SLEEP QUALITY, INSOMNIA SYMPTOMS, CHRONOTYPE, AND MENTAL HEALTH IN YOUNG ADULTS

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Abstract

There is a bidirectional relationship between sleep and mental health, with deteriorations in one often associated with concomitant decrements in the other. Young adults (YAs) are at an increased risk of experiencing sleep disturbance, as well as anxiety and mood disorders. Individuals at this developmental stage are also more likely to have an evening chronotype, the circadian preference most closely related to poor mental health outcomes. This dissertation comprises two studies that draw from the same data set. Study 1 examined the prevalence rates of, and relationships among, sleep disturbance as measured by three sleep metrics and mental health. Results from this first study demonstrated above average rates of anxiety, depression, and global distress. A dose-response relationship was found between sleep disturbance, as indicated by three separate sleep metrics, and mental health symptoms: the greater the number of sleep measures for which participants met or exceeded clinical cut-offs, the more severe was the mental health symptomology. Study 2 examined the prevalence rates of chronotype among YAs, and the relationship between chronotype and symptoms of anxiety, depression, and global distress, as well as the positive psychological constructs of mindfulness and perceived social support. The second study demonstrated a prevalence rate of evening chronotype that is consistent with other YA populations surveyed elsewhere. Additionally, it was found that chronotype shared a gradient relationship with mental health, with evening types endorsing greater scores on all mental health measures than their intermediate and morning counterparts. In contrast, morning types were more likely to report greater levels of mindfulness and perceived social support. Age had an inconsistent impact on the relationship between chronotype and mental health. This findings of these two studies

emphasize the increased risk at which YAs with poor sleep quality and/or evening chronotype are for experiencing symptoms of depression, anxiety, and distress. Study limitations and future directions for knowledge translation are discussed.

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Dedication

I would like to dedicate the success, not only of this dissertation, but that of my entire academic career, to my parents, Mike and Liz. The support they have lovingly and freely provided to me over the past 10 years is indescribable. I hope I make you proud.

Table of Contents

Abstract ..... **ii**

Acknowledgements ..... **iv**

Dedication ..... **v**

Table of Contents ..... **vi**

List of Tables ..... **viii**

List of Figures ..... **ix**

List of Abbreviations and Nomenclature ..... **x**

Chapter 1: Introduction **1**

1.0 Insomnia and Sleep Disturbance 2

1.1 The State of Sleep Among Young Adults 3

1.2 Sleep and Cognition 9

1.3 Sleep and Negative Mental Health 13

1.4 Sleep and Positive Mental Health 16

1.5 The Role of Chronotype 20

1.6 Summary 24

Chapter 2: Prevalence and Mental Health Correlates of Poor Sleep Quality, Insomnia Symptoms, and Daytime Sleepiness in Young Adults **25**

2.0 Abstract 26

2.1 Introduction 28

2.2 Methods 31

2.2.1 Participants 31

2.2.2 Study Variables 32

2.2.3 Analyses 34

2.3 Results 35

2.3.1 Demographic and Clinical Characteristics 35

2.3.2 Relationship Between Sleep and Mental Health 36

2.4 Discussion 38

Chapter 3: Night Owls and Early Birds: The Impact of Chronotype on Mental Health 51

3.0 Abstract 52

3.1 Introduction 54

3.2 Methods 57

3.2.1 Participants 57

3.2.2 Study Variables 57

3.2.3 Analyses 59

3.3 Results 59

3.3.1 Demographic and Clinical Characteristics 59

3.3.2 Relationship Between Chronotype and Mental Health 60

3.4 Discussion 61

Chapter 4: Overall Summary and Conclusions 74

4.0 Summary of Main Findings 75

4.1 Challenges and Limitations of the Current Work 76

4.2 Strengths of the Current Work 78

4.3 Implications and Directions for Future Research 80

References 84

List of Tables

Table 2.1: Demographic characteristics of participants.....47

Table 2.2: Proportion of sample reporting clinically significant sleep disturbance on one or more sleep metrics.....48

Table 2.3: Demographic characteristics of participants who met or exceeded the clinical cut-off score of one, two, three, or none of the sleep measures.....49

Table 3.1: Clinical characteristics of participants.....70

Table 3.2. Demographic characteristics of participants by chronotype.....71

List of Figures

Figure 2.1: Average score on mental health measures for participants who met or exceeded clinical cut-offs on one or more sleep metrics 50

Figure 3.1: Association between chronotype and mental health variables as measured by the HADS and K10 72

Figure 3.2: Association between chronotype and positive psychological variables as measured by the MOS-SSS and MAAS 73

List of Abbreviations and Nomenclature

Symbol	Definition
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
CBT-I	Cognitive behavioural therapy for insomnia
DSM-IV-TR	Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition, Text Revision
DSM-5	Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition
ESS	Epworth Sleepiness Scale
HADS	Hospital Anxiety and Depression Scale
HADS-Anx	Hospital Anxiety and Depression Scale, Anxiety subscale
HADS-Dep	Hospital Anxiety and Depression Scale, Depression subscale
ICD-10	International Classification of Diseases – Tenth Edition
ISI	Insomnia Severity Index
K10	Kessler Distress Scale
MAAS	Mindful Attention Awareness Scale
MEQ	Morningness-Eveningness Questionnaire
MOS-SSS	Medical Outcomes Study – Social Support Survey
MUN	Memorial University of Newfoundland
PSS	Perceived social support
PSQI	Pittsburgh Sleep Quality Inventory
SE	Sleep efficiency
SOL	Sleep onset latency
WASO	Wake after sleep onset
YA	Young adult

Chapter 1:

Introduction

1.0 Insomnia and Sleep Disturbance

One of the most common sleep disorders is insomnia, which affects approximately 13% of adults in Canada (Morin, LeBlanc, et al., 2011). Insomnia is characterized in the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5) as "a predominant complaint of dissatisfaction with sleep quantity or quality" associated with difficulty initiating or maintaining sleep, or waking too early (APA, 2013, p. 362). This disturbance must occur at least three nights per week for three months or more, despite adequate opportunity to sleep, and cause clinically significant impairment in one or more important areas of functioning (e.g., work, school, leisure). Although insomnia is a symptom of many other psychiatric disorders, including major depressive disorder, generalized anxiety disorder, and post-traumatic stress disorder, it can be diagnosed in concurrence with these and other disorders if the appropriate diagnostic criteria are met (2013).

When considering a diagnosis of insomnia, it is necessary to establish an understanding of how an individual sleeps on a typical night, including time to bed, sleep onset latency (SOL), frequency and duration of nighttime awakenings, time out of bed, and sleep efficiency (SE). Although not outlined in the DSM-5, it is generally accepted that SOL and/or wake-after sleep onset (WASO) of greater than 30 minutes, and SE below 85% are appropriate indicators of the presence of insomnia, if also occurring with all other pertinent diagnostic criteria (Schutte-Rodin, Broch, Buysse, Dorsey, & Sateia, 2008). As is the case in all psychodiagnostic assessment, a sound differential diagnosis must also be considered in order to rule out other possible causes of insomnia, including other sleep-wake disorders (e.g., narcolepsy, sleep apnea), or the effects of a substance

(e.g., prescription medication, drug of abuse). This thorough assessment process is complemented by the drafting of a timeline of the onset of sleep disturbance, especially the identification of potential precipitating and perpetuating factors, and how the disturbance departs from premorbid sleep patterns. Additional hallmark features of insomnia are the physiological (e.g., increased heart rate, restlessness, tension) and cognitive arousal (e.g., worry about falling asleep, racing thoughts, distractibility) that individuals experience around bedtime, factors which also serve to maintain the insomnia (Cunnington, Junge, & Fernando, 2013; Espie, 2002).

