RU SLEEPY? - SLEEP/WAKE CHARACTERISTICS AND SLEEP QUALITY AMONG UNDERGRADUATE STUDENTS ATTENDING RHODES UNIVERSITY

BY

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THESIS

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Abstract

Background: University students, specifically older adolescents and young adults, are at high risk of insufficient and poor-quality sleep due to age-related biological changes converging with several systemic factors unique to the university context. These include but are not limited to freedom and independence, communal living environments, academic demands and associated stress, erratic schedules, and high technology use. While there has been extensive research on sleep quality in students in other parts of the world, there has been comparatively less in South Africa, which may present unique contextual influencing factors. Thus, this study aimed to characterise sleep/wake characteristics and sleep quality in a sample of undergraduate students attending a South African University. Additionally, the study aimed to determine the impact of certain demographic factors on sleep quality in the students. Lastly, the current study aimed to determine what factors may influence the students' sleep quality.

Method: This study adopted a cross-sectional design and explored sleep quality and sleep/wake characteristics (e.g., bedtimes, rise times, sleep duration, sleep latency, etc.) through an online survey circulated amongst undergraduate students via Rhodes university email platforms and student social media pages. The testing period started on 15 August 2022 and continued until 8 October 2022. The survey consisted of three main sections: (1) socio-demographic factors; (2) the Pittsburgh Sleep Quality Index (PSQI); (3) an open-ended question that asked students to comment on the factors which they felt may be influencing their sleep over the previous month.

Results: 393 students participated in this study, which corresponds to a response rate of 6.30%. The results revealed notable levels of poor sleep quality (mean global score of 9.79 (±3.36)) and a high prevalence of poor sleepers within the whole sample (over 90%), as well as across different demographic groups. Analysis indicated poor overall sleep quality, and concerning sleep/wake characteristics, such as, bedtimes, rise times, sleep latency, time in bed, habitual sleep efficiency, sleep duration, etc. Additionally, participants reported extended sleep latencies and difficulties initiating sleep within 30 minutes. Daytime dysfunction was prominent, indicating challenges in daily functioning. Demographic comparisons revealed that male students generally reported better subjective sleep quality and lower global PSQI scores than female students, with

females presenting with poorer sleep quality overall. Students living in university residences reported significantly later bedtimes and shorter sleep durations than off-campus students. Regarding year of study, third-year students reported better subjective sleep quality, longer times in bed, longer sleep durations and overall better sleep quality than first- and second-year students. Regarding funding mechanisms, students on the National Students Financial Aid Scheme had significantly higher subjective sleep quality scores but later bedtimes than students in the "other" funding groups.

Thematic analysis revealed that several self-reported factors impacted student sleep negatively. Mental health issues were the most commonly cited theme (26.72% of students), which included anxiety, stress, worry, and overthinking. University-related factors were the second most frequently cited theme (25.49% encompassing academics, funding, and navigating university life). Environmental influences comprised of issues with noise, particularly in university residences, weather, and lighting.

Discussion: In sum, the results of this study indicate that in this sample, the drivers of poor sleep quality seemed to be late bedtimes, early rise times, prolonged sleep latency, frequent night awakenings, and overall short sleep duration, all of which were driven by several systemic factors. These findings underscore the importance of assessing sleep health beyond just sleep duration and indicate compromised sleep health within this population, evidenced by high levels of daytime dysfunction due to inadequate and poor-quality sleep. The challenges faced by university students extend across various aspects of their lives, including sleep health, with poor sleep quality and insufficient sleep having significant implications for academic performance, mental health, and overall well-being as they transition into adulthood.

Keywords: *Undergraduate University Students; Sleep Quality; PSQI; South Africa*

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CHAPTER 1
1. INTRODUCTION

1.1 Background

Existing research underscores the widespread issue of poor sleep among university students globally (Reid & Baker, 2008; Gilbert & Wear, 2010; Lund et al., 2010; Seun et al., 2010; Cheng et al., 2012; Lemma et al., 2012 [A & B]; Araujo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Benham, 2020; Ahammed et al., 2021; Du et al., 2021; Evans et al., 2021; Marelli et al., 2021). Obtaining sufficient hours of good-quality sleep is not merely a luxury but a fundamental biological necessity, the function of which goes beyond periods of fasting and rest (Borbely, 1982; Araùjo et al., 2014; Borbely et al., 2016; Grandner, 2017; Karthikeyan et al., 2019). Sleep is intimately connected with health, well-being, cognitive performance and functionality, physical and mental health, and daily functioning (Brown et al., 2002; Zisapel, 2007; Lund et al., 2010; Araùjo et al., 2013; Araùjo et al., 2014; Grandner, 2017; Matricciani et al., 2017; Chaput et al., 2018; Karthikeyan et al., 2019). Sleep/wake behaviours are driven by a complex interplay between physiological, biological, behavioural, and genetic factors, which can vary according to age, sex, and previous sleep duration (Buysse, 2014; Paruthi et al., 2016; Bathry & Tomopoulos, 2017; Grandner, 2017; Ohayon et al., 2017; Chaput et al., 2018). As such, there exists high levels of variability in sleep/wake behaviours among humans (Buysse, 2014; Paruthi et al., 2016; Bathory & Tomopoulos, 2017; Grandner, 2017; Ohayon et al., 2017; Chaput et al., 2018).

University students face several biological and systemic challenges to obtaining good quality, sufficient sleep. Research has established that older adolescents and young adults undergo significant shifts in sleep/wake behaviours, primarily driven by developmental changes in bio-regulatory systems (Brown et al., 2002; Hagenauer et al., 2009; Gaultney, 2010; Carskadon, 2011; Rossa et al., 2013; Assaad et al., 2014; Colrain & Baker, 2017; Crowley et al., 2018). These changes encompass the maturation of sleep/wake systems, specifically, the sleep/wake homeostatic process (Process S) and the circadian rhythm (Process C) (Hagenauer et al., 2009; Carskadon, 2011; Rossa et al., 2013; Colrain & Baker, 2017; Crowley et al., 2018). As such, older adolescents and young adults exhibit resistance to sleep pressure that

builds up during the waking period, while at the same time, there is a delay in the expression of circadian phases, resulting in a drive to stay up later into the evening and wake up later in the morning; the outcome being internal time cues sustaining wakefulness and sleepiness occurring out of sync with external socially dictated time cues, leading to circadian desynchrony (Medeiros et al., 2001; Dijk & Lockley, 2002; Carskadon, 2011; Shochat, 2012; Rossa et al., 2013; Kabrita et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018).

Many individuals within this demographic choose to attend university, wherein these bio-regulatory processes then converge and interact with several other systemic factors unique to the university system, such as new psychosocial and academic demands, reduced parental influence, reduced adult supervision, freedom to self-select bedtimes, increased independence, increased responsibility, academic demands, economic demands, social demands, irregular study schedules, and high levels of media usage (Medeiros et al., 2001; Dijk & Lockley, 2002; Shochat, 2012; Rossa et al., 2013; Kabrita et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018). These factors, in conjunction with the mentioned age-related biological changes, converge in the context of a university, putting students at a heightened risk of inadequate and poor-quality sleep, potentially impacting their overall well-being and academic performance (Fernandez-Mendoza et al., 2010; Araùjo et al., 2014; Peach et al., 2016; Nogueira et al., 2018). Furthermore, research has indicated that in addition to insufficient sleep, university students tend to report having low sleep quality when assessed by standard sleep quality measures (Arnett, 2000; Brown et al., 2002; Wolfson & Carskadon, 2003; Fernandez-Mendoza et al., 2010; Araujo et al., 2014; Kabrita et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018).

This is of relevance to mention as this contributed to the creation of the current study; while sleep duration and quality have been shown to be compromised amongst university students globally, there is a gap in research investigating student sleep quality within the South African university system, considering the context-specific attributes of the South African Higher Education system, contributing to what inspired the researcher to conduct the current study. Therefore, this study aimed to

characterise sleep/wake behaviours and sleep quality in a sample of undergraduate students attending a South African University. The secondary aim was to understand what factors may influence undergraduate students' sleep quality in the South African context.

1.2 Objectives

The objectives of this study were three-fold:

(1) To determine the sleep quality and sleep/wake characteristics of a sample of undergraduate students attending a South African University.

(2) To determine which, if any, demographic characteristics may be influencing the sleep quality of the students attending this university.

(3) To determine which, if any, factors may be both positively and negatively influencing the students' sleep quality.

CHAPTER 2
2. LITERATURE REVIEW

2.1. Understanding Sleep: An Overview

Sleep is a fundamental biological need which is vital for psychological, physiological, and social well-being and is characterised by an emergent set of neurochemical processes involving both the sleep-promoting and arousal centres in the brain (Zisapel, 2007; Grandner, 2017; Matricciani et al., 2017; Karthikeyan et al., 2019). Obtaining sufficient amounts of good-quality sleep is a fundamental biological necessity, with the function of initiating periods of fasting and rest and facilitating and optimising various metabolic processes (Borbély, 1982; Brown et al., 2002; Zisapel, 2007; Lund et al., 2010; Araùjo et al., 2014; Borbély et al., 2016; Grandner, 2017; Matricciani et al., 2017; Chaput et al., 2018; Karthikeyan et al., 2019). Additionally, sleep is intimately connected with health, well-being, academic performance, cognitive functionality, productivity, physical and mental health, and daily functioning (Borbély, 1982; Brown et al., 2002; Zisapel, 2007; Lund et al., 2010; Araùjo et al., 2014; Borbély et al., 2016; Grandner, 2017; Matricciani et al., 2017; Chaput et al., 2018; Karthikeyan et al., 2019).

Sleep is critical for several functions, physiological processes and elements of health and well-being. It plays a vital role in brain detoxification, brain thermoregulation, energy conservation, memory consolidation, learning, and tissue restoration (Maquet, 2001). According to Seigel (2009), sleep serves as a state of ‘adaptive inactivity’ that increases the efficiency of waking activities by decreasing muscle activity and brain and body metabolism during periods of inactivity, saving energy, and restoring bodily systems after waking. The lower metabolic rate of sleep allows for biological processes that occur during sleep to require a lower overall energy cost to waking hours (Assefa et al., 2015). Thus, sleep is necessary for energy conservation (Assefa et al., 2015). The protective and restorative or recuperative function of sleep prevents exhaustion and functions in the recovery of the nervous system (Assefa et al., 2015).

Robust changes occur during the normal sleep/wake cycle, specifically regarding mental and physical activity, cardiovascular function, temperature regulation, and

immune parameters, namely, the number, function and proliferation of leukocytes and the production of cytokines (Besedovsky et al., 2012). Sleep plays an active role in recalibrating changes incurred during waking periods (Vyazovskiy, 2015). The sleep period is characterised by a profound down-regulation in the hypothalamus–pituitary–adrenal (HPA) axis and the sympathetic nervous system, along with an associated drop in levels of norepinephrine, epinephrine, and cortisol in the blood (Besedovsky et al., 2012). Conversely, cell growth facilitators such as growth hormone, prolactin and melatonin show a notable increase in blood levels during sleep (Besedovsky et al., 2012).

The hormones released during sleep show predominant anabolic functions, growth hormone, for example, as opposed to the hormones associated with wakefulness, such as cortisol, which tend to exert catabolic effects; thus, sleep serves to counter the cerebral free radical flux seen during waking hours (Reimund, 1994; Assefa et al., 2015; Frank & Heller, 2018). Removal of excess cerebral free radicals results from a decreased rate of formation of free radicals and the increased efficiency of endogenous antioxidant mechanisms; by this logic, sleep acts as an antioxidant for the brain and body that repairs and restores what had been degraded during wakefulness (Reimund, 1994; Frank & Heller, 2018). The detoxification function of sleep is vital in eliminating metabolic by-products, synaptic proteins, and membranes that accumulate during wakefulness (Frank & Heller, 2018).

Additionally, sleep serves vital functions for complex neural systems, facilitating brain plasticity, learning, and memory consolidation in both developing and adult brains (Maquet, 2001; Frank & Heller, 2018). Sleep is vital for memory consolidation, learning, decision-making, and critical thinking (Gilbert & Weaver, 2010). Learning leads to long-term potentiation and the strengthening of the central excitatory synapses in the brain, known as the glutamatergic synapses; these processes eventually become unsustainable for the brain to maintain (Mignot, 2008). During sleep, the brain goes into proportional synaptic cleansing/downscaling, leaving only the most robust connections/synaptic pathways intact (Mignot, 2008). Thus, sleep facilitates the processing of memories, during which memory traces may be analysed, reactivated, and gradually incorporated into long-term memory (Maquet, 2001). In this way, sleep reduces energetic space requirements to make way for the maintenance

of the more robust synaptic circuits and improves the performance of the connections (Mignot, 2008).

In sum, obtaining adequate amounts of good quality sleep is critical for several elements of health and well-being, as well as being highly necessary for the optimal operation of cognitive functions related to academic success in higher education (Gilbert & Weaver, 2010). However, the definition of good quality sleep has historically been restricted to sleep duration recommendations. The following section explores the definitions of sleep health, recommendations, and the current research on influencers and determinants of optimal sleep. Subsequently, the mechanisms through which sleep is regulated will be discussed using the two-process model.

2.2. Understanding Sleep: Sleep Health and Recommendations

2.2.1. Sleep Duration

When discussing what constitutes good sleep, recommendations for optimal sleep are often primarily based on the number of hours slept. The National Sleep Foundation recommends that healthy sleep durations for adolescents (14-17) get between 8 and 10 hours of sleep per night, with the lowest acceptable range being 7 hours (Hirshkowitz et al., 2015; Mukherjee et al., 2015; Watson et al., 2015). For young adults (18-25), 7 and 9 hours of sleep per night are recommended, with the lowest acceptable range being 6 hours; less than 6 hours and more than 11 hours are not recommended for this age group (Duggan, 2015; Hirshkowitz et al., 2015; Mukherjee er al., 2015; Watson et al., 2015).

However, the sleep duration recommendations do not necessarily represent the ideal/optimal sleep duration each individual needs (Buysse et al., 1989; Hirshkowitz et al., 2015; Mukherjee et al., 2015; Chaput et al., 2018). There are notable inter-individual differences in the optimal sleep duration needed throughout a lifespan (Mukherjee et al., 2015). As a result, the need for sleep and inter-individual required sleep duration may differ from scientifically recommended hours of sleep (Hirshkowitz et al., 2015; Mukherjee et al., 2015; Chaput et al., 2018). Inter-individual variability in sleep needs may determine that, for some individuals, sleeping longer or shorter than the recommended hours may not necessarily result in adverse health outcomes

(Chaput et al., 2018). Sleep duration needs vary according to age, sex-specific factors, and environmental factors (Mukherjee et al., 2015). Ageing, getting older, in particular, is associated with changes in sleep, specifically with increased difficulty in initiating and maintaining sleep and the emergence of daytime napping (Mukherjee et al., 2015). Nonetheless, sleep duration recommendations consist of zones of optimal sleep, with the relationship between sleep duration and adverse health outcomes being U-shaped, with both extremities of sleep duration being either associated with or indicative of adverse health outcomes (Grandner, 2017; Chaput et al., 2018; Karthikeyan et al., 2019). Short sleep duration has been of particular focus in research due to its associations with adverse health outcomes (Chaput et al., 2018). Long sleep duration has been considered informative, as it may indicate poor sleep efficiency, which is the measure of the percentage of time spent asleep compared to the total time spent in bed, or other adverse health-related outcomes, such as depression or illness (Chaput et al., 2018). While some research has found mortality rates to be higher amongst individuals that report sleeping either less than 7 hours or more than 8 hours, in comparison to individuals sleeping approximately 7 to 8 hours per night (Steptoe, et al., 2006). Other researchers have found that some individuals may be attaining sleeping hours which could be considered on the low or high end of the spectrum with no adverse effects (Hirshkowitz et al., 2015; Mukherjee et al., 2015). It is important to acknowledge, however, that sleep is multidimensional, and healthy sleep parameters extend beyond just sleep duration, as will be discussed in the following section.

2.2.2. Sleep Health

Sleep health is a multidimensional construct that extends beyond the historical definition of the absence of sleep disorders (Buysse, 2014; Dalmases et al., 2018). Buysse (2014) proposes that sleep health is a multifaceted cycle of sleep and wakefulness that promotes physical and mental well-being. Health and sleep are intimately connected, with both being either positively or negatively influenced according to physiological, biological, and external factors at play (Araùjo et al., 2014; Buysse, 2014; Paruthi et al., 2016; Grandner, 2017; Chaput et al., 2018). Ramar et al. (2021) proposed sleep as having significant and multifaceted connections with health and chronic disease.

Buysse (2014) outlines five fundamental dimensions of sleep associated with health outcomes using the acronym RU-SATED. The five dimensions include regularity, subjective sleep quality, alertness, timing, efficiency, and duration. Regularity pertains to the consistency of sleep patterns throughout the day. Subjective sleep quality refers to an individual's subjective evaluation of their sleep as either poor or good. Alertness refers to the ability to remain attentive and awake during waking hours. Timing relates to the hours within the day when one chooses to sleep, ideally aligned with the circadian rhythm, typically during night-time. Sleep Efficiency is measured as the ratio of time asleep to the time available for sleeping and is defined as the ease of falling asleep and returning to sleep if awakened. Lastly, duration quantifies the total amount of sleep acquired within 24 hours (Buysse, 2014, p.11).

The RU-SATED dimensions are considered appropriate sleep health indicators for several reasons (Buysse, 2014). Firstly, each dimension of sleep can be associated with health outcomes, although these may differ for each dimension (Buysse, 2014). Secondly, most sleep dimensions can be measured through behavioural, self-report, and physiological analyses (Buysse, 2014). Finally, the five dimensions are not all unidirectional, meaning they can be expressed in both positive and negative terms; for instance, sleep duration and quality can be considered "good" if they fall within specific ranges and "bad" if they deviate too far in either direction from "healthy" ranges (Buysse, 2014, p.11).

2.2.3. Sleep Quality

The dimension of sleep which is of particular interest in the current study is sleep quality. Sleep quality is not unilateral and determines salient aspects of mental and physical health, vitality and overall wellness (Buysse, 2014; Ohayon et al., 2017). Sleep quality has long been considered difficult to define; however, current sleep quality recommendations established by Ohayon et al. (2017) define *sleep quality* as an individual's satisfaction with all aspects of the sleep experience, specifically by aspects characterised by four sleep continuity variables (*sleep latency (*the time it takes to fall asleep*), sleep efficiency* (amount of time in bed vs. time spent asleep)*, and wake after sleep onset* (indicating number of times sleep is disturbed to the point

of awakening after the onset of sleep)), five sleep architecture variables (*rapid eye movement* (REM) sleep, and arousals during *non-rapid eye movement* (NREM) sleep 1;2;3) and finally three nap variables (naps per 24 hours, nap duration, and days per week with at least one nap) (Ohayon et al., 2017; Nelson et al., 2022).

Recommendations for optimal sleep quality encompass several variables. For instance, a sleep latency of 15 minutes or less indicates good sleep quality across all age groups, while latencies of 45 to 60 minutes signify poor sleep quality, with a latency of 60 minutes or more being considered a clear indicator of poor sleep quality (Ohayon et al., 2017).

Sleep efficiency is another crucial factor of sleep quality. A sleep efficiency score of 85% or more indicates good sleep quality in most age groups. A sleep efficiency range between 64% and 74% for young adults suggests poor sleep quality (Ohayon et al., 2017; Pelayo, 2017).

Additionally, the number of awakenings before and after sleep onset indicates sleep quality, with fewer awakenings generally indicating better quality. Objective measures such as wake-after-sleep onset (WASO) also provide insights, with a WASO of 20 minutes or less considered good and 51 minutes or more indicating poor sleep quality across age groups (Ohayon et al., 2017; Nelson et al., 2022).

Moreover, sleep architecture, characterised by the alternating cycles between *rapid eye movement* (REM) and *non-rapid eye movement* (NREM) sleep, contributes to overall sleep quality. Optimal sleep typically involves 90-minute cyclic movements between these states, with excessive time in REM sleep (41% or more) and reduced non-REM3 (5% or less) indicating poor sleep quality across most age groups (Stickgold et al., 2001; Stickgold, 2005; Zielinski et al., 2016; Bathory & Tomopoulos, 2017; Ohayon et al., 2017). Furthermore, the frequency of naps per 24 hours indicates fewer naps associated with better sleep quality.

Positive outcomes of good sleep quality include feeling refreshed and rested, satisfied with sleep, better health outcomes, less daytime sleepiness, improved well-being, improved psychological functioning, and positive family / social relations (Harvey et

al., 2008; Ohayon et al., 2017). Negative consequences of poor-quality sleep include exhaustion, fatigue, daytime dysfunction, mood dysfunction, increased lipid and carbohydrate intake, slowed responses, increased alcohol/caffeine intake, and strained family/social relationships (Harvey et al., 2008; Chattu et al., 2018).

However, these recommendations are not prescriptive, and sleep quality needs may vary between individuals being influenced by a myriad of factors, making sleep quality a relative measure rather than an absolute (Buysse et al., 1988; Ohayon et al., 2017). Although sleep quality has been considered subjective, an effective way to assess the inherently complex dimension of sleep quality, particularly in population-wide studies, is the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988).

Pittsburgh Sleep Quality Index (PSQI)

The PSQI investigates both qualitative and quantitative factors affecting sleep quality over the last month (Buysse et al., 1989). This tool consists of 19 self-rated questions and five additional questions rated by a bed partner or roommate. The 19 self-rated questions (items) assess a wide variety of factors which may influence sleep quality based on seven components/sub-scales.

The seven components include: (1) subjective sleep quality (very good, fairly good, fairly bad, very bad); (2) sleep duration (hrs); (3) sleep latency (min); (4) habitual sleep efficiency (actual sleep duration/time in bed x 100); (5) frequency of sleep disturbances; (6) use of sleeping medications; (7) daytime dysfunction (Buysse et al., 1989). Each component is weighted equally and measured on a scale of 0 to 3. The sum of the component scores yields a single global score, which ranges from 0-21. Lower scores indicate good sleep quality, while higher scores indicate poorer sleep quality. According to Buysse et al. (1989 p.205), a global PSQI score above five accurately identifies poor sleep quality, matching clinical lab results. The term ’sleep problems’ may refer to any combination of acute or chronic challenges with prolonged sleep onset latency, excessive wake after sleep onset, short sleep duration, decreased sleep efficiency, and poor sleep quality based on assessment (Irish et al., 2015). It is important to note that the PSQI is a largely subjective measure for sleep. In order to obtain more objective measures researchers can use polysomnography or actigraphy

measures, which can allow researchers to have an understanding of sleep/wake behaviours if that is what is being tested for. However, these methods are often expensive and make it difficult to conduct large scale studies.

Now that the multidimensional nature of healthy sleep has been established, the following section will further discuss the mechanisms through which sleep/wake behaviours are regulated and controlled, using the two-process model of sleep regulation.

2.3. Sleep/wake Regulatory Mechanisms

Sleep is regulated through the rhythmic expression and interaction of the circadian rhythm (Process C) and sleep/wake homeostatic process (Process S), described and understood through the two-process model, which explains the mechanisms through which the sleep-independent Process C interacts with the sleep-dependent Process S determine salient aspects of sleep regulation (Borbély, 1982; Borbély & Achermann, 1999; Rajaratnam & Arendt, 2001; Dijk & Lockley, 2002; Siegel, 2003; Lack & Wright, 2007; Mignot, 2008; Borbély et al., 2016).

2.3.1. The Circadian Rhythm

The Circadian Rhythm (Process C) is the output of the internal biological clock. Generated by translational and transcriptional feedback loops involving a multi-oscillatory system of cellular 'clock genes' that are synchronized by the suprachiasmatic nuclei, this hypothalamic pacemaker acts as a circadian oscillator regulating the diurnal rhythms of body functions and behaviours, including influencing the thresholds for the onset and offset of a sleep episode (Borbély & Achermann, 1999; Rajaratnam & Arendt, 2001; Dijk & Lockley, 2002; Siegel, 2003; Lack & Wright, 2007; Mignot, 2008; Besedovsky et al., 2012; Borbély et al., 2016).

The circadian clock exhibits a ±24hour rhythm and serves as a sensor of environmental cues known as zeitgebers, translated as 'time givers' (Roenneberg et al., 2013). Entrainment is an active and ever-changing process through which biological rhythms synchronize to external environmental cues (Roenneberg et al., 2013). Any environmental factor oscillating in a 24-hour rhythm can act as a zeitgeber,

although the light/dark cycle is the most prominent influence on circadian clocks (Roenneberg et al., 2013). The light-dark cycle is responsible for most other environmental rhythms; as such, it is the primary source of information regarding the time of day (Roenneberg et al., 2013).

The circadian clock generates and maintains the rhythms of several biochemical, physiological, and behavioural processes including but not limited to, body temperature, blood pressure, alertness, mental performance, and triacylglycerol levels, as well as the synthesis and secretion of several hormones, such as cortisol, prolactin, growth hormone, and melatonin, all of which vary throughout the 24-hour day (Rajaratnam & Arendt, 2001; Dijk & Lockley, 2002; Lack & Wright, 2007). The circadian clock's precise cycle length/periodicity is genetically determined, with any variations in clock genes related to the inter-individual differences in natural sleep/wake times (Rajaratnam & Arendt, 2001).

2.3.2. The Sleep/Wake Homeostatic Process

The Sleep-Wake Homeostatic (Process S) is the sleep-dependant component of sleep propensity (Borbély, 1982). The sleep/wake homeostatic process maintains the equilibrium between sleep and wakefulness (Rajaratnam & Arendt, 2001; Borbély et al., 2016). This drive, which dictates sleepiness levels, will increase as a function of the time spent awake and dissipate following a restful sleep episode (Borbély, 1982; Rajaratnam & Arendt, 2001; Borbély et al., 2016).

2.3.3. Interaction Between Process C and Process S

The sleep-dependent Process S interacts with the sleep-independent Process C to determine salient aspects of sleep regulation as well as to determine prominent aspects of sleep/wake behaviour, sleep quality, sleep quantity, and characterise fluctuations in alertness and vigilance (Borbély, 1982; Borbély & Achermann, 1999; Rajaratnam & Arendt, 2001; Dijk & Lockley, 2002; Siegel, 2003; Lack & Wright, 2007; Mignot, 2008; Borbély et al., 2016; Reichert et al., 2016).

Humans are typically driven by the natural diurnal urge to rise in the morning/daytime due to circadian entrainment to the light/dark cycle (Process C) interacting with sleep propensity being low after a night of rest (Process S) (Mignot, 2008; Borbély et al., 2016). Throughout the day, wake-promoting neurochemicals released as a result of Process C counteract the growing need for sleep, characterised by Process S; the need for sleep subsequently increases during waking hours as a result of the accumulation of sleep-promoting substances in the brain and central nervous system (CNS) (Mignot, 2008; Borbély et al., 2016; Bathry & Tomopoulos, 2017). Borbély (1982) proposed the time course of Process S and the negative function of Process C, as depicted in Figure 1.

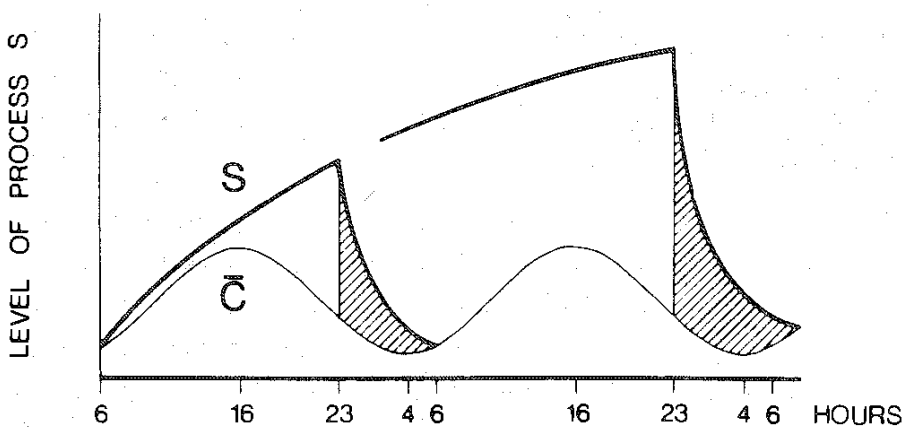

Figure 1: Time course of process S and the inverse function of process C (curve C). Taken from A Two Process Model of Sleep Regulation (Borbély, 1982).

Figure 2 illustrates how Processes S and C interact to regulate multiple aspects of sleep and wakefulness (Borbély, 1985; Borbély et al., 2015). The model in Figure 2 demonstrates how Process S, representing the homeostatic drive for sleep, accumulates during wakefulness and dissipates during sleep. Fluctuations in the model align with the day-night cycle, synchronized by the circadian pacemaker, represented by line C. When Process S reaches its lower threshold, it promotes wakefulness, meaning that following a sleep period, it will be at its lowest point (Borbély, 1985; Borbély et al., 2015). During waking hours, the need for sleep, driven by process S, accumulates and reaches its upper limit, indicating when sleep need is at its highest (Borbély, 1985; Borbély et al., 2015).

Conversely, Process C displays rhythmic variations inversely related to sleep propensity, peaking when the need for sleep is lowest, typically in the afternoon (Borbély, 1985; Borbély et al., 2015). This interaction is depicted by the widening gap between the curves of Processes S and C during the evening, indicating increased readiness for sleep. Conversely, this gap diminishes as sleep progresses until it reaches zero upon awakening (Borbély, 1985). Any disruptions to these processes can result in circadian desynchrony (Dijk & Lockley, 2002; Shochat, 2012). In summary, the sleep drive (Process S) increases with the duration of wakefulness, interacting with the rhythmic component of hormone release and temperature regulation (Process C), which is entrained to the light/dark cycle of the 24-hour day (Borbély, 1982; Waterhouse et al., 2012).

Having touched on the two-process model, the subsequent section explores the influencers and determinants of sleep broadly before focusing more on university and systemic factors related to the university context.

2.2. Influencers and Determinants of Sleep

Research has established that there are high levels of variability in behaviours and practices relating to sleep and sleep/wake patterns in the human population (Buysse, 2014; Paruthi et al., 2016; Bathory & Tomopoulos, 2017; Grandner, 2017; Ohayon et al., 2017; Chaput et al., 2018; Chaput et al., 2020; van de Langenberg et al., 2022). Sleep/wake practices are driven by a complex interplay between physiological, biological, behavioural, and genetic factors, which can vary according to age, sex, and previous sleep duration (Buysse, 2014; Paruthi et al., 2016; Bathory & Tomopoulos, 2017; Grandner, 2017; Ohayon et al., 2017; Chaput et al., 2018). Additionally, sleep is influenced by multiple individual, social and societal factors (Grandner, 2017).

The socio-ecological model, depicted in Figure 2, used to understand sleep in humans at a population level, characterises determinants of sleep as multileveled, made up of micro, meso, and macro factors. The micro level refers to the individual, the meso level consists of social factors, and the macro level comprises societal factors (Grandner et al., 2010; Grandner, 2017).

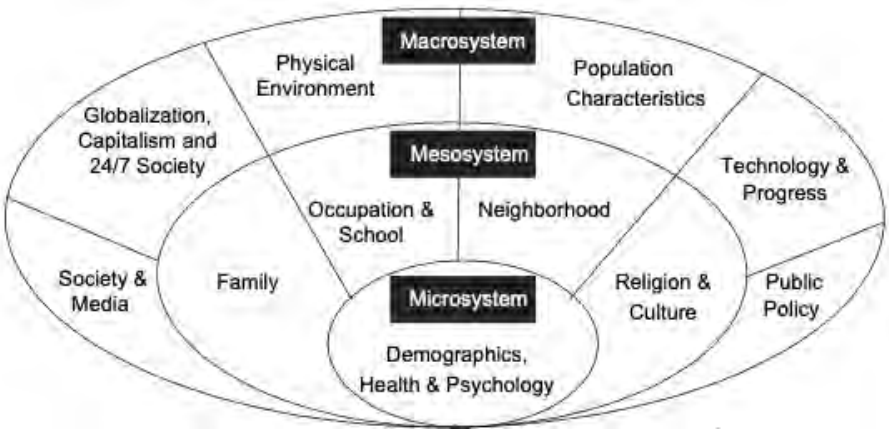

Figure 2: Model for socioecological determinants of sleep. Diagram taken from Mortality Associated with Short Sleep Duration: The Evidence, The Possible Mechanisms, and the Future (Grandner et al., 2010).

At the micro level, factors influencing sleep in the general population include genetics, beliefs and knowledge, attitudes regarding sleep, and overall health (Grandner, 2017). However, these factors do not act in isolation. The individual is embedded within a social context that they are a member of but exist outside of the individual; this would be considered the meso level and is made up of the home (e.g. family, bedroom), work/schooling, socioeconomics, neighbourhood, religion, ethnicity, culture, to name a few (Grandner, 2017). The social level is embedded within a societal framework, making up the macro influencing factors, comprising social forces outside the social level factors, such as globalisation, technology, public policy, and geographical location (Grandner, 2017). The factors at this macro level filter through the meso-level social factors and eventually come to bear down on the individual at the micro level (Grandner, 2017).

In sum, according to the socio-ecological model, sleep at a population level is influenced by micro, meso, and macro factors. The socio-ecological model integrates

these ideas to illustrate how various environmental, social, and societal aspects of modern life impact sleep quality and duration (Karthikeyan et al., 2019). Consequently, sleep patterns differ among different segments of the population, with certain groups (Buysse, 2014; Paruthi et al., 2016; Bathory & Tomopoulos, 2017; Grandner, 2017; Ohayon et al., 2017; Chaput et al., 2018; Chaput et al., 2020; van de Langenberg et al., 2022), such as older adolescents and young adults attending university, being particularly vulnerable to inadequate and poor-quality sleep (Brown et al., 2002; Steptoe et al., 2006; Reid & Baker, 2008; Suen et al., 2009; Vail-Smith et al., 2009; Gilbert & Wear., 2010; Lund et al., 2010; Orzech et al., 2011; Cheng et al.., 2012; Lemma et al., 2012 [A & B]; Araújo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Benham, 2020; Du et al., 2021; Marelli et al., 2021).

Prior to delving into the sleep behaviours of university students and the determinants of student sleep, contextualisation of the university setting both globally and in South Africa is provided, as this is important for the reader to keep in mind when trying to understand the current research on student sleep/wake behaviour, sleep quality, and determinants of sleep. Subsequently, existing research on sleep among university students will be explored. This will be followed by examining the factors influencing sleep in this demographic.

2.3. Contextualising the Undergraduate University Context

Along the academic journey, transitions are expected, with students encountering new knowledge, moving between educational stages, and adapting to different institutional contexts (Hussey & Smith, 2010). Assimilating to university life involves more than adapting to academic demands; but also involves profound personal, social, lifestyle-related modifications in order to adapt to the unique conditions within the university system (Medeiros et al., 2001; Hussey & Smith, 2010; Rossa et al., 2014; Kabrita et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018). This section focuses on the experiences of undergraduate students, specifically first-, second-, and third-year students, and provides some context as to the specificities of challenges faced in the South African higher education system, particularly at Rhodes University.

2.3.2. First Year Experience

For first-year university students, the transitional period from high school to university is often related to increases in stress levels, which, in turn, can bring about significant and long-lasting effects on the sleep of the students; for more advanced undergraduate students, a common stress factor includes facing continuing pressure for academic performance (Amaral et al., 2018; Ramachandiran & Dhanapal, 2018). The following will further discuss aspects specific to each level of undergraduate studies and the correlating influencing factors that can affect sleep. The first year of university is regarded as a period wherein students experience notable transition and is considered an essential aspect of social, cultural, and academic assimilation into higher education, which encompasses specific practices and academic demands to become accustomed to (Maunder et al., 2013).

The transition from the school environment to the university environment can, and in many cases may result in academic, social, and psychological shock, mainly due to the vast differences in the education system, academic requirements, methods of teaching, type of relationships between lecturers and students, as well as the relationships between the students themselves (Ramachandiran & Dhanapal, 2018). Much of the learning during the first year of university is directed at understanding how to cope with the change and adapt to their new environment and institutional demands (Jones, 2018).

