potential predictors of SP in university students. The results showed that napping, sleep quality and family-with-SP predicted SP frequency in students when controlled by demographics, thus providing evidence for clinicians who treat SP in students and potential assessments for Recurrent Isolated Sleep Paralysis in students. This study also suggested that SP is genetic but can be reduced by having a healthy sleep schedule and napping for less time and less frequently. Therefore, overall fear associated with SP can be reduced by decreasing these behaviors.

Appendix 1.

Hierarchical Regression Model for +SP Group

Predictor Variables	**Regression 1**	**Regression 2**	**Regression 3**
Age	-0.13	-0.16	-0.02
(0, 18-24 years old)			
Education	-0.02	-0.02	0.02
(0, Some High School)			
Gender	-0.42	-0.48	-0.61
(1, Female)			
PSQI		0.06	0.07
Caffeine			0.14
Alcohol			0.10
Napping			0.48 (*)
Family			0.06
R^2 (Unadjusted)	0.03	0.05	0.13
R^2 Change	0.03	0.02	0.08

Note: This table demonstrates the three steps of the hierarchical regression model predicting SP frequency among university students, while controlling for demographics and sleep quality. The table shows the correlations between each variable and SP frequency, as well as the variance of each regression in addition to the change of variance for each model. $p < 0.001$= ***, $p < 0.01$ = **, $p < 0.05$ = *, $p < 0.1$ = (*)

ANOVA model summary – Sleep Paralysis Predictors in +SP Group

Model	SS	df	F	Sig
Regression	3.119	3	0.562	0.643
Residual	96.719	52		
Total	99.839	55		
Regression	1.864	4	1.006	0.321
Residual	94.855	51		
Total	99.839	55		
Regression	7.820	8	1.056	0.389
Residual	87.035	47		
Total	99.839	55		

Note: This table shows the ANOVA analysis of variance, degrees of freedom, sum of squares, F-statistic, and p-value for the hierarchical regression model. It reveals that model summery of the three steps in hierarchical regression model predicting SP frequency in university students.

Appendix 2.

Definition of Terms

Sleep Paralysis (SP): Sleep phenomenon of muscle atonia while conscious, creating an in-between sensation of wakefulness and dissociation while falling asleep or waking up (Hobson, 1995; Paradis et al., 2009)

+SP: This term describes individuals in the sample that experienced SP at least twice in the past 6 months. (American Academy of Sleep Medicine, 2005)

-SP: This term describes individuals in the sample that experienced SP either never or less than twice in the past 6 months. (American Academy of Sleep Medicine, 2005)

University Students: Individuals actively enrolled in a college or university.

Sleep Quality: Clinical construct that includes the quantitative aspects of sleep duration, sleep latency and continuity in addition to subjective aspects such as "depth" or "restful" sleep (Buysse et al., 1989).

Bedtime: The average time when the participant goes to bed.

Napping Behavior: The frequency a person naps during the past month, average duration of each nap and the time a participant takes naps (i.e., Morning, Afternoon, and Night).

Alcohol Use: The number of alcoholic drinks (e.g., wine, beer, spirits) a participant had used. It is measured as the number of drinks in the past week, the average number of drinks at one time, and how many nights per week a participant drinks. While different drinks amount to various levels of alcohol, "one drink" is defined as one shot liquor, one beer, 4 ½ oz of wine, etc.

Nicotine Use: The average amount of nicotine used (i.e., cigarettes, cigars, electronic vaper, or other nicotine devices) in the past day and week, in addition to the time of nicotine use (i.e., During the day, In the Evening, During the Night). While it is understood that various devices have different amounts of nicotine, “one use” is defined as one cigarette, cigar, or electronic nicotine vaporizer used in a specific period.

Caffeine Use: The number of caffeinated drinks in the past day and week, and the time of caffeine use (i.e., Morning, Afternoon, Evening). This includes coffee, tea, soda, sports drinks, and energy supplements containing caffeine. While it is understood that various beverages have different amounts of caffeine, “one drink” will be defined as one shot of espresso, one cup of coffee, one sports drink, one cup of tea, etc.

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