One in three individuals may experience some symptoms of sleep disturbance that do not meet the diagnostic criteria for insomnia (APA, 2013). Not only does the construct of sleep disturbance imply a somewhat less severe presentation than in the case of insomnia, it also captures symptoms and experiences that are more general in nature than those captured by the insomnia diagnosis (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The distinction between insomnia and sleep disturbance is also semantic: In the sleep literature, many research articles refer to "sleep disturbance" or "insomnia symptoms," rather than "insomnia" proper unless a thorough assessment of insomnia, as outlined above, had been carried out in the study (Gould, Beaudreau, O'Hara, & Edelstein, 2015; Kravitz et al., 2008; Polo-Kantola et al., 2014). In other words, "insomnia" is subsumed within "sleep disturbance," but not all sleep disturbance may be classified as insomnia.

1.1 The State of Sleep Among Young Adults

For the purposes of this dissertation, young adults (YAs) are defined as those between the ages of 18 and 35. Although the National Sleep Foundation defines young

adulthood as spanning from 18 to 25 (Hirshkowitz et al., 2015), many studies in the sleep literature have included participants in their 30s in YA samples (Levenson, Shensa, Sidani, Colditz, & Primack, 2017; Schwarz et al., 2018; Sivertsen et al., 2019), and some even include participants into their 40s (Simor, Zavecz, Pálosi, Török, & Köteles, 2015; Tinajero et al., 2018). The prevalence of poor sleep quality within this population, as measured by the Pittsburgh Sleep Quality Index (PSQI), commonly falls between 40-65% (Becker, Luebbe, & Langberg, 2014; Carney, Edinger, Meyer, Lindman, & Istre, 2006; Kenney, LaBrie, Hummer, & Pham, 2012). A number of other studies of North American YA populations have reported prevalence rates within this range. In a survey of 1,125 students aged 17-21 at an American university, 60% of the sample was classified by the PSQI as poor-quality sleepers (Lund, Reider, Whiting, & Prichard, 2010). One-quarter of this sample reported sleeping for less than 6.5 hours per night on average, and self-reported tension and stress were significantly associated with poor quality sleep. These findings are consistent with another multi-site study of over 7,600 American university students (Becker et al., 2018). Here, the PSQI was also employed to quantify sleep quality. Over 60% of participants exceeded the clinical cut-off for poor sleep on the PSQI, with female participants having poorer sleep quality than male participants. Other studies of university students conducted in the United States also reflect this pattern (Forquer, Camden, Gabriau, & Johnson, 2008; Gaultney, 2010; Orzech, Salafsky, & Hamilton, 2011), but the high prevalence of poor sleep among YAs is not unique to North America. University students from 26 countries were asked to provide a subjective rating of the severity of sleep problems they had experienced in the previous 30 days (Peltzer & Pengpid, 2015). Findings from the 20,222 participants showed that, using this less

standardized approach, the prevalence of subjective sleeping problems that were "severe" or "extreme" was almost 11%.

A recent population-based study conducted in the United States provided additional support for the prevalence of poor sleep among adults in general. Over 6,300 adults over the age of 18 responded to questions regarding having told a physician about trouble sleeping, as well as the frequency of characteristic insomnia symptoms such as: trouble initiating sleep; WASO; trouble returning to sleep following nighttime awakenings; waking up earlier in the morning than intended and being unable to fall back asleep; not feeling rested during the day regardless of sleep duration; feeling excessively sleepy during the day; and short sleep duration (Yong, Li, & Calvert, 2017). Participants who endorsed any of the above symptoms of poor sleep quality at a frequency of 16-30 times per month were classified as having poor sleep. The authors found that 19.2% of the sample experienced poor sleep quality by this metric. Similar prevalence rates for sleep disturbance within adult population-based samples have been demonstrated in a Canadian sample (Morin, LeBlanc, et al., 2011). Two-thousand geographically- and age-representative participants were assessed in interviews using insomnia criteria from the DSM – Fourth Edition, Text Revision (DSM-IV-TR; APA, 2000) and the International Classification of Diseases – Tenth Edition (ICD-10; WHO, 1992). Estimates from this study place the prevalence rate of insomnia symptoms between 16% and 24%. Taken together, the above studies demonstrate the troublingly high prevalence of sleep disturbance and insomnia symptoms within the population at large, including YAs.

As for sleep disturbance that exceeds the cut-off for insomnia, a recent study of 447 American undergraduate students found that 22.5% exceeded the clinical cut-off for

diagnosable insomnia on the Insomnia Severity Index (ISI; Gress-Smith, Roubinov, Andreotti, Compas, & Luecken, 2015), whereas almost 70% of this sample endorsed experiencing mild insomnia symptoms. A systematic review of the literature on insomnia prevalence among university students demonstrated similarly high rates. With a sample size of 16,478 students from across the globe, 18.5% of all participants reported insomnia on one or more validated measures of insomnia (Jiang et al., 2015). Other studies report more modest results, including one that found an average ISI score of 8.67 (which is indicative of mild insomnia), and a 12% prevalence rate of significant insomnia symptoms among 548 American university student participants (Gellis, Park, Stotsky, & Taylor, 2014). Still, studies like these demonstrate the disparity that exists between YAs and the general population: Prevalence rates of insomnia disorder at the population level have been estimated to range from about 7% internationally (Jiang et al., 2015), to 13% as estimated by a 2011 study of 2,000 Canadian adults using the same cut-off criteria on the ISI (Morin, LeBlanc, et al.). The ubiquity of sleep disturbance and insomnia disorder discussed here is worrisome for adults of all ages, but especially so for YAs, for reasons that will be discussed in Sections 1.2 and 1.3.

Sleep-related problems in YAs can be influenced by a number of factors. In his review of the literature, Millman (2005) explains that daytime sleepiness among adolescents and YAs is often related to reduced parental influence and the freedom to self-select bedtime, increased academic demands, and increased time spent on extracurricular activities. In fact, stress has been cited as the primary factor affecting sleep initiation, as reported by 68% in a sample of over 1,000 students (Lund et al., 2010). When asked about the type of stress affecting sleep, 39% of students reported academic

stress, while 25% reported emotional stress. The relationship between sleep and stress was supported, and elaborated on, by a Canadian longitudinal investigation of university students (Galambos, Vargas Lascano, Howard, & Maggs, 2013). A sample of 186 students completed measures of sleep, stress, social support, alcohol use, and academic performance at five 12-month intervals. Stress was predictive of several sleep factors: Participants who reported high stress levels on the Perceived Stress Scale were also more likely to note lower sleep quantity, greater sleep disturbance, and later rise times.