Transitional experiences are not exclusive to first-year students. However, universities tend to make a concerted effort for first-year students by developing programmes that assist new students in adjusting to campus life (Lipka, 2006). Undergraduates across all years of study do experience transitions and adjustments throughout the educational experience (Maunder et al., 2013).

2.3.3. Second Year Experience

Second-year students are no longer in the 'honeymoon phase' of entering university and are becoming more aware of their environment and university experience (Sterling, 2018). The second year is a period wherein students face an increased workload, as they are dealing with not only the demands of their major courses but

also the demands of the general education courses they are required to take (Sterling, 2018). Courses may become more challenging for second-year students in the sense that these students begin to focus on potential fields of interest, leading students to feel more invested in these courses than in their first-year general education courses, which may have been unrelated to their desired path (Tobolowsky, 2008). This increased investment may result in additional pressure and stress (Tobolowsky, 2008). Second-year students face unique challenges outside of increased academic demands, such as navigating institutional demands, deciding on the selection of a major, and meeting expectations (Sterling, 2018).

2.3.4. Third Year Experience

Traditionally, the third year of university is when students can focus on the main courses in their major (Tobolowsky, 2008). Additionally, these students tend to have increased leadership responsibilities through peer leadership, mentorship, and resident advisors (Tobolowsky, 2008). Furthermore, the third year in most faculties in universities in South Africa often marks the end of undergraduate studies, making it an exit year. Many students in the third year are facing the upcoming transition either into the workforce or into postgraduate studies. Despite the many unique challenges presented to each year of study, institutional support tends to decrease for second and third-year students; however, these students often experience increased responsibilities and expectations (Lipka, 2006).

2.4. Contextualizing the South African University Setting:

South Africa's higher education (HE) sector comprises 124 Private Higher Education Institutions and 26 Public Universities (Department of Higher Education and Training, 2017). The 26 universities are categorised based on the expected outcomes for the students and degree levels (Uleanya & Rugbeer, 2020). The South African Higher Education (SAHE) sector is a differentiated system that classifies the 26 South African Universities based on three institutional types, namely, Research-Intensive Universities (RIU), Comprehensive Universities (CU), and Universities of Technology (UoT) (Hlengwa, 2019; Uleanya & Rugbeer, 2020).

South African higher education institutions often offer higher professional and research-oriented higher education (Nuffic, 1952). Public Universities in South Africa offer several degree options, including Higher Certificate (duration: 1 year), National Diploma (Duration 3 years), bachelor's degree (Duration: 3 to 6 years depending on study programme), Bachelor Honours Degree (Duration: 1 year), master's degree (Duration 1 – 3 years), and a Doctoral degree (PhD) (Duration: at least two years) (Nuffic, 1952; *Higher Education Qualifications South Africa, Degrees programmes*. (n.d.)). A bachelor's degree can be made up of Commerce, Humanities, And Science (duration of three years) or law (duration of four years); other examples which fall under the bachelor's program include nursing, medicine, and veterinary science (duration of 4 to 6 years) (Nuffic, 1952; *Higher Education Qualifications South Africa, Degrees programmes*. (n.d.)). Bachelor's Honours and master's degrees allow students to study in their field of study of their bachelor's degree (Nuffic, 1952; *Higher Education Qualifications South Africa, Degrees programmes*. (n.d.)).

2.4.2. Challenges in South African Higher Education Institutions

The South African Higher Education system must contend with the imbalances brought about through the legacy of the apartheid regime, which aid in dividing universities into historically advantaged institutions (HAI) and historically disadvantaged institutions (HDI), which further add to the complexities experienced within the South African University System (Hlengwa, 2019).

Between 2000 and 2010, enrolment in higher education has more than doubled, increasing from 2.3 million to 5.2 million in Africa (Kwasi-Agyeman et al., 2020). According to an article published by Universities South Africa (U.Africa, 2018), graduation rates in South Africa were between 50 and 62%, depending on the degree programme. As of 15 April 2023, Rhodes University reported between 8700 and 9300 registered students at the time of this study, of which between 6400 and 6550 were undergraduate students (Rhodes University Gateway 2024).

2.4.2.1. Fiscal Challenges Facing South African Higher Education

Whilst increased enrolment in higher education in South Africa is a positive sign for the progression of the youth, it has put a strain on the fiscal situation of higher

education institutions (Kwasi-Agyeman et al., 2020). Government funding for the HE sector has been reduced in real terms, while the student enrolment rate has increased as the years have progressed (Kwasi-Agyeman et al., 2020). Since 2015, South Africa has experienced heightened tension between the expectation of maintaining globally competitive educational standards and increased access to higher education at a lower cost to the students (Ayuk & Koma, 2019).

The current challenge for universities in South Africa is to adequately provide students access to quality education to ensure global competitiveness (Ayuk & Koma, 2019). In response to economic challenges faced by universities in South Africa, the National Student Financial Aid Scheme (NSFAS) was implemented to assist in financing higher education for students who would not have access to higher education due to financial reasons (Ayuk & Koma, 2019). NSFAS has somewhat fulfilled this purpose; however, reports have demonstrated that the agency has been under increasing pressure to meet financial obligations (Ayuk & Koma, 2019). The consequence is an increase in the burden of financing higher education, which universities have placed on students through increased tuition fees (Ayuk & Koma, 2019). The increase in tuition fees has exacerbated the related costs of higher education, such as student accommodation and living expenses, among others (Ayuk & Koma, 2019).

Most universities in South Africa, particularly historically disadvantaged institutions, have a limited capacity for generating third-stream income (Ayuk & Koma, 2019). The consequence is an increase in the burden of financing higher education, which the universities place on the students through tuition fees (Ayuk & Koma, 2019). Increasing tuition fees has impacted and exacerbated the related costs of higher education, such as student accommodation and living expenses (Ayuk & Koma, 2019). This increased financial burden on students has created unrest at South African universities (Mavunga, 2019).

2.4.2.2. Student Unrest in South African Universities

Social unrest can present as strikes, political or civil violence, peaceful demonstrations, and disruptive or violent demonstrations (Lancaster, 2018). In South Africa, there has been a significant increase in local protest action since 2004; this

phenomenon has come about with such scale and intensity that it has been described as an insurgency/insurrection (Bohler-Muller et al., 2017). Students, workers, and various actors have demonstrated increased protest tactics to achieve economic, social, or political change (Bohler-Muller et al., 2017).

Student activism has been described as a form of action that seeks to change how the university systems function or challenge a particular paradigm; this may be politically, socially, or economically motivated (Stuurman, 2018). Student protests, violent or peaceful, are forms of student activism (Stuurman, 2018). Participation in student activism is guided by self-interest, which may arise to bring particular issues to the forefront, such as high tuition fees, economic imbalances, student living, etc. (Stuurman, 2018).

In 2016, South African students demonstrated student activism, which resulted in shutting down most university campuses for approximately six weeks (Stuurman, 2018). During this time, university campuses became violent spaces marked by heavily armed police, with students being subjected to different forms of violence, as well as many students being stuck with criminal charges (Stuurman, 2018). The primary concern/basis for the protest action was a lack of access to free quality education (Stuurman, 2018). Student protests related to the #FeesMustFall, amongst others, have become mainstream/commonplace on university campuses across South Africa (Abdool & Kruyer, 2017).

At Rhodes University, in particular, student protestors have engaged in protest action, ranging from non-violent disruptive acts, including an 'academic shutdown' that involved students restricting access to the university campus through the use of blockades, physically chaining the doors to academic venues, interrupting lectures, and being disruptive in test venues and libraries, to more definitively unlawful action, such as acts of intimidation, and assault to name a few (Abdool & Kruyer, 2017). South African Higher education was considered to be in a state of turmoil during the time of increased student activism (Frick., 2018). Demands for the decolonisation of the university curricula, pressure on institutions to insource staff, calls to diversify staff and student bodies, increased state intervention, uncertainty around government funding

of the sector, substantive changes to national policy directives, and student protests have created a sector which is in constant flux (Frick., 2018).

With the university context established, the following section will discuss global research regarding sleep among university students, both internationally and locally, aiming to enhance our understanding of sleep in this demographic.

2.5. Current Sleep Research in University Students

Existing research has extensively demonstrated that globally, undergraduate students tend to report a high insufficient and poor-quality sleep, as well as a high prevalence of poor sleepers within sample cohorts (Brown et al., 2002; Steptoe et al., 2006; Reid & Baker, 2008; Suen et al., 2009; Vail-Smith et al., 2009; Gilbert & Wear., 2010; Lund et al., 2010; Orzech et al., 2011; Cheng et al.., 2012; Lemma et al., 2012 [A & B]; Araújo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Benham, 2020; Du et al., 2021; Marelli et al., 2021). Additionally, university students in many previous studies reported long sleep latencies (> 30 minutes), which is strongly associated with poor sleep quality (Reid & Baker, 2008; Sweileh et al., 2011; Lemma et al., 2012 [A]; Ohayon et al., 2017; Lawson et al., 2019).

Table 1 summarises global research investigating sleep/wake characteristics in university students with a particular focus on studies conducted prior and during the COVID-19 pandemic. The objective behind having research gathered during COVID was to acknowledge what was found regarding the state of student sleep during this time. The aim of Table 1 is to provide to provide a scope of the current global research in this area.

2.5.1. Research on Student Sleep Prior to COVID-19

In sum, Table 1 presents some of considerable amount of research that has been conducted amongst student cohorts across different socio-cultural regions using the Pittsburgh Sleep Quality Index (Steptoe et al., 2006; Reid & Baker, 2008; Gilbert & Wear, 2010; Seun et al., 2010; Lund et al., 2010; Cheng et al., 2012; Lemma et al., 2012 [A]; Lemma et al., 2012 [B]; Araújo et al., 2013; Kabrita et al., 2014; Schlarb et

al., 2017; Seun-Fadipe & Mosako, 2017). The results of the global research demonstrate that sleep duration and quality in students globally is highly variable with many students falling below the recommended hours of sleep and reach the clinical cut-off point for poor sleep quality (Steptoe et al., 2006; Reid & Baker, 2008; Gilbert & Wear, 2010; Seun et al., 2010; Lund et al., 2010; Cheng et al., 2012; Lemma et al., 2012 [A]; Lemma et al., 2012 [B]; Araújo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017).

Table 1: Summary of research on sleep/wake characteristics of university students globally both prior to and during the COVID-19 pandemic

Author	Continent	Country	Age & Sample size	Study Design	Measures	Sleep Quality of students	Sleep Duration of Students
Reid & Baker (2008)	**Africa**	South Africa	Mean age: 21 yrs. (±3 yrs.) 986 second year university students	Cross-sectional	Self-developed questionnaire including: Sleep and lifestyle characteristics. Fatigue-related driving history. Epworth Sleepiness Scale (ESS)(Johns, 1991) Academic characteristics.	Poor subjective sleep quality found in sample.	ESS scores greater than 10 indicating high levels of daytime sleepiness.
Lemma et al. (2012) [A]		Ethiopia	Mean age: 17-35 yrs. 2551 undergraduate students	Cross-sectional	Questionnaire including: Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Depression and Anxiety Scale-21 (DASS-21) (Henry & Crawford, 2005) Perceived Stress Scale (PSS) Selected modules of the World Health Organization STEPS instrument (WHO, 2009)	Mean global PSQI score was 6.23. 55.8% of students reported poor sleep quality.	Mean sleep duration was 6.79 hrs (±1.9hrs) Only 37.6% of students reported sleeping more than 7 hrs per night.
Lemma et al. (2012) [B]			Mean age: 21.6 yrs. (±1.7) 2230 undergraduate students		Self-administered questionnaire including: Demographic characteristics Stimulant use questions Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988)	55.9% of females were classified as poor sleepers (PSQI global score >5). 52.7% of males were classified as poor sleepers (PSQI global score >5).	44% of sample slept less than 6 hrs. 14.4% of sample slept more than 8 hrs.

Seun-Fadipe & Mosako (2017)		Nigeria	Mean age: 21.9 yrs. 505 university students	Cross-sectional	Socio demographic questionnaire Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) General Health Questionnaire (Goldberg & Hiller, 1979) Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983)	Mean PSQI score was 5.83 (±2.97). 50.1% of sample were classified as poor sleepers (PSQI score >5).	45% of sample slept between 7 and 8 hrs per night. 16.8% of students slept less than 5 hrs per night.
Suen et al. (2009)	**Asia**	Hong Kong	Mean age: 20.69 (+1.56) yrs. 400 full time students	Cross-sectional	Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Sleep hygiene practice questionnaire (Brown et al., 2002; Lacks, 1987; Manni et al., 2000)	Mean PSQI score of 5.20 (+2.45). 170 (42.5%) were classified as good sleepers (PSQI global score <5). 230 (57.5%) were classified as poor sleepers (PSQI global score >5).	Mean sleep duration of poor sleepers: 6h16. Mean sleep duration of good sleepers: 7h43.
Seun et al. (2010)			Mean age of 20.70 (±1.6) yrs. 400 undergraduate and postgraduate university students	Cross-sectional	Self-filled questionnaire including: Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Sleep hygiene knowledge assessment (17 items) Sleep-hygiene practice assessment (22 items)	Majority of students had PSQI scores >= 5.	Not stated.

Cheng et al. (2012)		Taiwan	4318 first year university students	Cross-sectional	Self-filled questionnaire including: Pittsburgh Sleep Quality Index (PSQI)(Chinese version) (Buysse et al., 1988). Chinese Health Questionnaire (CHQ) Chinese Internet Addiction Scale-Revision (CIAS-R) Self-reported Measurement of Support Function (MSF) Maudsley Personality Inventory (MPI)	54.7% sample reported poor sleep quality. Mean PSQI score was 6.0 SD: ±2.5.	Poor sleepers reported shorter total sleep duration 6h25 (±1.46) Good sleepers reported longer total sleep duration 7h18 (±1.06)
Kabrita et al. (2014)		Lebanon	Age range: 17-25 yrs. 540 university students	Cross-sectional	Pre-tested questionnaire including: Demographic, occupational, socioeconomic characteristics, and health behaviours Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Morningness-Eveningness Questionnaire (MEQ) (Johns, 1991)	58.7% of respondents reported poor sleep quality. Mean PSQI score was 6.57 ±3.49.	Total sleep duration (both weekends and weeknights considered): 7h95 (±1.34hrs)
Schlarb et al. (2017)	**Europe**	Luxembourg and Germany	Mean age: 23.71 yrs. 2777 students from Germany 184 students from Luxembourg	Cross-sectional	Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988). Epworth Sleepiness Scale (ESS) (Johns, 1991) Morningness Eveningness Scale (German version; *d*-MES) (Griefahn, 2001). Patient Health Questionnaire (PHQ-D) (Gräfe et al., 2004). Social-interaction-anxiety Scale (Stangier, 1999). Test Anxiety Questionnaire (Hodapp, 2011). Self-Efficiency Questionnaire (SWE) (Hinz, 2006).	39.3% of students reported good sleep quality (PSQI score <= 5). 42.8% of students reported impaired sleep (PSQI score 6-10). 17% of students reported severe sleep problems (PSQI >10).	Students reported sleeping between 3-12 hrs per night. Majority reported sleeping 7hrs per night.

Lund et al. (2010)	**North America**	Midwestern United States	Age range: 17-24 yrs. 1125 university students	Cross-sectional	Online survey including: Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988). Epworth Sleepiness Scale (ESS)(Johns, 1991) Horne-Ostberg Morningness Eveningness Scale (MES) (Johns, 1991) Subjective Units of Distress Scale (SUDS) Profile of Mood States (POMS).	34.1% of students reported good quality sleep (<5). 38% of students reported poor sleep (>5).	Mean total sleep time was 7h02. 25% of students reported getting less than 6hrs. 29.4% of students reported getting 8hrs or more.
Gilbert & Wear (2010)			Mean age: 19.50 yrs. (±2.02 yrs.) 468 undergraduate students	Cross-sectional	Questionnaire including: Demographic survey Goldburg Depression Inventory (GDI) (Goldburg, & Hiller, 1979) Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988)	70% of sample reported poor sleep quality.	Mean total sleep time was 7h20 (±1.2) (range of 4-12 hrs)
Galambos et al. (2013)		Canada	185 first university students tracked for 4 years of university	Longitudinal	Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988)	Not Stated.	Wave 1: 6h72 (±1.29) Wave 2: 6h87 (±1.27) Wave 3: 6h86 (±1.09) Wave 4: 6h87 (±1.10) Wave 5: 6h93 (±1.16)
Araújo et al. (2013)	**South America**	Brazil	Mean age: 21.5 yrs. (±4.5 yrs.) 701 undergraduate students	Cross-sectional	Questionnaire Sociodemographic characteristics Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988)	Mean PSQI score: 9.40 (±2.2). 95.3% of sample had PSQI scores >5.	Mean sleep duration for whole sample: 6h30 ±1.4 hrs.
Samaranayake et al. (2014)	**Oceania**	New Zealand	Median Age: 20 yrs. Age range: 16-38 1292 university students	Cross-sectional	Auckland Sleep Questionnaire	39.4% of sample reported a significant sleep problem for the prior month.	Not tested for.

Steptoe et al. (2006)	**Other**	24 different countries	Age range: 17-30 yrs. 17465 university students	Cross-sectional	International Health and Behavior Study – anonymous questionnaire study of health behaviours, attitudes, and risk awareness in university students Beck Depression Inventory (Beck et al., 1988)	Not tested for.	Average sleep durations ranged from 6-8 hrs. 63% of students reported 7-8 hrs of sleep. 21% of students reported <6-7 hrs of sleep. 16% reported 8-10 hrs.
Research Gathered During COVID-19							
Author	**Continent**	**Country**	**Age & Sample size**	**Study Design**	**Measures**	**Sleep Quality of students**	**Sleep Duration of Students**
Mvula et al. (2021)	**Africa**	Zambia	Age range: 18-24 212 University students	Cross-sectional	Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Reduced Morning-Eveningness questionnaire (Adan & Almirall, 1991)	79.2% of the sample were classified as poor sleepers (PSQI global score >5).	Majority of students (42.90%) reported sleeping between 5-6 hrs per night.
Ahammed et al. (2021)	**Asia**	India	Total of 1317 university students 846 undergraduate students 471 graduate and postgraduate students	Cross-sectional	Online survey including: Socio-demographic characteristics Self-report Generalized Anxiety Disorder (GAD-7) (Spitzer et al., 2006) WHO-5 Well-Being Index (WHO-5) (Mental Health Centre North Zealand, 2020) The Fear of COVID-19 Scale (FCV-19s) (Ahorsu et al., 2020) Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988)	27% of total sample were classified as poor sleepers (PSQI global score >5). Mean sleep quality for males: 8.11 (±5.81). Mean sleep quality for females: 9.08 (±5.61).	Not tested for.
Benham (2020)	**South America**	Southwestern United States	Age range: 18-52 Mean age: 21.3 yrs. (±4.86) 1222 undergraduate students	Longitudinal	Online survey including: Perceived Stress Scale. (Cohen et al., 1988) Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Insomnia Severity Index (Bastien et al., 2001)	Pre-COVID-19 64% were classified as poor sleepers (PSQI global score >5). Samples during 2020 showed 66.5% of students being were classified as poor sleepers (PSQI global score >5).	Pre-COVID-19 45.5% of students reported getting >=7hrs per night. During spring semester 2020 59.9% of students reported getting >= 7hrs per night. During summer semester 2020 63.6%

							of students reported getting >=7hrs sleep per night.
Cellini et al. (2020)	**Europe**	Italy	Age range: 18-35 yrs. 1310 young adults 809 university students	Cross-sectional	Online survey including: Pittsburgh Sleep Quality Index – Italian Version (PSQI: Curcio et al., 2013) Depression, Anxiety, Stress Scales (DASS-21) (Henry & Crawford, 2005)	Pre-lockdown PSQI score for students was ±5.2. During lockdown PSQI score for students was ±5.8.	During lockdown students delayed bed by ±40min and delayed wake time by ±45min. During lockdown TIB increased by ±5min for students.
Marelli et al. (2021)			Mean age 22.84 yrs. (±2.68) 307 university students 93 administration staff	Cross-sectional	Online survey including: Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Beck Anxiety Inventory (BAI) (Beck et al. 1998) Beck Depression Inventory (BDI) (Beck et al. 1996)	Pre-COVID-19 global PSQI score was 5.37 (±3.01). During COVID-19 global PSQI score was 6.97 (±3.54).	Pre-COVID-19 mean total sleep duration was 7h17 (±1.03) During COVID-19 mean total sleep duration was 7h20 (±2.21)
Viselli et al. (2021)			Age range: 18-25 2016 sample: 240 undergraduate students Age range: 18-25 2020 sample: 240 undergraduate students	Cross-sectional + retrospective	Survey including: Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988) Insomnia Severity Index (Bastien et al., 2001) Beck Depression Inventory (BDI) (Beck et al. 1996)	Mean Global PSQI score for 2016 sample: 5.96 (±2.64). Mean Global PSQI score for 2020 sample: 6.61 (±2.96).	Mean PSQI sleep duration score 2016 sample: 0.48 ±0.65. Mean PSQI sleep duration score 2020 sample: 0.52 ±0.69.

Evans et al. (2021)		United Kingdom	Age range: 18-31 254 undergraduate students	Longitudinal	Online questionnaire (2 time points) AUDIT-C questionnaire (Bush et al., 1998) Reduced Morning-Eveningness questionnaire (Adan & Almirall, 1991) Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988). Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith, 1983). Warwick Edinburgh Mental Well-being Scale (Tennant et al.,2007). De Jong Gierveld Loneliness Scale (Gierveld and Tilburg, 2006).	Pre-COVID-19 mean global PSQI score: 6.58 (±3.35). During COVID-19 mean global PSQI score: 6.60 (± 3.16).	Not tested for
Du et al. (2021)	**Asia, North America & Europe**	China, Malaysia, Taiwan, South Korea, United States, Ireland, and Netherlands	Mean age: 22.5 yrs. (±5.5yrs) 2254 university students	Cross-sectional	Questionnaire including: Perceived Stress Scale-10 (PSS-10) (Cohen et al.,1983). Food Frequency Questionnaire (FFQ) – Starting the Conversation (STC) (Paxton et al., 2011). Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988).	Mean PSQI global score was 6.8 (±3.5).	Mean sleep duration was 7h50 (±1.2hrs).

2.5.2. Student Sleep During COVID-19

More recently, it has been proposed that poor sleep quality was maintained among undergraduate students across the globe during the COVID-19 pandemic, depicted in Table 1 (Benham, 2020; Ahammed et al., 2021; Du et al., 2021; Evans et al., 2021; Marelli et al., 2021). While these findings underscore the pervasive nature of poor sleep during the pandemic, findings during the COVID-19 pandemic were mixed. Some studies found slight differences in PSQI scores between two specified time points, specifically Viselli et al. (2021), who observed a slight increase in PSQI scores when comparing students in 2016 and 2020, indicating it had worsened. Evans et al. (2021) found no significant difference in sleep quality among undergraduate students in the UK before and during COVID-19. While the restrictions and lifestyle challenges related to COVID-19 were over during the time of this study, it is vital to acknowledge the state of student sleep during this time, as in order to understand present situations, one cannot ignore what has preceded data collection, especially with the gravity and sphere of influence that a global pandemic can hold.

In sum, global research using standard sleep measures suggests that students are a population that is at risk of poor quality and insufficient sleep (Steptoe et al., 2006; Reid & Baker, 2008; Gilbert & Wear, 2010; Seun et al., 2010; Lund et al., 2010; Cheng et al., 2012; Lemma et al., 2012 [A]; Lemma et al., 2012 [B]; Araújo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Benham, 2020; Ahammed et al., 2021; Du et al., 2021; Evans et al., 2021; Marelli et al., 2021). The level of severity of poor sleep ranges across different contexts, with global PSQI scores ranging from 5.20 (±2.45) at the lowest (Seun et al., 2010) to 9.40 (±2.2) at the highest (Araújo et al., 2013). Additionally, the range of students classified as poor sleepers based on PSQI measures (Global PSQI score >5) also shows variation from study to study, ranging from 27% at the lowest (Ahammed et al., 2021) to 95.3% of the total sample at the highest (Araújo et al., 2013). However, despite the range across contexts, it can still be concluded that global sleep quality among university students is generally poor. It is

Now that the state of university student sleep globally and locally has been discussed, the next section will go further into a more micro-level determinant of sleep, with

specific reference to developmental changes experienced in old adolescents and young adults.

2.5.3. Research Emerging from Africa and South Africa

Table 1 also shows the scope of global research in this area and highlights the need for more research pertaining to sleep in university students emerging out of South Africa. Several studies emerging out of Africa present findings which are in line with global research on university students exhibiting poor sleep quality has been found in the African continent as well (Lemma et al., 2012 [A & B]; Seun-Fadipe & Mosako, 2017). There is, however, comparably less research on undergraduate sleep/wake characteristics emerging from South Africa. To the best of the researcher's knowledge, there are very few published papers on sleep in undergraduate students from South Africa, namely a study by Holdstock and Verschoor (1974) and a study by Reid and Baker (2008) (included in Table 1), and Nicholson et al. (2021). Holdstock & Verschoor (1974) investigated sleep and its relation to examination performance in a small sample of 6 female graduate students in a South African university.

Reid & Baker (2008) were the first study to provide information regarding sleep/wake behaviour and the factors that interact with sleep quality and daytime sleepiness in university students in a research-intensive South African university. The Reid and Baker (2008) study had a large population of 986 second-year students, where students were distributed across several undergraduate disciplines. Reid and Baker (2008) found that as a group, their sample of students showed signs of insufficient night-time sleep, with napping being shared among the sample. 82% of the Reid and Baker (2008) sample reported good sleep quality, with 18% reporting poor sleep quality. However, this study relied heavily on Male/Female gender binaries and ethnicity as the main variables analysed. This approach can be limiting as it can create rhetoric which can create divisions between people, classifying them as "good" and "poor" sleepers based on ethnicity or gender binaries rather than focusing on contextual factors of being in a South African university and how that can affect sleep/wake behaviour and sleep quality.

Nicholson et al. (2021) placed a particular focus on testing if methods of emotional regulation and neurobiological factors, particularly sleep quality, may have an effect on the presence and severity of psychiatric symptoms in a group of undergraduate students attending a South African university. Nicholson et al (2021), found that in their sample of students the use of maladaptive emotional regulation strategies and decreased use of cognitive reappraisal (an adaptive strategy), was associated with poor sleep quality. Poor sleep quality, in turn, was linked with increased prevalence of posttraumatic symptoms and depression in students (Nicholson et al., 2021). Thus, according to Nicholson et al. (2021), the means through which students manage their emotions indirectly affects mental health through the impact it has on sleep quality. However, along with only using self-report measures, the Nicholson et al. (2021), study had a relatively small sample size made up of students from the University of Cape Town, this may influence the generalisability of the results found in this study

It is important to note that Holdstock & Verschoor (1974), the Reid & Baker (2008), and the Nicholson et al. (2021) studies out of South Africa is that they were mainly based on self-report measures, although these methods are a valid method of assessing sleep quality, self-report measures are subject to various sources of inaccuracy (Paulhus & Vazire, 2007).

A further limitation of the Holdstock & Verschoor (1974), the Reid & Baker (2008), and the Nicholson et al. (2021) studies is that their assessment of students' sleep quality in South Africa occurred specifically during exam periods. Academic demands may differ between exam and non-exam terms; thus, characterising sleep quality during non-exam terms is needed to provide more information on how sleep/wake characteristics may present in undergraduate students during this time. This thesis aims to address this gap.

2.5.3.1. Factors Influencing Sleep in Students in Higher Education in South Africa

Students specifically in universities are exposed to some of the uniform demands faced by university students in other countries, specifically university-related academic stressors, family/personal pressure, economic burden, pressure to meet scholarship

requirements, competition between students in class, time management, course-related and examination-related stress (Ramachandiran & Dhanapal, 2018; Gardani et al., 2022). However, the sleep/wake characteristics of the students in South African universities may be influenced by additional factors unique to the South African context, such as financial challenges, frequent civil unrest and political instability affecting higher education. For instance, student protests and violent demonstrations, notably the #FeesMustFall movement, have created a highly stressful environment for students, exacerbating their mental health issues and disrupting their sleep (Bohler-Muller et al., 2017; Mavunga, 2019; Stuurman, 2018). Furthermore, the COVID-19 pandemic introduced new stressors, including disruptions to education and lifestyle changes, compounding existing challenges and negatively impacting sleep quality (Dragun et al., 2021; Celini et al., 2020; Marelli et al., 2021). The pandemic increased global uncertainty and anxiety, leading to worsened sleep disturbances among students (Daniel, 2020; Rahiem, 2020; Rapanta, 2020; Gupta et al., 2020). The relationship between stress and sleep in university students is discussed at a later point in this paper. This research aims to extend the understanding of the state of sleep of undergraduate students within the South African context. In approaching this analysis, the next section will begin by examining the characteristics and developmental stages of older adolescents and young adults. Following this, the subsequent section will explore broader systemic factors that specifically influence sleep patterns in university students.

2.6. Sleep Characteristics and Factors Influencing in Sleep Older Adolescents and Young Adults in the University System:

The underlying mechanisms for insufficient and poor sleep quality in university students are complex and multi-factorial (Dowdell & Clayton, 2019). This section aims to utilise the socio-ecological model to explain some of the known micro-meso-and macro factors which have shown to negatively impact sleep in university students.

2.6.2. Micro-Related Factors

2.6.2.1. Age-Related Biological Changes

As adolescents mature, resistance to sleep pressure develops (Carskadon, 2011). At the same time, their circadian phase expression becomes delayed, creating a drive to stay up later into the evening and wake up later in the morning (Carskadon, 2011). More mature adolescents exhibit a slower build in sleep pressure, resulting in resistance to increased sleep pressure, thus making more mature adolescents slower to fall asleep than younger adolescents (Hagenauer et al., 2009; Crowley et al., 2018). However, the rate at which sleep pressure dissipates does not change across adolescent development, which implies that the need for sleep does (sleep/wake homeostat) not change during this developmental period (Crowley et al., 2018). It is important to specify that throughout the aging process of adolescents progressing through into young adulthood sleep duration changes slightly at different ages. This is expressed by Maslowsky & Ozer (2014), who explained that during adolescents (13-18) sleep duration has shown to decrease, from the age of 19 sleep duration begins to increase again, then from the age of 22 it decreases again. The initial increase at the age of 19 was associated with the transition out of high school into a more flexible schedules. The decrease seen in early adulthood (±22 years old) was explained by the increased responsibilities incurred at this time, such as work, university, and family life (Maslowsky & Ozer, 2014).

Older adolescents and young adults in the university context are at high risk of insufficient and poor-quality sleep due to numerous additional micro;meso; and macro-related factors within the context of the university converging with age-related biological development, leading to a multitude of negative repercussions for the students (Medeiros et al., 2001; Hazama et al., 2008; Reid & Baker, 2008; Gaultney, 2010; Rossa et al., 2014; Araùjo et al., 2014; Kabrita et al., 2014; Samaranayake et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018; Dragun et al., 2021).

Developmental changes in sleep/wake behaviour and the transition to more evening-type behaviours suggest physiological underpinnings and have also been attributed to the development of several brain regions which continue into young adulthood

(Hagenauer et al., 2009). The observed delay in sleep onset is characterised by the sleep drive being delayed beyond an individual's conventional bedtime; this then causes difficulties with falling asleep and waking at the desired time (Brown et al., 2002; Gaultney, 2010). This delay in sleep onset then interacts with rise times during the week (on school mornings), which then results in curtailing and limiting the quantity of sleep those in this developmental phase can obtain, as shown by the Perfect Storm model presented in Carskadon (2011) which posits that a lower need for sleep does not drive the loss of sleep during this developmental phase, but rather, it is the result of the convergence of biological, psychological, and socio-cultural influencers (Carskadon, 2011). Furthermore, according to Crowley et al. (2007), young adults exhibit a lower sleep homeostatic impulse than older adults; this means that young adults exhibit a lower desire to sleep in proportion to the time they have spent awake; thus, they consequently end up going to sleep later and achieving less sleep.

Two hypotheses have been proposed to explain this demographic's developmental circadian phase delay (Hagenauer et al., 2009; Crowley et al., 2018). Hypothesis 1 posits that the free-running circadian periods lengthen throughout puberty, with late and post-pubertal adolescents exhibiting adult-like free-running circadian physiology (Crowley et al., 2018). Hypothesis 1 is characterised by the theory that the delayed circadian phase correlates with secondary sex development (Hagenauer et al., 2009). According to this theory, homeostatic and circadian sleep regulation may be sensitive to gonadal hormones (Hagenauer et al., 2009). Females tend to show a delay in sleep timing earlier than males, paralleling their pubertal onset (Hagenauer et al., 2009). Males have shown more significant changes in chronotype across adolescence and young adulthood than females; however, this may be due to sexual differentiation in the phenomenon itself or to the masking of the phenomenon by the oestrogenic phase advance of rhythms during the time of ovulation (Hagenauer et al., 2009).

Hypothesis 2 posits that pubertal development sparks an altered circadian response to light, which may be explained by either a blunted response to phase-advancing morning light or an exaggerated response to the evening phase-delaying light (Hagenauer et al., 2009; Crowley et al., 2018). Although this could be explained by the increased opportunity for evening light exposure as adolescents mature, extrinsic

factors can interact with bioregulatory systems to perpetuate a cycle of delayed sleep timing and restricted sleep duration (Hagenauer et al., 2009).

The biological development observed in adolescence and young adulthood could be considered a micro-level influencer and determinant of sleep. This behaviour change is driven by intrinsic factors, specifically biological and developmental changes (Colrain & Baker, 2017). These developmental changes interact with extrinsic factors, which relate more to meso-and macro-level influencers. Extrinsic influencing factors can interact with the micro-level bioregulatory systems to result in the continuation of a cycle of delayed sleep timing and restricted sleep duration in this age group (Hagenauer et al., 2009). Additionally, adolescents and young adults represent a mixed group in sleep patterns due to differences in responsibilities, school, work, and social life (Hirshkowitz et al., 2015). Much like sleep in young adults who enter the workforce differs significantly from that of young adults who enter the university space, again, patterns are due to differences in responsibilities, rigorous academic demands, work demands, living environments, and new social opportunities (Hirshkowitz et al., 2015). Thus, older adolescents and young adults within the university system are highly susceptible to sleep difficulties due to the ongoing changes and maturation of the neuroendocrine system, coupled with various psychosocial influences playing a role in shortening total sleep duration (Rossa et al., 2014; Assaad et al., 2014).

Having discussed the biological influence on sleep for adolescents and young adults, the following section will explore the research expanding on the systemic factors that have an influence on sleep patterns in university students better to understand the current research on sleep/wake patterns in university students. Firstly, expanding further on the additional micro-related factors shown in research that influence sleep in university students. A further micro-related challenge faced by university students is mental health, alcohol/caffeine/ and drug use, as well as technology use. These factors will be discussed in further detail below.

2.6.2.2. Mental Health

Research has demonstrated a link between insufficient sleep and increased prevalence and severity of psychopathology, specifically anxiety, stress, and depression in young adults attending university; additionally, a high prevalence of

mental health struggles has been found in undergraduate students in previous research (Buysse et al., 1988; Hunt & Eisenberg, 2010; Zhai et al., 2015; Cox & Olatunji, 2016; Milojevich & Lukowsk, 2016; Pensuksan et al., 2016; Dickinson et al., 2018). Poor quality and insufficient sleep have been shown to play a role in the development and maintenance of depressive and anxiety-related symptoms (Harvey, 2011; Cox & Olatunji, 2016).

Milojevich and Lukowsk (2016) found that global sleep quality was widely associated with clinically relevant symptoms of psychological distress, including antisocial problems, anxiety, attention-deficit/hyperactivity problems, and depressive symptoms. Samaranayake and Fernando (2014) found that the two most common causes of sleep problems in their sample were depression and anxiety symptoms. Previous studies suggest poor sleep quality may be interrelated with mental and emotional health, specifically that the relationship between poor mental health and sleep quality is bidirectional, particularly generalised anxiety, depression and insomnia (Ohayon & Roth, 2003; Jansson-Frojmark & Lindblom, 2008; Preišegolavičiūtė et al., 2010; Orsal et al., 2012; Peach et al., 2016; Dinis & Bragança, 2018). Further, studies have shown that poorer global sleep quality was associated with reduced mental health in university students (Harvey, 2011; Cox & Olatunji, 2016; Milojevich & Lukowsk, 2016; Pensuksan et al., 2016; Dickinson et al., 2018).

The comorbidity between poor sleep and depression is known to be more significant among university students, as university students have been described as a population which is at heightened risk of stress and depressive symptoms (Peach et al., 2016). Research has demonstrated a consistent relationship between sleep and depression, with more evidence suggesting that poor sleep quality precedes the development of depression rather than depression predicting poor sleep (Peach et al., 2016). Peltz et al. (2017) found links between sleep disturbance and depressive symptoms. They argued that students who struggle with emotional regulation at bedtime are more likely to be poor sleepers or suffer from insomnia (Peltz et al., 2017).

2.6.2.3. High Levels of Stress

University students often report high levels of stress (Ramachandrian & Dhanapal, 2018; Du et al., 2020). This demographic has to cope with academic, social, and personal challenges while attending university (Ramachandran & Dhanapal, 2018). Lund et al. (2010) suggest that academic and emotional stress negatively impact sleep quality, which, according to Galambos et al. (2013), can be linked to reduced sleep duration, increased sleep disturbance, and delayed wake times, particularly during high stress. According to Lund et al. (2010) and Assaad et al. (2014), perceived stress holds significant explanatory power for poor sleep quality in university students, more so than sleep schedule regularity, alcohol or drug use, exercise frequency, or the use of technology before bed. University students share common stressors, including, but not limited to, academic stressors, family-related pressures, peer pressure, financial burdens, scholarship requirements, competition amongst students in class, time management, course-related, and examination-related stress (Ramachandiran & Dhanapal, 2018; Gardani et al., 2022).

The interaction between sleep and stress is bidirectional (Assaad et al., 2014; Gardani et al., 2022). Perceived stress can serve as a precipitating, predisposing, and perpetuating factor in sleep difficulties, and the experience of poor sleep serves to impair the adequacy of daytime functioning in university students (Assaad et al., 2014; Gardani et al., 2022). Lemma et al. (2012[B]) supported and supplemented this finding, which found that perceived stress and depressive symptoms were most strongly associated with reports of poor sleep quality. In some cases, the academic year of study is considered a perceived stressor in its own right, accompanied by less structured learning methods and a higher degree of academic independence (Gardani et al., 2022).

2.6.2.4. Caffeine / Alcohol / Cigarette / Drug Use

2.6.2.4.1. Caffeine

According to Faris et al. (2017), the consumption of caffeinated beverages is suggested to have a negative effect on sleep quality. The associations between caffeine and stimulant use and sleep are biologically plausible (Lemma et al., 2012b). Caffeine prevents adenosine from binding with their cell receptors, thus preventing

feelings of fatigue (Lemma et al., 2012b). Thus, increasing alertness and reducing fatigue and may lead to reduced sleep duration and quality (Lemma et al., 2012b).

2.6.2.4.2. Cigarettes

According to Edvardsson et al. (2009), adolescents have been shown to initiate smoking cigarettes between the grades of 7 and 10, with the years from grade 10 onwards showing the largest group of smokers in their study. The use of cigarettes in young adults has been associated with elevated scores for subjective sleep quality based on PSQI ratings, increased risk of long sleep latencies, sleep durations of less than 6 hours, daytime dysfunction, lowered sleep efficiency, use of sleep medicine, nonrestorative sleep, difficulties with morning awakenings, excessive daytime sleepiness, and overall reduced sleep quality, represented by PSQI ratings of above 5 (Zhang & Wing, 2006; Lemma et al., 2012b; Lohsoonthorn et al., 2013; Cohrs et al., 2014; Zunhammer et al., 2014; Arbinaga et al., 2019). Zunhammer et al. (2014) found a significant relationship between smoking cigarettes and poor sleep quality, in that smoking a pack of 20 cigarettes per week is associated with increases in global PSQI scores.

According to the findings of Cohrs et al. (2014), smokers exhibited a higher risk of demonstrating impaired sleep latency, short sleep duration, and overall poor sleep quality even after adjusting for age, income, BMI, education, depressive symptoms, alcohol consumption, symptoms of ADHD, anxiety and perceived stress in adults aged 18-65. Furthermore, Cohrs et al. (2014) reported that severe nicotine dependence and daily consumption of cigarettes were associated with shorter sleep duration (Cohrs et al., 2014). The relationship between nicotine smoking and sleep quality may be bidirectional. As suggested by Zhang and Wing (2006), there is a possibility that poor sleep quality may increase the consumption of cigarettes.

2.2.2.1.1. Alcohol Use

It has been well-established that university students often engage in excessive alcohol consumption (Dowdall, 2008; Kenny et al., 2012). Ebrahim et al. (2013), studied the effects of a single dose of alcohol on sleep patterns in healthy individuals, findings

indicated alcohol shortens sleep onset latency as well as the initiation of slow wave sleep, however, alcohol can play a role in disrupting the maintenance of sleep, particularly through reducing the time spent in REM sleep, thus impairing overall quality of sleep as well as the restorative function of sleep. According to Kenny et al. (2012), university students tend to drink in excess frequently, and many experience poor sleep quality and irregular sleep patterns. Kenny et al (2012), investigated the mechanisms through which poor sleep quality may worsen the negative effects of alcohol consumption, specifically with regard to binge drinking. No direct link between sleep quality and the amount of alcohol students drank on a weekly basis was found, however, a link was established between poor sleep quality and riskier drinking behaviours, such as binge drinking, as well as alcohol-related consequences such as accidents and hangovers (Kenny et al., 2012). Thus, according to Kenny et al. (2012), poor sleep quality worsens the effects of heavy drinking, leaving to more severe consequences for university students that are already experiencing poor sleep quality who tend to over consume alcohol (Kenny et al., 2012). According to Haairo et al. (2013), the relationship between heavy drinking and insomnia symptoms was bidirectional. Alcohol consumption has been associated with an increased prevalence of daytime dysfunction and the use of sleeping medications (Lohsoonthorn et al., 2013). Lund et al. (2010) reported that students with poor sleep quality are more likely to consume alcohol than those with optimal sleep quality, and they are twice as likely to use alcohol to induce sleep.

2.2.2.1.1. Drug Use

Fadhel (2020) found high rates of drug use amongst their sample of university students and found a notable relationship between sleep quality and drug use. As drug use increases, the overall PSQI score increases, meaning drug users report poorer sleep quality compared to non-drug users (Fadhel, 2020). Navarro-Martínez et al. (2020) found that high rates of poor sleep quality in their sample of university students were significantly associated with drug use. The relationship between substance use and sleep problems appears to be bi-directionally, particularly during adolescence (Johnson & Breslau, 2001). Clegg-Kraynok et al. (2011) explored the non-medical use of psychostimulant use in university students, specifically medications with the active ingredients of: methylphenidate, mixed-salt amphetamine, dextroamphetamine

and modafinil under the trade names of Ritalin, Adderall, Dexedrine, DextroStat, Provigil and Nuvigil. According to DeSantis et al. (2008), unlike most illicit substances used in universities, stimulants are not used exclusively for entertainment purposes. While alcohol, marijuana, barbiturates, and cocaine were used exclusively to “get high” or “have fun”, a common reason for the nonmedical use of ADHD medication in students is to enhance academic performance and concentration (DeSantis et al., 2007; Clegg-Kraynok et al., 2011). Clegg-Kraynok et al. (2011) found no difference in sleep duration between users and non-users. However, all subjects reported poor sleep quality, with users reporting worse sleep quality than non-users with the non-medical use of psychostimulants being linked with lower academic performance (Clegg-Kraynok et al., 2011). Nonmedical stimulant use is suggested to be part of a cycle where students use the medications, to stay awake, but in tern suffer worse sleep quality which can lead to further misuse of these medications due to the results of poor-quality sleep (Clegg-Kraynok et al.., 2011)

According to Johnson & Breslau (2001), there are a number of mechanisms through which substance use and sleep problems may be linked; it appears that substance use results in sleep problems, while sleep problems tend to be an early indicator of psychiatric problems, resulting in substance use. The findings of Angarita et al. (2016) suggested that while acute substance use may improve subjective sleep quality ratings, there is overwhelming evidence that chronic alterations in sleep occur from chronic use of addictive substances, which may be distinct from some or all of the acute effects of the substances. Effects of chronic use of substances such as cocaine, cannabis, opiates and alcohol on sleep include but are not limited to decreased sleep duration, increases in sleep latency, increased wake time after sleep onset, and difficulties in achieving slow-wave sleep (Angarita et al., 2016).

2.7.2.4. Technology Use

Bauducco et al. (2024) posited that the relationship between sleep and technology is, in fact, bidirectional. This hypothesis is supported by Poulain et al. (2019) and Brautsch et al. (2023). Poulain et al. (2019), in particular, conducted a longitudinal study which found that using devices and the internet before sleep was associated with an increased prevalence of daytime sleepiness and problems sleeping. A year

later, daytime sleepiness was found to be related to increased use of devices before bed (Poulain et al., 2019).

The *Goldilocks hypothesis*, however, suggests that there are empirically derivable moderate levels of technology use that are “just right” for optimally connected young people. According to this hypothesis, technology use at moderate levels is not inherently harmful and may even be advantageous in certain aspects (Przybylski & Weinstein, 2017). According to the Goldilocks hypothesis, these tools may be used to combat the environmental noise cited by most students as an inhibitor of sleep by drowning out the unpleasant noise and replacing it with more relaxing sounds, which improve mood and increase relaxation. It is argued that adolescents and young adults have implemented technology use as a “time filler” and as an “emotional regulation tool” (Bauducco et al., 2024, p. 6).

2.7.2.4.1. Technology use as a time filler:

As a result of the developmental changes experienced by older adolescents and young adults pushing sleep onset later experienced by this demographic, an organic “freeing up of time” in the evenings (Bauducco et al., 2024, p. 6), thus, in order to avoid boredom, and ‘fill the void’ during this time many older adolescents and young adults turn to using their devices (Bauducco et al., 2024). This hypothesis suggests that the time spent on devices before sleep is time that older adolescents and young adults would have spent awake regardless, rather than the use of technology being the mechanism behind delayed sleep for this demographic (Bauducco et al., 2024). This theory posits that the use of devices by adolescents and young adults passes the time until they are physiologically prepared to sleep (Bauducco et al., 2024). Technology use may become harmful in instances of overuse, wherein students are displacing sleep activities (Przybylski & Weinstein, 2017). Ayran et al. (2019) demonstrated that internet addiction or problematic internet use in university students negatively affects sleep quality, according to PSQI measures.

2.7.2.4.2. Emotional Regulation:

The time spent awake preceding sleep onset may be a distressing time, filled with intrusive thoughts and negative emotions, which can heighten the state of arousal and thus negatively impact sleep onset (Bauducco et al., 2024). Devices are an available and appealing tool for coping with heightened emotional arousal before sleep (Bauducco et al., 2024). Despite using devices as a distraction from difficulties in sleep onset faced by adolescents and young adults as well as to down-regulate negative emotions, it should be noted that while the use of devices can be helpful for older adolescents and young adults, this strategy may contribute to the perpetuation of sleep difficulties over time (Bauducco et al., 2024).

2.7.2.4.3. Negative influence of technology

Falling asleep is a complex process involving the release of neurotransmitters, including melatonin, which induces sleep (Rosen et al., 2016). However, the light given off by devices can slow melatonin release and, thus, delay sleep onset (Rosen et al., 2016). Other mechanisms through which technology can negatively impact sleep, outside of light exposure, include heightened arousal, disruption of sleep, and time displacement (Bauducco et al., 2024). However, although most studies show a strong negative association between sleep and technology use, experimental studies show mixed results, and it is unclear if sleep problems are the result of light emitted by screens, time spent on devices, or media content influencing mood (Hale et al., 2019).

Furthermore, evidence shows that devices can result in interrupted sleep and that these interruptions may be a meaningful mechanism underlying the relationship between technology use and poor sleep (Bauducco et al., 2024). Most university students sleep with their phone alerts on (vibrate or sound on), and the majority of students will wake up during a sleep episode to check their phone at least once a night (Rosen et al., 2016; Dowdell & Clayton, 2018). This is supported by Rod et al. (2018), who found that the majority of the undergraduate students in their study reported interrupted sleep due to devices on at least one weekday during a four-week testing

period, with those who reported frequently interrupted sleep also reported shorter self-reported sleep duration and higher body mass index.

2.2.3. Meso-related Factors

The introduction of a new environment can lead to several unhealthy lifestyle-related behaviours, which can affect sleep habits, including inappropriate eating habits, reduced physical activity, increased sedentary behaviour, increased levels of media usage, increased risk-taking, alcohol consumption, smoking, and changes in sleep habits (Cheng et al., 2012; Nogueira et al., 2018). Students' time in university is marked by challenges and lifestyle modifications (Nogueira et al., 2018). Although young adults can better adapt to novelty changes, which can be a positive trait, this can also make them more vulnerable to sudden changes (Dragun et al., 2021). Gilbert and Weaver (2010) noted that as students enter university, their sleeping habits are typically one of the first of their daily routines to be modified; most often, this change is detrimental to the student. Numerous contextual factors of university life can be linked with sleep/wake characteristics (Tavernier & Adrien, 2019). Changes university students face that are worth highlighting at the meso-level include separation from family, increased independence and responsibility, decreased adult supervision, flexibility to select class schedules, freedom to self-select bedtimes (Medeiros et al., 2001; Lund et al., 2010; Rossa et al., 2014; Kabrita et al., 2014; Adams et al., 2016; Peach et al., 2016; Peltz et al., 2017; Amaral et al., 2018; Nogueira et al., 2018; Gardani et al., 2022). The meso-level challenges and changes confronting university students are discussed in further detail below.

2.2.3.1. Academic Demands

It is essential to acknowledge the role of academic stress on sleep quality as poor sleep quality in university students has been associated with decreased academic achievement (Zunhammer et al., 2014; Ramachandrian & Dhanapal, 2018), which can play a role in the onset of mental illness, which further exacerbates poor sleep quality (Hunt & Eisenberg, 2010).

Academic-related stress among university students is widespread across all years of study and has been associated with poorer sleep quality (Zunhammer et al., 2014;

Ramachandrian & Dhanapal, 2018). Researchers agree that some of the common academic stressors university students face are family pressure, scholarship requirements, competition between classmates, financial burdens, examination stress, time-management challenges, and course-related stressors (Ramachandrian & Dhanapal, 2018). Other factors contributing to academic demands in university that can negatively impact sleep quality include lecture start times, independent study regimes, and fewer contact hours (Foulkes et al., 2019; Swinnerton et al., 2021; Yeo et al., 2023). These factors are discussed in more detail below.

2.2.3.1.1. Lecture Start Times

Previous research has suggested there may be a temporal misalignment between older adolescents and young adults propensity for late sleep and the early start times for academic activities, which, in combination with the tendency to work late into the night to cope with academic demands, results in short sleep duration for university students (Crowley & Carskadon, 2007) Swinnerton et al. (2021) and Yeo et al. (2023) found an association between lecture start times and sleep in university students. Specifically, Swinnerton et al. (2021) found that students reported having longer, better-quality sleep on nights preceding a day when lectures started later.

Furthermore, it has previously been established that every hour delay from the earliest lecture start time was associated with more than half an hour of extra sleep for the student and a higher likelihood of improved sleep quality (Swinnerton et al., 2021). Yeo et al. (2023) found that sleep behaviours and learning outcomes were associated with the time-of-day students had their first class, in that many students found themselves having to decide between sleeping longer instead of attending an early class or waking up early to attend class but have a shorter sleep duration. Additionally, Yeo et al. (2023) demonstrated that having morning classes on more than one day of the week was associated with poorer academic performance. Due to morning classes having a cumulative negative impact on student sleep and attendance, student performance may suffer throughout the day; supporting this concept, Yeoet al (2023) found that students with no morning classes achieved more favourable marks; this then decreased as the number of morning classes increased.

2.2.3.1.2. Fewer Contact Hours and Independent Study Schedules

University students often have fewer contact hours, with varying lecture start times (e.g., 8 am one day and 2 pm the next) (Foulkes et al., 2019). This schedule allows students to wake up later, which can negatively impact sleep quality. According to Foulkes et al. (2019), irregular contact hours can lead students to stay in bed until their scheduled activities, reducing daily physical activity and disrupting sleep cycles. This behaviour can make it difficult for students to distinguish between work and relaxation environments, further impairing sleep (Foulkes et al., 2019).

The transition from a structured high school timetable to an independent study regime in university presents challenges (Foulkes et al., 2019). With considerable freedom in setting bedtimes and study schedules, many students work late or pull all-nighters, contributing to poor sleep quality (Foulkes et al., 2019). Galambos et al. (2009) also found that increased time spent on coursework and anticipating tests can significantly reduce sleep duration.

2.2.3.1.3. Separation from Family

Galambos et al. (2011) found that students living away from home experienced lower-quality sleep. It was concluded that living away from home and in off-campus accommodation brings financial burdens (Galambos et al., 2011). Furthermore, living on campus likely sets up social conditions that shape sleep schedules in ways that are different from living off campus (Galambos et al., 2013). According to Galambos et al. (2013), students living in off-campus spaces are out from under the control of their parents and must thus regulate their sleep independently. University students who are more independent from parental care tend to report experiencing lower-quality sleep (Galambos et al., 2011). Being away from home, where parents generally enforce bedtimes, students have control over their bedtimes and whether they will attend morning classes (Orzech et al., 2011). Furthermore, personal independence may be associated with late-night social activities, which may provide the opportunity for increased alcohol intake and possible drug experimentation/abuse (Gardani et al., 2022).

2.2.4. Macro-Related Factors

Macro-level influencers include, but are not limited to, increased environmental noise, ever-increasing cost of living and tuition fees that expose students to financial strain (may be related to socioeconomic status), and the development of new social networks with increased opportunities to socialise (Medeiros et al., 2001; Lund et al., 2010; Rossa et al., 2014; Kabrita et al., 2014; Adams et al., 2016; Peach et al., 2016; Peltz et al., 2017; Amaral et al., 2018; Nogueira et al., 2018; Gardani et al., 2022).

2.2.4.1. Economic Burden

Economic hardship refers to a lack of economic resources necessary to meet the needs of the individual and their family (Ross & Hill, 2013). Not having money to purchase adequate amounts or quality food is a component of the more general concept of economic hardship (Ross & Hill, 2013). Economic hardship is considered a chronic stressor which has previously been associated with anxiety, depression, and unhealthy habits (Ross & Hill, 2013). Beiter et al. (2015) found that for many students, financial strain was an issue being frequently reported; for most, university is a time when they are living away from home and responsible for everyday living costs, such as food, rent, utility bills, and clothing. Financial and economic stress often align with poor sleep quality, which can play a role in exacerbating mental health issues among students. Peltzer and Pengpid (2015) found that having a poorer family background was associated with nocturnal sleep problems in undergraduate students from 26 countries.

Financial burdens may contribute to creating a system wherein the students experience increased levels of perceived stress. According to Peltz et al. (2021), students who perceived their financial situation as more strained increased their working hours per week, which predicted more significant levels of sleep disturbance; this, in turn, predicted higher levels of depressive symptoms. Perceived stress triggers the body's fight-or-flight response: economic stressors can expose individuals to prolonged activation of the physiological stress response, leading to inevitable consequences for their sleep, health, and well-being (Ross & Hill, 2013). Furthermore, insufficient and poor-quality sleep has been associated with a dramatic alteration in the perception of the environmental context one finds oneself in and the challenges

one may face (Meerlo et al., 2015). In most cases, challenges have been described as more stressful than they would be under conditions where one is well-rested (Meerlo et al., 2015).

2.2.4.2. Environmental Disturbance

Noise is a common theme in research looking into factors affecting sleep in university students, and studies such as Forquer et al. (2008) found that “noise from others” was the most frequently cited reason for premature waking in students. Peltz et al. (2017) found that both with and without a roommate, university students reported environmental noise which disrupted sleep, this being associated with higher sleep disturbance and higher levels of depressive symptoms, which, as discussed above, has shown associations with poor sleep quality (Peach et al., 2016).

Differences have also been found when looking at students who live on and off campus. Research has shown an increased incidence of mental health challenges in students living off campus. Beiter et al. (2015) found that students living off campus ranked highest on stress, depression, and anxiety when compared to students living on campus. One way of explaining these outcomes is that off-campus students have the added stress of paying rent and utilities each month, preparing meals, and addressing problems that may arise in their living space (Beiter et al., 2015).

Having established that university students are highly susceptible to poor quality and insufficient sleep, alongside understanding the underlying mechanisms, it is crucial to examine the effects of inadequate sleep. This underscores the importance of addressing the issue of inadequate sleep patterns promptly, as habits formed during university may persist into adulthood.

2.3. Effects of Insufficient Sleep

Obtaining insufficient poor-quality sleep has varying effects depending on the frequency and degree of sleep loss or insufficient sleep (Bonnet & Arand, 2003). Due to the role that sleep serves, specifically neuronal recovery, maintenance, and plasticity, insufficient sleep can severely affect brain function (Meerlo et al., 2015).

Although the extent of the effects of sleep loss on the current sample extends beyond the scope of this thesis, it is pertinent to discuss the effects insufficient and poor-quality sleep can have on the students experiencing it.

Negative repercussions for insufficient poor quality sleep include level deficits in concentration, attention, memory, and critical thinking with increased levels of anxiety, depression, irritability, increased daytime sleepiness, fatigue, increased absenteeism, increased risk of accidents, decrements in daytime functioning, deficits in memory and attention, decreased problem-solving capacity, motor impairment, and reduced productivity (Brown et al., 2002; Zisapel, 2007; Lund et al., 2010; Chaput et al., 2018; Grandner, 2017; Matricciani et al., 2017); and finally, psycho-social functioning, physical health, metabolic health, immunological health, occupational functioning, appetite, obesity, diabetes, hypertension, cardiovascular health, cancer, inflammation, pain, vitality, mortality, use of drugs and alcohol, and overall quality of life (Brown et al., 2002; Zisapel, 2007; Lund et al., 2010).

Individuals may recover from the adverse effects of insufficient or disrupted sleep with a subsequent period of recovery sleep. However, frequent/chronic sleep loss could induce neurobiological changes, which are not necessarily immediately prevalent but accumulate over time (Meerlo et al., 2015).

2.7. Summary and Rationale for the Study

To summarise, optimal functioning, health, and sleep are intimately connected, with both being either positively or negatively influenced according to physiological, biological, and external factors at play (Araùjo et al., 2014; Buysse, 2014; Paruthi et al., 2016; Grandner, 2017; Chaput et al., 2018). There are high levels of variability in behaviours and practices relating to sleep and sleep/wake patterns in the human population (Buysse, 2014; Paruthi et al., 2016; Bathory & Tomopoulos, 2017; Grandner, 2017; Ohayon et al., 2017; Chaput et al., 2018). Sleep/wake practices are driven by a complex interplay between physiological, biological, behavioural, and genetic factors, which can vary according to age, sex, and previous sleep duration (Buysse, 2014; Paruthi et al., 2016; Bathory & Tomopoulos, 2017; Grandner, 2017;

Ohayon et al., 2017; Chaput et al., 2018). Additionally, sleep is influenced by multiple individual, social and societal factors (Grandner, 2017).

Research has shown that as adolescents mature, they exhibit a shift in the intrinsic rhythmic expression of sleep/wake behaviours (Crowley et al., 2018). As adolescents mature, resistance to sleep pressure develops (Carskadon, 2011). At the same time, their circadian phase expression becomes delayed, creating a drive to stay up later into the evening and wake up later in the morning (Carskadon, 2011). Older adolescents and young adults in the university context are at high risk of insufficient and poor-quality sleep due to numerous external factors influencing sleep/wake regulatory mechanisms, which converge with age-related biological development within the context of university, which can influence maladaptive sleep/wake behaviours resulting in poor quality and insufficient sleep, all of which can lead to a multitude of negative repercussions for the students (Medeiros et al., 2001; Reid & Baker, 2008; Rossa et al., 2014; Araùjo et al., 2014; Kabrita et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018; Dragun et al., 2021).

Insufficient and poor-quality sleep can lead to deficits in concentration, attention, memory, critical thinking, and increased anxiety, depression, and irritability (Brown et al., 2002). Additionally, it can cause daytime sleepiness, fatigue, absenteeism, accidents, reduced productivity, and negatively impact psycho-social, physical, metabolic, and overall health, including increased risks of obesity, diabetes, cardiovascular issues, and mortality (Brown et al., 2002; Zisapel, 2007; Lund et al., 2010; Chaput et al., 2018; Grandner, 2017; Matricciani et al., 2017).

It is well established in global research that undergraduate students tend to report poor-quality sleep, as well as a high prevalence of poor sleepers within sample cohorts (Brown et al., 2002; Steptoe et al., 2006; Reid & Baker, 2008; Vail-Smith et al., 2009; Gilbert & Wear., 2010; Lund et al., 2010; Orzech et al., 2011; Cheng et al.., 2012; Lemma et al., 2012 [A & B]; Araujo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Benham, 2020; Du et al., 2021; Marelli et al., 2021). There is, however, comparably less research on undergraduate sleep/wake characteristics emerging from South Africa (Holdstock & Verschoor, 1974; Reid & Baker, 2008).

Students in South African universities are exposed to some of the common demands faced by university students in other countries; the sleep/wake characteristics of the students in South African universities may be influenced by additional factors unique to the South African context. Thus, in order to extend researchers' understanding of the state of sleep of undergraduate students within the South African context, this study aimed to characterise sleep/wake characteristics and sleep quality in a sample of undergraduate students attending a South African University as well as establish which factors may positively or negatively affect sleep quality of the students.

CHAPTER 3
3. METHODS & PROCEDURES

3.1. Study Design

The current study adopted a cross-sectional design using the Pittsburgh Sleep Quality Index and additional open-ended questions. The findings in the current study were based on self-report, thus were made up of subjective measures with a quantitative component. The survey was online and hosted on Google Forms. At the time of data collection, students had returned to attending university in person, thus returning to the traditional university setting after the previous years of online learning due to the COVID-19 pandemic. Data was collected during a non-exam term to gather information on the quality of students' sleep when students were not influenced by the stressors related to examinations. The testing period started on 15 August 2022 and continued until 8 October 2022; this was specifically during a non-exam period.

3.2. Local Research Context

The following study was conducted at Rhodes University. The university was founded in 1904 in the Eastern Cape province of South Africa (Mabizela, 2021). The university where this study was conducted is considered relatively small, with an enrolment of between 8700 and 9300 students (Mabizela, 2021). It is primarily a research-intensive university and is regarded as a critical African research institution. Between 6400 and 6550 students are enrolled in the university's undergraduate program, with 40 and 50% of the students living in residence / on-campus accommodation, with up to 4000 students living off campus, i.e. oppidan students (https://www.ru.ac.za/admissiongateway/whyrhodes/factsandfigures/).

The students are organised into six faculties: Science, Humanities, Commerce, Pharmacy, Law, and Education (Rhodes University, 2022). According to the statistics as of 23 June 2022, the student population was divided into the faculties as follows: Humanities - 41%, Science - 18%, Commerce - 15%, Education - 14%, Pharmacy – 9%, Law – 3% (Rhodes University 2022).

Rhodes University offers Bachelor, Bachelor of Honours, Masters, and PhD programmes. The choice between the humanities, Science, Commerce, Education, Pharmacy, and Law is available for undergraduates. Humanities offers a diverse range of courses for students. Bachelor of Humanities offers several courses, typically taking three years to complete undergraduate courses (Rhodes University, 2021a). Ten courses must be completed, including two major subjects (Rhodes University, 2021a). Commerce requires students to complete seven compulsory courses and courses in subjects that hold particular interest for the student (Rhodes University, 2021b).

Regarding the education faculty, students have two options to complete their bachelor's degree (Rhodes University, 2021c). Students can complete a four-year Bachelor of Education foundation phase degree, or students have the option of completing a bachelor's degree in another faculty and a one-year Postgraduate Certificate In Education (PGCE) (Rhodes University, 2021c). In the Law faculty, students have four bachelor's degree options (Rhodes University, 2021d). Option 1 includes a four-year LLB programme; option 2 includes a four-year LLB programme after the completion of the first year of another degree; option 3 includes a five-year combined Law and Humanities / Commerce / Science programme, and the final option includes a three-year LLB for graduate students (only available for students who have already completed a three-year bachelor's degree) (Rhodes University, 2021d). The undergraduate degree is typically awarded within the Science faculty after three years (Rhodes University, 2021e). However, there is flexibility within this faculty and if students choose to pursue a Bachelor of Science in Software Development, the undergraduate degree can take up to 4 years (Rhodes University, 2021e). Finally, the Bachelor of Pharmacy undergraduate programme is 4-years (Rhodes University, 2021f).

3.3. Data Collection Method & Tools

The study made use of an anonymous self-administered questionnaire hosted on Google Forms. The questionnaire consisted of three main sections; (1) socio-demographic factors; (2) the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989); (3) one open-ended question that asked students to comment on the factors

which they felt may be influencing their sleep over the previous month. More details provided below.

3.3.1. Overview of Questionnaire Sections

3.3.1.1. Section 1: Socio-Demographic Characteristics

Socio-demographic variables included questions relating to age (in years), academic year of study (first, second, or third year), gender (female, male, non-binary, prefer not to say), residential location while attending university (at parent's house, on-campus residence – with or without a roommate, off-campus/"Oppidan" — with or without a roommate), academic faculty (Science, Humanities, Commerce, Education, Pharmacy, Law), funding for studies (self-funded, student loan, university financial aid, National Student Financial Aid Program (NSFAS), Ikusasa Student Financial Aid Program (ISFAP), Bursary (Government offered), Bursary (Private sponsor), Scholarship (half or full), Crowdfunding, Fundi, and Other options which may not have been listed. The following demographic variable was employment status (part-time employment + full-time studying, full-time employment + part-time studying, studying full-time + not employed). The final variable was commuting to university, specifically, methods and duration of travel (private vehicle, carpool, cab services, public taxi bus, Rhodes taxi service, walking, bicycle, skateboard). The justification for asking the above questions can be found in Appendix A.

3.3.1.2. Section 2: Sleep/wake Characteristics and Sleep Quality

3.3.1.2.1. The Pittsburgh Sleep Quality Index (PSQI)

The present study used the PSQI to investigate the sample's sleep/wake characteristics and sleep quality parameters. The PSQI has been extensively applied in order to explore subjective sleep quality over one month. This method has been used in assessing sleep quality in students in multiple studies across the globe (Gilbert & Wear, 2010; Lund et al., 2010; Seun et al., 2010; Cheng et al., 2012; Lemma et al., 2012[A & B]; Araujo et al., 2013; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Benham, 2020; Cellini et al., 2020; Ahammed et al., 2021; Du et al., 2021; Evans et al., 2021; Marelli et al., 2021; Viselli et al., 2021). The 1-month interval

is considered a clinically and scientifically relevant time frame (Buysse et al., 1989). The PSQI is used in sleep-related research to (1) to identify ‘good sleepers’ or ‘poor sleepers’; (2) despite being a subjective questionnaire, this tool has been standardised and validated as a measure for sleep quality; (3) to provide a brief but clinically accepted assessment of sleep disturbances which may influence sleep quality (Buysse et al., 1989).

3.3.1.2.1.1. Sleep-Related Variables

The Pittsburgh Sleep Quality Index (PSQI) was used to measure sleep variables and sleep quality for the current study. The PSQI is made up of 19 self-rated questions and five additional questions, which are rated by a bed partner or roommate. The 19 self-rated questions (items) assess a wide variety of factors which may influence sleep quality based on seven components/sub-scales. The seven components include: (1) subjective sleep quality (very good, fairly good, fairly bad, very bad); (2) sleep duration (hrs); (3) sleep latency (min); (4) habitual sleep efficiency (actual sleep duration/time in bed x 100); (5) frequency of sleep disturbances; (6) use of sleeping medications; (7) daytime dysfunction (Buysse et al., 1989). In this instrument, aspects of sleep disturbances include experiencing difficulty with falling asleep within 30 minutes, waking in the middle of the night or early in the morning, frequently having to wake up to use the bathroom, feeling too hot or too cold in the sleeping environment, not being able to breathe comfortably, coughing or snoring loudly, having bad dreams, having pain, and other reasons (Buysse et al., 1989).

Each of the seven components is equally weighted and measured on a scale of 0 to 3. The overall sum of the scores for the seven components generates one global score, which ranges from 0-21. Lower scores indicate good sleep quality, while higher scores indicate poorer sleep quality. Global scores of five or more indicate poor sleepers and, according to Buysse et al. (1989), represent the clinical cut-off point for potential sleep disorders. The global score of the PSQI gives a single overall assessment of sleep quality, allowing for direct comparisons of individual subjects or groups (Buysse et al., 1989).

In the instance that participants experienced “other” factors which resulted in disturbed sleep, the PSQI includes an open-ended follow-up question that allowed participants to express what they believed had been disturbing their sleep over the previous month. This question is more qualitative and is not scored on a quantifiable scale. The question states: “Please state and describe any other reason(s) your sleep may be disrupted or disturbed”.

3.3.1.3. **Section 3:** *Additional Open-Ended Question Relating to Positive and/or Negative Influencers of Sleep Quality*

Following completing the PSQI, students were invited to answer one additional open-ended question, “What do you believe has influenced your sleep over the previous month?”. This question aimed to allow the students to give their perspective on their sleep and how they feel the system may be influencing it. The response may help to explain both positive and negative, and students were asked to provide as much detail as they were comfortable with. Following this open-ended question, an additional question was added wherein the students were asked if there was anything more participants would like researchers to know regarding their sleep/wake behaviour to allow students to express any additional thoughts. This question was optional, and students could choose not to answer. The Google Forms document containing the study survey can be found in Appendix E.

3.4. Participant Characteristics

3.4.1. Inclusion & Exclusion criteria

This study used convenience, purposive, and snowball sampling techniques. All undergraduate students attending Rhodes University in the Eastern Cape of South Africa were invited to participate in this study. All students over 18 registered as first-year, second-year, and third-year students in all faculties living as Oppidan (off-campus) students or in residence were included in the current study. This decision was made as one of the main objectives of this study was to characterise the sleep/wake behaviour and sleep quality of a large sample of undergraduate university students. The exclusionary criteria included students who were under 18 years of age, postgraduate students, and students who did not attend Rhodes University.

3.5. Ethical Approval Process

Ethical approval application for the study was submitted to the Rhodes University (RU) Ethics Committee on 11 May 2022 and was granted provisional acceptance with pending Gatekeeper permission on 06 July 2022 (ref: 2022-5517-6884) (Appendix A). Gatekeeper permission was granted on 14 July 2022, and the study was approved to continue [14 July 2022] (Appendix B)

3.6. Study Preparations, Sampling Procedures & Data Collection

3.6.1. Distribution of Invitation to Participants

Following ethical clearance from the Rhodes University Ethics Committee (ref: 2022-5517-6884), permission from the Rhodes University gatekeeper for the students, and the finalisation of the online questionnaire, the survey was opened on the 15th of August 2022. The invitation to participate in the study was disseminated to students by sending a link to the survey using Rhodes University email forums and specific Rhodes-related Facebook groups that Rhodes students use. The first request for assistance in disseminating the study was emailed to relevant parties. On the 15th of August –permission to disseminate the study using Rhodes University platforms was granted. From the 16th to the 17th of August, requests were sent to residence administrators to share the study with their students using email platforms. The email to the administration teams and wardens requesting assistance with disseminating the study to the residence and Oppidan students presented the study with a brief explanation of the aim of the research and the intention to reach the students via online platforms to ensure inclusivity and expand the project's reach. The email included the ethical and gatekeeper letters approving the research and the pre-approved email for the students. The email communication sent to the administrators and wardens and the pre-approved email to the students can be found in Appendix C

The email invitation and the social media invitation to the study that was shared with the students was a brief message directed to the undergraduate students, which mentioned that the study was investigating sleep, the time it would take to complete the survey, how their participation would contribute to a better understanding in sleep

quality of undergraduates and included a link to the Google Forms document which hosted the survey, found in Appendix E. Once students followed the link to the survey form, an information/introductory page outlined a brief background to the study, objectives, the contents of the questionnaire, participant rights, the risks and benefits associated with participation and contact details of the researchers. At the bottom of the briefing page, participants could click ‘Next’, which took them directly to the questionnaire. By clicking ‘Next’, participant consent was assumed. All questions in the survey were compulsory unless stated otherwise, and the questionnaire took 10 to 15 minutes to complete. The testing lasted two months, from the 15th of August to the 08th of October 2022.