Intuitively, lack of awareness of good sleep hygiene among students may also contribute to sleep problems within this population. Seventy-four students participated in a survey study regarding the relationship between sleep quality (as indicated by the PSQI), and sleep hygiene awareness and practices (Brown, Buboltz, & Soper, 2002). Engagement in sleep hygiene behaviours was associated with better sleep quality on the PSQI, such that more frequent use of sound sleep hygiene practices was associated with better quality sleep. There was, however, no association between awareness of sleep hygiene and sleep quality – that is, both students who had good and poor awareness of proper sleep hygiene experienced similar sleep quality. This study suggests that it may not be sufficient to merely teach YAs about sound sleep hygiene, as there appears to be a disconnect between knowledge and implementation of sleep hygiene. More concrete behavioural interventions may be necessary to effect meaningful change.

Some variations in sleep are normative across the lifespan, as indicated by a large American sample of participants in a longitudinal study (Maslowsky & Ozer, 2014). Here, two shifts were demonstrated between the ages of 13 and 32: Adolescents showed a steady decrease in sleep duration from 8.5 hours per night to 7.3 hours per night at age 18.

At this point, duration increased into emerging adulthood, peaking at age 22, again at 8.5 hours per night. After this, a second, more gradual decrease in sleep duration occurred, until, at age 32, average duration was 7.7 hours. That said, maladaptive sleep patterns in adolescence and young adulthood are particularly troublesome because once developed, they can persist for years, even extending into midlife. A cohort study published in 2010 examined data from the National Child Development Study in the UK, which included 7,781 individuals spanning almost three decades (Dregan & Armstrong). Here, the presence of sleep disturbance at age 16 predicted the presence of sleep disturbance at age 42. This was true even after controlling for family (e.g., marital status), environmental (e.g., number of people per household), and personal (e.g., job satisfaction) characteristics. A more recent publication reflected similar continuity of sleep disturbance. Participants in a longitudinal study provided self-report data regarding nightmares, sleeping more/less than others, trouble sleeping, feeling overtired, and restless sleep (Fatima, Doi, Najman, & Al Mamun, 2017). Almost 42% of those who endorsed sleep problems at age 14 reported persistence of these problems at age 21. This continuity was predicted by experiencing anxiety or depression in adolescence, while exercising three or more days per week seemed to have a protective effect, reducing the likelihood that adolescent sleep problems would persist into young adulthood. Findings like these emphasize the importance of early intervention on sleep issues, as well as the beneficial effect of maintaining good mental and physical health from an early age. Although many of the data cited thus far have been self-report (as is the case especially in the sleep quality literature), less subjective reports in the field of sleep and cognition will be discussed next.

1.2 Sleep and Cognition

Poor quality sleep has also been shown to negatively impact many core cognitive processes including executive functioning (Wilckens, Woo, Kirk, Erickson, & Wheeler, 2014), psychomotor performance (Dinges & Banks, 2009), and memory (Rasch & Born, 2013). In one study of memory and sleep, researchers investigated the impact of increasing levels of sleep debt on working memory (Del Angel et al., 2015). Here, 13 university student participants completed tasks of auditory and visual working memory after one night of normal sleep (the baseline condition), after one, four, and five nights of reduced sleep (four hours per night), and again after one night of recovery. Auditory working memory was significantly impaired after five nights of reduced sleep, while visual working memory demonstrated significant decrements after one and five nights of reduced sleep. Other aspects of memory are similarly impacted by sleep disturbance. A study of 28 YAs examined the impact of sleep deprivation on the ability to accurately recognize previously encoded visual stimuli (Yoo, Hu, Gujar, Jolesz, & Walker, 2007). Participants were shown a set of 150 neutral photos on day two of a four-day protocol, while testing occurred on day four. Control participants were permitted a sleep window of seven to nine hours the night before learning, while those in the sleep deprivation condition were kept awake, accumulating approximately 35 hours of sleep debt before the encoding session. Both groups were allowed to sleep normally for two nights following encoding. The authors found that following testing on the fourth day, there was a 19% deficit in recognition among participants who were sleep deprived compared to those who slept normally following learning. These findings, taken with those regarding working

memory discussed previously, demonstrate that sleep both before and after learning is crucial for optimal memory function.

In addition to memory, good quality sleep has been shown to be a critical factor in facilitating higher order executive functioning, including the concept of cognitive flexibility, or "the deployment of cognitive control resources to adapt to changes in events" (Honn, Hinson, Whitney, & Van Dongen, 2018, p. 2; Whitney, Hinson, Jackson, & Van Dongen, 2015). A recent investigation of the impact of sleep on individuals' ability to react responsively to tasks had 19 YA participants randomized to a control (sleep as normal), or sleep deprivation condition (30.5 hours of wakefulness; Honn et al., 2018). Participants completed one variation of a *go/no-go* task that required accuracy feedback to learn which stimuli required a *go* or *no-go* response, and a second *go/no-go* task that included a surprise reversal of the stimulus-response pairings. Participants in the sleep deprivation condition were significantly less able to discriminate between *go* and *no-go* stimuli compared to their counterparts in the control condition, and less able to dynamically recruit attentional resources to meet changing task demands. The authors hypothesize that sleep deprivation may have created this deficit as a result of feedback blunting, or the process by which feedback becomes less effective at informing behavior modification under dynamic and changing circumstances.

Impairments in executive functioning have also been reported for sleep disturbance, although to a less extreme extent than sleep deprivation. One study permitted participants aged 21-30 to sleep as normal during a one-week protocol window, with sleep quality quantified by WASO and total sleep time (TST), as estimated by actigraphy (Wilckens et al., 2014). Participants completed two variations of a task-switching

experiment in which they were required to make timed judgments regarding whether numbers presented on cue cards were greater or less than five, or if the numbers were odd or even. Those who reported higher WASO and shorter TST were more likely to demonstrate poorer accuracy and longer response times.

The above literature suggests that sophisticated and critical thought often required by YAs pursuing higher education, or in fast-paced and demanding work environments, certainly stands to be compromised when sleep quality deteriorates. In fact, the potential for decrement in academic performance was borne out in a large survey which included over 16,000 participants. In this study, students indicated how many nights per week they slept until feeling well-rested and also provided researchers with their grade point average (GPA; Wald, Muennig, O'Connell, & Garber, 2014). Over three-quarters of participants reported sleeping until well-rested fewer than five nights each week, and these students were more likely to obtain lower GPAs than those students reporting adequate sleep. Similar results were demonstrated in another survey of 255 university students in 2012 (Onyper, Thacher, Gilbert, & Gradess). In this case, sleep was examined using sleep diaries, the PSQI, and a measure of daytime sleepiness, and in addition to providing their GPAs, students also completed several tests of cognitive ability, including a delayed memory recall task, a perceptual-motor speed task, and a sustained attention task. The authors found that although both daytime sleepiness and shorter sleep duration were associated with lower GPA, the effect of sleepiness was greater. Sleepiness also resulted in lower scores on tests of cognitive ability and was linked with a greater tendency to miss classes. Interestingly, the impact of sleep disturbance on GPA appears to be as strong, and in some cases even stronger, than the effects of other factors, including

perceived stress, binge drinking, and marijuana or other illicit drug use (Hartmann & Prichard, 2018). Factors such as these are often regarded by university administration as being of greater negative valence, and consequently tend to receive more attention, despite the fact that in a sample of over 47,000 American college students, 66% reported being interested in receiving health information on sleep from their institutions, while only 27% reportedly did so (ACHA, 2017). It should be stated here that the direction of many of the aforementioned relationships is not clear due to the nonexperimental design of the research. For instance, in the Wald et al. study of sleep and GPA, it is uncertain whether lower GPA causes poor sleep, poor sleep causes lower GPA, or whether students with lower GPAs are simply less likely to sleep well due to some other variable.