The link to the questionnaire was then sent a second time to residence administrators and Wardens on the 07th of September to reach more students and expand our subject population. On the 18th of September 2022, a final response from residence Administrators agreeing to share our study on Rhodes University platforms was received. Furthermore, to reach the off-campus students on the 08th of September, the Oppidan page on Facebook granted permission to post the link to the survey on the Oppidan Facebook platform and on the 03rd of October, an email request was sent to the Oppidan warden requesting assistance with the dissemination of study to Oppidan students using Rhodes University Oppidan email communications, to make the study available to the off-campus students as well as the residence students. The survey was open for two months and was closed on the 08th of October 2022.

A Microsoft Excel sheet, including all the raw data, was downloaded from the Google Form page to an Excel document for regular data reduction and cleaning throughout the testing period. After the testing period, the survey was closed on Google Forms, and the final data was downloaded and added to the existing Excel spreadsheet where all the data had been collected.

3.7. Analyses

3.7.1. Data Cleaning and Reduction

Throughout the testing period, the raw dataset was periodically downloaded from Google Forms onto a Microsoft Excel document, where it was cleaned and coded onto a Microsoft Excel document. Two full participant questionnaire responses were excluded due to the age of the participants being under 18, and another full questionnaire was excluded due to unreadable data, meaning the data did not translate clearly once downloaded from the platform and was uninterpretable. Throughout the rest of the data set there were some instances where single responses were excluded for responses being incorrectly answered. Appendix D details other instances where data cleaning issues were evident and how the researcher approached these issues.

3.7.2. Descriptive Statistics

TIBCO Statistica® (Version 14.0.0) was the software used to conduct all statistical testing. Once the survey was closed and data was cleaned and coded, descriptive statistics were broad and focused on the demographic-related data, global scores for the sample, and sleep/wake time-related data.

Initial descriptive statistics included descriptive statistics on demographic characteristics; including mean distributions of students according to age (mean, range, standard deviation), academic year (mean, range, standard deviation), gender (number of females, males, non-binary and prefer not to say), living context (Number of students at home, in residence (with or without roommate), Oppidan (with or without roommates and total living on campus vs. off campus), faculty (number of students per faculty), employment status (number of students employed vs. unemployed), commuting option (i.e. highlighting commuting options available, and the frequency of students using each option), and funding option (number of students per funding option), of the funding options, the NSFAS group was the largest; the numerous other funding options provided rendered smaller groups per option; thus, in order to lower complexity when running statistics, the funding groups were made into three distinct groups, namely, Self-funded, NSFAS, and other funding options, wherein all the

smaller options were grouped and analysed as one group. The other funding groups included; Student loan (3.08%), University financial aid (1.28%), ISFAP (0%), Government bursary (2.31%), Private Bursary (5.64%), Half scholarship (1.54%), Full scholarship (0.26%), Fundi (0%), and other (1.03%). Due to the small sizes of these groups, they were analysed together as one group named “Other funding options”. Furthermore, frequency counts were conducted for much of the data in the current study.

Summary statistics for demographic variables were calculated. Summary statistics included the frequency and distribution of categorical variables and continuous variables. Furthermore, descriptive statistics were run for group comparisons by calculating and comparing the mean PSQI scores and time-related data for different years of study, gender, living context, faculty, funding option, and commute option.

3.7.3. Inferential Statistics

Prior to any inferential statistics, the data were tested for normality using the Shapiro-Wilks test using TIBCO Statistica®. Data was normally distributed; thus, parametric statistics were applied, and reporting was conducted using mean and standard deviation. Inferential statistics were conducted to determine if there were significant differences within the specified variables of interest. For statistical tests, a significance level of 0.05 was used to determine statistical significance.

T-tests were conducted to assess differences in global scores, sleep disturbances, time-related data (bedtime, risetime, time in bed, sleep duration, and sleep latency), and subjective sleep quality for Gender (female vs. male) and Living Context (Residence vs. Oppidan). One-way Analysis of Variance (ANOVA) was used to compare data between global scores, sleep/wake time-related data, and subjective sleep quality for Year of Study (First; Second; Third year), Living Context (Residence and Oppidan), Faculty (Science, Humanities, Commerce, Education, Pharmacy, and Law) and Funding Options (Self-funded; NSFAS; Other funding groups). Post-hoc analyses were performed using Tukey HSD tests to elucidate specific contrasts within these variables further. This approach enabled a thorough examination of the data,

providing valuable insights into the interplay of these factors within the study sample. A breakdown of statistical tests used can be found in Table 2.

Table 2: Statistical tests applied in analysis.

Variable of interest	Statistical Test Used	Post-hoc analysis
Gender	T-test	
Year of study	General Linear Model & ANOVA test	Tukey HSD test
Living context	T-test	
Year of study	General Linear Model & ANOVA test	Tukey HSD test
Faculty	General Linear Model & ANOVA test	Tukey HSD test
Funding	General Linear Model & ANOVA test	Tukey HSD test

3.7.4. Method of Thematic Analysis for Qualitative Data

The initial open-ended question was derived from the PSQI (Q5a – Q5j) wherein respondents could describe any sleep disturbances they may have been experiencing over and above the options provided in the previous PSQI questions, this was the last question the students were asked before the end of the survey. The second open-ended question came at the end of the survey, in which students were asked if there was anything more the students would like the researchers to know about their sleep. Responses from the two open-ended questions were analysed using the Braun and Clarke (2006) thematic analysis method, which provided guidelines for identifying, analysing, and reporting patterns within the data. The Braun and Clarke Method was applied manually in the current study using Microsoft Excel following the upcoming steps.

The Braun and Clark (2006) method includes six primary phases:

(1) *Familiarising oneself with the data*, which involved repeated reading and taking notes or writing out ideas of any notable meanings or patterns. The focus was to become familiar with all aspects of the data.

(2) *Generating initial codes* involved reviewing responses, allocating equal attention to each data point, and recording codes in new columns. This process helps to organise the data into meaningful units systematically. When a single

answer covered multiple aspects, separate columns were used. These initial codes aimed to identify and organise basic data features into groups. These codes were broader than the eventual themes identified later. Several potential themes were coded, maintaining the original context provided by the data. Codes were then colour-highlighted throughout the dataset.

(3) *Searching for themes* involved identifying broader themes by sorting the codes into potential themes. All initial codes were colour-coded into potential themes by determining how different codes might combine to form sub-themes, which combine to form the overall themes. The phase ended with all data extracts being coded and a collection of themes and sub-themes developed.

(4) *Reviewing themes* involved refining the themes identified in the previous phase. This phase focused on ensuring that the data within the themes make sense of being grouped whilst maintaining clear and distinguishable boundaries between themes.

(5) *Defining and naming themes* was the process of identifying the core of each theme. This process provided details about each theme and how it fits within the overall narrative of the dataset.

(6) *Producing the report* involved quantifying the frequency of the occurrence of key themes across the set of open-ended inquiries to compile the qualitative data report. This process entailed tabulating the total number of responses or codes per open-ended question. The number of responses surpassed the total number of participants due to instances where individuals referenced multiple themes within a single response. Each response yielded multiple codes as many students wrote full explanations as to why they believed their sleep was affected. Subsequently, after determining codes for the responses for each open-ended question, these coded responses were classified by colour and numerically to allow for a frequency count to show the number of times themes were articulated in each open-ended question. The cumulative responses for both questions were then combined to establish the overall count of responses for each question respectively. This composite figure was then

employed to calculate the percentage frequency of each theme across the entirety of responses. This enabled researchers to discern the relative significance of each mentioned theme, potentially providing insights into the primary theme's students cite as being contributing factors to poor sleep quality.

It is essential to note the researcher's positionality in this study. Positionality refers to being part of the community (insider), not part of the community (outsider), or somewhere in between (Wilson et al., 2022). In this study, the researcher can be seen as an in-betweener. Having attended Rhodes University for undergraduate and postgraduate studies, the researcher has some familiarity with the organization and the challenges students face at Rhodes and in Grahamstown. This prior knowledge could influence how the researcher perceives student responses. Additionally, the researcher is no longer an undergraduate and did not live in Grahamstown while writing this thesis. The researcher also acknowledges that personal experiences, such as being a privileged white female, may have influenced the interpretation of findings, which might differ from those of the study participants from different demographic backgrounds and lived experiences

CHAPTER 4
4. RESULTS

4.1. Descriptive Characteristics of Sample:

Of the ±6,236 undergraduate students at Rhodes University in 2022 (https://www.ru.ac.za/media/rhodesuniversity/content/institutionalplanning/documents/Rhodes_University_Enrolment_Targets_2020-2025.pdf) 393 students participated in this study, which corresponds to a response rate of 6.30%. Three participants were excluded due to falling within the exclusion criteria set by the researchers. The mean age of the sample was 20.88 (±3.14), with the age range being 18 – 50.

As shown in Table 3, within the total sample, 76.41% (n=298) identified as female, and male 20.51% (n=80) identified as male. A total of 2.31% (n=9) identified as non-binary; 0.77% (n=3) responded as “prefer not to say”. Due to these groups being relatively small, they could not be included in statistical analysis; however, descriptive statistics were still run for these groups, and their data was included in the results that followed.

Regarding year of study, 38.21% (n=149) of students were in the third year, with the majority of students stating they lived in residence on campus, 62.31% (n=243), with 87.65% (n=342) of the whole sample reported walking to university as a means of commuting. When broken down further into the groups initially analysed, it was found that 4.10% of students lived at their parent’s house, 61.79% lived in residence without a roommate, 0.51% lived in residence with a roommate, 14.62% lived in off-campus housing without a roommate, and 18.97% lived in off-campus housing with a roommate. The largest group of students reported being in the humanities faculty, 48.72% (n=190). In the current sample, the majority of students reported receiving funding through the National Student Financial Aid Scheme (NSFAS) 50.64% (n=197), with the following highest number of students reporting being self-funded, 33.93% (n=132). Furthermore, within the current sample, the majority of students were full-time students with no additional employment endeavours, while 14.81% reported studying full-time while having a part-time job, and only 1.56% were employed full-

time while studying part-time. A breakdown of the sociodemographic details of the sample can be found in Table 3.

Table 3: Socio-demographic details of whole sample

Variables	Valid n (%)	Mean (±SD)
Age		20.88 (±3.14)
Gender	390 (100%)	
Female	298 (76.41%)	
Male	80 (20.51%)	
Non-binary	9 (2.31%)	
Prefer not to say	3 (0.77%)	
Year of study	390 (100%)	
First Year	131 (33.59%)	
Second Year	110 (28.21%)	
Third Year	149 (38.21%)	
Living Context	390 (100%)	
Residence (On Campus)	243 (62.31%)	
Oppidan (Off Campus)	147 (37.69%)	
Faculty	390 (100%)	
Science	71 (18.21%)	
Humanities	190 (48.72%)	
Commerce	64 (16.41%)	
Education	17 (4.36%)	
Pharmacy	40 (10.26%)	
Law	8 (2.05%)	
Funding Options	389 (100%)	
Self-funded	132 (33.93%)	
NSFAS	197 (50.64%)	
Other	60 (15.42%)	
Employment Status	390 (100%)	
Part-time job + full-time studying	57 (14.81%)	
Full-time job + part-time studying	6 (1.56%)	
Studying full-time (not employed)	323 (83.90%)	
Commuting Method	381 (100%)	
Private Vehicle	31 (7.95%)	
Walking	342 (87.69%)	
Other	17 (4.36%)	

4.2. Sleep/Wake Characteristics for the Whole Sample

On average, participants reported a bedtime of 00h25 (± 1h 42min) with a mean rise time of 7h15 (±1h 48min). The average sleep duration was 5 hours and 55 minutes (±1h 27min). Additionally, participants displayed a mean sleep latency of 39.21 minutes. A breakdown of the mean sleep and time-related data for the whole sample can be found in Table 4.

Table 4: Sleep & Time-related data for whole sample

Variable	Whole Sample (n=390)
Bedtime (hh:mm) (n=389)	00:25 (±01:42)
Rise-time (hh:mm) (n=388)	07:15 (±01:48)
Sleep Latency (mins) (n=378)	39:12 (±34.06)
Hours of sleep (hh:mm) (n=385)	05:55 (±01:27)
Time In Bed (hh:mm) (n=391 & n=388)	06:55 (±02:21)
Habitual Sleep Efficiency (%) (n=384)	85.84% (±14.09)

4.2.1. Component Score Analysis

In the analysis of PSQI component scores for the entire sample, each mean component score was derived for the whole sample; from this, several noteworthy findings emerged; Table 5 shows the mean component scores for the whole sample. According to the analysis, daytime dysfunction (Component 7) had the highest mean score at 1.86. Sleep latency (Component 2) and sleep duration (Component 3) also garnered elevated mean scores of 1.75 and 1.65, respectively. Conversely, habitual sleep efficiency and use of sleeping medication (Components 4 and 6) demonstrated lower mean scores of 0.74 and 0.67, respectively, indicating comparatively better outcomes concerning sleep efficiency and use of sleeping medication.

Table 5: Mean component scores for whole sample. Respondents rated their overall sleep quality over the past month using a Likert scale ranging from 0 to 3, with the following options: 0- Very good; 1- Fairly good; 2- Fairly bad; 3 - Very bad

PSQI Components	Mean Score
Component 1 – Subjective Sleep Quality (n=390)	1.59 (±0.74)
Component 2 – Sleep Latency (n=390)	1.75 (±1.05)
Component 3 – Sleep Duration (n=385)	1.65 (±0.93)
Component 4 – Habitual Sleep Efficiency (n=384)	0.70 (±0.98)
Component 5 – Sleep Disturbance (n=390)	1.57 (±0.60)
Component 6 – Use of Sleep Medication (n= 390)	0.67 (±1.06)
Component 7 – Daytime Dysfunction (n= 390)	1.86 (±0.86)
PSQI GLOBAL SCORE (n=390)	9.79 (±3.36)

4.2.1.1. Component 1 - Subjective Sleep Quality

Most participants had a mean subjective sleep quality rating of 1.59 (±0.74), which, when rounded, yields a mean score of 2 for this component. A score of 2 represents "fairly bad", indicating that, on average, participants described their sleep as fairly bad. The distribution of responses for the whole sample and the respective groups can be found in Appendix F.

4.2.1.2. Component 4 – Habitual Sleep Efficiency

In Component 4 of the PSQI, particularly habitual sleep efficiency, challenges arose due to errors in how respondents reported hours spent in bed versus their actual hours of sleep obtained. This discrepancy led to over 100% sleep efficiency recorded for 60 students. To address this issue in scoring, these values were treated as 100%. The mean (and SD) for the entire sample's sleep efficiency % and mean time spent in bed are detailed in Table 5. On average, the entire sample spent 6 hours and 55 minutes in bed, while their actual hours of sleep averaged 5 hours and 55 minutes, resulting in an average sleep efficiency above 80%, as shown in Table 5. The mean habitual sleep efficiency for Component 4 stood at 0.70 (±0.90), and rounding this figure would result in a score of 1.

4.2.1.3. Component 5 – Sleep Disturbances

Component 5 of the Pittsburgh Sleep Quality Index (PSQI) assesses sleep disturbances. Specifically, it measures the frequency of these disturbances over the past month. These disturbances can lead to frequent awakenings during the night, leading to fragmented and less restful sleep. The distribution of students sleep disturbances was analysed according to whole sample, year of study, gender, living context, and funding groupings, the findings indicated that when separated by groups the distribution of students remained relatively similar, Appendix H shows the distribution of answers when controlled by demographic group. Figure 3 depicts the distribution of responses for component 5 for the whole sample.

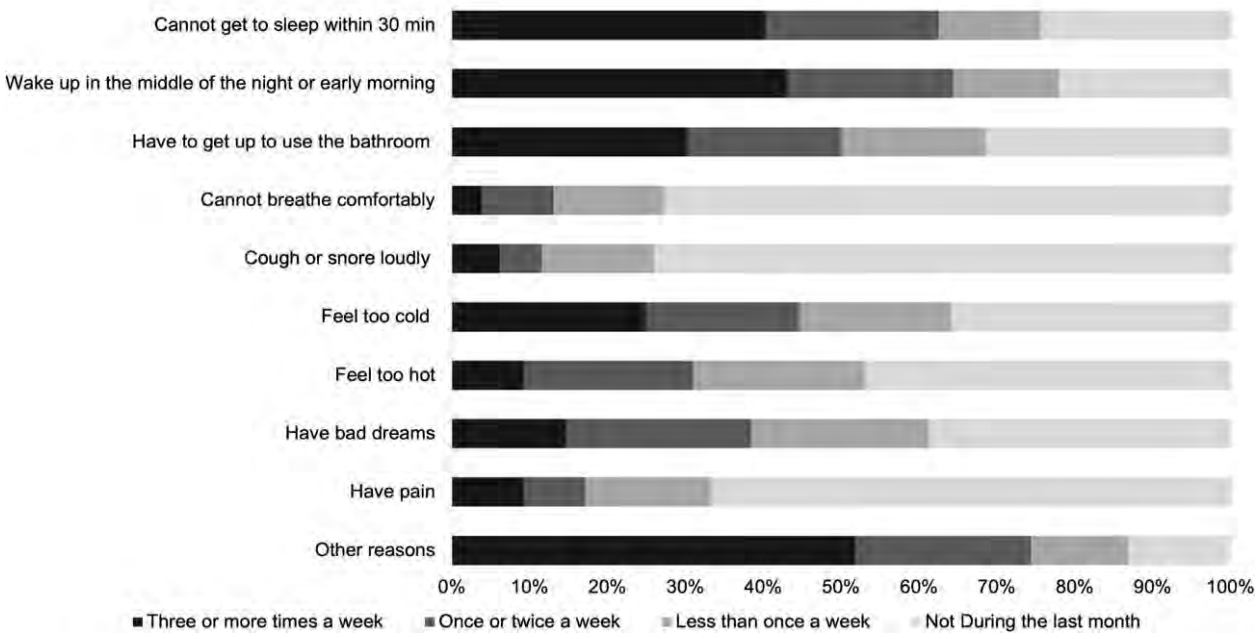

Figure 3: PSQI Sleep Disturbances for the whole sample. The scale used for this component is categorical, where respondents are asked to rate the occurrence of various sleep disturbances on a scale of 0 to 3, with the following options: 0 - Not during the past month; 1 - Less than once a week; 2 - Once or twice a week; 3 - Three or more times a week. This component is included in the PSQI to capture potential disruptions in sleep which can impact overall sleep quality.

4.2.1.3.1. Sleep Disturbance Analysis

Figure 3 depicts the distribution of responses for component 5 the whole sample. The analysis of sleep disturbances within the entire sample as documented in component

5 of the PSQI, highlighted three prominent issues. Among these were difficulties "getting to sleep within 30 minutes," experienced by 40.26% (n=157) of the sample more than three times a week. Additionally, "waking up in the middle of the night and in the early morning" was experienced more than three times a week by 43.08% (n=168) of the sample, while "other reasons" were cited by 51.79% (n=202) of the sample as being experienced more than three times a week.

The “other reasons” category was further elaborated on through the open-ended question in the PSQI, providing additional context and depth to these reported disturbances. Upon stratifying the data based on various demographic factors such as gender, year of study, living context, and funding option, a consistent and similar trend emerged, and therefore, were not included in the main results section. Across all sleep disturbance subgroups, a number of participants consistently identified these same three sleep disruptions as the most prevalent. Detailed tables breaking down responses on sleep disturbances of the different demographic groups, as well as the statistical tests run on TIBCO Statistica® can be found in the accompanying tables located in Appendix H.

4.2.2. Global PSQI Score

The mean global PSQI score for the sample was 9.79 (±3.38), surpassing the cut-off of 5. According to (Buysse et al., 1989) PSQI global scores greater than 5 indicates the presence of sever difficulties in at least two areas tested, or, moderate difficulties in three or more areas tested. The range for PSQI scores for the whole sample was 3 to 20, with three students scoring a global score of 3 and one student scoring a global score of 20. When broken down by good (scores ≤5) and bad (scores >5) sleepers analysis revealed that 90.26% (n=352) of students in this sample obtained global scores above the clinical cut-off point outlined by the PSQI (≤5) and thus classified as poor sleepers, as can be seen in Figure 4 below.

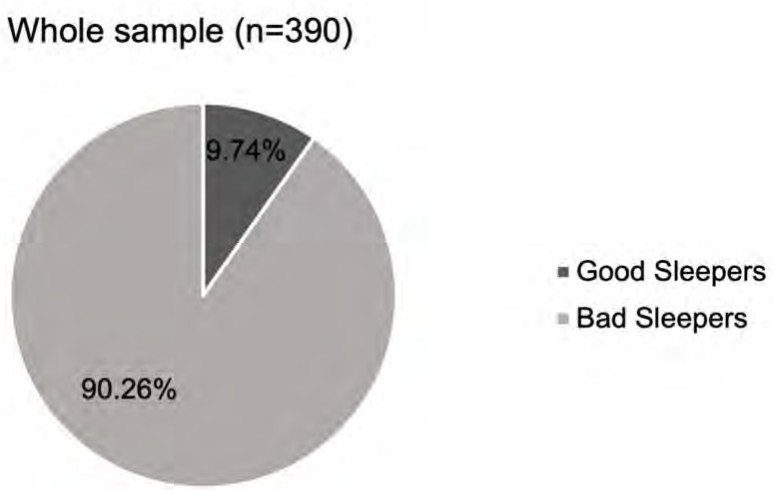

Figure 4: Percentage (%) of good and poor sleepers among the sample.

4.3. Sleep/Wake Characteristics According to Gender

When compared by gender responses which showed significant difference included subjective sleep quality and PSQI global scores. Subjective sleep quality showed a significant difference between the mean scores of males and females (*t(376)= 1.992**, *p = 0.047**) where females achieved significantly higher scores than males, denoting poorer subjective sleep quality in females. Furthermore, there were statistically significant differences between the Global Scores of males and females (*t = 2.401, p = 0.017**). Female students had a significantly higher PSQI global score ratings than males, underscoring those female students reported experiencing significantly poorer sleep quality.

As shown in Table 6 there was no significant difference in bedtimes (t(375)= 0.776, p = 0.438) rise times (t(374)= 0.108, p = 0.913), sleep latency (t(364)= 1.349, p = 0.178), time in bed (t(64)= -0.217, p=0.829), habitual sleep efficiency (t(370)= 0.267, p= 0.790) and sleep duration (t(371)= -0.814, p = 0.416) between females and males in this study. The non-binary and prefer not to say groups were not included in the statistical analysis due to being too small; however, from the data collected this group had the longest sleep latencies reported, as well as the highest PSQI global scores. The statistical analysis run to compare sleep characteristics in females and males can be found in Appendix I.

Table 6 Sleep & Time-related data by gender

Variable	Females	Males	*p*-value	Non-binary and Prefer not to say
Valid n (%)	298 (76.41%)	80 (20.51%)		12 (3.08%)
Bedtime (hh:mm)	00:26 (±01:41)	00:16 (±01:48)	0.438	00:58 (±01:40)
Rise-time (hh:mm)	07:15 (±01:46)	07:13 (±02:00)	0.913	07:57 (±01:23)
Sleep Latency (mins)	39:59 (±34.14)	34:37 (±29.99)	0.178	50:50 (±51.21)
Hours of sleep (hh:mm)	05:53 (±01:31)	06:02 (±01:12)	0.416	06:01 (±00:52)
Subjective sleep quality	1.64 (±0.74)	1.45 (±0.73)	*0.047**	1.50 (±0.80)
Time In Bed (hh:mm)	6:48 (±02:06)	6:57 (±01:33)	0.829	6:58 (±01:31)
Habitual Sleep Efficiency (%)	85.94 (±13.98)	85.45 (±15.14)	0.790	85.92 (±10.19)
PSQI Global Score	9.99 (±3.37)	8.98 (±3.31)	*0.017**	10.17 (±2.82)

When broken down by good (scores ≤5) and bad (scores >5) sleepers analysis revealed that there were a higher percentage of good sleepers (scores ≤5) in the male population (15%) than the female population (9%), see Figure 5 A and B. Within the Non-binary and prefer not to say groups 100% of the population fell within the range of poor sleepers (scores >5), see Figure 5 C.

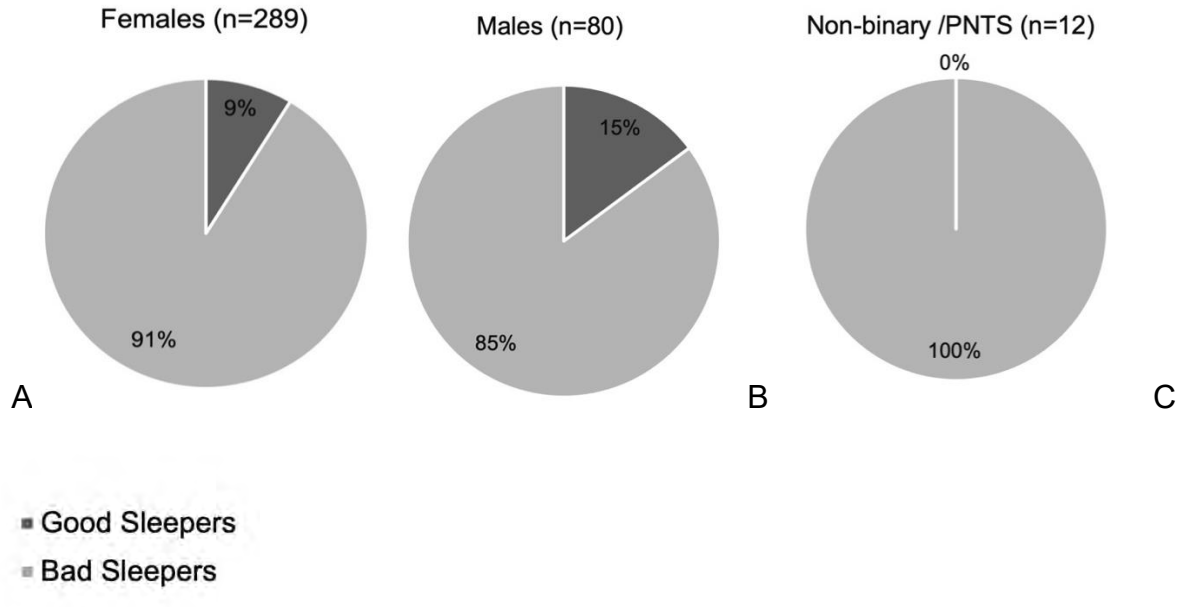

Figure 5: Percentage (%) of good and poor sleepers among the Females (A), Males (B), and Non-Binary and Prefer not to say (C) groups.

4.4. Sleep/Wake Characteristics According to Year of Study

The mean age of the first-year group was 20.27 yrs. (±4.35), for second year 20.51 yrs. (±1.80), and third year 21.68 yrs. (±2.41). Table 7 outlines the observed differences in sleep and time related data across the three years of study. There were statistically significant differences in sleep duration between the three years of study (*F(2)= 4.529, p= 0.011*).* Post-hoc analysis showed that it was the third-year group that reported a significantly longer sleep duration compared to the first- and second-year groups. However, there was no significant difference found between the sleep durations of first and second-year students. There was a significant effect of year of study on subjective sleep quality (F(2)= 4.365, p= *0.010**). Post-hoc analysis indicated that third-year students reported significantly better subjective sleep quality compared to first- and second-year students, with no difference between first- and second-year groups (Table 7). There was also a main effect for time in bed (*F(2) = 3.22, p= 0.041*),* with post-hoc analysis revealing that, third year students spent significantly more time in bed than the second year students, but not first year students. Finally, analysis indicated that there was a significant difference in global PSQI scores among the three groups (*F(2)= 5.594, p = 0.004*),* see Table 7. Post-hoc analysis indicated that the difference lay with the third-year group, as this group achieved a significantly lower score than the first-and second-year students, showing a comparatively better sleep quality compared to first- and second-year students, although, still considered poor.

There were no statistically significant differences in bedtimes (F(2)= 1.72, p = 0.180), rise times (F(2)= 0.955, p = 0.386), sleep latency (F(2)=1.684, p = 0.187), and habitual sleep efficiency (F(2)= 0.02, p=0.977) across the three undergraduate years. The statistical tests run to compare sleep characteristics in the year of study can be found in Appendix J.

Table 7: Sleep & Time-related data by year of study

Variable	First Year	Second Year	Third Year	*p*-value
Valid n (%)	131 (33.58%)	110 (28.21%)	149 (38.25%)	
Bedtime (hh:mm)	00:24 (±01:45)	00:40 (±01:47)	00:16 (±02:00)	0.180
Rise-time (hh:mm)	07:07 (±02:09)	07:13 (±01:46)	07:25 (±01:28)	0.386
Sleep Latency (mins)	39:29 (±32.72)	43:37 (±39.01)	35:55 (±31.02)	0.187
Hours of sleep (hh:mm)	05:45 (±01:33)	05:44 (±01:26)	06:12 (±01:19)	*0.011**
Subjective sleep quality	1.69 (±0.78)	1.66 (±0.71)	1.45 (±00:42)	*0.010**
Time In Bed(hh:mm)	6:44 (±02:34)	6:33 (±01:34)	7:09 (±01:34)	*0.041**
Habitual Sleep Efficiency (%)	85.87 (±14.48)	85.05 (±13.16)	85.66 (±14.50)	0.977
PSQI Global Score	10.12 (±3.32)	10.35 (±3.28)	9.08 (±3.35)	*0.004**

Analysis of the percentage of good sleepers (scores ≤5) versus poor sleepers (scores >5) within each group indicated that of the three groups, the second year group has the highest percentage of poor sleepers, with the first year group following closely behind. The third-year group has the highest percentage of good sleepers compared to the first- and second-year groups, see Figure 6.

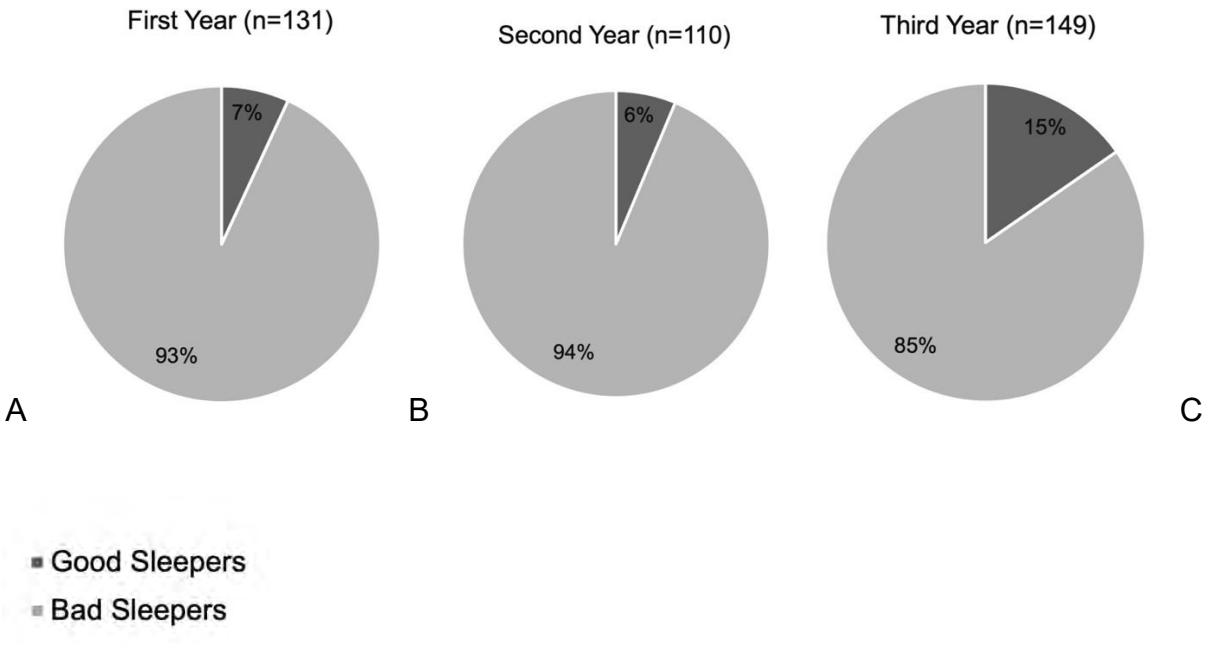

Figure 6: Percentage (%) of good and poor sleepers among the First Year (A), Second Year (B) & Third Year (C) Groups

4.5. Sleep/Wake Characteristics According to Living Context

When analysed by living context, the students living on campus in university residences (RES) reported a significantly shorter mean commute time (t(361)= -4.460, p>0.01*) compared to the off-campus Oppidan students. There was a significant difference in bedtimes between residence and Oppidan students (*t(387)= 2.822*, *p = 0.005**), with residence students reporting significantly later bedtimes than Oppidan students. There was also a significant difference found for sleep duration between residence and Oppidan students (*t(383)= -2.253, p = 0.025**) with Oppidan students obtaining more hours of sleep than residence students.

No significant differences were found between residence and Oppidan students for rise times (t(386)= 0.074, p= 0.941), sleep latency (t(376)= 0.294, p= 0.769), subjective sleep quality (t(388)= 0.858, p= 0.391), time in bed (t(67)= -1.623, p= 0.109), habitual sleep efficiency (t(382)= 1.45, p=0.148) and global PSQI scores (t(388)= -0.226, p=0.821), see Table 8. Statistical tests run to compare sleep characteristics by living context grouping can be found in Appendix K.

Table 8: Sleep & Time-related data by living context

Variable	**Residence (On Campus)**	**Oppidan (Off Campus)**	***p*-value**
Valid n (%)	242 (63.31%)	147 (37.69%)	
Commute Time (mins)	10:46 (±6.74)	14:30 (±9.14)	*p<0.001**
Bedtime hh:mm	00:36 (±01:42)	00:07 (±01:40)	*0.005**
Rise-time hh:mm	07:16 (±01:57)	07:15 (±01:33)	0.941
Sleep Latency (mins)	39.34 (±34.02)	38.47 (±34.21)	0.769
Hours of sleep hh:mm	05:48 (±01:28)	06:08 (±1:24)	*0.025**
Subjective Sleep Quality	1.62 (±0.75)	1.55 (±0.71)	0.391
Time In Bed (hh:mm)	06:39 (±02:11)	07:09 (±01:36)	0.109
Habitual Sleep Efficiency (%)	86.65 (±14.44)	84.50 (±13.44)	0.148
PSQI Global Score	9.76 (±3.23)	9.84 (±3.58)	0.821

Analysis of the percentage of good sleepers (scores ≤5) versus poor sleepers (scores >5) within the residence and Oppidan groups showed that a higher percentage of

residence students were classified as poor sleepers compared to the Oppidan students, suggesting poorer sleep quality in this group. See Figure 7.

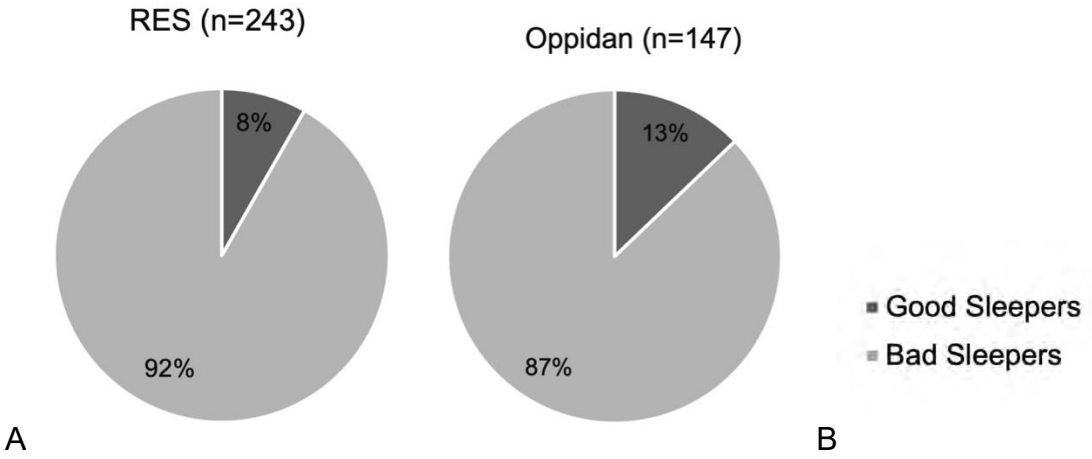

Figure 7: Percentage (%) of good and poor sleepers among the RES (A) and Oppidan (B) students.

4.6. Sleep/Wake Characteristics According to Funding Options

Analysis revealed that bedtimes differed significantly between the funding groups *(F(2)= 6.07, p=0.0025*)*, with post hoc analysis revealing that the NSFAS students reporting significantly later bedtimes than the self-funded and other group. There was no difference in bedtimes of the self-funded group and the group classified as "other", see Table 9. Subjective sleep quality showed significant difference (*F(2)= 3.194, p=0.0208*)* across the different groups, with post-hoc analysis indicating that, in this instance, the NSFAS students reported a significantly higher subjective sleep quality score than students within the "other" group, with no significant differences between NSFAS students and the Self-funded students see Table 9.

There were no statistically significant differences between funding groups for rise times (F(2)= 1.841, p=0.1601), sleep latency (F(2)=0.3552, p= 0.7013), sleep durations (F(2)= 2.493. p= 0.0840), time in bed (F(2) = 1.99, p= 0.1386) habitual sleep efficiency (F(2) = 1.83, p= 1.625), and global PSQI scores (F(2) = 1.522, p=0.2196).

Statistical tests run to compare sleep characteristics between funding groups can be found in Appendix L.

Table 9: Sleep and time-related data for funding options

Variable	Self-funded	NSFAS	Other	*p*-value
Valid n (%)	132 (34.29%)	194 (50.39%)	60 (15.54%)	
Bedtime (hh:mm)	00:13 (±01:37)	00:42 (±01:43)	23:55 (±01:40)	*0.0025**
Rise-time (hh:mm)	07:19 (±01:36)	07:21 (±02:00)	06:49 (±01:26)	0.1601
Sleep Latency (mins)	38.09 (±29.17)	40.39 (±37.11)	36.34 (±33.70)	0.7013
Hours of sleep (hh:mm)	06:00 (01:22)	05:46 (±01:31)	06:13 (±01:17)	0.0840
Subjective sleep quality	1.55 (±0.66)	1.69 (±0.77)	1.39 (±0.76)	*0.0208**
Time in Bed (hh:mm)	07:06 (±01:39)	06:39 (±02:16)	06:55 (±01:38)	0.1386
Habitual Sleep Efficiency (%)	84.02 (±14.72)	86.42 (±14.12)	87.82 (±13.50)	0.1625
PSQI Global Score	9.84 (±3.42)	9.97 (±3.24)	9.07 (±3.55)	0.2196

Analysis of the percentage of good sleepers (scores ≤5) versus poor sleepers (scores >5) within the funding groups showed that there was a higher percentage of “good sleepers” within the “Other” funding options group than within the Self-funded and NSFAS groups, see Figure 8

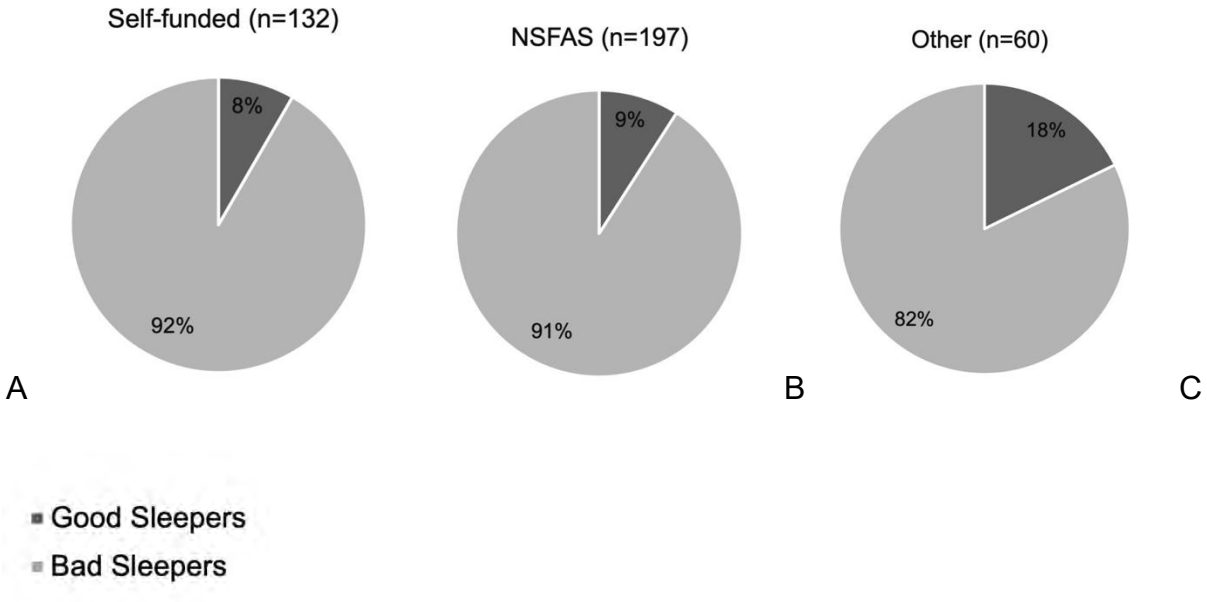

Figure 8: Percentage (%) of good and poor sleepers among the Self-Funded (A); NSFAS (B); and Other (C) funding options.

4.7. Results From Thematic Analysis: Sleep Disturbances Described by Participants From the PSQI Open-Ended Question and Additional Open-Ended Question:

The results from the thematic analyses begin with the thematic analysis of the PSQI open-ended question (q5b to q5j) relating to sleep disturbances. The second open ended question was question number 26, with number 27 being optional. 390 students responded to the PSQI open ended question, as mentioned in the method, the number of responses surpassed the total number of participants due to instances where individuals referenced multiple themes within a single response. Each response yielded multiple codes as many students wrote full explanations as to why they believed their sleep was affected. Thereafter, the thematic analysis of the PSQI open-ended question and an additional open-ended question was added at the end of the survey to assess any additional factors affecting their sleep either positively or negatively. The total number of responses for the open-ended question from the PSQI was 582. The total number of responses for the additional open-ended question and the follow-up question was 799; therefore, the total number of responses overall for all open-ended questions was 1381. Of this, the total number of negative influencing factors cited in the PQSI open-ended question was 540, and the total number of negative factors mentioned in the second open-ended question was 680. Thus, the total number of negative influencing factors cited was 1220; this number was used to derive the percentage of frequency of negative influencing factors.

There were 34 total positive influencing factors cited in the PSQI open-ended question and 106 in the second open-ended question. Thus, the total number of positive factors cited by students was 140; this number was used to derive percentages found in Table 10 and Table 11 below.

4.7.1. Factors Affecting Student Sleep Negatively

The thematic analysis provided insight into what students felt were prominent factors affecting their ability to obtain good sleep quality, as organised in Table 10. Mental health-related, university-related, environmental, and sleep-related factors emerged as dominant themes. Factors such as pain/illness/discomfort-related factors,

technology use, personal circumstances, substance/medication use, employment-related factors, and physical activity were additionally identified through thematic analysis. However, these factors were relatively less frequently mentioned. The subsequent section will delve into the prominently mentioned themes, briefly touching on the various subthemes within each.

Table 10: Total number of themes cited as negatively affecting sleep

Total negative factors	Frequency cited (n)	*% of total*
Mental health-related	326	*26.72*
University-related factors	311	*25.49*
Environmental-related	196	*16.07*
Sleep-related	168	*13.77*
Pain/discomfort/illness	79	*6.48*
Technology-related	65	*5.33*
Personal factors	49	*4.02*
Substance/medication-related	32	*2.62*
Employment-related	2	*0.16*
Physical Activity	2	*0.16*

7.2.1.2. Mental Health-Related Factors

In the analysis of open-ended responses from the students, a prominent theme that emerged was the impact of mental health challenges on sleep patterns. Within this overarching theme two main subthemes emerged **Challenges with Mental Health** and **Diagnosed Mental Illness**.

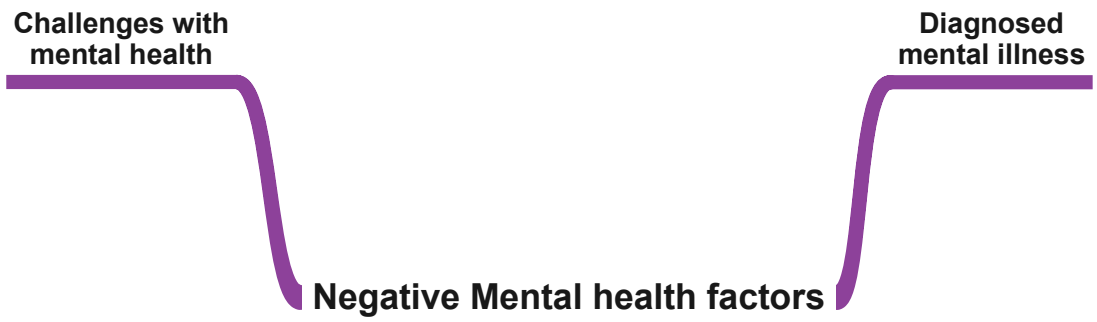

Figure 9: Main Themes and sub-themes for negative mental health-related factors.

Within the subtheme of **Challenges with Mental Health**, emerging themes were identified, with prominent themes relating to anxiety, stress, worry and overthinking, stress and anxiety were prominently mentioned. Examples of statements from students include, "*Been suffering from anxiety and insomnia*" with another stating, "*…the anxiety and stress have negatively affected my sleeping patterns. this has been happening a lot this past month, I'm under a lot of pressure"*. While another made note that, "*Stress has made it worse. Nothing made it better…".*

With regard to overthinking, participants shared how their minds were often consumed by excessive rumination and persistent, intrusive thoughts, making it challenging to achieve restful sleep. One student described this experience: *"… When my brain is too occupied, it gets difficult to switch off and go to sleep..."* Another participant echoed this sentiment: *"Sometimes I just struggle sleeping because I think a lot before falling asleep, and it's like I cannot silence my brain, so I spend hours in my bed thinking and worrying."*

Within the theme of **Diagnosed Mental Illness factors**, students cited that diagnosed mental health conditions had a negative effect on the quality of their sleep. Among the identified mental health disorders, participants specifically referenced diagnoses such as Generalized Anxiety Disorder, Bipolar 2 Disorder, Major Depressive Disorder, and panic disorder. The questions specifically asked students to "Please state and describe any other reason(s) your sleep may be disrupted or disturbed" and "What factors, if any, have affected the quality of your sleep over the past month (either positively or negatively)."

The accounts from students directly referring to diagnosed mental health conditions being a contributor to disturbed sleep included: *"I have diagnosed major depressive disorder, anxiety disorder and panic attack disorder."* underscoring the compounding effects of multiple diagnosed conditions. Another individual disclosed, "*Anxiety, I was diagnosed with severe anxiety*". Additionally, a student acknowledged their struggle with bipolar type 2, stating, *"I have bipolar type 2. Sleeping is difficult by default".*

7.1.2.3. University-Related Factors:

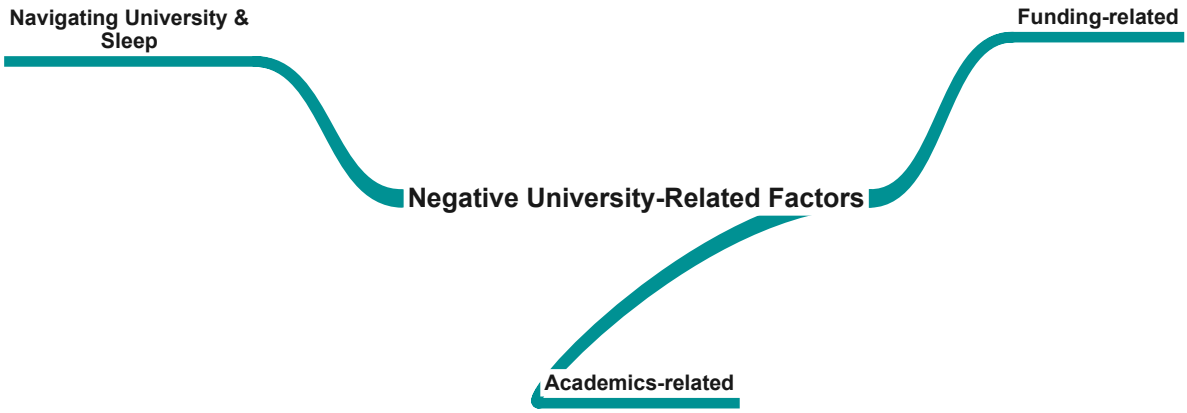

Figure 10: Negative University-related factors affecting student sleep quality.

Th The second most prominent theme centred on the adverse impact of **University-Related Factors** on students' sleep quality. Three distinct subthemes emerged under the overarching theme of **University-Related Factors:** academics, funding-related, and navigating university and sleep.

Within the theme of academics, a diverse array of subthemes surfaced. Participants voiced concerns about academic obligations, as illustrated by statements like: *"Stressing out about submissions and feeling guilty for sleeping when there is work to be done."* This illustrates the juggling act students face in striving for academic success while grappling with the imperative of restorative rest. As one student succinctly put it, *"I've been stressing about my academics a lot for the past few weeks and the pressure I feel is a lot to handle sometimes",* while another student expressed, *"Stress and anxiety sometimes because I feel like I'm not understanding the content or maybe I haven't covered what I had planned to cover for the day"*

The theme of navigating university and sleep comprised of the subthemes of high workload and poor time management. Students described the strain of balancing lectures, tutorials, and additional coursework, often leading to late-night work sessions. This was described as exerting a significant influence on their sleep schedules, leaving limited time for restorative rest with statements such as *"Is it possible to get enough sleep when you're a student?"* as well as statements such

as *"…I also think the way undergrad is set up in varsity makes it difficult to not work into the early hours because lectures go till 6pm but you're still expected to do more work when you get home which takes even more time. So, this affects my sleep majorly because I'm so busy during the day so the only time I have is from 8pm to midnight".* Numerous participants emphasized that the *"high workload"* significantly impacts their sleep quality. One student articulated, *"It's just that sometimes you have so much work to do and many deadlines to meet, so sleeping becomes the least of your priorities."* Others echoed this sentiment, saying, *"The stress I feel because of the workload at hand gives me restless sleep. Fuels my anxiety as well."* Another stated, *"Overload of work and deadlines, needing to pull all-nighters due to work needing to be complete."* Another participant described it as an *"overload of work... pressure to catch up and complete my workload for that week."*

Additionally, participants voiced concerns about the early timing of lectures, impacting their ability to get adequate sleep. Another subtheme within the main theme of *academics* was poor time management, with students offering insights such as: *"When assignments are due at midnight on RUConnected, this motivates me to procrastinate until I end up staying up late to finish off my work and submit at the last minute. After this I usually struggle to fall asleep."* This subtheme also encompassed reflections on time management skills, procrastination tendencies, and the consequent impact on sleep patterns, with another student stating stated that *"I have a lot of school-work to catch up on. It's entirely my fault. I wasn't doing things on time, so I had to sacrifice my sleep."* and *"Too much workload, stressing too much about school and not managing time efficiently.*

Within the context of university-related influencing factors, students further underscored funding and the inherent challenge of maintaining healthy sleep routines while navigating the demands of academia. Regarding funding, students voiced their concerns with one off-campus student who articulated, *"As an off-campus student, I get more stress from my finances, since I do not have funding, and academics also contribute but major stressor is finances."* Another student expressed, *"Psychological factor, I have been stressed as of late, I have no academic funds. It is really stressful when you really don't know if you are going to have money for rent and food, it makes me struggle to sleep."* The looming question of securing

funding for future academic pursuits also weighed heavily on students' minds, as one participant articulated, *"Stressing about my future and family finances,"* and another expressed, *"Anxiety of what's to come after the degree and if I will be able to find funding if intending to pursue an honours degree."* The dual pressures of academics and funding prospects emerged as significant sources of stress for these students.

7.1.2.4. Environment-Related Factors

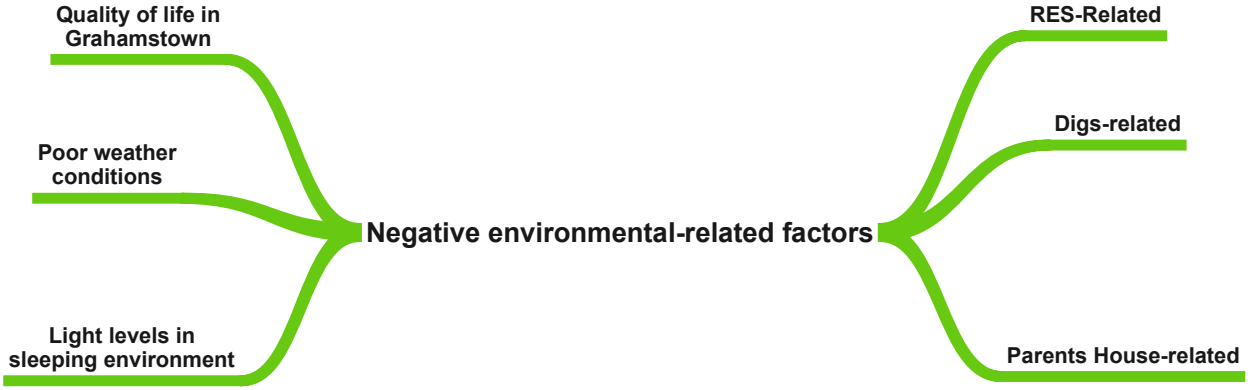

Figure 11: Main themes and sub-themes for negative Environmental-related factors.

The third most prominently cited negative influence on student sleep was **Environmental-related factors**. This theme encompassed six sub-themes: residence-related, Oppidan-related (referred to as Digs-related factors in analysis), overall quality of life in Grahamstown, parents house-related, 'poor weather conditions, and light levels in the sleeping environment. Among these sub-themes, residence-related and Oppidan-related factors stood out as key concerns for the students.

In relation to residence-related factors, a recurring theme was noise in and around the residence. One student described, *"Residence Noise, guys who speak at the top of their lungs at 06h30 in the morning are my alarm now and the warden does nothing about it despite several complaints. I hate this house so much."* The same sentiment was reiterated in the second follow-up question, *"Residence noise. I cannot stress that enough, people here are NOT considerate, that includes the management…If I resided in a quieter residence, I wouldn't have any of these sleep*

problems. They are the only problem." A female student shared, *"Noise is something that hinders my sleep. I live in RES with loud girls, so it tends to take a while for them to settle in order for me to fall asleep."* Another student cited the residence infrastructure as an issue, stating, *"My sleeping problems is a major issue, another one is the person that stays in the room above mine. The infrastructure in my res is quite bad and I can hear them move around in their room - and they tend to stomp - especially in the night."*

Oppidan-related factors encompassed codes which specifically referenced living in off-campus housing (either with roommates or without roommates). Noise also emerged as a significant concern. Students expressed frustration with *"traffic outside, animals on the street or of neighbours"* and *"Noise outside and inside the house, people playing music and being loud."* They also pointed out disturbances caused by *"housemates parties",* and noise in relation to loadshedding, for example, *"Noise, coming from my surroundings e.g., Alarm when the electricity comes back."*

Moreover, students identified poor weather conditions as a contributing factor to their poor sleep quality. One student noted*, "the cold weather has definitely also affected my quality of sleep as I am not used to it and my heater does not keep my room warm enough,"* while others cited disruptions due to weather-related noises such as *"Due to some noises around res, lightning or heavy rain."*

Furthermore, students indicated that the overall quality of life in Grahamstown had an impact on their sleep. They expressed sentiments like, *"I don't sleep well in Grahamstown. I am more anxious than usual when I am here and it definitely affects my sleep,"* underlining how the broader environment influenced their rest.

7.1.2.5. Sleep-Related Factors:

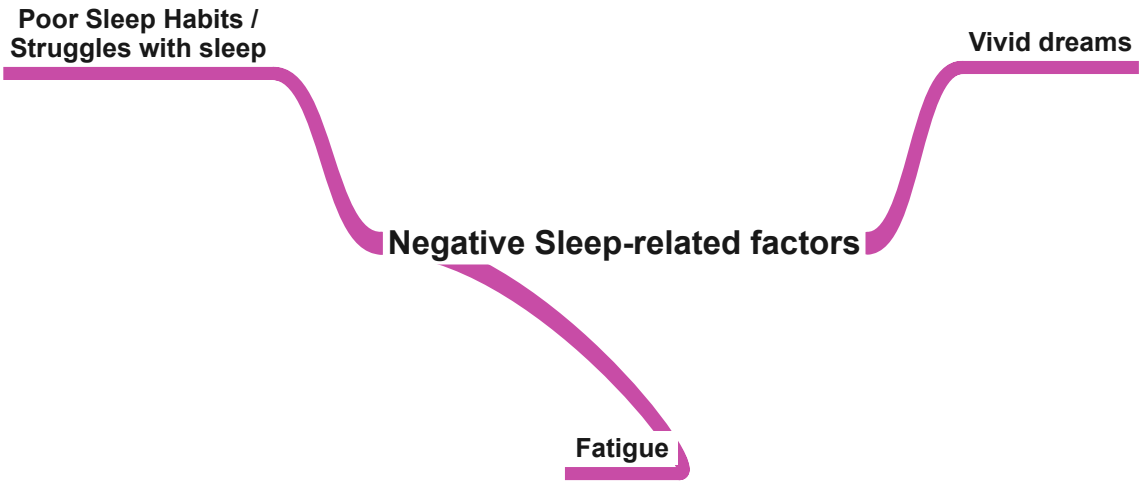

Figure 12: Main themes and sub-themes for negative Sleep-related factors.

The fourth most prominently cited factor negatively impacting student sleep quality was **Sleep-related factors.** This category encompassed subthemes like poor sleep habits, vivid dreams, and fatigue.

Under the theme of poor sleep habits, a prominent subtheme of irregular sleep schedule encompassed a large variety of sub-themes. Students provided reflections on this, with one student remarking, *"Unusual sleeping times - waking up early for uni while still sleeping very late."* Another noted, *"I sleep for 1-hour intervals, but it feels like I have been asleep for a really long time."* A third shared their evolving sleep experiences, stating, *"My sleep has changed over the years. When I was younger, from age 9 as far as I can remember, I used to struggle with insomnia..."* They went on to describe how their sleep patterns shifted during school holidays and later in university.

Within the domain of struggles with sleep, which holds slight differences to poor sleep habits, students revealed they experienced sleep disorders, specifically, *"insomnia"* as a key challenge affecting their sleep quality. A recurring sentiment was the struggle with being light sleepers. One student expressed, *"I'm suffering from insomnia, when I'm stressed, I struggle to sleep."* Another stated, *"…I am a light sleeper meaning I hear the slightest of sound. Footsteps in the corridor and the*

aggressiveness in opening of doors of my housemates heightens my anxiety levels as if something is wrong or someone is approaching my door, which is uncomfortable." Students highlighted vivid dreams as another sleep-related disturbance. They expressed awakening during the night due to these dreams, as one student conveyed, *"I've been having bad dreams too and waking up during the night."* Another shared the fear associated with sleeping, citing, *"Fear of sleeping because I know I'll have a bad dream."*

Regarding the subtheme of fatigue, students stated that they struggle to sleep when they are *"To tired, then I sometimes struggle to fall asleep".* The students have also found they are not feeling rested after a sleep episode, possibly due in part to fatigue which has perhaps built up over time, evidenced in statements such as *"When I wake up, I feel even more tired than I did when I slept.",* and statements such as: *"I struggle to wake up in the morning, and I sleep a lot. sometimes I wake up tired",* and *"Getting up is always the hardest thing because I feel most tired when I need to wake up".* Other students cited that their levels of fatigue were the reason they sometimes missed class, with a statement such as *"the worst thing about struggling to sleep is that most of the times I have to attend classes in the morning, and I struggle to wake up or if I do i will have difficulty concentrating in class and I've missed classes due to this.".* Where another student stated that even though they have a high need for sleep, they find that it is not possible to get enough sleep while attending university, *"At this point, I wish I could get 24 hours sleep just to rest but that is impossible. Rest is not really an option until I bag this this degree".*

4.7.2. Factors Influencing Student Sleep Positively

The survey's second open-ended question prompted students to explore factors influencing their sleep positively or negatively. This provided an opportunity for them to share insights into what aids their sleep. The number of positive influencing factors were significantly less than that of the negative influencing factors, as can be seen from Table 11.

Table 11: Total number of positive influencing factors cited

Total positive factors	Frequency cited	% of total
No other disturbance	46	32.86
Technology-related	19	13.57
Substance/medication use	17	12.14
Comfort-related	16	11.43
University-related	13	9.29
Sleep-related	12	8.57
Physical activity-related	8	5.71
Personal factors	5	3.57
Environmental-related	2	1.43
Mental health-related	2	1.43
Employment-related	0	0.00

Despite a lower count of positive influencing factors than negative ones, **technology-related factors** emerged as the most frequently mentioned; in some instances, this was through creating background noise, and in other instances, this was through watching videos and scrolling social media. Some students stated that using technology for background noise has a positive effect on sleep, with some students expressing that Autonomous Sensory Meridian Response (ASMR) has a positive effect on sleep with some students stating, *"I listen to ASMR"* and others stating, *"When I have trouble sleeping (which happens very rarely), I listen to podcasts or ocean sounds on Spotify to have some noise in the background while I sleep. Sometimes my thoughts are too loud and distracting, so I require other people's voices or other sounds to drown out the ones in my head.".* Additionally, using technology to provide soothing nature soundscapes was also cited by students, *"Playing a sound of rain helped me sleep effectively"* and *"Soothing Nature videos help me sleep faster when stressed."* Another finding was students saying that scrolling social media and watching videos helped them fall asleep, with students making statements such as, *"I have nightmares and sleep paralysis, which makes me scared to sleep, so I scroll through social media or watch videos till I fall asleep.",* some acknowledged scrolling social media was detrimental, whereas watching videos

enhanced ability to fall asleep with the statement: *"Scrolling through social media tends to keep me up longer than watching videos on YouTube".*

Substance/medication use emerged as the next frequently mentioned positive influence, with students noting that certain substances and medications positively impact their ability to fall asleep. As reflected in the quotes, one student shared, "Most nights I'm under the influence of cannabis, so I go to sleep really quickly," while another mentioned, "sleeping pills have positively affected my sleep as I sleep longer".

Comfort-related factors were also highlighted, encompassing practices that enhanced students' comfort for more restful sleep. For instance, one student described, "Placing a hot water bottle on my bed alleviates the discomfort of the res beds, mimicking the warmth of an electric blanket at home. Sleeping with a stuffed animal gives the illusion of cuddling, reducing the loneliness I feel in Grahamstown and helping me sleep more peacefully." Another student expressed, "I sleep better when my partner shares the same bed with me."

The next two most frequently mentioned positive influencers were **University and Sleep-related factors.** Regarding university-related factors, students explained that working hard academically positively aids in falling asleep quicker. They also noted, *"Finishing my school on time affected positively,"* and mentioned the exhaustion from daily activities on campus: *"Having to move around from lecture to lecture,"* and *"Being busy with school tires me out, making it easier to sleep. Going back to physical classes and walking exhausts me, resulting in better sleep sometimes."*

Sleep-related factors encompassed aspects directly tied to sleep, which students felt positively influenced their rest. For instance, one student mentioned their consistent wake-up times, saying, *"I wake up every day at the same time at 02h00 or 03h00. I have better quality sleep when I sleep fewer hours than longer hours"* and *"I'm usually very tired during the day, so I sleep easily by not napping during the day, which impacts me positively."*

CHAPTER 5
5. DISCUSSION

The aim of the current study was to characterise sleep/wake behaviours and sleep quality in a sample of undergraduate students attending a South African University, with the objective being to determine which, if any, factors may be positively or negatively influencing the students' sleep quality. The following discussion begins with a summary of the findings for the whole sample, which will be followed by discussing findings regarding the effects of demographic characteristics. Additionally, throughout the discussion, findings from the thematic analysis will be integrated to support the interpretation of the results.

5.1. Summary of Major Findings for Whole Sample

To the researcher's knowledge, this is one of the few studies investigating sleep quality in university students in a South African context during a non-examination term covering all three years of undergraduate studies. Two significant findings emerged from the data gathered in the current study. First, this sample exhibited high mean global sleep quality scores, indicative of poor sleep quality, with a high proportion of poor sleepers. These findings could result from a combination of short average sleep duration (05h55 (±01:27)), long sleep latencies, and evidence of sleep disturbance, resulting in a high component score for daytime dysfunction.

The second key finding was that the students cited mental health challenges as a major factor which negatively affected their sleep, with mental health-related factors being the most frequently mentioned inhibitor of sleep amongst this set of participants. Other prominent negative influencing factors cited by the current sample were university-related, environmental, and sleep-related factors.

Given reported sleep/wake characteristics and qualitative data collected from the current sample, researchers observed several factors which may potentially contribute to the overall poor sleep quality reported by this sample, which can have adverse implications for physical health, academic performance, mental health, and overall wellbeing of the students in the current study. Thus, this section will discuss these major findings, drawing from the quantitative (sleep characteristics) and qualitative

data gathered (e.g., multiple stressors and environmental factors) to provide possible explanations for poor sleep quality in this sample of students. These discussion points will draw on the data from the whole sample first, followed by a summary of the findings for the different demographic groups and a further discussion of those findings.

The group data revealed that, on average, the sleep quality was poor. The poor sleep quality observed in students in the current study was consistent with findings of global research highlighting undergraduate students as a group at risk of poor sleep quality (Arnett, 2000; Brown et al., 2002; Vail-Smith et al., 2009; Fernandez-Mendoza et al., 2010; Lund et al., 2010; Orzech et al., 2011; Araujo et al., 2014; Kabrita et al., 2014; Peach et al., 2016; Amaral et al., 2018; Nogueira et al., 2018; Benham, 2020; Ahammed et al., 2021; Du et al., 2021; Evans et al., 2021; Marelli et al., 2021). However, the global sleep quality scores of the current sample were higher than what has been found in many previous studies that compared sleep quality prior to (Seun et al., 2010; Cheng et al., 2012; Lemma et al., 2012 [A]; Kabrita et al., 2014; Seun-Fadipe & Mosako, 2017) and during the COVID-19 pandemic (Cellini et al., 2020; Du et al., 2021; Evans et al., 2021; Marelli et al., 2021; Viselli et al., 2021).

Another major finding of this study was that the students in the current study exhibited a heightened prevalence of students with global PSQI scores above the clinical cut-off point (<5); specifically, 90.26% of students in the current study met the criteria for poor sleep and high levels of sleep disturbance according to PSQI cut-off criteria (Buysse et al., 1989). This percentage of poor sleepers surpasses that which has been reported in most prior research, including a study conducted during the COVID-19 pandemic, which specifically classified individuals as good and poor sleepers (Gilbert & Wear, 2010; Lund et al., 2010; Preišegolavičiūtė et al., 2010; Cheng et al., 2012; Lemma et al., 2012 [A&B]; Orsal et al., 2012; Kabrita et al., 2014; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017; Becker et al., 2018; Benham, 2020). Araujo et al. (2013) reported a higher percentage of poor sleepers than that of the current study, with 95.3% of the sample being classified as poor sleepers.

The possible reasons for the poor quality in this group, similar to the concept of what good sleep quality means, are multifaceted. Therefore, a number of possible contributing factors may influence poor sleep quality and a high number of poor

sleepers. Firstly, these findings could be explained by late reported bedtimes, with the average bedtime being after midnight (00:25 ±.1:42). One of the main drivers for the observed late bedtimes could be the phase of development that the majority of the students are in, many of them being late adolescents and early adults. Late bedtimes are a characteristic common to late teenagers and early adults (Rossa et al., 2013; Bruce et al., 2017; Crowley et al., 2018). Although this was not tested for, the impact of cannot be meaningfully concluded in the current study, it may hold some explanatory power. Perhaps larger numbers combined with circadian measuring tools could have assisted in determining the circadian phase expression for this sample. The theory for this explanation stems from the fact that as adolescents transition (15-18 years) into young adulthood (18-26 years), there is a recognised delay in the intrinsic rhythmic system governing sleep/wake behaviour, particularly affecting processes S and C and therefore the overall sleep/wake cycle (Rossa et al., 2013; Bruce et al., 2017; Crowley et al., 2018). More specifically, these changes are driven by a natural delay in the internal circadian clock combined with a slower rise in sleep homeostatic pressure (Hagenauer et al., 2009; Carskadon, 2011; Crowley et al., 2018). Lund et al. (2010) demonstrated that insufficient sleep due to the interaction of bio-regulatory changes, psychosocial demands, and academic demands extends past high school years into young adulthood, wherein many individuals attend university.

Another possible explanation for late bedtimes may be that the students have the autonomy to self-select bedtimes, and as a result of academic demands, as indicated by the thematic data, many students go to sleep late. Evidence for this was found in the theme of navigating university and sleep, which was comprised of statements wherein students cited challenges related to late-night studying and managing coursework. Under this theme, statements highlight the strain of balancing lectures, tutorials, and additional coursework, often leading to late-night work sessions. Knowlden and Naher (2023) found that time management behaviours are associated with global sleep quality scores, particularly in the sense that adequate sleep requires the allocation of sufficient time for sleep. Poor time management behaviours may influence sleep quality through a stress-related negative influence on sleep (Kowelden & Naher, 2023). This may provide some further explanatory power for the late bedtimes observed in the current sample. The ineffective time management challenges seen in this sample may be converging with developmental changes and

other cited challenges, resulting in keeping students up later. This subtheme also encompassed reflections on time management skills, procrastination tendencies, and the consequent impact on sleep patterns. Findings in the Kowelden & Naher (2023) study indicated it was, in fact, effective time management behaviours which brought about the feelings of perceived control of time, which, in turn, accounted for a significant variance in global sleep quality within their sample of university students in an American college. Furthermore, their living environment, particularly for those students in residence, may contribute to late bedtimes; this will be discussed in more detail at a later point.

An additional contributor to the poor sleep quality overall in the current sample may be due, in part, to the reported extended sleep latencies. The self-reported mean sleep latency for the whole sample in the current study was 39:21 minutes, which is higher than that which was reported by the majority of students in another South African university by Reid & Baker (2008), wherein 74% of the sample fell asleep within 30 minutes. Lemma et al. (2012[B]) found that long sleep latencies were reported by 48.5% of their total sample. Sweileh et al. (2011) and Lawson et al. (2019) have both indicated that university students are at high risk of long sleep latencies (> 30 minutes), which is associated with poor sleep quality. The extended sleep latency, like the late bedtimes, may be linked to the developmental changes observed in this demographic. Lund et al. (2010) explain that university students may be more susceptible to sleep difficulties due to changes in the hypothalamic–pituitary–adrenal axis (HPA axis), found to occur during the developmental phase of older adolescents and young adults, resulting in increased cortisol secretion in the peri-sleep phase (Forbes et al., 2006).

Secondly, stress was a common theme which emerged within two distinct/separate themes: unspecified stress linked to **challenges with mental health** and stress specifically attributed to **university-related factors**. Previous research has reported that stress can have a negative impact on sleep, resulting in fewer hours spent sleeping, more disturbances during sleep, and later rise times, particularly during times when the individual is experiencing high levels of stress (Amaral et al., 2018). One of the main qualitative themes which emerged in the current study is that this sample battles with stress, with most students citing academic stress as a main driver for poor sleep. Within the subthemes of academic-related stress, participants voiced concerns

about academic obligations. The university system is a space which can exacerbate stress-related sleep difficulties, and erratic schedules (high-stress periods such as tests and exams) are examples of situations that may influence students' sleep due to stress and anxiety (Assaad et al., 2014). Research by Lund et al. (2010) and Assaad et al. (2014) underscores the significant explanatory power of perceived stress for poor sleep quality among university students, surpassing factors like sleep schedule, regularity, substance use, exercise frequency, or bedtime technology use before bed. The mechanisms for this bidirectional relationship include the dysregulation of neurotransmitters, alterations in stress levels, and disruptions in the circadian rhythm (Ali & Vigar, 2024).