Nonetheless, there is conclusive evidence for a dose-response effect, such that the greater the sleep loss, the greater the deterioration in performance on cognitive tasks (Dinges & Banks, 2009). Interestingly, these findings are not only true of complete sleep deprivation, but they also pertain to restricted sleep, or sleep that lasts less than seven hours per night. Even though sleep disturbance leads to increasing impairment, there is evidence that the subjective experience of this effect plateaus; that is, individuals gradually become unaware of their continually compromised functioning (2009). This suggests that individuals may lack insight regarding the consequences of their poor sleep through habituation to a chronic state of sleep deprivation. These findings may also explain why many people do not seek help for sleep-related issues: they may simply be oblivious to the magnitude of its impact. This underestimation of the physical and mental health consequences of poor sleep is troubling across populations, though it is particularly

worrisome for YAs, given the high prevalence of disordered sleep within this population (Forquer, Camden, Gabriau, & Johnson, 2008; Lund, Reider, Whiting, & Prichard, 2010).

1.3 Sleep and Negative Mental Health

Sleep disturbances are also common among individuals with psychological disorders, with particularly high prevalence among those with anxiety, mood, and substance-use disorders, as well as schizophrenia, and post-traumatic stress disorder (Drummond & McKenna, 2009). Although sleep disturbance is known to be a symptom of many psychiatric disorders, the bidirectional relationship between poor sleep and mental illness can be underappreciated. Often, poor quality sleep aggravates or even precedes the development of mental illness altogether (2009).

The relationship between sleep and mental health has been repeatedly demonstrated in the literature, with varying degrees of rigor in the assessment of sleep. One such example comes from a study of 287 undergraduate students who completed measures of depression, anxiety, quality of life, and cognitive and physical functioning (Nyer et al., 2013). In this investigation, sleep disturbance was measured using a single item on the Beck Depression Inventory (BDI) regarding waking up earlier than intended and difficulty reinitiating sleep, a feature shared by depression and insomnia. Participants who endorsed experiencing any level of sleep disturbance on the BDI (over 76% of the sample) were more likely to report anxiety that was significantly more intense and frequent than those participants who reported no sleep disturbance. This was also true for scores of general cognitive and physical performance, with students reporting sleep disturbance also noting more impaired functioning in motivation, ability to focus, and mental acuity. Even investigations which assessed sleep using validated measures

specifically for that purpose have found similar results: A sample of 69 students aged 18-25 completed the PSQI and the Adult Self Report Form, a broad measure of mental health and substance use that maps on to DSM-IV-TR diagnostic categories (Milojevich & Lukowski, 2016). Global sleep quality scores on the PSQI were positively associated with externalizing (i.e., aggressive and rule-breaking behaviours), internalizing (i.e., anxious and somatic problems), attention deficit/hyperactivity, depressive, and somatic problems. Further regression analyses showed that more frequent sleep disruption predicted anxiety and somatic problems, however shorter sleep duration did not predict any one particular presentation.

Sleep diaries can also provide researchers with a rich understanding of their participants' sleep habits, but are employed less often than brief sleep measures due to the relatively greater degree of labour involved with completing them (on the part of study participants), and scoring them (on the part of researchers). In addition to submitting a seven-day sleep diary, researchers from one study also had their 373 YA participants report on the presence, nature, and chronicity of sleep problems, including such issues as trouble falling asleep, long or frequent nighttime awakenings, and sleep apnea (Taylor et al., 2011). Mental health was measured using the Symptom Checklist-90, a self-report test of distress regarding symptoms including, but not limited to, somatization, obsessions/compulsions, depression, anxiety, and psychoticism, as well as a global distress score. Independent *t*-tests showed that participants with insomnia symptoms reported higher levels of somatization, obsessions/compulsions, depression, and anxiety, and greater overall psychological distress. These findings suggest that poor sleep is

associated with psychological dysfunction beyond the commonly investigated presentations of depression and anxiety.

The relationship between sleep and mental health is far from simple, as the two often share both direct and indirect associations. This was demonstrated by a longitudinal study conducted with 930 students between the ages of 18 and 25 (Wong et al., 2013). Participants completed measures of sleep, physical and mental health, and academic functioning across three semesters. Structural equation modelling demonstrated that daytime dysfunction (as indicated by the PSQI) predicted both anxiety and depression, and anxiety was also predicted by sleep disturbance. Further analysis found that these indicators of sleep quality were also related to self-esteem, with anxiety and depression acting as mediating factors. A second study that assessed sleep using the PSQI investigated 440 students with an average age of 22.8 years (Wallace, Boynton, & Lytle, 2017). In addition to the sleep measure, researchers administered the Centre for Epidemiological Studies Depression scale, and the Cohen's Perceived Stress Scale. Participants reported obtaining an average of 8.4 hours of sleep per night, which is within the recommended range for this age group (Watson et al., 2015), and neither depression nor stress were associated with sleep duration. Despite participants' seemingly healthy amount of sleep, quality of sleep was rather more dubious: 29% of the sample demonstrated clinically significant sleep-onset insomnia, while participants reported, on average, as many as six nights per month that they did not get enough rest. Depression and anxiety were, in the case of sleep quality, both significant predictors, with the relationship between depression and sleep quality being slightly more robust. It's been hypothesized that the association between stress and sleep is in fact mediated by

depression (Cohen, Janicki-Deverts, & Miller, 2007), and these data seem to reflect that. This particular study also suggests that sleep duration may be an inaccurate metric of the state of sleep among young adults, and instead sleep quality may be a more valuable target for intervention.

One final study demonstrated the complex interplay between mental health and sleep, by investigating the relationship between sleep, depression, and physical health (or somatic) complaints using path modeling (Schlarb, Claßen, Hellmann, Vögele, & Gulewitsch, 2017). Over 2,400 university students in a German sample completed measures of somatic, depressive, anxiety, and panic symptoms, as well as the PSQI. Here, somatic complaints (including tension headaches, irritable bowel syndrome, and chronic back pain) were positively associated with poor subjective sleep quality, difficulty falling asleep, daytime dysfunction, sleep disturbances, and use of sleeping medication, and that these associations were significantly stronger for participants reporting higher levels of depression. Additionally, anxiety seemed to have only an indirect impact on sleep quality in this analysis, via somatic complaints and depression.