The high stress levels reported by the sample may additionally explain the extended sleep latencies and late bedtimes found within this sample. According to Chen et al. (2014), young adults who report long sleep latencies are more likely to report poor mental health. For example, struggles with anxiety can lead to difficulties falling asleep and, thus, a delayed sleep onset (Ali & Vigar, 2024). The negative effect of stress is linked with the prolonged activation of the body's stress response, which can either be downregulated or exacerbated by psychological processes such as repetitive negative thinking (RNT) and cognitive emotion regulation strategies (CER) (Amaral et al., 2018). Repetitive Negative Thinking (RNT) is defined as a perseverative (repetitive), abstract, and harmful focus on one's experiences and problems which the individual believes are too difficult to control (Nota & Coles, 2016). This links to the theme of overthinking reported by students in the current study. A study by Nota and Coles (2016) found that RNT may be uniquely related to sleep duration and timing. Aside from difficulties sleeping, RNT has also been associated with a wide array of emotional problems and has been constituted as a significant predictor in the onset of psychological distress (Amaral et al., 2015). This is evident in the current sample, as mental health challenges were the most frequently mentioned negative influencing factor on sleep quality. University students may lack proper coping strategies for the stress they encounter and subsequently experience higher levels of internalisation, anxiety, worry, and rumination/overthinking (Lund et al., 2009). This should be researched in more detail in future studies.

In addition to late bedtimes and extended sleep latencies, the current sample reported relatively early rise times (07:15 [±1.48]). This early waking time was likely due to scheduling demands. At Rhodes University, residence students have breakfast from 07:00 to 08:15 (https://www.ru.ac.za/desmondtutu/desmondtutuhall/dininghall-meals). Thus, students in residence must wake up before breakfast, which is scheduled from 07:00 to 08:00, to attend the first lecture, which starts at 07:45. Similarly, off-campus students need to wake up early to commute to and must wake up early to attend morning lectures.

On top of the late bedtimes, long sleep latencies, early rise times and the self-reported negative influence of stress, an additional possible explanation of what may be contributing to the overall poor sleep quality in this sample may lie in the frequent nightly awakenings reported by the sample. According to component 5 of the PSQI, frequent nightly awakenings typically indicate continuous sleep disturbances, which can result from stress, anxiety, sleep disorders, or environmental factors such as noise and discomfort. These frequent nightly awakenings can result in fragmented sleep, thus resulting in poor overall sleep quality. The current study's findings differ from the findings of the Reid and Baker (2008) study in South Africa, which found that most of their student population either never or very seldomly experienced nightly awakenings. The analysis of sleep disturbances within the entire sample highlighted three prominent issues, namely, "getting to sleep within 30 minutes," "waking up in the middle of the night and in the early morning" and "other reasons"

The late bedtimes, long sleep latencies, frequent awakenings, and early rise times in the current sample likely all interacted to result in a short overall average sleep duration for the sample. The participants in the current study reported a mean sleep duration that was less than six hours, which falls below the lowest recommended sleep duration for this age group (Duggan, 2015; Hirshkowitz et al., 2015; Mukherjee et al., 2015; Watson et al., 2015). This is consistent with other research that found university students tend to sleep less than other age groups, most of whom report an average of 6-6.9 hours per night (National Sleep Foundation, 2011; Kloss et al., 2016). However, the mean sleep duration for the whole sample in this study was shorter than what has been found in several previous studies characterising sleep in university students, including studies conducted at universities in African countries (Steptoe et al., 2006;

Gilbert & Wear., 2010; Lund et al., 2010; National Sleep Foundation, 2011; Cheng et al., 2012; Lemma et al., 2012 [A]; Araujo et al., 2013; Kabrita et al., 2014; Kloss et al., 2016; Schlarb et al., 2017; Seun-Fadipe & Mosako, 2017). Furthermore, the mean sleep duration reported by students in this study was also shorter than that reported by students in several studies conducted during the COVID-19 pandemic (Benham, 2020; Du et al., 2021; Marelli et al., 2021). It is worth noting that Benham (2020) and Marelli et al. (2021) reported on sleep duration before and during the pandemic, both of which were higher than that of the students in the current study.

The qualitative results of the current study revealed an additional explanation for the overall poor sleep quality observed in the current sample. Thematic analysis revealed that students frequently cited poor mental health as a variable they believed to be associated with their poor sleep quality; this finding is consistent with many previous studies (Ohayon & Roth, 2003; Jansson-Frojmark & Lindblom, 2008; Preišegolavičiūtė et al., 2010; Lemma et al., 2012[A]; Ozlem et al., 2012; Assaad et al., 2014; Peach et al., 2016; Dinis & Bragança, 2018; Kalmbach et al., 2018; Gardani et al., 2022). A prominent mental health-related factor frequently cited by students was anxiety. The subtheme of anxiety encompasses both non-specified feelings of anxiety (classified under **challenges with mental health**) and diagnosed anxiety disorders (classified under **diagnosed mental illness)**. It is important to acknowledge the high frequency of self-reported anxiety amongst the current sample. The high rates of self-reported anxiety felt amongst this cohort may offer some explanation as to why this group scored such elevated global PSQI scores. Findings of Orzech et al. (2011) explain this being a possibility as they found that students who self-reported high levels of anxiety and depression exhibited highly elevated PSQI scores when compared to students who did not self-report these factors.

Furthermore, according to Forbes et al. (2006), poor mental health, specifically the prevalence of anxiety and depression, was associated with increased peri-sleep-onset cortisol release, but the patterns differ based on age. Forbes et al. (2006) suggest that puberty, emotional disorders, and cortisol levels are interconnected in complex ways. This hyperactivity in the neuroendocrine system may contribute to delayed sleep onset due to promoting hyperarousal around bedtime, which can result in longer sleep latencies and later bedtimes (Lund et al., 2010). However, mental health was not

exclusively tested in the current study and thus extends beyond the scope of this study, although this may offer a possible explanation for the extended sleep latencies found in this sample. Future research should investigate the effect of the psychological influencers, particularly the effect of anxiety, worry, and overthinking/ rumination and the impact of this on sleep among students in South African universities.

A further explanation for the late bedtimes, poor overall sleep quality, and high stress and anxiety levels reported by the current sample may be found within the theme of navigating university and sleep, specifically within the subtheme of high workload. These findings align with previous research, which reported that higher subjective workload is associated with shorter sleep duration as well as a higher subjective impact on sleep quality, which, in turn, is associated with higher measures of poor mental health outcomes, particularly increased feelings of depression and anxiety (Gall et al., 2023). The higher subjective workload experienced by the students may offer some further explanation as to why this sample showed such high levels of poor mental health, with anxiety and feelings of depression being frequently mentioned by the students. While workload is a multifaceted construct, the student's perception of a high workload may be the result of learning how to navigate the increased demand in learning faced each year as they transition through their undergraduate years of study.

According to the results of the current study, there seems to be an effect of the late bedtimes, early rise times, and long sleep latencies in that the results show evidence of high levels of daytime dysfunction, with this component garnering the highest mean score of the seven components tested in the PSQI. When considered together, these findings highlight the significance of considering more than just sleep duration in assessing sleep health and serve as evidence of compromised sleep health within this population with high levels of daytime dysfunction as a consequence of insufficient and poor-quality sleep. At the same time, complex and multifaceted challenges faced by university students stretch into multiple areas of the student’s life simultaneously, including sleep health. The following section aims to further understand these results by discussing the demographic differences found between genders, years of study, living context, and funding options.

5.2. Summary of Major Findings According to Demographic Grouping

When comparisons between genders were made, male students generally had better subjective sleep quality and lower global PSQI scores compared to female students. A higher percentage of females were classified as poor sleepers (scores >5). All non-binary and Prefer Not to Say students scored above 5, indicating overall poor sleep quality. No significant differences were found in bedtimes, rise times, sleep latency, time in bed, habitual sleep efficiency, and sleep duration between those who identified as female and those who identified as male in the current study. The higher number of females participating in the study may have influenced the results. However, the elevated global PSQI score (9.99 (±3.37)) for the female students aligns with the findings of Tsai & Li (2004) and Arbinaga et al. (2019), as well as observations made by Ahammed et al. (2021), all of whom similarly found that female students reported poorer sleep quality than male students. These findings are further echoed by Zhang & Wing (2006), who found higher rates of sleep problems among females. Furthermore, the data in the current study indicated a higher percentage of poor sleepers in the female sample, echoing the findings of Becker et al. (2018). However, it is notable that the overall proportion of poor sleepers in both genders was notably higher in the current cohort of students, with 91% of females and 85% of males falling above the PSQI threshold for poor sleep. The findings of the current study differ from those of Assaad et al. (2014), which found that male students reported poorer sleep quality than females. Two studies observed mean global PSQI scores which were almost as high as what was found in the current sample and within demographic groups of the current study, specifically, Araujo et al. (2013), which found a global PSQI score of 9.4 and Ahammed et al. (2021), which had a mean PSQI score of 9.08, but only for the female group in their sample.

Previous researchers have attributed the gender-based differences in the prevalence of sleep problems to socioeconomic disparities or higher rates of affective disorders in females (Arber et al., 2009; Bruck & Astbury, 2012; Fatima et al., 2016). However, in the study conducted by Arbinaga et al. (2019), the gender differences in sleep quality remained after controlling for socioeconomic disparities and the presence of affective disorders. This shows that while higher rates of affective disorders such as depression and anxiety may play a role in contributing to poor sleep in females, it is not the main

mechanism through which sleep quality is affected (Arbinaga et al., 2019). Arbinaga et al. (2019) suggest that biological differences may affect gender differences in sleep quality. Concerning more specific sleep characteristics, there were no significant differences between males and females in bedtimes, rise times, sleep latency, time in bed, habitual sleep efficiency, and sleep duration. This aligns with the findings of Ligouri et al. (2011) and Seun-Fadipe and Mosaku (2017), who also discovered no substantial variations in sleep/wake characteristics between genders. In essence, while subjective sleep quality displays gender distinctions, the more specific aspects of sleep suggest a more uniform pattern. More detailed research, inclusive of more objective measures would be important to better understand the impact of gender on sleep.

Findings regarding *year of study* indicated that third-year students reported significantly longer sleep duration, better subjective sleep quality, and improved global PSQI scores when compared to first- and second-year students. Furthermore, the third-year group had a higher percentage of "good sleepers" compared to first-and-second-year students, with 93% of first-years, 94% of second-years, and 85% of third-years classified as poor sleepers. There were no statistically significant differences in bedtimes, rise times, sleep latency, and habitual sleep efficiency across the three undergraduate years. These findings seem to indicate further that as students' progress through their years of study, changes occur that influence sleep quality. This finding is echoed by Lemma et al. (2012[A]), who established through their study that year of study in university was associated with reduced odds of poor sleep quality. It is plausible that as the students' progress through to their third year of university, they may develop better-coping strategies for the challenges of being in university; this sentiment is echoed by Dinis & Bragança (2018) and Seun-Fadipe (2017), who suggested improved sleep quality in later years of study indicates the development of better coping strategies for academic demands. Romero-Blanco et al. (2020) showed similar findings in that poor sleep quality was maintained in subgroups of first- and second-year students.

While it is recognised that sleeping patterns among university students may change over the course of a semester, it is argued that the most pronounced changes in sleep patterns occur during the first few days or weeks of the academic year

(Galambos et al., 2011; Liguori et al., 2011). While this has mainly been tested in first years, it is plausible that second and third-year students also experience changes in sleep throughout the semester, as can be seen in the improvement in sleep quality in third-year students. Further explanation for the improvement in sleep quality may be that first-year involves significant academic, social, and psychological adjustments, and these students often experience increased stress due to the transition from high school, affecting their sleep (Maunder et al., 2013; Amaral et al., 2018; Ramachandiran & Dhanapal, 2018). Second-year students face increased workloads and academic pressure as they focus on their two major courses as well as two additional courses, in the case of Rhodes Students, leading to more stress (Sterling, 2018; Tobolowsky, 2008; Rhodes University, 2021(a)). Third-year students typically concentrate on their major courses and take on leadership roles (Tobolowsky, 2008). At Rhodes, third-year students typically only have to focus on their two major subjects, with some possibly having to do one additional subject if credits are needed (Rhodes University, 2024). Thus, the differing demands third years are exposed to may be more conducive to better quality sleep than what first and second-year students are exposed to.

Another important factor that students highlighted as impacting their sleep was the challenges around finances. When comparisons were made between students under different funding models, NSFAS students reported the latest bedtimes and shortest sleep durations, averaging 5h46, while subjective sleep quality ratings were similar between NSFAS and self-funded students, with the 'Other funding options' group reporting better quality. Additionally, 91% of NSFAS students and 82% of students under other funding plans were classified as poor sleepers, with no significant differences found across funding groups for other sleep metrics like rise times, sleep latency, or PSQI scores While complex and multifaceted, the findings for this group may be explained by the financial stress the NSFAS group may be experiencing. In the current study, 50.39% of the total sample were students receiving NSFAS funding. These students reported significantly later bedtimes than the self-funded and other groups, possibly due to working extra hours or financial stress (Peltz et al., 2012). Although our study did not specifically examine working hours, NSFAS students reported fewer hours of sleep than their self-funded counterparts, but this was not statistically significant. The need to maintain grades for continued funding might also

contribute to their later bedtimes, though data in the current study could not conclusively prove this.

Interestingly, NSFAS students reported significantly better subjective sleep quality scores compared to the “other funding options” group, indicating students from the various additional funding options provided had worse subjective sleep quality than NSFAS students. Additionally, students from different living contexts may experience financial strain. It is crucial that future research understand the challenges faced by students on NSFAS funding, given that these students may require additional support to cope with the financial stress and demands of being at university. As highlighted in *Chapter 1 of Understanding Students: Putting Students at the Centre of Institutional Design, presented by Universities South Africa* (U.Africa, 2018), financial strain emerges as a significant factor driving students to contemplate dropping out of university, with tuition fees and living expenses cited as key reasons to leave university and in many cases increasing tuition fees has impacted and exacerbated the related costs of higher education, such as student accommodation and living expenses, created unrest in South African Universities (Ayuk & Koma, 2019: Mavunga 2019). While not explored in great detail in the current study, it is pertinent to highlight the impact of financial stress, particularly for students relying on NSFAS funding.

Many students receiving NSFAS funding have cited issues contributing to increased stress levels within this population. The dual pressures of academics and funding prospects emerged as significant sources of stress for these students. According to an article published by Universities South Africa (2023), students have cited some critical issues with the funding scheme, including delays in funding disbursement, a lack of communication from NSFAS towards students, a need for an increase in funding to cover living expenses, the psychological effect of NSFAS the lack of funding on students increasing levels of anxiety, stress, depression. As mentioned previously, experiencing financial burdens to this extent may contribute to creating a system wherein the students experience increased levels of perceived stress. As Ross & Hill (2013) explained, economic stressors can expose individuals to prolonged activation of the physiological stress response, leading to certain consequences for their sleep, health, and well-being. Financial burden increases perceived stress levels (Ross & Hill, 2013; Ayuk & Koma, 2019; Mavunga, 2019). Peltz et al. (2021) support the

notion that financial strain plays a role in students' sleep and mental health. Higher financial strain is linked to increased sleep disturbances, emphasising the interconnectedness of financial challenges and well-being. The combined link between financial stress, sleep, and academic performance indicates a need for support for students receiving academic funding.

With regard to *living context* (Residence and Oppidan), Oppidan students reported longer sleep durations, earlier bedtimes, and a higher percentage of "good sleepers" compared to residence students, who had significantly shorter commutes but later bedtimes and shorter sleep durations, with no differences found in other sleep metrics like rise times, sleep latency, or PSQI scores. Given that the residence students and Oppidan students had similar rise times, it would make sense that with the later bedtimes, residence students have shorter sleep durations. It is possible that residence students reported later bedtimes due to living in communal spaces with other students, which can bring with it high levels of noise. The mechanism through which noise disturbs sleep is via the permanently open auditory channels within the brain and the brain's ability to process incoming stimuli while asleep (Griefahn, 2002). It is an essential factor involved in noise-induced sleep disturbances, which are considered detrimental when attempting to sleep (Griefahn, 2002). Noise is a common theme in research looking into factors affecting sleep in university students, and studies such as Forquer et al. (2008) found that "noise from others" was the most frequently cited reason for premature waking in students. Environmental noise, which occurs in residence halls, can increase sleeping environment disturbances, and students living in residence who report disruptive noise around the time when they go to bed and during sleep tend to report poorer sleep quality (Peltz & Rogge, 2016). The noise disturbances the students are experiencing may be having a negative influence and may be compounding the student's self-reported poor mental health by disrupting their sleep and thus affecting levels of daytime sleepiness. Peltz (2020) demonstrated that the presence of noise during sleeping hours negatively influences students' mental health by influencing levels of restedness. At the same time, environmental noise is largely out of the individual's control, although the consequences of not addressing this disturbance can adversely affect daytime functioning (Peltz, 2020).

Having discussed the factors negatively impacting sleep in this sample of university students, the subsequent section will examine the findings on the positive end of the spectrum, wherein students identified factors they believed positively influenced their sleep.

Unexpected Findings

Alcohol Use:

An unexpected finding in the current study was that only two students of the whole sample explicitly mentioned alcohol consumption as a negative influence on sleep. This was unexpected, as alcohol use is often reported as highly prevalent among university students (Dowdall, 2008; Kenny et al., 2012). Furthermore, Lund et al. (2010) reported that students with poor sleep quality are more likely to report drinking alcohol than students with optimal quality sleep, as well as being twice as likely to use alcohol to induce sleep than optimal quality sleepers. The fact that the students did not report alcohol use despite having such poor global sleep quality and insufficient sleep, it was unexpected that this is not one of the mechanisms they believe is affecting them. However, it is possible that either this is not a priority for this sample of students, given the high levels of financial stress they are under, or alcohol use is being under-reported in this sample.

Technology Use:

Technology use preceding sleep has long been considered to have negative effects on sleep in several ways, mainly through heightened arousal, light exposure, disruption of sleep, and time displacement (Bauducco et al., 2024). However, it was surprising that technology was not more commonly mentioned as affecting student sleep. This is particularly unexpected given the pervasive nature of technology in students' lives and the substantial body of research highlighting its negative impact on sleep (Rosen et al., 2016; Dowdell & Clayton, 2018; Ayran et al., 2019; Hale et al., 2019; Rod et al., 2018).

Some students in the current study did cite technology as a negative influencing factor, but it was only sixth on the list of negative influencers. This acknowledgement indicates

that while some students recognize the detrimental effects of technology on their sleep, many do not prioritize it as a primary concern.

Research has indicated that most university students sleep with their phone alerts on (vibrate or sound on), and the majority of students wake up during a sleep episode to check their phone at least once a night (Rosen et al., 2016; Dowdell & Clayton, 2018). This finding is corroborated by statements from students in the current study, who cited using technology as negatively affecting their sleep over the previous month. Scrolling social media was another mechanism students believed was disrupting their sleep. These observations align with previous research, such as the findings of Ayran et al. (2019), who demonstrated that internet addiction or problematic internet use in university students negatively affects sleep quality.

This discrepancy is intriguing, as it aligns with the current discourse surrounding sleep and technology. While many studies have shown a strong negative association between sleep and technology use, experimental studies show mixed results (Hale et al., 2019). The relationship between sleep and technology has been considered bi-directional (Poulain et al., 2019; Brautsch et al., 2023; Bauducco et al., 2024). Device and internet use before sleep is associated with increased daytime sleepiness and sleep problems, while daytime sleepiness is related to increased use of devices before bed (Poulain et al., 2019). Future studies should consider studying the relationship between technology and sleep in university students of today, during a time when technology forms a large part of daily life, particularly for young adults attending university.

5.3. Systemic Factors Highlighted by Students as Impacting Sleep Positively

While it is important to understand the barriers inhibiting sleep in this sample, it is also essential to acknowledge what the students cited as enhancing their ability to sleep. This study encouraged students to point out what they believed were factors positively influencing sleep; the main factors which emerged were the use of technology, the use of substances and/or medications, comfort-related practices, healthy challenges within academics, and good sleep hygiene practices.

With regard to the most frequently mentioned factor that positively influences sleep, technology, students specifically mentioned using technology to enhance their ability to fall asleep. The students in the current study mentioned using technology to provide soothing nature soundscapes. Han et al. (2019) found that nature sounds are more likely to induce relaxation, and individuals tend to prefer Autonomous Sensory Meridian Response (ASMR) videos and nature sounds over the ambient noise common in busy indoor environments. Interestingly, when comparing mediums of ambient noise, Han et al. (2019) found that natural sounds contributed to higher-quality napping, which may be translated into sleep. The relaxing effect of nature sounds can possibly be attributed to what was referred to as the 'biophilia hypothesis', which states that humans tend to be biologically inclined to seek connections with the natural environment and other forms of life (Rogers, 2019). This content shared via media outlets has previously been shown to help people fall asleep and can function as a mediator in creating auditory environments suitable for sleep (Porfirio, 2021). Audio-visual content, which creates an environment of tranquillity, can act as a tool for self-regulation and thus is, in essence, a tool with a design which assists with sleeping (Porfirio, 2021). Furthermore, it is still being determined in research whether the students recognise the actual effects of time spent using screens for academic use, as in this instance, technology use has only referred to leisure usage.

As explored by Przybylski and Weinstein (2017), technology use at moderate levels is not inherently harmful and may even be advantageous in certain aspects (Przybylski & Weinstein, 2017). Technology use may become harmful in instances of overuse, which may displace alternate activities (Przybylski & Weinstein, 2017), for example, interfering with sleep timing. Therefore, the students in the current study seem to be using technology to combat the environmental noise cited by most students as an inhibitor of sleep by drowning out the unpleasant noise and replacing it with more relaxing sounds, which improve mood and increase relaxation. It is acknowledged that the relationship between technology and sleep is complex and needs to be better understood in combination with education and raising awareness of the effects of screen use at night on sleep.

5.4. Implications of Poor-Quality Insufficient Sleep Found in the Current Sample

The late bed-times, prolonged sleep latency, early rise times, short sleep duration, and high overall global PSQI scores found in this cohort are concerning for a multitude of reasons, one prevalent element being the connotation between quality sleep and academic performance. Gilbert and Weaver (2010) found a significant negative correlation between overall marks for the year and poor sleep quality. Specifically, poor sleep quality is associated with poorer academic performance. Additionally, previous studies have suggested that poor sleep quality may be interrelated with mental and emotional health, specifically that there is a bidirectional relationship between poor mental health and poor sleep quality (Ohayon & Roth, 2003; Jansson-Frojmark & Lindblom, 2008; Preišegolavičiūtė et al., 2010; Orsal et al., 2012; Peach et al., 2016; Dinis & Bragança, 2018).

Poor mental health has been shown to decrease sleep quality and vice versa; poor sleep quality worsens struggles with mental health, with studies showing an association between poor global sleep quality, as measured by the PSQI, and a higher prevalence and more severe depression, anxiety, and stress-related symptoms in undergraduate students (Preišegolavičiūtė et al., 2010; Pensuksan et al., 2016). However, the current study could not determine the bidirectionality of the relationship between sleep quality and mental health; there appears to be a broader challenge prevalent within this sample, which needs more in-depth research. The findings of the current study and those of previously published research underscore the importance of more thoroughly investigating the link between sleep habits, problems with sleep, and mental health and wellness among the young adult population.

When considered together, these findings highlight the significance of considering more than just sleep duration in assessing sleep health and serve as evidence of compromised sleep health within this population with high levels of daytime dysfunction as a consequence of insufficient and poor-quality sleep. While complex and multifaceted, it is recognised that challenges faced by university students stretch into multiple areas of the student's life simultaneously, including sleep health (Galambos et al., 2011). Poor sleep quality and insufficient sleep exhibited by

university students can have profound consequences for academic functioning, mental health, and well-being, as well as bring challenges as late adolescents progress toward adulthood (Galambos et al., 2011). However, it is pertinent to note that it extends beyond the scope of this thesis to determine the effects of the poor sleep quality within this sample, although there may be implications for the students in numerous aspects of their lives, some being mental health, cognitive processing necessary to meet the demands of university, the inability to regulate emotions and mood, and overall physical well-being, which may, in turn, exacerbate the perceptions around stress.

5.5. RECOMMENDATIONS

The majority of the students in the current study reported poor sleep quality, with poor mental health-related factors being the most prominently cited disturbance of sleep, which could be explained by (or explain) the short sleep duration, long sleep latencies, sleep disturbance, the result of which was a high component score for daytime dysfunction. These findings suggest that this cohort needed to practice optimal sleep hygiene practices, while specific changes could be introduced in different parts of the university systems to help address these challenges. The following recommendations will be discussed in keeping with the theoretical theme of the socio-ecological model and will break down recommendations based on their proximity to the students, i.e., by breaking them down into micro-, meso-, or macro-related recommendations.

5.5.1. Micro-Level Recommendations:

The poor sleep quality (driven by late bed-times, long latencies, early awakenings and short sleep durations) points to the need for students to understand the importance of good sleep hygiene in the first instance. The recommendation for students would be to practice better sleep hygiene practices, meditation, or progressive muscle relaxation techniques to reduce stress levels before sleep, thereby allowing for better quality sleep. Furthermore, students should be educated on the potential stressors they will incur during their undergraduate years of university, as well as workshops to help students cope with stress; these practices may contribute towards decreasing the amount of stress faced by students daily (Ramachandran & Dhanapal, 2018).

Brown et al. (2002) and Suen et al. (2010) acknowledged that some sleep-related behaviours are easier to change than others. For example, maintaining consistency with a sleep/wake schedule and going to bed without being thirsty is relatively easy to change (Brown et al., 2002; Suen et al., 2010). Thus, these sleep hygiene practices should be emphasised for students to implement (Brown et al., 2002). Putting aside stress and worries before bed may prove to be more difficult for students and may require future intervention in the form of counselling or psychotherapy (Brown et al., 2002; Suen et al., 2010).

Gao et al. (2014) studied the effects of comprehensive sleep management on sleep in university students in China. The study included information about healthy sleep behaviours and habits, as well as music therapy and progressive muscle relaxation training to improve students' sleep quality. Progressive muscle relaxation training as a cognitive behavioural therapy technique, which involves the voluntary continuous and systematic stretching and relaxing of muscles coupled with deep breathing exercises and music therapy, proved an effective method for improving sleep (Gao et al.,2014).

In dealing with the high levels of environmental noise experienced by the sample, a micro-recommendation would include students using audio-visual content to create an environment of tranquillity that can act as a tool for self-regulation a which may assist with sleeping. The students in the current study mentioned using technology to provide soothing nature soundscapes. Audio-visual content, which creates an environment of tranquillity, can act as a tool for self-regulation and thus is, in essence, a tool with a design which assists with sleeping (Porfirio, 2021). Furthermore, for the off-campus students living with roommates who would prefer not to use audio-visual content to drown out unwanted noise, a micro-level recommendation would be to use foam earplugs, which will minimise the effect of environmental noise during sleeping hours. However, in these instances blue light exposure should still be limited, and content should not be too distracting, in order for this to be an effective method for helping with sleep.

5.5.2. Meso-Level Recommendations:

Sleep Hygiene and Environmental Noise

As students can benefit from education and training regarding optimal sleep hygiene practices, a means of a meso-level intervention in sleep hygiene for university students would be for universities to provide increased availability of information regarding healthy sleep/wake practices and good sleep hygiene from individuals better equipped with the knowledge and training for achieving this, as suggested by Reid & Baker (2008); Suen et al. (2010); Ramar et al., (2021), and Schmickler et al. (2024). Schmickler et al. (2024) suggested that sleep hygiene education programmes could take place in a brief online sleep education program, specifically through the use of the Sleep 101 programme (http://sleep101.info/), developed by Charles A. Czeisler, Director of Sleep Medicine at Harvard Medical School. Although such programmes would need to be adapted to be applicable within the South African context, future research could possibly focus on developing a sleep health education programme for university students within the South African context. However, while education on optimal sleep hygiene practices could be beneficial, Brown et al. (2002) found that having good sleep hygiene knowledge was weakly associated with good sleep hygiene practices and was not directly associated with overall sleep quality. In contrast, actual healthy sleep practices are strongly related to overall sleep quality – this suggests that knowing about proper habits does not necessarily influence sleep quality, whereas practising proper habits is far more strongly associated with overall improvements in sleep quality (Brown et al., 2002). Thus, while having universities introduce sleep hygiene education programmes and educating residence staff as a meso-level intervention, the students are responsible for putting these practices in place. Therefore, the actual implementation of sleep hygiene practices is a micro-level intervention.

Furthermore, it is recommended that residence staff be educated on optimal sleep hygiene practices to assist in creating a more conducive living space for students. It is possible that if the staff in residences had better knowledge of sleep hygiene, it may highlight the need for the staff to be stricter regarding the enforcement of noise curfews.

Environmental noise was another major factor students cited as a frequent disruptor of sleep; this relationship in large student samples is now an important future research direction. Brown et al. (2002) and Suen et al. (2010) stated that attempts at minimising environmental disturbances while trying to sleep can be particularly challenging for university students, especially in university residences. Rhodes Residences currently has noise curfews; however, with the number of complaints regarding this issue, these should be more widely advertised and enforced more stringently. The persistence of the issue may necessitate negotiation with resident wardens (staff employed to manage the residences) or revision of policies regarding residence quiet hours (Brown et al., 2002).

A second recommendation would be to ensure anonymity for students reporting noise complaints in residences to minimise the social complexities surrounding reporting noise in residences (Foulkes et al., 2019). This may be useful, although it may also be helpful to promote open lines of communication in residences regarding the impact the noise is having on the students' sleep.

Galambos et al. (2013) further recommended the introduction of living options, such as substance-free and noise-controlled residences, to reduce noise-related impediments to sleep. Although in the context of Rhodes University, this may be a challenge as there is minimal funding to build new residences, in this instance, a more practical recommendation would be to follow the advice of Suen et al. (2012) and encourage residents to revise policies regarding excessive noise in residences.

Workload:

It is recommended that campus administrators consider the effects of student scheduling demands and workload on the ability of students to obtain sufficient hours of quality sleep (Suen et al., 2010; Foulkes et al., 2019). Additionally, as part of the sleep education programmes introduced in universities, it is recommended that students be taught about the importance of maintaining consistency in waking up simultaneously each day, regardless of timetable commitments (Foulkes et al., 2019).

5.5.3. Macro-Level Recommendations:

The high levels of financial stress reported by the students in the current study extend beyond the scope of the current study. However, this is a pervasive issue for university students and has been shown to play a role in negatively affecting sleep. While NSFAS has somewhat fulfilled this purpose, there have been reports that the agency has been placed under increasing pressure to meet financial obligations (Ayuk & Koma, 2019). The consequence of this is an increase in the burden of financing higher education, which has been placed on students by universities through increased tuition fees (Ayuk & Koma, 2019).

The mechanisms through which sleep is being negatively affected through economic strain extend beyond the scope of the current study. Thus, a macro-level recommendation would be to prioritise research investigating the effects of the current financial situation in South African universities on the sleep and overall well-being of university students. The goal of this research should be not only to better understand the mechanisms through which economic stress affects sleep but also to come up with practical recommendations to assist in minimising the effects of economic stress on university students.

5.6. Limitations of The Study and Future Research Recommendations

Several limitations of the current study should be noted. Firstly, given the current study's cross-sectional nature, it is impossible to determine the exact contributors to the poor sleep quality found. Therefore, future research should focus on better understanding the main drivers of poor sleep/wake behaviour using more objective measures and scales, particularly those relating to mental health.

The current study made use of self-report measures which were gathered using an internet survey, and thus has certain limitations inherent to self-report internet-based surveys, particularly recall bias, (Gupta et al., 2020), or response distortion (Razavi, 2001) which may skew the results, or may be subject to underreporting by students, particularly on poor habits, thus this method has the potential for influence of common method variance over the results, potentially over highlighting, or under highlighting

correlations between variables (Razavi, 2001), particularly in the case of the current study where only one measure for sleep quality was utilised. Objective sleep assessments include polysomnography, and actigraphy. However, in the context of this study these measures would not have been useful, due to the aim of the study this was not necessarily what was being tested for.

Secondly, the study is limited by the relatively small sample size of 393 students, which corresponds to a response rate of 6.30%. Therefore, the results of this study are not generalisable to the broader Rhodes University student population or those of other institutions in other cities, where the constraints on students may be different. Thus, future research should focus on broadening the sample of students from different institutions in different contexts to understand the prevalence of poor sleep in students and the different contextual drivers of this.

This study is only focused on undergraduate students, and there is a need to understand the experiences of postgraduate students, who face different pressures and constraints in their studies.

The demographic questions in the current study did not include a question asking students if they had been diagnosed with a sleep disorder/issue. Therefore, students with clinical sleep issues were not excluded from the sample, this may have influenced the findings of this study.

It is important to note that questions 23, 24, and 25 (bed partner/ roommate related questions) presents with some concerns, with the limitation here being that it was impossible to know if the student answered these questions for their roommate/bedpartner (i.e. there is no way of telling if the bedpartner/roommate actually answered the questions).

Another limitation includes the fact that the PSQI does not differentiate between weekend or weekday sleep over the last month, this is an important point as university students may use the weekend to manage sleep debt.

This study was comprised of a survey completed online and thus has certain limitations inherent to internet-based surveys, particularly errors in reporting behaviours (Lemma et al., 2012) or recall bias. While self-reporting is a valid method of assessing sleep quality, it is subject to various sources of inaccuracy (Paulhus & Vazire, 2007). Future research should follow up with more objective measures, such as sleep diaries and actigraphy, to obtain more objective data on the actual sleep-wake behaviour of students in different living arrangements.

Another limitation of the current study was that the sample comprised the majority of females, which could have influenced the themes, and global scores found. Future studies should evaluate the present factors in predominantly male and non-binary populations.

Comparisons between different demographic groups revealed differing impacts on sleep. It would be important to understand better which demographic factors best explain differences in sleep quality, particularly why third-year students generally had better sleep quality than first or second years.

This study was not able to comprehensively investigate the relationship between technology use and student sleep, although students in the current study indicate that technology is helping them sleep. This poses two points that should be explored in future research. Specifically, what is the prevalence of technology use in students, and how does this impact their sleep, either positively or negatively? In this instance, it is unknown the exact number of hours students spend using their devices for leisure and how much time they spend using them for their academics. The complex relationship between technology and relaxation needs to be better understood in combination with education and raising awareness over the effects of screen use at night on sleep.

The current study did not include any screening measures for mental health; therefore, the relationship between sleep quality and mental health could not be determined. The findings of the current study and those of previously published research underscore the importance of more thoroughly investigating the link between sleep habits, problems with sleep, and mental health and wellness among the students. It would be

important to understand more comprehensively the drivers of both poor sleep and mental health challenges and develop and implement appropriate interventions.

CHAPTER 6:
6. STUDY CONCLUSIONS

The current study aimed to characterise sleep/wake behaviours and sleep quality in a sample of undergraduate students attending a South African university, with the objective of determining which, if any, factors may be influencing the sleep quality of the sample, either positively or negatively.

The main finding in the current study is that the global sleep quality was poor, and the sleep duration was insufficient in the current sample of undergraduate university students. Various systemic reasons were identified as negatively impacting the sleep of the current sample. The complex and multifaceted challenges faced by university students stretch into multiple areas of the student's life simultaneously, including sleep health. The short-term consequences of not addressing the issue of poor sleep quality and insufficient sleep exhibited by this cohort can have profound consequences for academic functioning, mental health, and well-being and can result in challenges as the students progress toward adulthood.

This study highlights the importance of future research in this area, particularly in the South African context, given the many systemic challenges students face. This is to prevent these individual's developing poor sleep practices, which can have an impact on health later on, especially considering the long-term consequences of not addressing these issues being the development of psychiatric disorders, declines in psychosocial functioning, physical health, metabolic health, immunological health, occupational functioning, vitality, mortality, increased occurrence of appetite, obesity, diabetes, hypertension, cardiovascular health, cancer, inflammation, pain, use of drugs and alcohol, and an overall decrease in quality of life. Furthermore, it is important to acknowledge that university students represent the future decision-makers in society; thus, addressing these issues while students progress through university is crucial in the attempt to demonstrate the value of better sleep health behaviours as they transition to adulthood and the working world.

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APPENDIX

Appendix A: Justification for Socio-demographic questions included in study.

Age:	
Question	How old are you (years)?
Why it is relevant	Young adults have been identified as a demographic which is at high risk of low quality and insufficient sleep.
Previous research	Roenneberg et al (2004) – Observed increasingly later bedtimes in adolescents up until the age of 20, where an abrupt shift again takes place bringing the mid-point sleep times becoming increasingly earlier. Park et al. (2019) —Findings suggest worsening sleep as a result of developmental changes as adolescents transition into young adulthood. Robbins et al (2020) — Sleep quality and duration was higher among older individuals than among younger individuals. Low proportion of young adults obtained recommended sleep duration. Grandner et al. (2012) — Higher rates of sleep disturbance reported by younger adults than older adults.
Year of study:	
Question	What academic year of study are you in? (First, Second, Third year)
Why it is relevant	Pilcher et al. (1997) — Found that sleeping patterns are one of the first daily habits for first year university students to change Lund et al. (2010) — The phenomenon of erratic and insufficient sleep exhibited in high school students extends past adolescents in high school to young adulthood. First year students report irregular weekly bedtime and wake time and longer sleep duration than students from upper academic divisions. In addition to irregular sleep schedules, university students experience low sleep quality when assessed by standardized measures. Arnett (2000) — For most emerging adults (18 to 25 years) in industrialized societies the years from the late teens through the twenties are characterized by profound changes. For the portion of young adults entering university balancing the academic, social, and personal demands is a central feature of this age period.
Gender:	
Question	What is your gender (male, female, non-binary, or prefer not to say)

Why it is relevant	Results pertaining to sleep duration and quality based on gender have been mixed, this may be due to contextual differences between studies. There is very little pertaining to gender differences in sleep duration and quality of South African students.
Previous research	Tsai & Li (2004) — Female students went to bed later and woke up earlier, had longer sleep latency, more frequent night-time awakenings, and poorer sleep quality than males. Gender differences in sleeping patterns and difficulties sleeping were significant in university students. Amaral et al. (2015) — Female participants report more problems sleeping than males. Liguori et al. (2011) — No significant differences in sleep duration were found between genders. Seun-Fadipe & Mosaku (2017)— No significant differences in sleep duration between genders Cheng et al. (2012) — undergraduate females had poorer sleep quality than undergraduate males. Robbins et al. (2020) – Women experienced higher sleep quality and longer sleep duration in nearly every age group than men. Petrov et al. (2014)— Women were more likely to report daytime impairments relating to sleep than men. Peltz et al. (2021)— Females reported significantly higher levels of sleep disturbances than males. For female subjects, family SES was negatively associated with average number of working hours per week, sleep disturbances, and depressive symptoms. Galambos et al (2011) — Female students reported shorter sleep duration than male students
Geographic Location	
Question	While you attend university, where do you mostly live?
Why it is relevant	Living away from home and in off-campus accommodation brings financial burdens (Galambos et al., 2011).
Previous research	Galambos et al. (2011) found that students living away from home experienced lower-quality sleep.

	Living on campus likely sets up social conditions that shape sleep schedules in ways that are different from living off campus (Galambos et al., 2013). Students living in off-campus spaces are out from under the control of their parents and must thus regulate their own sleep; university students who are more independent from parental care tend to report experiencing lower-quality sleep (Galambos et al., 2011; Galambos et al. 2013). Being away from home, where parents generally enforce bedtimes, students have control over choosing their bedtimes and whether they will attend morning classes (Orzech et al., 2011). Personal independence may be associated with late-night social activities, which may provide the opportunity for increased alcohol intake and possible drug experimentation/abuse (Gardani et al., 2022).
Financial aid or Self-funded	
Question	Are you on financial aid or self-funded?
Why it is relevant	Stress caused by economic burdens influences sleep
Previous research	In response to challenges economic challenges faced by universitas in South Africa the National Student Financial Aid Scheme has been put in place to finance higher education for students who would not have access to higher education due to financial reasons (Ayuk & Koma, 2019). NSFAS has somewhat fulfilled this purpose, however, there have been reports that the agency has been placed under increasing pressure to meet financial obligations (Ayuk & Koma, 2019). The consequence of this being an increase in the burden of financing higher education, which has been placed on students by universities through increased tuition fees (Ayuk & Koma, 2019). The increase in tuition fees has exacerbated the related costs of higher education, such as student accommodation and living expenses, among others (Ayuk & Koma, 2019). Peltzer & Pengpid (2015) — coming from a poorer family background was associated with nocturnal sleep problems in undergraduate students from 26 countries. Peltz et al. (2021) — The students that perceived their financial situation as more strained increased their working hours per week, which predicted greater levels of sleep disturbance, this, in turn, predicted higher levels of depressive symptoms.
Parttime Work	
Question	Do you have a parttime job?

Why it is relevant	There are finite hours in a day, more time allocated to one area will detract from other areas. Spending time working, over and above time allocated to academic demands takes away from time one is able to allocate top sleep, which could affect academic functionality.
Previous research	Logan et al (2015) — Working more than 20 hours per week at an off-campus job are more likely to be negatively affected than students working fewer hours. First year and second year students may at risk of negative outcomes when employed at more than 20 hours a week at an off-campus job. Lederer et al. (2015) — Increased hours spent doing off-campus work tended to negatively affect sleep and physical activity, as well as increasing the probability of feeling overwhelmed. Given the finite hours in a day that students have to perform their responsibilities this is perhaps an unsurprising finding.
Oppidan or Residence	
Question	Do you live in RES or are you an oppidan?
Why it is relevant	Living off campus could influence commute time to university. Living in residence means the students have less control over noise levels during sleeping hours.
Previous Research	The sleep environment is typically defined as the physical space and related context in which sleep occurs. (eg. noise, and temperature (Ref). Environmental noise which occurs in residence halls can commonly endure sleeping environment disturbances. In a residence setting students typically have very little control over hallway noise, or noise from surrounding rooms (Peltz & Rogge, 2016). Peltz & Rogge (2016) — This is consistent with previous research which has shown that Environmental noise which occurs in residence halls is a common sleeping environment disturbance. In a residence setting students typically have very little control over hallway noise, or noise from surrounding rooms. Peltzer & Pengpid (2015) — Staying off campus (on their own, or with parents) was associated with nocturnal sleep problems

Appendix B: Ethical Approval Letter pending Gatekeeper permission.

RHODES UNIVERSITY
Where leaders learn

Rhodes University Human Research Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
t: +27 (0) 46 603 7727
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za
NHREC Registration number: RC-241114-045

https://www.ru.ac.za/researchgateway/ethics/

6 July 2022

Céline young

Email: g16y5696@campus.ru.ac.za g16y5696@campus.ru.ac.za

Review Reference: 2022-5517-6884

Dear Céline young

Title: Characterising sleep/wake behaviour & sleep quality of undergraduate students at Rhodes University in 2022 (Provisional)

Researcher: Céline young

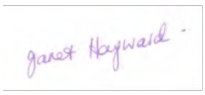
Supervisor(s): Ms. Celine Young,

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Human Research Ethics Committee (RU-HREC). Your Approval number is: 2022-5517-6884

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying you when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Sincerely,



Dr Janet Hayward

Chair: Rhodes University Human Research Ethics Committee, RU-HREC

cc: Ethics Coordinator

Appendix C: Gatekeeper permission letter

RHODES UNIVERSITY
Where leaders learn

Office of the Registrar
Eden Grove Building, Lucas Avenue, Makhanda, 6139, South Africa
PO Box 94, Makhanda, 6140, South Africa
t: +27 (0) 46 603 8101
f: +27 (0) 46 603 7561
e: registrar@ru.ac.za

www.ru.ac.za

14 July 2022

Ms C Young
Department of Human Kinetics & Ergonomics

Dear Ms Young

REQUEST FOR GATEKEEPERS PERMISSION TO CONDUCT RESEARCH WITH RHODES UNIVERSITY STUDENTS

Name of research proposal: To characterize the sleep/wake behavior and sleep quality of undergraduate students at Rhodes University.

This serves to confirm that you have been granted permission to conduct your proposed research at Rhodes University as requested.

Kindly be advised that the University is not obliged to make any arrangements in terms of this research, and that the onus is on the researcher. It is also your responsibility to protect the integrity of the University in the manner in which you collate and engage the data.

Please note that where necessary, permission must be sort from the HR Director for staff-related matters.

This letter is valid from 14 July 2022 to 13 July 2024.

Yours sincerely

AL Moodly

Professor A.L Moodly
REGISTRAR

Appendix D: Email Communication Sent to the Administrators and Wardens Containing the Pre-Approved Email For Students

Good Day

My name is Celine Young.
I am conducting my Master's research on the sleep quality of the Rhodes University Undergraduate student population through the use of an online survey.
My supervisor is Dr Jonathan Davy.

In order to ensure inclusivity and expand the reach of my research, I intend to distribute the link to the survey through email communications to students.

This email serves as a request for assistance in the dissemination of the attached pre-approved email via communications with the undergraduate students in your residence hall.

I have been granted ethical approval from the Rhodes ethics committee (ethics number: 2022-5517-6884), and I have permission from the RU registrar and gatekeeper for students to conduct my research on the undergraduate students at Rhodes University. Please find attached my ethics approval letter and gatekeeper permission letter.

Pre-approved email for students:

CALLING ALL RHODES UNIVERSITY UNDERGRADS!!
WE WOULD LIKE TO KNOW ABOUT YOUR SLEEP WHILE AT UNIVERSITY!

My name is Celine Young, I am conducting masters-level research.

I am inviting you to participate in a sleep study. I want to know about your sleep!

Participation includes the completion of a 10-15 minute online questionnaire.

Your participation in this research will be contributing to a better understanding of the sleep quality of undergraduate students and the factors that influence it!

If you are interested in participating please follow the link below to find more information about the study and your rights around participating:

https://forms.gle/idC7WyViapAmuGdu8

Characterising sleep/wake behaviour & sleep quality of undergraduate students at a South African University

BACKGROUND TO THE STUDY

My name is Celine Young, and I am a Masters student from the Department of Human Kinetics and Ergonomics at Rhodes University. I invite all Rhodes University undergraduate students to participate in the following Master's research project which aims to explore the sleep quality in undergraduate students at Rhodes University in 2022. Your participation will include the completion of the following questionnaire.

OVERVIEW OF THE QUESTIONNAIRE:

This questionnaire should take approximately 10 to 15 minutes to complete and consists of three main sections. Section 1 asks about your basic demographic characteristics (age, gender, year of study), while Section 2 will ask you about your sleep wake behaviour over the last month through the Pittsburg Sleep Quality Index (PSQI). Section 3 contains one open ended question relating to factors which may affect your sleep while at un.

The PSQI is a short questionnaire from which we gain insights into your sleep quality. It consists of 19 self-rated questions and 5 questions rated by the bed–partner or roommate. The 19 self-rated questions assess a wide variety of factors relating to sleep quality, such as; subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction.

CONSENT FORM

In order to take part in this study, please make sure that you have read and understand the following:

1. The purpose of the following research project is to characterise the sleep wake behaviour and sleep quality in undergraduate students at Rhodes University in 2022.

2. Rhodes University has given ethical clearance for this research project (ethics approval number: 2022-5517-6884) and I have seen/may request to see the clearance certificate by contacting the Ethics Coordinator (ethics-committee@ru.ac.za).

3. By participating in this research project, I will be contributing towards a understanding the sleep wake behaviour and sleep quality in undergraduate students at Rhodes University.

4. I will participate in the project by: completing an online survey which is hosted on the google forms platform.

5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

Appendix E: Online Survey Hosted on Google Forms

6. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

7. While the risks associated with this study are low, some participants may feel some level of discomfort while completing the questionnaire or may be left with questions relating to their sleep health. Students are within their rights to terminate their participation in this study if they feel distressed by the subject matter. In the instance where participants have questions/concerns regarding factors explored in this study, the contact information of the researchers has been provided below. If the concerns of the participant extend beyond the practice scope of the researchers, the participant will be put in contact with a general practitioner or a medical expert who may be able to provide advice and assistance. Students are also encouraged to contact the Rhodes University Counselling center should they wish to seek psychological support.

8. The Researcher intends to publish the research results in the form of a masters thesis, journal articles, and sleep health conferences. However, confidentiality and anonymity of records will be maintained, given that my name and identity will not be asked for during the course of this study.

9. In terms of the Protection of Personal Information Act (No. 4, 2013), it remains my right to request the Researcher to provide me with a detailed explanation of exactly how confidentiality and anonymity will be achieved. I may request to know how my personal information will be stored securely, and for how long it will be stored.

10. If any data collected from me for this research project is to be used by the researcher for any further project, I am to be informed in writing, and my written consent requested again. I need not give consent if such further research is incompatible with the initial data presented for this study (POPIA, s15(3)). Equally, I can simply reject the request. In such cases a formal request needs to be made by the researcher via the Ethics Coordinator (ethics-committee@ru.ac.za).

11. In terms of the Protection of Personal Information Act, I possess the right to receive feedback about this research. This will take the form of email which will provide participants with a document which will contain a detailed summative breakdown of the results for the entire cohort, individual data will not be provide individual data, unless requested by participants personally. This breakdown will include the results gathered, an explanation of the results, as well as possible recommendations from researchers., unless I elect not to receive feedback..

12. Any further questions that I might have regarding the research, or my participation will be answered by Celine Young, email: g16y5696@campus.ru.ac.za, cellphone: 0794915553; and Dr. Jonathan Davy, email: Jonathan.davy@ru.ac.za, cellphone: 072 226 0430. Any concerns regarding your rights in this study may be directed to the Rhodes University Ethics Committee (RUESC), email: ethicscommittee@ru.ac.za
ERAS does not respond to private emails (e.g. Gmail addresses).

13. By signing this informed consent declaration, I am not waiving any legal claims, rights or remedies.

14. A copy of this informed consent declaration will be provided to me, app on request.

and the original will be kept on record.

PARTICIPANT RIGHTS:
- The following questionnaire is anonymous, such that, no responses will be linked to your personal identity.
- All questionnaires will be handled exclusively by researchers.
- In order to obtain a complete set of data it is required that all questions be answered, unless otherwise stated.
- If you do not wish to answer any questions you may withdraw from participating from this study, at any point in time.
- Data collected in this study will be held by the Department of Human Kinetics and Ergonomics at Rhodes University, for teaching and research purposes only.
- If you wish to obtain any feedback from this research please contact the researchers using the below contact information.

Ms. Celine Young
Masters Student
Department of Human Kinetics & Ergonomics Rhodes University
Cellphone: 079 491 5553
Email: g16y5696@campus.ru.ac.za

Dr. Jonathan Davy
Supervisor to this study
Department of Human Kinetics & Ergonomics Rhodes University
Email: Jonathan.davy@ru.ac.za
Cellphone: 072 226 0430

Rhodes University Ethics Committee Email: ethicscommittee@ru.ac.za

* Indicates required question

1. PARTICIPANT CONSENT *

By choosing to consent to this study you are stating that you have read the confirm that the above information has been explained to you in a language that you understand and you are aware of this document's contents. You are encouraged to ask all the questions that you wish to ask the researchers so that you fully understand what is expected of you during the research. If you choose NOT to participate in this study you are not required to fill out the questionnaire.

Check all that apply.

- [ ] I consent to participate in this study

Socio-demographic information

This section includes 6 questions which aim to gain information pertaining to your age, gender, geographical location, academic funding, faculty, employment, and living situation.

6. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

7. While the risks associated with this study are low, some participants may feel some level of discomfort while completing the questionnaire or may be left with questions relating to their sleep health. Students are within their rights to terminate their participation in this study if they feel distressed by the subject matter. In the instance where participants have questions/concerns regarding factors explored in this study, the contact information of the researchers has been provided below. If the concerns of the participant extend beyond the practice scope of the researchers, the participant will be put in contact with a general practitioner or a medical expert who may be able to provide advice and assistance. Students are also encouraged to contact the Rhodes University Counselling center should they wish to seek psychological support.

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10. If any data collected from me for this research project is to be used by the researcher for any further project, I am to be informed in writing, and my written consent requested again. I need not give consent if such further research is incompatible with the initial data presented for this study (POPIA, s15(3)). Equally, I can simply reject the request. In such cases a formal request needs to be made by the researcher via the Ethics Coordinator (ethics-committee@ru.ac.za).

11. In terms of the Protection of Personal Information Act, I possess the right to receive feedback about this research. This will take the form of email which will provide participants with a document which will contain a detailed summative breakdown of the results for the entire cohort, individual data will not be provide individual data, unless requested by participants personally. This breakdown will include the results gathered, an explanation of the results, as well as possible recommendations from researchers., unless I elect not to receive feedback..

12. Any further questions that I might have regarding the research, or my participation will be answered by Celine Young, email: g16y5696@campus.ru.ac.za, cellphone: 0794915553; and Dr. Jonathan Davy, email: Jonathan.davy@ru.ac.za, cellphone: 072 226 0430. Any concerns regarding your rights in this study may be directed to the Rhodes University Ethics Committee (RUESC), email: ethicscommittee@ru.ac.za
ERAS does not respond to private emails (e.g. Gmail addresses).

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- All questionnaires will be handled exclusively by researchers.
- In order to obtain a complete set of data it is required that all questions be answered, unless otherwise stated.
- If you do not wish to answer any questions you may withdraw from participating from this study, at any point in time.
- Data collected in this study will be held by the Department of Human Kinetics and Ergonomics at Rhodes University, for teaching and research purposes only.
- If you wish to obtain any feedback from this research please contact the researchers using the below contact information.

Ms. Celine Young
Masters Student
Department of Human Kinetics & Ergonomics Rhodes University
Cellphone: 079 491 5553
Email: g16y5696@campus.ru.ac.za

Dr. Jonathan Davy
Supervisor to this study
Department of Human Kinetics & Ergonomics Rhodes University
Email: Jonathan.davy@ru.ac.za
Cellphone: 072 226 0430

Rhodes University Ethics Committee Email: ethicscommittee@ru.ac.za

* Indicates required question

1. PARTICIPANT CONSENT *

By choosing to consent to this study you are stating that you have read the confirm that the above information has been explained to you in a language that you understand and you are aware of this document's contents. You are encouraged to ask all the questions that you wish to ask the researchers so that you fully understand what is expected of you during the research. If you choose NOT to participate in this study you are not required to fill out the questionnaire.

Check all that apply.

- [ ] I consent to participate in this study

Socio-demographic information

This section includes 6 questions which aim to gain information pertaining to your age, gender, geographical location, academic funding, faculty, employment, and living situation.

2. How old are you (years)? *

3. What academic year of study are you in? *

Mark only one oval.

- First Year
- Second Year
- Third Year

4. Gender *

Mark only one oval.

- Female
- Male
- Non-binary
- Prefer not to say

5. While you attend university, where do you mostly live? *

Mark only one oval.

- At parents house
- Residence (RES)(No roommate)
- Residence (RES)(With roommate)
- Digs (off campus) (No roommate)
- Digs (off campus) (With roommate)

6. What faculty are you studying in? *

Mark only one oval.

- Science
- Humanities
- Commerce
- Education
- Pharmacy
- Law

7. How are you funding your university studies currently? *

Mark only one oval.

- Self-funded
- Student Loan (Bank funded)
- University financial aid
- NSFAS (National Student Financial Aid Scheme)
- ISFAP (Ikusasa Student Financial Aid Programme)
- Bursary (Government offered)
- Bursary (Private sponsor)
- Scholarship (Half)
- Scholarship (Full)
- Crowdfunding (e.g. Feenix)
- Fundi
- Other: _____

8. Are you currently employed? *

Mark only one oval.

- I have a part-time job while studying full time
- I am employed full-time while studying part-time
- I am studying full time (currently not employed)

9. How do you commute to university? *

Mark only one oval.

- Private vehicle
- Carpool (lifts with friends)
- Cab service
- Public taxi bus
- Rhodes taxi service
- Walking
- Bicycle
- Skateboard

10. How long does it take you get to campus when you commute (minutes)?

The Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a self-rated questionnaire which assesses sleep quality and sleep disturbances during the PREVIOUS MONTH. This index was developed by Buysse et al. (1989), and has been used extensively in sleep related studies. The PSQI consists of 19 self-rated questions and 5 questions which are rated by the bed-partner or roommate. This tool assesses a wide array of sleep-related factors, including; subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction.

INSTRUCTIONS:
The following questions relate to your usual sleeping habits DURING THE PAST MONTH ONLY. Your answers should indicate the most accurate reply for the majority of days and nights in the last month.

Please answer all questions.

11. During the last month, what time have you usually gone to bed? (eg: 21h00) *

12. During the last month, how long (in minutes) has it usually taken you to fall asleep each night? *

13. During the last month, what time have you usually gotten up in the morning? (eg:06h00) *

14. During the last month, how many hours of ACTUAL SLEEP did you get each night (in hours and minutes)? (This may be different from the number of hours you spent in bed). *

15. Please select the response which best applies to you *

Mark only one oval per row.

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
I cannot get to sleep within 30 minutes				
I wake up in the middle of the night or early in the morning				
I wake up to use the bathroom				
I cannot breath properly				
I cough or snore loudly				
I feel too cold				
I feel too hot				
I have had bad dreams				
I have pain when I am trying to sleep				

am trying to sleep

16. Please state and describe any other reason(s) your sleep may be disrupted or disturbed *

17. How often during the last month have you had trouble sleeping because of the above mentioned reasons *

Mark only one oval.

- Not in the past month
- Less than once a week
- Once or twice a week
- Three or more times a week
- There are no other reason(s) my sleep is being disrupted or disturbed

18. During the last month, how would you rate your overall sleep quality? *

Mark only one oval per row.

	Very good	Fairly good	Fairly bad	Very bad
Sleep quality scale				

19. During the last month, how often have you taken medicine (either prescribed or over-the-counter) to help you sleep? *

Mark only one oval.

- Not during the last month
- Less than once a week
- Once or twice a week
- Three or more times a week

20. During the last month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activities? *

Mark only one oval.

- Not during the last month
- Less than once a week
- Once or twice a week
- Three or more times a week

21. During the last month, how much of a problem has it been for you to keep up enthusiasm to get things done? *

Mark only one oval.

- No problem at all
- Only a very slight problem
- Somewhat of a problem
- A very big problem

22. Do you have a bed partner or roommate? *

Mark only one oval.

- No bed partner or roommate
- Partner/roommate in the other room
- Partner/roommate in the same room, but not in the same bed
- Partner in the same bed

23. You can SKIP this question if you do not have a bed partner/roommate, or if they are not currently with you.

If you have a roommate or bed partner, please ask them how often in the past month you have had...

Mark only one oval per row.

	Not during the past month	Less than one week	Once or twice a week	Three or more times a week
Loud snoring				
Long pauses between breaths while asleep				
Legs twitching or jerking while you sleep				
Episodes of disorientation or confusion during sleep				

24. If you have a roommate or partner, please ask them to describe any other restlessness while you sleep

For example, how many nights in the month have you been restless? Are you restless during the entire night of sleep or during certain phases of sleep in the night? You may SKIP this question if you do not have a bed partner/roommate, or if they are not currently with you.

25. If there are other instances of restlessness in your sleep, how often in the past month did they occur?

You can SKIP this question if you do not have a bed partner/roommate, or if they are not currently with you

Mark only one oval.

- Not during the last month
- Less than once a week
- Once or twice a week
- Three or more times a week

Open-Ended Question

The following section aims to understand your perspective on your sleep quality and what you believe may have been influencing your sleep over the previous month. You are encouraged to give as many details as you can.

26. What factors, if any, have affected the quality of your sleep over the past month * (either positively or negatively).

27. If there is ANYTHING MORE you would like the researchers to know about your sleep/wake behaviour and sleep quality at this time please feel free to express these points below.

You have reached the end of the questionnaire.

Thank you for your participation in this study.

We would like to reach as many Rhodes University students as possible. We would be most grateful if you could share this survey with your friends and classmates who are also enrolled in their undergraduate studies at Rhodes. The link to use when sharing the survey is provided below.

https://forms.gle/idC7WyViapAmuGdu8

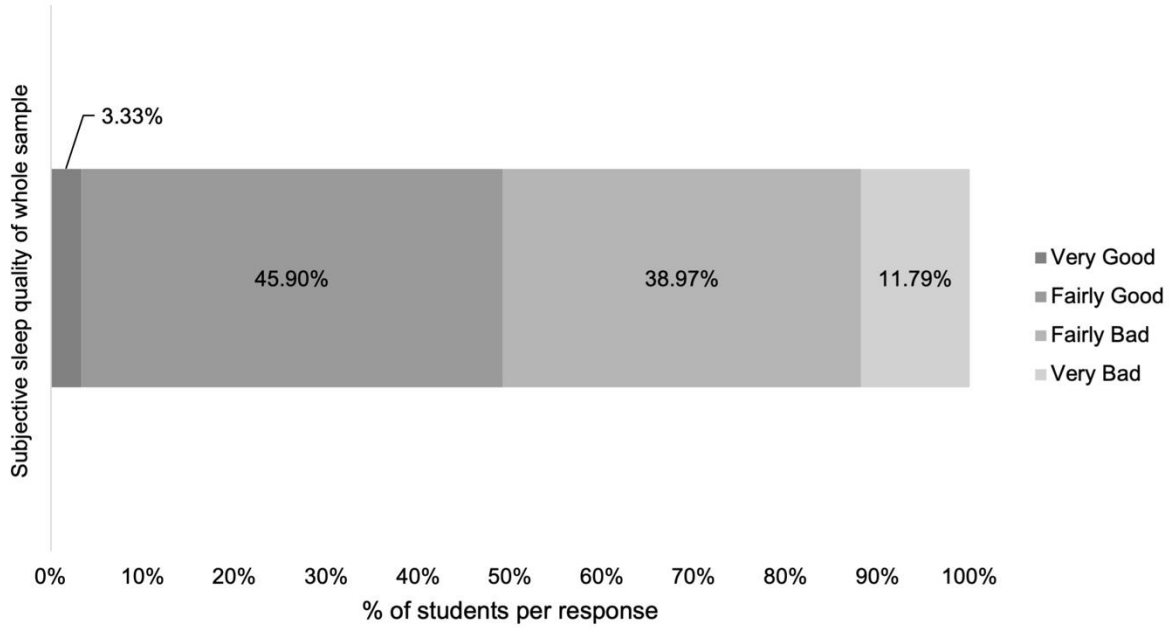
Please submit the questionnaire to save your responses.

Appendix F: Steps Towards Data Cleaning and Reduction

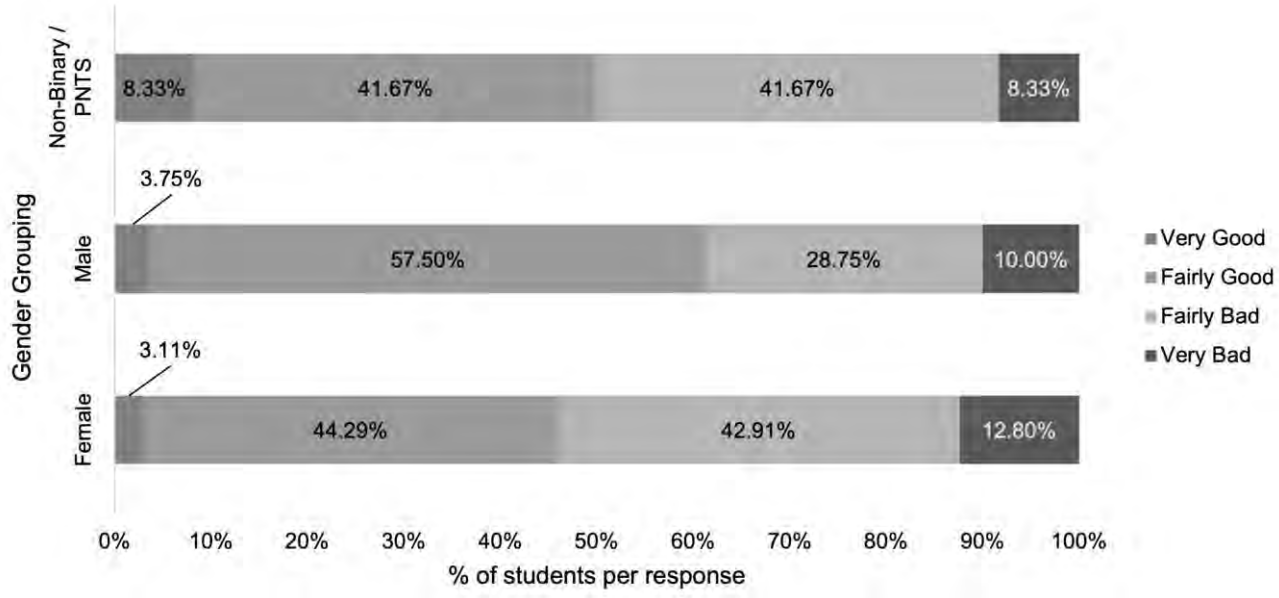
Variable	Participant Response	Cleaned Response
Commute Time & Sleep Latency	Time data: - Minutes (e.g., “20 minutes”) - Two numbers given (e.g., “15-20 minutes” or “Between 30 minutes and an hour”)	- “Minutes” was removed. - Value was converted into decimal representation of minutes to register as a number (e.g., “20 minutes” = 20,00) - Two numbers given – midpoint was calculated then value was converted into decimal representation of the time derived (e.g., “15-20 minutes” = 17,50 or “5-10 minutes” = 7,50 Or, Between 30 minutes and an hour” = 45,00 OR “60-120 minutes” = 90,00)
Bedtime	Time Data: - Time of day (PM/AM) (e.g., “23h00 earliest and 1h00 latest” OR “12h15” OR “between 23h00 and 2h00”)	- All words were removed, and the value was converted into a decimal representation of the time. - Any minutes were converted into decimal hours (e.g.,12am was represented as 24,00) - Any time after 12am was represented as the numbers which come consecutively after 24. (e.g., 1am = 25,00; 2am = 26,00). - If two time points were given the clean data was the mid-point between the two times (e.g., “23h00 earliest and 1h00 latest” = 24,00 OR “12h15” = 24,25 OR “between 23h00 and 2h00” = 24,50).
Rise Time	Time data - Time of day (A.M) (e.g., “6h10” OR “Around 12 and 13pm” OR “”5h00, 9h00, 6h00”)	- All words were removed, and the value was converted into a decimal representation of the time. - Any minutes were converted into decimal hours (e.g., “6h10 = 6,17). - 24hour time was used. - If two or more time points were given the clean data was the mid-point between the two times (e.g., “Around 12 and 13pm” = 12,50 “5h00, 9h00, 6h00” = 7,00).
Hours Of Actual Sleep	Time data: - Hours / Hours & Minutes (e.g., “4 hours at least” or “8 hours 35 minutes”) - Two-time points provided (e.g., “Between 4 hours and 7 hours”)	- All words were removed, and the value was converted into a numerical representation of the hours with two decimal points (e.g., “4hours at least” = 4,00). - Any minutes were converted into decimal hours (e.g., 8hours 35 minutes” = 8,58). - If two separate hour points were given the clean data was the mid-point between the two times (e.g., “4hrs – 7 hrs” = 5.50)
Excluded Responses		
Variable	**Reason For Exclusion**	**Procedure With Excluded Response**
Commute Time	Commute time responses were excluded if the time was not viable / too high or if no time was given. This included 7 individual responses. (e.g., “it depends” OR “12 hours” OR “I	These responses were isolated, and the entirety of the participant’s responses were kept for data collection, the commute time alone was removed and was not included in data analysis. These responses were moved to the sheet containing all

	rarely use cars, I only ever walk" OR "6 hours. 3600 minutes")	the excluded data under a heading specific to where it was taken from (i.e., commute time)
Sleep Latency	Sleep latency time responses were excluded if the time was not viable / too high or if no time was given. These responses were compared to hours in bed, if the hours in bed and sleep latency did not compute in relation to each other the response was excluded. Participant responses included: "usually in the morning the next day around 3 am till 6 am" OR "6 hours" OR "4 hours or less than 4 hours" OR "it takes me hours to fall asleep"	These responses were isolated and excluded individually, with the rest of the participants' responses being included in data analysis
Bedtime	One participant entered an unreadable response to bedtime. The participant response to this question was "no"	This response was removed from data that was analyzed. The only other response from this participant that was excluded was rise time. Despite this, the participant was still able to be included in the study and this did not affect the analysis of their data.
Rise Time	Two responses were excluded pertaining to rise times due to a time not being provided. The participant responses included: "no" AND "an hour before my first lecture starts (doesn't have a set time)"	Excluding these individual responses did not affect the overall data analysis, thus the rest of the participants' responses were included in data analysis.
Hours of Actual Sleep	5 participants' responses were excluded for giving answers that did not provide hours or giving hours that were too high to be realistic. Participant responses included: "28 hours" OR "I am not aware" OR "uncertain" OR "240 hours" OR "165 hours"	Due to this response being excluded, the component 3 score for these participants was excluded. To score the PSQI a minimum of 5 components need to be scored, thus the participants could still be included in the overall data analysis as they were only missing one component score According to Beck et al. (2004), when computing a global score, a number of approaches can be applied. It is possible to impute a mean score for a missing component based on the scores of the other components. Although, a PSQI global score computation can be completed if at least 5 of the 7 components are present.
Excluded Participants		
Age	Two participants were excluded based on age. Exclusion criteria: <18	Entirety of the two participants responses was highlighted in red and removed from the data that was analyzed. These responses were moved to a separate sheet to keep track of excluded participants.
Unreadable Data	One participant was excluded based on majority of responses coming up as "e" – rendering the data unreadable.	This response was removed from data that was analyzed. The only other response from this participant that was excluded was rise time. Despite this, the participant was still able to be included in the study and this did not affect the analysis of their data.