1.4 Sleep and Positive Mental Health

As strong as the relationship is between poor sleep and deleterious psychological consequences, so too is the relationship between high quality sleep and positive psychological well-being. Several studies have demonstrated this, including one published in 2014 that examined 171 young women (average age = 20 years; Kalmbach, Pillai, Roth, & Drake, 2014). Here, researchers asked participants to complete the Positive and Negative Affective Schedule (PANAS), and three questions probing TST, SOL, and subjective sleep quality on a daily basis, as well as baseline measures of anxiety

and depression. The PANAS measures such affective state profiles as joviality (i.e., happiness, cheerfulness, optimism); self-assurance (i.e., pride, confidence, fearlessness); serenity (i.e., calmness, relaxation); fear (i.e., nervousness, jitters, shakiness); sadness (i.e., loneliness, feeling downhearted); and hostility (i.e., anger, irritability). Using hierarchical linear modeling, greater levels of daily joviality and serenity predicted higher subjective sleep quality. Serenity was also associated with long sleep duration and short SOL. These findings held true even with the influence of baseline levels of depression and anxiety, suggesting that the impact of positive affective states on sleep is robust in the presence of such risk factors. Not only do affective states impact sleep, but affective traits (more enduring affective qualities of individuals) do as well. One article summarizing the results of two related studies of undergraduate student samples concluded that trait vigor (i.e., feeling energetic and lively) was strongly associated with sleep quality and SE as measured by the PSQI, and that this relationship was most evident during times of high stress, namely exam season (Pressman, Jenkins, Kraft-Feil, Rasmussen, & Scheier, 2017). Additionally, state calm (i.e., feeling relaxed and at ease) was associated with better SE, but only during times of low stress – as, interestingly, state and trait calm were associated with poorer sleep outcomes during times of high stress. The researchers postulated that this unexpected finding was perhaps due to high levels of calm inhibiting motivation among students to complete school tasks ahead of time, consequently having to study and finish projects late into the night before deadlines.

An additional aspect of positive mental health is mindfulness. Mindfulness has been defined as "intentionally paying attention to present-moment experience (physical sensations, perceptions, affective states, thoughts, and imagery) in a nonjudgmental way,

thereby cultivating a stable and nonreactive awareness" (Carmody, Reed, Kristeller, & Merriam, 2008, p. 394). Mindfulness has been shown to relate to sleep among university students. A longitudinal study of 441 female students, with a mean age of 19, completed measures at the beginning and end of a two-year academic period (Murphy, Mermelstein, Edwards, & Gidycz, 2012). Participants completed the Mindful Attention Awareness Scale (MAAS) and a three-item measure of sleep quality, probing sleep duration, feeling rested, and daytime tiredness. Higher scores on the MAAS (indicating greater levels of trait mindfulness) were positively correlated with sleep quality. Mediation analyses also demonstrated that mindfulness partially mediated the relationship between sleep quality and physical health (as measured by the Cohen and Hoberman Inventory of Physical Symptoms), and that sleep quality also partially mediated the relationship between mindfulness and physical health, suggesting bidirectional mediation.

Mindfulness training programs have been shown to aid in increasing sleep quality among students who struggle with sleep problems, as borne out by one randomized controlled trial (RCT) investigating the effects of a brief mindfulness intervention on several health outcomes, including sleep and perceived stress (Greeson, Juberg, Maytan, James, & Rogers, 2014). Here, participants in the treatment condition (n=45) attended four 75-minute classes weekly in which principles of mindfulness were taught and practiced, including such exercises as meditative breathing, mindfulness walks, and guided imagery. In addition, participants were asked to commit to daily 10-minute mindfulness practices and complete a daily meditation log and required readings. Waitlist controls (n=45) did not engage in any such intervention. The participants who received the mindfulness training demonstrated a significant improvement in sleep as measured by

the Medical Outcomes Study – Sleep Scale, with a medium effect size on sleep observed for the intervention group compared to the waitlist control. A similar pattern of change in favour of the mindfulness intervention was also evidenced for perceived stress, as measured by the Perceived Stress Scale. In addition to the positive outcomes of the mindfulness intervention on sleep, the program was also appeared to be well-liked by participants, as evidenced by high retention rates. This suggests that the implementation of such an intervention on university campuses would likely be met with enthusiasm.

Although not immediately obvious, a second positive psychological construct that is related to sleep is social support. Perceived social support (PSS) is "the availability of someone to provide help or emotional support" (Sherbourne & Stewart, 1991, p. 705). A recent meta-analysis that included over 105,000 participants from 61 studies found that regardless of the facet of social support that was captured by the studies included in the analysis (be it PSS, social integration, or received social support), there was an association between higher levels of social support and greater sleep quality (Kent de Grey, Uchino, Trettevik, Cronan, & Hogan, 2018). More specifically, in a longitudinal study of 942 YA university students, participants completed self-report measures at three times points over three years (Tavernier & Willoughby, 2015). Measures included the ISI, estimates of sleep duration, quantification of weekend sleep delay and weekend oversleep, three items from the social adjustment subscale of the Student Adaptation to College Questionnaire, and two measures of emotion regulation. Path analyses suggested that there was a bidirectional relationship between sleep problems and positive social ties, such that greater positive social connection predicted lower scores on the ISI (less sleep disturbance), and vice-versa. The authors also found that emotion regulation had an

important role to play in this relationship: Greater positive social ties predicted better emotion regulation, which in turn led to better sleep quality. In contrast, more sleep problems led to poorer emotion regulation, which predicted fewer positive social ties.

Another study found that, of the 64 American university students sampled, those who were classified as lonely (a construct closely related to social support) by the UCLA-R Loneliness Scale reported lower SE than those who were not lonely (Cacioppo et al., 2002). A subsequent study by some of the same authors went further and used the responses of 215 adults from a population-based study (Hawkley, Preacher, & Cacioppo, 2010). Here, participants completed self-report measures of daytime dysfunction, sleep duration, and loneliness. Not only did loneliness predict daytime dysfunction, but dysfunction in turn predicted subsequent loneliness. This research suggests that individuals who experience low social support may be at risk for sleep disturbance, and that the effects of this disturbance may perpetuate their sense of lack of social support.

1.5 The Role of Chronotype

Circadian preference, or chronotype, describes individual differences in diurnal rhythmicity; that is, whether an individual's biology makes them a "morning person" or an "evening person." Chronotype can be determined using physiological measures like bodily temperature rhythms (Baehr, Revelle, & Eastman, 2000), and salivary cortisol levels (Randler & Schaal, 2010). Subjective measures, including diaries of sleep and wake time preference that also monitor daytime alertness, and questionnaires (Kyriacou & Hastings, 2010), have also been validated.

It has been estimated that approximately one-quarter of the adult population is classified as morning type, and one-quarter as evening type, while the other 50% falls

under the classification of intermediate or neutral, characterized by no strong predisposition toward an advanced or delayed sleep phase (Taillard, Philip, Chastang, & Bioulac, 2004). These proportions have been replicated and shown to be consistent across cultures (Paine, Gander, & Travier, 2006); however, evening chronotypes are more common among young adults (Dagys et al., 2012). A shift toward eveningness occurs during puberty, and is followed by a second shift back toward a neutral rhythm occurring in the early 20s (Skeldon, Derks, & Dijk, 2016). There are several hypotheses about the reason for this shift toward eveningness among adolescents, including reduced sensitivity and responsiveness to light, a lengthening of the internal circadian period, and a slower rate at which sleep pressure accumulates (Crowley, Acebo, & Carskadon, 2007). Despite delayed sleep phase being a short-term state for many YAs, there are consequences associated with the evening chronotype that have the potential to persist into adulthood. Eveningness is associated with a multitude of maladaptive psychological and behavioural outcomes, from lower positive affect (Hasler, Allen, Sbarra, Bootzin, & Bernert, 2010) and depressive symptoms (Hidalgo et al., 2009; Selvi, Gulec, Agargun, & Besiroglu, 2007), to increased suicidality (Selvi et al., 2011). There have been mixed findings regarding the relationship between chronotype and anxiety, with some research suggesting that eveningness is associated with elevations in anxiety (Díaz-Morales & Sánchez-Lopez, 2008; Pabst, Negriff, Dorn, Susman, & Huang, 2009), and others failing to find such a relationship (Alvaro, Roberts, & Harris, 2014; Antypa, Vogelzangs, Meesters, Schoevers, & Penninx, 2016).

The negative impact of evening chronotype on mental health, as well as the sleep consequences associated with this circadian phase, have been demonstrated among YAs.

One study examined 756 participants with a mean age of 25 who completed the Morningness-Eveningness Questionnaire (MEQ), as well as measures of sleep disturbance, negative emotionality, depression, and stress (Simor et al., 2015). Evening chronotype was correlated with insomnia symptoms and negative emotionality. Hierarchical linear regressions showed that chronotype was a modest predictor of negative emotionality, but that insomnia symptoms and daytime sleepiness predicted negative emotionality much more robustly, suggesting that the negative psychological outcomes experienced among those with an evening chronotype likely cannot be blamed entirely on the unique circadian rhythm observed in these individuals.

The relationship between chronotype, sleep, and mental health does not appear to be simple, however. A study of over 1,000 European university students investigated the mediating role of sleep debt, sleep quality, and weekend bedtime delay on the relationship between chronotype and daytime functioning, a variable defined in the study by levels of daytime sleepiness and depression (Bakotic, Radosevic-Vidacek, & Koscec Bjelajac, 2017). Evening chronotype was correlated with greater levels of both metrics of daytime dysfunction, as well as with greater sleep debt, poorer sleep quality, and greater bedtime delay. Findings from the mediation analyses offered a richer understanding of these relationships: While chronotype impacted daytime sleepiness both directly and indirectly (through sleep debt, sleep quality, and weekend bedtime delay), chronotype impacted depression in an entirely indirect manner, primarily through poor sleep quality. These findings suggest that, regardless of sleep habits or quality, individuals with an evening chronotype are more likely to experience daytime sleepiness than their morning type counterparts. Alternatively, depression among evening types seems to be primarily due to

poor sleep quality, which suggests that mood complaints among those with an evening chronotype could be ameliorated by improving sleep.

Existing studies of chronotype and mindfulness have used measures of daydreaming and mind-wandering to indirectly assess mindfulness, and have reported a negative correlation between these constructs and age, as well as positive correlations with evening preference (Carciofo, Du, Song, & Zhang, 2013; Carciofo, Du, Song, & Zhang, 2014). It has been posited that this relationship is due in part to the greater frequency of social jet lag (or the fatigue that occurs due to discrepancy in sleep timing between work days and days off; Wittmann, Dinich, Merrow, & Roenneberg, 2006) experienced by evening types. The resulting decrease in alertness and diminished efficiency of cognitive processing may increase the likelihood of mind wandering or daydreaming (Carciofo et al., 2014).

There is a dearth of research on the relationship between chronotype and social support, but given what has already been discussed regarding the negative psychological outcomes of evening chronotype, there is much to be surmised about the potential relationship between these two constructs. Research has long suggested that PSS is also associated with mental health, such that individuals with depression are more likely to report low levels of social support (George, Blazer, Hughes, & Fowler, 1989; Peirce, Frone, Russell, Cooper, & Mudar, 2000), while high levels of PSS seem to moderate this relationship (Cobb, 1976; Cohen & Wills, 1985). As evening types tend to have greater levels of depression and anxiety, it stands to reason that PSS may in some way influence the relationship between chronotype and mental health.

1.6 Summary

Sleep disturbance and insomnia are significant issues for YAs, and are associated with deteriorations in several domains, including cognition and mood. This is also true of evening chronotype: YAs are more likely to have an evening circadian preference, the correlates of which include, but are not limited to, poor sleep, increased depressive symptoms, and lower levels of mindfulness. The effects of poor sleep at this developmental stage have the potential to persist well into adulthood and middle age. There is a consistent association between good quality sleep and greater mental wellness.

The objectives of Study 1 are to examine prevalence rates of sleep disturbance as measured by insomnia symptoms, subjective sleep quality, and daytime sleepiness, as well as mental health symptomology (including anxiety, depression, and global distress), and to determine the relationship between sleep and mental health. Study 2 will investigate prevalence rates of the three chronotypes among YAs, and examine the relationship between chronotype and anxiety, depression, and global distress, as well as mindfulness and perceived social support. The findings will prove valuable in developing targeted prevention and/or intervention programs to support students.

Chapter 2:

Prevalence and Mental Health Correlates of Poor Sleep Quality, Insomnia Symptoms, and Daytime Sleepiness in Young Adults

2.0 Abstract

INTRODUCTION: Sleep and mental health share a strong bidirectional relationship, and young adults (YAs) represent a segment of the population that are more likely to experience complaints related to both. The present study investigated the relationship between the psychological variables of depression, anxiety, and global distress, and three sleep factors among Canadian YAs after controlling for demographic and educational variables.

METHODS: We surveyed 3,167 university students aged 18-35. Participants completed the Pittsburgh Sleep Quality Index (PSQI); the Insomnia Severity Index (ISI); the Epworth Sleepiness Scale (ESS); the Hospital Anxiety and Depression Scale (HADS); and the Kessler Psychological Distress Scale (K10). We conducted one-way ANOVAs to evaluate the impact of exceeding clinical cut-offs on one or more of the sleep measures on mental health.

RESULTS: The majority of the sample (70.6%) was female with an average age of 22.21 years (*SD*=3.73). Most YAs (68.8%) reported experiencing poor quality sleep, with over half of the sample (55.3%) reporting some insomnia symptoms. 25.3% reported having mild to severe daytime sleepiness. 27.9% and 61.7% of the sample fell in the clinically significant range of depression and anxiety, respectively. Overall, psychological distress was in the mild to moderate range (*M*=14.31; *SD*=8.51). There was a significant difference in depression scores [$F(3,2357)=220.39$, $p<.0005$, $d=1.25$], with participants exceeding cut-offs on all three measures reporting greater HADS-Depression scores than those who exceeded cut-offs on just two sleep measures, who were themselves more likely to receive higher depression scores than participants who exceeded the cut-off on

just one sleep measure. Participants who did not exceed the clinical cut-off on any one sleep measure reported the lowest levels of depression. A similar gradient pattern was also demonstrated with HADS-Anxiety scores [$F(3,2357)=190.58$, $p<.0005$, $d=1.12$], and K10 scores [$F(3,2223)=256.57$, $p<.0005$, $d=1.47$].