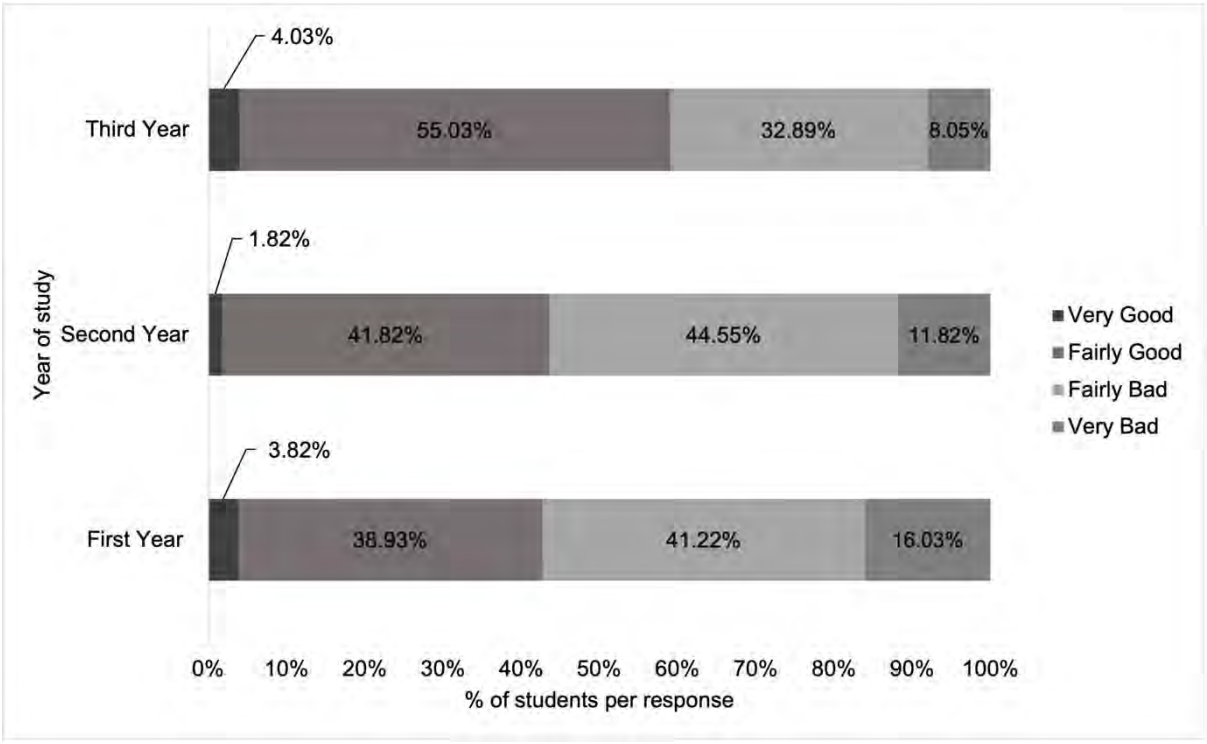
Appendix G: The Distribution of Subjective Sleep Quality Distribution Responses for the Whole Sample and the Respective Groups



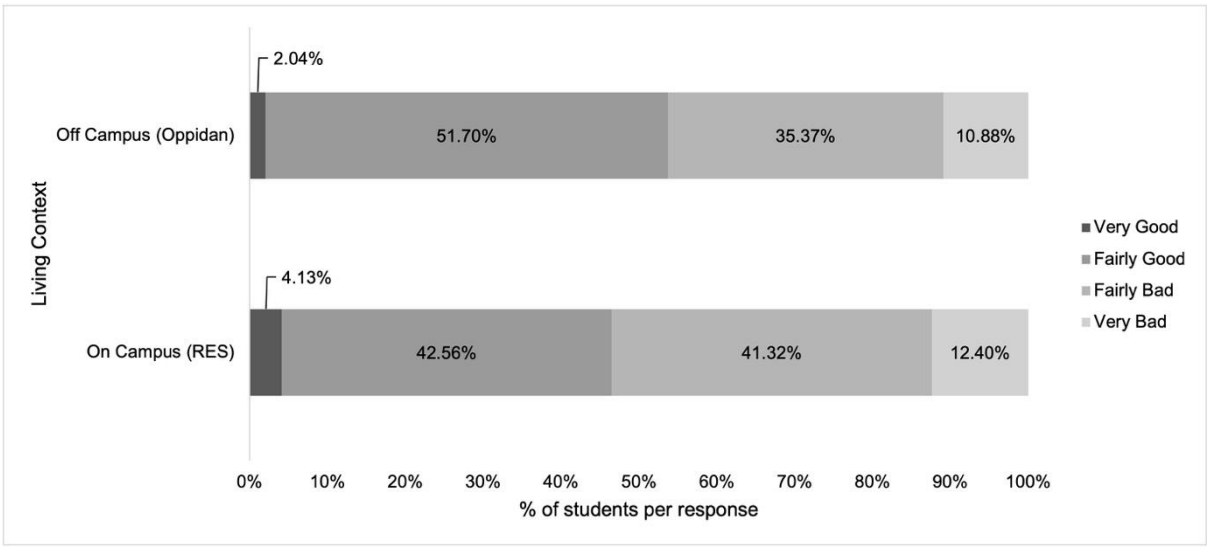
Subjective Sleep Quality ratings for whole sample. Component 1 of the Pittsburgh Sleep Quality Index (PSQI) assesses subjective sleep quality. Respondents rate their overall sleep quality over the past month using a Likert scale ranging from 0 to 3, with the following options; 0 - Very good; 1 - Fairly good; 2 - Fairly bad; 3 - Very bad.



Distribution of responses by gender for subjective sleep quality (component 1) (%)



Distribution of responses for subjective sleep quality by year of study (% of the group)



Distribution of responses of subjective sleep quality ratings according to living context (% students per response)

Appendix H: Distribution of responses for sleep disturbances questions in PSQI according to demographic groups

Distribution of responses for sleep disturbances separated by Gender (% of students per response)

Question & Group	Not During the last month	Less than once a week	Once or twice a week	Three or more times a week
Q5A. Cannot get to sleep within 30 min				
% Females	*24.83%*	*10.74%*	*23.83%*	*40.60%*
% Males	*23.75%*	*21.25%*	*17.50%*	*37.50%*
% Non-Binary/PNTS	*16.67%*	*16.67%*	*16.67%*	*50.00%*
Q5B. Wake up in the middle of the night or early morning				
% Females	*18.46%*	*13.09%*	*21.14%*	*47.32%*
% Males	*38.75%*	*11.25%*	*21.25%*	*28.75%*
% Non-Binary/PNTS	*0.00%*	*41.67%*	*25.00%*	*33.33%*
Q5C. Have to get up to use the bathroom				
% Females	*28.86%*	*17.11%*	*20.47%*	*33.56%*
% Males	*40.00%*	*20.00%*	*18.75%*	*21.25%*
% Non-Binary/PNTS	*41.67%*	*41.67%*	*8.33%*	*8.33%*
Q5D. Cannot breathe comfortably				
% Females	*68.12%*	*16.11%*	*11.41%*	*4.36%*
% Males	*90.00%*	*6.25%*	*1.25%*	*2.50%*
% Non-Binary/PNTS	*75.00%*	16.67%	*8.33%*	*0.00%*
Q5E. Cough or snore loudly				
% Females	*74.16%*	*14.43%*	*6.04%*	*5.37%*
% Males	*76.25%*	*13.75%*	*1.25%*	*8.75%*
% Non-Binary/PNTS	*58.33%*	*16.67%*	*16.67%*	*8.33%*
Q5F. Feel too cold				
% Females	*32.55%*	*17.79%*	*20.81%*	*28.86%*
% Males	*48.75%*	*22.50%*	*15.00%*	*13.75%*
% Non-Binary/PNTS	*33.33%*	*41.67%*	*25.00%*	*0.00%*
Q5G. Feel too hot				
% Females	*46.64%*	*20.47%*	*23.15%*	*9.73%*
% Males	*48.75%*	*25.00%*	*18.75%*	*7.50%*
% Non-Binary/PNTS	*41.67%*	*41.67%*	*8.33%*	*8.33%*
Q5H. Have bad dreams				
% Females	*37.25%*	*21.81%*	*24.16%*	*16.78%*
% Males	*46.25%*	*26.25%*	*18.75%*	*8.75%*

% Non-Binary/PNTS	*25.00%*	*25.00%*	*50.00%*	*0.00%*
Q5I. Have pain				
% Females	*63.42%*	*16.11%*	*9.73%*	*10.74%*
% Males	*81.25%*	*13.75%*	*1.25%*	*3.75%*
% Non-Binary/PNTS	*50.00%*	*33.33%*	*8.33%*	*8.33%*
Q5J. Other reasons				
% Females	*12.42%*	*9.40%*	*22.15%*	*56.04%*
% Males	*17.50%*	*23.75%*	*18.75%*	*40.00%*
% Non-Binary/PNTS	*0.00%*	*16.67%*	*58.33%*	*25.00%*

T-tests comparing sleep disturbances according to gender grouping (per question A-J) with females as group 1 and males as group 2.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5a score	1.802013	1.687500	0.750221	376	0.453591	298	80

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5a score	1.213447	1.207506	1.009865	0.983997

a.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5b score	*1.973154*	*1.400000*	*3.844798*	*376*	*0.000142*	*298*	*80*

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5b score	*1.160206*	*1.268908*	*1.196161*	*0.293430*

b.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5c score	1.587248	1.212500	2.448230	376	0.014812	298	80	1.223000

c.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Std.Dev. 2	F-ratio Variances	p Variances
Q5c score	1.187421	1.060825	0.769701

d.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5d score	0.520134	0.162500	3.516584	376	0.000491	298	80

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1 Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5d score	0.861404	0.561277	2.355374	0.000014

e.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5e score	0.426174	0.425000	0.011039	376	0.991198	298	80

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1 Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5e score	0.830553	0.896900	1.166149	0.365767

f.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5f score	1.459732	0.937500	3.477823	376	0.000565	298	80	1.217184

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Std.Dev. 2	F-ratio Variances	p Variances
Q5f score	1.094795	1.236082	0.261463

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5g score	0.959732	0.850000	0.845194	376	0.398540	298	80

g.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5g score	1.043687	0.982119	1.129308	0.525093

h.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5h score	*1.204698*	*0.900000*	*2.212599*	*376*	*0.027526*	*298*	*80*

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5h score	*1.116924*	*1.001265*	*1.244370*	*0.246603*

i.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1							
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5i score	*0.677852*	*0.275000*	*3.311149*	*376*	*0.001019*	*298*	*80*	*1.029978*

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis))		
	Std.Dev. 2	F-ratio Variances	p Variances
Q5i score	*0.674584*	*2.331224*	*0.000017*

j.

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis)) Group 1: 1							
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5j score	*2.218121*	*1.812500*	*3.001737*	*376*	*0.002864*	*298*	*80*	*1.052210*

Variable	T-tests; Grouping: T-test Gender Codes (Statistica Data (For sleep disturbance analysis))		
	Std.Dev. 2	F-ratio Variances	p Variances
Q5j score	*1.148403*	*1.191198*	*0.304582*

Distribution of responses for sleep disturbances over the last month (% of students by year of study)

Question & Group	Not during the month	Less than once a week	Once or twice a week	Three or more times a week
Q5A. Cannot get to sleep within 30 min				
First Year	*22.90%*	*9.92%*	*22.14%*	*45.04%*
Second Year	*23.64%*	*14.55%*	*22.73%*	*39.09%*
Third Year	*26.17%*	*14.77%*	*22.15%*	*36.91%*
Q5B. Wake up in the middle of the night or early morning				
First Year	*26.72%*	*16.03%*	*16.03%*	*41.22%*
Second Year	*20.91%*	*9.09%*	*26.36%*	*43.64%*
Third Year	*18.79%*	*14.77%*	*22.15%*	*44.30%*
Q5C. Have to get up to use the bathroom				
First Year	*35.11%*	*19.85%*	*16.03%*	*29.01%*
Second Year	*27.27%*	*16.36%*	*21.82%*	*34.55%*
Third Year	*31.54%*	*18.79%*	*21.48%*	*28.19%*
Q5D. Cannot Breathe Comfortably				
First Year	*69.47%*	*13.74%*	*11.45%*	*5.34%*
Second Year	*67.27%*	*16.36%*	*11.82%*	*4.55%*
Third Year	*79.87%*	*12.75%*	*5.37%*	*2.01%*
Q5E. Cough Or Snore Loudly				
First Year	*69.47%*	*19.08%*	*4.58%*	*6.87%*
Second Year	*75.45%*	*9.09%*	*8.18%*	*7.27%*
Third Year	*77.18%*	*14.09%*	*4.03%*	*4.70%*
Q5F. Feel Too Cold				
First Year	*42.75%*	*14.50%*	*19.08%*	*23.66%*
Second Year	*35.45%*	*16.36%*	*22.73%*	*25.45%*
Third Year	*30.20%*	*26.17%*	*18.12%*	*25.50%*
Q5G. Feel Too Hot				
First Year	*46.56%*	*19.08%*	*23.66%*	*10.69%*
Second Year	*46.36%*	*20.91%*	*21.82%*	*10.91%*
Third Year	*47.65%*	*25.50%*	*20.13%*	*6.71%*
Q5H. Have Bad Dreams				
First Year	*45.04%*	*22.14%*	*18.32%*	*14.50%*
Second Year	*37.27%*	*21.82%*	*25.45%*	*15.45%*
Third Year	*34.23%*	*24.16%*	*27.52%*	*14.09%*
Q5I. Have Pain				
First Year	*62.60%*	*17.56%*	*6.87%*	*12.98%*
Second Year	*67.27%*	*16.36%*	*8.18%*	*8.18%*
Third Year	*69.80%*	*14.77%*	*8.72%*	*6.71%*
Q5J. Other Reasons				
First Year	*16.03%*	*11.45%*	*20.61%*	*51.91%*

Second Year	*8.18%*	*9.09%*	*22.73%*	*60.00%*
Third Year	*14.09%*	*16.11%*	*24.16%*	*45.64%*

ANOVA tests comparing sleep disturbances according to year of study grouping (per question A-J)

a.

Effect	Univariate Tests of Significance for Q5a score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*1227.638*	*1*	*1227.638*	*837.5701*	*0.000000*
Year of Study	2.676	2	1.338	0.9130	0.402194
Error	567.231	387	1.466		

b.

Effect	Univariate Tests of Significance for Q5b score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*1321.108*	*1*	*1321.108*	*924.5343*	*0.000000*
Year of Study	3.668	2	1.834	1.2834	0.278264
Error	553.001	387	1.429		

c.

Effect	Univariate Tests of Significance for Q5c score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*859.7492*	*1*	*859.7492*	*577.9986*	*0.000000*
Year of Study	3.7893	2	1.8947	1.2738	0.280948
Error	575.6466	387	1.4875		

d.

Effect	Univariate Tests of Significance for Q5d score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*78.7341*	*1*	*78.73410*	*120.4267*	*0.000000*
Year of Study	*5.1258*	*2*	*2.56292*	*3.9201*	*0.020632*
Error	253.0177	387	0.65379		

e.

Effect	Univariate Tests of Significance for Q5e score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*74.7640*	*1*	*74.76405*	*103.1208*	*0.000000*
Year of Study	1.3169	2	0.65845	0.9082	0.404112
Error	280.5805	387	0.72501		

f.

Effect	Univariate Tests of Significance for Q5f score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*685.3513*	*1*	*685.3513*	*474.4311*	*0.000000*
Year of Study	1.9469	2	0.9734	0.6739	0.510339
Error	559.0506	387	1.4446		

g.

Effect	Univariate Tests of Significance for Q5g score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*338.4886*	*1*	*338.4886*	*320.3379*	*0.000000*
Year of Study	1.3388	2	0.6694	0.6335	0.531290
Error	408.9279	387	1.0567		

h.

Effect	Univariate Tests of Significance for Q5h score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*501.5862*	*1*	*501.5862*	*421.0258*	*0.000000*
Year of Study	2.9093	2	1.4546	1.2210	0.296070
Error	461.0497	387	1.1913		

i.

Effect	Univariate Tests of Significance for Q5i score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*138.0202*	*1*	*138.0202*	*144.5667*	*0.000000*
Year of Study	2.3222	2	1.1611	1.2161	0.297499
Error	369.4753	387	0.9547		

j.

Effect	Univariate Tests of Significance for Q5j score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*1771.226*	*1*	*1771.226*	*1554.615*	*0.000000*
Year of Study	*7.409*	*2*	*3.704*	*3.251*	*0.039786*
Error	440.922	387	1.139		

Sleep disturbances separated by living context (% of students per response)

Question & Group	Not During the last month	Less than once a week	Once or twice a week	Three or more times a week
Q5A. Cannot get to sleep within 30 min				
Residence	*29.22%*	*8.64%*	*21.40%*	*40.74%*
Oppidan	*16.33%*	*20.41%*	*23.81%*	*39.46%*
Q5B. Wake up in the middle of the night or early morning				
Residence	*24.28%*	*13.99%*	*22.22%*	*39.51%*
Oppidan	*18.37%*	*12.93%*	*19.73%*	*48.98%*
Q5C. Have to get up to use the bathroom				
Residence	*31.69%*	*16.05%*	*21.81%*	*30.45%*
Oppidan	*31.29%*	*22.45%*	*16.33%*	*29.93%*
Q5D. Cannot breathe comfortably				
Residence	*73.25%*	*15.23%*	*7.82%*	*3.70%*
Oppidan	*72.11%*	*12.24%*	*11.56%*	*4.08%*
Q5E. Cough or snore loudly				
Residence	*75.31%*	*15.23%*	*4.94%*	*4.53%*
Oppidan	*72.11%*	*12.93%*	*6.12%*	*8.84%*
Q5F. Feel too cold				
Residence	*38.27%*	*20.16%*	*19.75%*	*21.81%*
Oppidan	*31.97%*	*18.37%*	*19.73%*	*29.93%*
Q5G. Feel too hot				
Residence	*44.44%*	*22.22%*	*23.87%*	*9.47%*

Oppidan	*51.02%*	*21.77%*	*18.37%*	*8.84%*
Q5H. Have bad dreams				
Residence	*41.98%*	*19.75%*	*20.58%*	*17.70%*
Oppidan	*33.33%*	*27.89%*	*29.25%*	*9.52%*
Q5I. Have pain				
Residence	*65.02%*	*16.05%*	*8.64%*	*10.29%*
Oppidan	*69.39%*	*16.33%*	*6.80%*	*7.48%*
Q5J. Other reasons				
Residence	*13.58%*	*14.40%*	*20.99%*	*51.03%*
Oppidan	*12.24%*	*9.52%*	*25.17%*	*53.06%*

T-tests analysing sleep disturbances according to living context grouping (per question A-J) with Residence as group 1 and Oppidan as group 2.

	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2						
Variable	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5a score	1.736626	1.863946	-1.00671	388	0.314699	243	147

a.

	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1			
Variable	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5a score	1.264820	1.114287	1.288436	0.093768

b.

	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2						
Variable	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5b score	1.769547	1.993197	-1.79436	388	0.073534	243	147

	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1			
Variable	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5b score	1.207919	1.167462	1.070509	0.655901

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2							
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5c score	1.510288	1.448980	0.480277	388	0.631301	243	147	1.224280

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1		
	Std.Dev. 2	F-ratio Variances	p Variances
Q5c score	1.217361	1.011399	0.948883

c.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5d score	0.419753	0.476190	-0.662563	388	0.508004	243	147

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5d score	0.790400	0.854748	1.169451	0.283089

d.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5e score	0.386831	0.517007	-1.46564	388	0.143556	243	147

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5e score	0.781072	0.953392	1.489910	0.006235

e.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2							
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5f score	1.251029	1.476190	-1.79955	388	0.072708	243	147	1.181271

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1		
	Std.Dev. 2	F-ratio Variances	p Variances
Q5f score	1.223812	1.073323	0.623845

f.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5g score	0.983539	0.850340	1.242152	388	0.214931	243	147

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5g score	1.032397	1.015994	1.032551	0.838872

g.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5h score	1.139918	1.149660	-0.085264	388	0.932096	243	147

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5h score	1.148558	0.995564	1.330968	0.058886

h.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2	Std.Dev. 1
Q5i score	0.641975	0.523810	1.157263	388	0.247877	243	147	1.012018

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Std.Dev. 2	F-ratio Variances	p Variances
Q5i score	0.916615	1.218998	0.190047

i.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Group 2: 2 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Q5j score	2.094650	2.190476	-0.853959	388	0.393655	243	147

j.

Variable	T-tests; Grouping: T-test Living Codes (Sleep Disturbances by living context) Group 1: 1 Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Q5j score	1.092467	1.042477	1.098206	0.537565

Sleep disturbances according to funding option (% of students per response)

Question & Group	Not During the last month	Less than once a week	Once or twice a week	Three or more times a week
Q5A. Cannot get to sleep within 30 min				
Self-funded	*20.45%*	*12.88%*	*25.76%*	*40.91%*
NSFAS	*24.87%*	*11.17%*	*20.81%*	*43.15%*
Other	*30.00%*	*20.00%*	*20.00%*	*30.00%*
Non-classified	1	0	0	0
Q5B. Wake up in the middle of the night or early morning				
Self-funded	*20.45%*	*15.15%*	*24.24%*	*40.15%*
NSFAS	*21.83%*	*13.20%*	*21.83%*	*43.15%*
Other	*26.67%*	*11.67%*	*13.33%*	*48.33%*
Non-classified	0	0	0	1
Q5C. Have to get up to use the bathroom				
Self-funded	*31.06%*	*15.91%*	*26.52%*	*26.52%*
NSFAS	*31.98%*	*20.30%*	*14.72%*	*32.99%*
Other	*30.00%*	*18.33%*	*21.67%*	*30.00%*
Non-classified	1	0	0	0
Q5D. Cannot breathe comfortably				
Self-funded	*78.79%*	*7.58%*	*10.61%*	*3.03%*
NSFAS	*69.04%*	*18.27%*	*8.12%*	*4.57%*
Other	*71.67%*	15.00%	*10.00%*	*3.33%*
Non-classified	1	0	0	0
Q5E. Cough or snore loudly				
Self-funded	*77.27%*	*14.39%*	*2.27%*	*6.06%*
NSFAS	*74.11%*	*12.69%*	*6.60%*	*6.60%*
Other	*66.67%*	*20.00%*	*8.33%*	*5.00%*

Non-classified	*1*	*0*	*0*	*0*
Q5F. Feel too cold				
Self-funded	*30.30%*	*21.97%*	*24.24%*	*23.48%*
NSFAS	*39.59%*	*17.77%*	*16.24%*	*26.40%*
Other	*36.67%*	*20.00%*	*21.67%*	*21.67%*
Non-classified	0	0	0	1
Q5G. Feel too hot				
Self-funded	*41.67%*	*25.76%*	*24.24%*	*8.33%*
NSFAS	*47.72%*	*20.30%*	*20.30%*	*11.68%*
Other	*55.00%*	*20.00%*	*21.67%*	*3.33%*
Non-classified	1	0	0	0
Q5H. Have bad dreams				
Self-funded	*35.61%*	*27.27%*	*25.76%*	*11.36%*
NSFAS	*37.56%*	*20.81%*	*23.35%*	*18.27%*
Other	*50.00%*	*20.00%*	*20.00%*	*10.00%*
Non-classified	0	0	1	0
Q5I. Have pain				
Self-funded	*69.70%*	*18.94%*	*6.06%*	*5.30%*
NSFAS	*63.45%*	*16.75%*	*10.15%*	*9.64%*
Other	*70.00%*	*8.33%*	*5.00%*	*16.67%*
Non-classified	*1*	*0*	*0*	*0*
Q5J. Other reasons				
Self-funded	*12.12%*	*12.88%*	*31.06%*	*43.94%*
NSFAS	*13.20%*	*11.68%*	*17.26%*	*57.87%*
Other	*15.00%*	*15.00%*	*20.00%*	*50.00%*
Non-classified	0	0	1	0

ANOVA tests of sleep disturbances according to funding grouping (per question A-J) with Self-funded as group 1; NSFAS as group 2; Other as group 3

a.

Effect	Univariate Tests of Significance for Q5a score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*919.9949*	*1*	*919.9949*	*633.4693*	*0.000000*
ANOVA Funding Codes	6.1223	2	3.0612	2.1078	0.122903
Error	560.5923	386	1.4523		

b.

Effect	Univariate Tests of Significance for Q5b score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*1045.769*	*1*	*1045.769*	*726.9450*	*0.000000*
ANOVA Funding Codes	0.060	2	0.030	0.0209	0.979272
Error	555.292	386	1.439		

c.

Effect	Univariate Tests of Significance for Q5c score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*687.2624*	*1*	*687.2624*	*459.6266*	*0.000000*
ANOVA Funding Codes	0.0472	2	0.0236	0.0158	0.984340
Error	577.1713	386	1.4953		

d.

Effect	Univariate Tests of Significance for Q5d score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*58.6242*	*1*	*58.62419*	*88.01662*	*0.000000*
ANOVA Funding Codes	0.8502	2	0.42508	0.63820	0.528796
Error	257.0984	386	0.66606		

e.

Effect	Univariate Tests of Significance for Q5e score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*61.6777*	*1*	*61.67774*	*84.82203*	*0.000000*
ANOVA Funding Codes	1.0298	2	0.51488	0.70808	0.493227
Error	280.6772	386	0.72714		

f.

Effect	Univariate Tests of Significance for Q5f score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*542.1444*	*1*	*542.1444*	*375.6941*	*0.000000*
ANOVA Funding Codes	1.2048	2	0.6024	0.4174	0.659022
Error	557.0163	386	1.4430		

g.

Effect	Univariate Tests of Significance for Q5g score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*245.9200*	*1*	*245.9200*	*233.5751*	*0.000000*
ANOVA Funding Codes	2.9924	2	1.4962	1.4211	0.242707
Error	406.4009	386	1.0529		

h.

Effect	Univariate Tests of Significance for Q5h score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*360.7408*	*1*	*360.7408*	*303.7763*	*0.000000*
ANOVA Funding Codes	4.8405	2	2.4202	2.0381	0.131682
Error	458.3832	386	1.1875		

i.

Effect	Univariate Tests of Significance for Q5i score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*112.1034*	*1*	*112.1034*	*117.5626*	*0.000000*
ANOVA Funding Codes	3.3643	2	1.6821	1.7641	0.172728
Error	368.0753	386	0.9536		

j.

Effect	Univariate Tests of Significance for Q5j score (Statistica Data (For sleep disturbance analysis)) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*1360.700*	*1*	*1360.700*	*1176.286*	*0.000000*
ANOVA Funding Codes	1.798	2	0.899	0.777	0.460413
Error	446.516	386	1.157		

Appendix I: statistical tests run to compare sleep characteristics in females (group :1) and males (group: 2)

Variable	T-tests; Grouping: T-test Gender Codes (Statistical Analysis data) Group 1: 1 Group 2: 2						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Commute Time	12.65328	11.54545	1.071626	349	0.284628	274	77
Bedtimes	24.43302	24.26557	0.775650	375	0.438444	298	79
Sleep Latency	39.98038	34.15333	1.349295	364	0.178081	291	75
Rise times	7.23599	7.21114	0.108312	374	0.913807	297	79
Hours of sleep	5.88078	6.03260	-0.814351	371	0.415967	296	77

Variable	T-tests; Grouping: T-test Gender Codes (Statistical Analysis data) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Commute Time	8.24878	7.11151	1.345413	0.124866
Bedtimes	1.68307	1.79048	1.131704	0.465528
Sleep Latency	34.13932	30.05018	1.290671	0.189715
Rise times	1.75765	2.00781	1.304916	0.121441
Hours of sleep	1.51832	1.19130	1.624366	0.012484

a.

Time-related data t-test comparing females (group 1) and males (group 2)

Variable	T-tests; Grouping: T-test Gender Codes (Statistica S.E % Data) Group 1: 1				
	Mean 1	Mean 2	t-value	df	p
CLEAN HABITUAL SLEEP EFFICIENCY (%)	85.93742	85.45221	0.266524	370	0.789984

Variable	T-tests; Grouping: T-test Gender Codes (Statistica S.E % Data) Group 1: 1			
	Valid N 1	Valid N 2	Std.Dev. 1	Std.Dev. 2
CLEAN HABITUAL SLEEP EFFICIENCY (%)	295	77	13.98133	15.13543

Variable	T-tests; Grouping: T-test Gender Codes (Statistica S.E % Data)	
	F-ratio Variances	p Variances
CLEAN HABITUAL SLEEP EFFICIENCY (%)	1.171905	0.357865

b.

Habitual sleep efficiency t-test comparing females (group 1) and males (group 2)

Variable	T-tests; Grouping: gENDER Time In Bed (Working data for thesis. Statistica) Group 1: 6 Group 2: 5						
	Mean 6	Mean 5	t-value	df	p	Valid N 6	Valid N 5
T-test Gender Codes	1.200000	1.222222	-0.216612	64	0.829200	30	36

Variable	T-tests; Grouping: gENDER Time In Bed (Working data for thesis. Statistica) Group 1: 6			
	Std.Dev. 6	Std.Dev. 5	F-ratio Variances	p Variances
T-test Gender Codes	0.406838	0.421637	1.074074	0.850670

Time in bed t-test comparing gender groupings (with females as group 1 and males as group 2)

Variable	T-tests; Grouping: T-test Gender Codes (Statistical Analysis data) Group 1: 1 Group 2: 2						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
GLOBAL SCORES	*9.989933*	*8.975000*	*2.401117*	*376*	*0.016830*	*298*	*80*

Variable	T-tests; Grouping: T-test Gender Codes (Statistical Analysis data) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
GLOBAL SCORES	*3.369985*	*3.306974*	*1.038471*	*0.860990*

Global score t-test comparing gender grouping (with females as group 1 and males as group 2)

Appendix J: statistical tests run to compare sleep characteristics in the year of study groups.

Effect	Univariate Tests of Significance for Sleep Latency (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*582401.6*	*1*	*582401.6*	*503.8249*	*0.000000*
Year of Study	3894.1	2	1947.1	1.6844	0.186964
Error	433485.1	375	1156.0		

ANOVA test comparing sleep latencies of the three years of study.

Effect	Univariate Tests of Significance for Rise times (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*20060.10*	*1*	*20060.10*	*6180.193*	*0.000000*
Year of Study	6.20	2	3.10	0.955	0.385623
Error	1249.66	385	3.25		

ANOVA test comparing rise-times of all three years of study.

Effect	Univariate Tests of Significance for Bedtimes (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*228850.8*	*1*	*228850.8*	*79042.68*	*0.000000*
Year of Study	10.0	2	5.0	1.72	0.179598
Error	1117.6	386	2.9		

ANOVA test comparing bedtimes of all three years of study.

Effect	Univariate Tests of Significance for YOS Time In Bed (Working data for thesis. Statistica) Sigma-restricted parameterization Effective hypothesis decomposition; Std. Error of Estimate: 1.9658				
	SS	Degr. of Freedom	MS	F	p
Intercept	*17716.91*	*1*	*17716.91*	*4584.517*	*0.000000*
Year of Study	*24.91*	*2*	*12.45*	*3.223*	*0.040922*
Error	1487.84	385	3.86		

ANOVA test comparing Time in bed of all three years of study.

Effect	Univariate Tests of Significance for Hours of sleep (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*13183.95*	*1*	*13183.95*	*6464.593*	*0.000000*
Year of Study	*18.47*	*2*	*9.24*	*4.529*	*0.011376*
Error	779.05	382	2.04		

ANOVA test comparing hours of sleep of all three years of study.

Effect	Univariate Tests of Significance for COMPONENT 1 SCORE (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition; Std. Error of Estimate: 0.7317				
	SS	Degr. of Freedom	MS	F	p
Intercept	*986.3691*	*1*	*986.3691*	*1842.183*	*0.000000*
Year of Study	*4.9636*	*2*	*2.4818*	*4.635*	*0.010250*
Error	207.2133	387	0.5354		

ANOVA test comparing subjective sleep quality of all three years of study.

Effect	Univariate Tests of Significance for GLOBAL SCORES (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*37254.46*	*1*	*37254.46*	*3378.078*	*0.000000*
Year of Study	*123.38*	*2*	*61.69*	*5.594*	*0.004027*
Error	4267.95	387	11.03		

ANOVA test comparing global PSQI scores of all three years of study

Appendix K: Statistical tests run to compare sleep characteristics of the two living context groups (with Residence students being group 1 and Oppidan students being group 2)

Variable	T-tests; Grouping: T-test Living Codes (Statistical Analysis data) Group 1: 1 Group 2: 2 Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
Commute Time	*10.76835*	*14.48966*	*-4.45997*	*361*	*0.000011*	*218*	*145*
Bedtimes	*24.60409*	*24.10544*	*2.82224*	*387*	*0.005015*	*242*	*147*
Sleep Latency	39.57282	38.51215	0.29365	376	0.769184	234	144
Rise times	7.25834	7.24442	0.07373	386	0.941260	241	147
Hours of sleep	*5.78830*	*6.12840*	*-2.25245*	*383*	*0.024859*	*241*	*144*

Variable	T-tests; Grouping: T-test Living Codes (Statistical Analysis data) Group 1: 1 Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
Commute Time	*6.73582*	*9.14381*	*1.842783*	*0.000045*
Bedtimes	*1.70210*	*1.66884*	*1.040252*	*0.800161*
Sleep Latency	34.01716	34.24092	1.013199	0.920973
Rise times	1.94299	1.54785	1.575744	0.002877
Hours of sleep	*1.45720*	*1.39298*	*1.094327*	*0.556836*

T-tests comparing time-related variables between Residence and Oppidan students.

Effect	Univariate Tests of Significance for CLEAN HABITUAL SLEEP EFFICIENCY (%) (Statistica S.E % Data) Sigma-restricted parameterization Effective hypothesis decomposition; Std. Error of Estimate: 14.0781 SS	Degr. of Freedom	MS	F	p
Intercept	*2252899*	*1*	*2252899*	*11367.14*	*0.000000*
ANOVA Funding Codes	724	2	362	1.83	0.162449
Error	75314	380	198		

T-test comparing habitual sleep efficiency scores between living context groups with residence being group 1 and Oppidan being group 2.

Variable	T-tests; Grouping: lIVING Time In Bed (Working data for thesis. Statistica) Group 1: 6					
	Mean 6	Mean 5	t-value	df	p	Valid N 6
Statistica Living Codes	1.156250	1.324324	-1.62317	67	0.109249	32

Variable	T-tests; Grouping: lIVING Time In Bed (Working data for thesis. Statistica) Group 1: 6				
	Valid N 5	Std.Dev. 6	Std.Dev. 5	F-ratio Variances	p Variances
Statistica Living Codes	37	0.368902	0.474579	1.654988	0.156134

T-test comparing time in bed between living context groups with residence being group 1 and Oppidan being group 2.

Variable	T-tests; Grouping: T-test Living Codes (Statistical Analysis data) Group 1: 1 Group 2: 2					
	Mean 1	Mean 2	t-value	df	p	Valid N 1
COMPONENT 1 SCORE	1.617284	1.551020	0.858387	388	0.391209	243

Variable	T-tests; Grouping: T-test Living Codes (Statistical Analysis data) Group 1: 1				
	Valid N 2	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
COMPONENT 1 SCORE	147	0.753525	0.713698	1.114719	0.473880

T-test comparing subjective sleep quality scores between Residence and Oppidan students.

Variable	T-tests; Grouping: T-test Living Codes (Statistical Analysis data) Group 1: 1 Group 2: 2						
	Mean 1	Mean 2	t-value	df	p	Valid N 1	Valid N 2
GLOBAL SCORES	9.757202	9.836735	-0.226268	388	0.821112	243	147

Variable	T-tests; Grouping: T-test Living Codes (Statistical Analysis data) Group 1: 1			
	Std.Dev. 1	Std.Dev. 2	F-ratio Variances	p Variances
GLOBAL SCORES	3.227385	3.578935	1.229720	0.156633

T-test comparing PSQI Global scores between Residence and Oppidan students.

Appendix L: Statistical tests run to compare sleep characteristics of the funding groups *with Self-funded as group 1; NSFAS as group 2; Other as group 3.*

Effect	Univariate Tests of Significance for Sleep Latency (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*445677.6*	*1*	*445677.6*	*382.5660*	*0.000000*
ANOVA Funding Codes	827.6	2	413.8	0.3552	0.701261
Error	435698.5	374	1165.0		

ANOVA test comparing sleep latencies of the three funding groups with Self-funded as group 1; NSFAS as group 2; Other as group 3.

Effect	Univariate Tests of Significance for Rise times (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*15720.12*	*1*	*15720.12*	*4872.514*	*0.000000*
ANOVA Funding Codes	11.88	2	5.94	1.841	0.160081
Error	1238.89	384	3.23		

ANOVA test comparing rise-times of all three funding groups with Self-funded as group 1; NSFAS as group 2; Other as group 3.

Effect	Univariate Tests of Significance for Bedtimes (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*180743.7*	*1*	*180743.7*	*63991.11*	*0.000000*
ANOVA Funding Codes	*34.3*	*2*	*17.1*	*6.07*	*0.002543*
Error	1087.4	385	2.8		

ANOVA test comparing the bedtimes of all three funding groups with Self-funded as group 1; NSFAS as group 2; Other as group 3.

Effect	Univariate Tests of Significance for COMPONENT 1 SCORE (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*731.4033*	*1*	*731.4033*	*1359.835*	*0.000000*
ANOVA Funding Codes	*4.2106*	*2*	*2.1053*	*3.914*	*0.020753*
Error	207.6146	386	0.5379		

ANOVA test comparing the subjective sleep quality scores between funding groups with Self-funded as group 1; NSFAS as group 2; Other as group 3.

Effect	Univariate Tests of Significance for CLEAN HABITUAL SLEEP EFFICIENCY (%) (Statistica S.E % Data) Sigma-restricted parameterization Effective hypothesis decomposition; Std. Error of Estimate: 14.0781				
	SS	Degr. of Freedom	MS	F	p
Intercept	*2252899*	*1*	*2252899*	*11367.14*	*0.000000*
ANOVA Funding Codes	724	2	362	1.83	0.162449
Error	75314	380	198		

ANOVA test comparing the habitual sleep efficiency scores between the three funding options.

Effect	Univariate Tests of Significance for GLOBAL SCORES (Statistical Analysis data) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
Intercept	*28550.92*	*1*	*28550.92*	*2537.733*	*0.000000*
ANOVA Funding Codes	34.24	2	17.12	1.522	0.219639
Error	4342.72	386	11.25		

ANOVA test comparing global PSQI scores between funding groups.