CONCLUSION: This study supports the dose-response relationship between poor sleep and depression, anxiety, and distress among YAs: The greater the severity of sleep disturbance participants endorsed, the more likely they were to report symptoms of depression, anxiety, and distress. Education, prevention, and/or intervention are warranted to address such mental health concerns given the broad array of life domains that they impact.

2.1 Introduction

Although sleep disturbance occurs, in one form or another, among about 40% of Canadian adults (Morin, LeBlanc, et al., 2011), and among around one-third of adults older than age 60 (Cho et al., 2008; Ohayon, Zulley, Guilleminault, Smirne, & Priest, 2001), it is particularly concerning for YAs. Up to 60% of YAs report poor sleep quality, as indicated by a PSQI score of greater than five (Lund et al., 2010). Large proportions of this group, as high as 70% in fact, often fail to achieve the recommended sleep duration of 8-9 hours. The consequences of low sleep quality and duration include daytime sleepiness, to the point that some university students may even fall asleep during class at least once per week (Forquer et al., 2008; Lund et al., 2010). These findings have been replicated in other large student samples (Gaultney, 2010; Orzech et al., 2011), suggesting that these issues of sleep disturbance are widely common.

The reasons that YAs report greater sleep disturbance seem to be numerous and, for those who are enrolled in post-secondary education, include the stress and anxiety resulting from being immersed in a novel and demanding environment, both academically- and socially-speaking. YAs who obtain insufficient sleep quantity (Noland, Price, Dake, & Telljohann, 2009), or experience insomnia symptoms (Bernert, Merrill, Braithwaite, Van Orden, & Joiner Jr, 2007), are significantly more likely to report experiencing academic or family stress.

Among the most common sleep disorders is insomnia, the symptoms of which impact approximately one-third of adults (APA, 2013). In a longitudinal, population-based cohort study conducted in the UK, authors investigated the relationship between numerous physical and mental health correlates, and insomnia, among 2,662 individuals

in the general population (Morphy, Dunn, Lewis, Boardman, & Croft, 2007). Participants reported information relating to physical and mental health, sleep, and demographic information, and were tested at baseline and 12 months follow-up. Those participants who reported insomnia were at over twice the risk of experiencing anxiety, and nearly three times the risk of experiencing depression, relative to those who did not report insomnia.

Poor sleep quality that does not necessarily reach diagnostic criteria for insomnia can be equally detrimental. Among a sample of 115 university students, incongruence between self-reported sleep need and the actual duration of sleep obtained was related to negative mood symptoms, including anxiety and tension, while insufficient sleep duration was associated with difficulty concentrating and impaired memory (Oginska & Pokorski, 2006). These findings were confirmed by a 2015 study in which 51 YAs aged 18 to 30 completed the PSQI and the Anxiety Control Questionnaire (ACQ; Gould et al.). The authors found negative correlations between multiple PSQI components and ACQ scores, and those students reporting lower perceived control over anxiety were also more likely to report lower subjective sleep quality, longer SOL, lower SE, and greater use of sleeping medication.

The relationship between poor sleep and psychological well-being is especially relevant within YA populations, as rates of stress, depression, and anxiety disorders are known to be higher than average in this group. A large American study of 9,090 adults aged 18 and older used the World Health Organization's Composite International Diagnostic Interview (CIDI), a structured instrument to be used by trained interviewers (Kessler et al., 2003). Participants in the 18-29 range reported major depressive disorder at a rate three times higher than that of participants older than 60. Another study

consisting of over 85,000 participants from 17 countries also employed the CIDI to investigate the relationship between age and various mental health disorders, including major depressive disorder, generalized anxiety disorder, panic disorder, post-traumatic stress disorder, and social anxiety disorder (Scott et al., 2008). Again, the data suggested that of all age categories, the prevalence rate of any of these psychiatric disorders (in the absence of comorbid physical health or chronic pain concerns) was highest among participants aged 18-34, with the youngest participants having five times greater odds of reporting clinical depression or anxiety than those aged 65-75.

There have been few studies of sleep among YAs that have included metrics of subjective sleep quality, insomnia, daytime sleepiness, and psychological correlates (Taylor, Bramoweth, Grieser, Tatum, & Roane, 2013). With these limitations of the literature, and the aforementioned association between higher rates of disordered sleep and poor mental health in mind, the objectives of this study are as follows:

1. Characterize the prevalence of poor subjective sleep quality, insomnia, and daytime sleepiness in a sample of university students
2. Examine whether triangulation of sleep-related concerns across multiple metrics is associated with a decrease in psychological well-being

It was hypothesized that the prevalence of sleep disturbance would be higher in our sample than in the general population, and that increasing severity of sleep disturbance (as indicated by meeting or exceeding the clinical cut-off on a greater number of measures) would be associated with decreased psychological well-being (as indicated by higher scores on the HADS and K10).

2.2 Methods

2.2.1 Participants

Participants were included on the basis of being full- or part-time university students at Memorial University of Newfoundland (MUN). Recruitment was conducted by a variety of means, including: flyers promoting the survey posted throughout campus buildings and in residences; in-person recruitment in high traffic areas; mass emails distributed by the Registrar's Office and the Internationalization Office listserv; and advertising on relevant student-related Facebook groups. Significant efforts were made to recruit a sample that was representative of the MUN population. For instance, particular courses were targeted for in-class recruitment when it was observed that participants of that faculty were underrepresented. Additionally, exclusively male participants were sought out near the end of recruitment in an attempt to match the proportion of males in the sample to that of MUN students as a whole. To enhance participation, participants were offered the opportunity to be entered into a draw for one of 12 $50 gift cards to a local shopping mall. They were then referred to a link that directed them to the online survey, hosted on Survey Monkey. Data were collected from June 2016 through May 2017.

Participants answered a number of basic demographic questions probing age, gender, sex, ethnicity, academic information, and frequency of use of hypnotic and stimulant substances. They then completed a number of validated measures. The complete battery entailed the Prescription Drug Attitudes Questionnaire, the Morningness Eveningness Questionnaire, the Pittsburgh Sleep Quality Index, the Epworth Sleepiness Scale, the Insomnia Severity Index, the Hospital Anxiety and Depression Scale, the

Medical Outcome Study – Social Support Survey, the Kessler Psychological Distress Scale, the Mindful Attention Awareness Scale, and the International Physical Activity Questionnaire. In sum, the survey took approximately 35 to 40 minutes to complete. Not all measures were included in the present analyses.

2.2.2 Study Variables

The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) probes seven areas related to sleep quality in the past four weeks: SOL, sleep duration, habitual SE, sleep disturbances, subjective sleep quality, use of sleeping medication, and daytime dysfunction. The 19 items operate on a four-point Likert scale, with global scores greater than five indicative of poor sleep quality, and those less than or equal to five indicative of good sleep quality. The PSQI has been validated against structured clinical interviews and objective measures of sleep including polysomnographic testing (Buysse et al., 1989). Among college students, the PSQI demonstrates moderate convergent validity with sleep diaries, SOL, WASO, and sleep duration, as well as good divergent validity with daytime sleepiness (Dietch et al., 2016). Cronbach's alpha estimates the internal consistency as .83 within this population (Taylor et al., 2013).

The Insomnia Severity Index (ISI; Bastien, Vallières, & Morin, 2001) is composed of seven items and assesses the severity of night-time insomnia symptoms and daytime dysfunction within the past two weeks. Items are scored on a five-point Likert scale, with scores of eight or greater indicative of insomnia symptoms, and scores of 15 or greater regarded as the optimal cut-off for clinically significant and diagnosable insomnia disorder (Bastien et al., 2001). The ISI has also been shown to demonstrate good sensitivity and specificity in detecting insomnia among those already diagnosed

(Smith & Wegener, 2003). Concurrent, content, and predictive validity have been demonstrated, and internal consistency (Cronbach's alpha) has been estimated as .90.

The Epworth Sleepiness Scale (ESS; Johns, 1991) is an eight-item measure of daytime sleepiness, with questions probing the participant's likelihood of dozing under various circumstances, with no reference to a particular time frame. Items are scored on a four-point Likert scale, with scores of 11 or greater suggestive of excessive daytime sleepiness (Johns, 2000). Cronbach's alpha has been estimated to be .82 (Hagell & Broman, 2007; Johns, 1992).

Anxious and depressive symptoms were measured using the Hospital Anxiety and Depression Scale (HADS; Snaith & Zigmond, 1986), a 14-item scale with subscales for symptoms of anxiety (HADS-Anx) and depression (HADS-Dep) in the past week. Each subscale consists of seven items scored on a four-point Likert scale. Scores are summed across items within each subscale, with a maximum score of 21 for each. Higher scores are indicative of more severe symptomology; scores of eight or more suggest the presence of clinically significant anxious or depressive symptoms. The HADS has been validated against the Structured Clinical Interview for the DSM (SCID; Brennan, Worrall-Davies, McMillan, Gilbody, & House, 2010), which is regarded as the gold standard among diagnostic interviews in psychology and psychiatry. Along with good sensitivity and specificity (Bjelland, Dahl, Haug, & Neckelmann, 2002), both the anxiety and depression subscales demonstrate internal consistency, with Cronbach's alpha estimated as .80 and .76, respectively (Mykletun, Stordal, & Dahl, 2001).

Global psychological distress was measured using the Kessler Psychological Distress Scale (K10). The K10 (Kessler et al., 2002) is a 10-item measure that provides an

estimate of global distress based on items that also query anxious and depressive symptoms in the previous four weeks. Each item is scored on a five-point Likert scale, with a minimum score of 0 and a maximum score of 40. Higher scores are equivalent to more severe distress, with scores of 20 or greater indicative of distress that lies within the clinical range. The K10 has shown convergent validity with the CIDI, as well as the General Health Questionnaire, a psychological symptom measure (Andrews & Slade, 2001). The K10 demonstrates strong discriminant validity, with an internal consistency estimated by Cronbach's alpha as .93 (Kessler et al., 2002). Although both the K10 and the HADS are comprised of similar items that probe anxious distress, the K10 was chosen for inclusion as it would facilitate future comparison between our sample and that of the Canadian Community Health Survey, a national initiative of public and private organizations to collect "information related to health status, health care utilization and health determinants for the Canadian population" (Statistics Canada, 2018).

2.2.3 Analyses

Frequencies were tabulated to characterize the sample based on demographic information. We conducted separate one-way analyses of variance (ANOVAs) with Tukey's post-hoc multiple comparisons to determine the relationship between sleep disturbance and mental health variables. Effect size was estimated by Cohen's *d*. Each measure of sleep was represented as a categorical variable. On the PSQI, those that exceeded a score of 5 were placed in the sleep disturbance group, as were those who met or exceeded a score of 15 on the ISI, and those who scored 11 or greater on the ESS. Participants who met or exceeded cut-off scores for one, two, three, or none of the sleep metrics were categorized together for analysis, resulting in four groups. This method of

indexing the severity sleep disturbance was chosen due to the different facets of sleep each of the measures quantifies (i.e., insomnia symptoms [the ISI], sleep quality [the PSQI], and daytime dysfunction [the ESS]). Additionally, the measures have been shown to demonstrate only moderate convergent validity (Dietch et al., 2016), and therefore do not measure constructs that overlap in an excessive manner. HADS and K10 scores were treated as continuous variables. Significance level was set at $p < .05$. Data were analyzed using SPSS statistical software (Version 24.0; IBM Corp., 2016).

Missing data varied by measure, ranging from 20.6% nonresponse on the PSQI to 29.7% nonresponse on the K10. No statistical analyses to compensate for these missing data (i.e., case deletion, multiple imputation) were completed in the present study.

2.3 Results

2.3.1 Demographic & Clinical Characteristics

The total sample size was 3,699, though after excluding participants younger than 18 and older than 35, the sample size used in data analysis was 3,167. Demographic characteristics of the sample are reported in Table 2.1. The majority of participants (70.6%) were female, with an average age of 22.21 years (SD = 3.73). Participants were mostly white (84.9%), with 88.6% of participants being domestic students. The large majority of the sample (82.4%) was comprised of undergraduate students, and 92.1% were registered for full-time studies. Most participants represented the Science (25.0%) and/or Humanities and Social Science (20.4%) faculties. The sample was representative of the MUN student body except in terms of gender (i.e., males underrepresented), according to statistics from the Registrar's Office. The survey received a response rate of approximately 21.3%.

Using the recommended clinical cut-off of greater than 5, 68.8% of students reported experiencing poor quality sleep on the PSQI. Over half of the sample (55.3%) reported some insomnia symptoms, while nearly one in five participants (17.8%) met or exceeded the cut-off score of 15 for diagnoseable insomnia disorder. Finally, 74.7% of participants experienced normal levels of daytime sleepiness, while one quarter of the sample (25.3%) met the cut-off criteria of 11 for excessive daytime sleepiness. Thirty-four percent of participants met the clinical cut-off for at least one of the sleep metrics, while 17.3% and 8.1% met the cut-offs for two and all three measures, respectively. About one in five participants (19.5%) did not meet the clinical cut-off for either the PSQI, the ISI, or the ESS. Sleep characteristics of the sample are demonstrated in Table 2.2, while demographic characteristics of participants who met or exceeded the clinical cut-off score of one, two, three, or none of the sleep measures are presented in Table 2.3.

The sample also demonstrated significant levels of psychological concerns, with 27.9% and 61.7% of the sample in the clinically significant range of depression and anxiety, respectively, demonstrated by scores greater than seven on each subscale. Overall, psychological distress was in the mild to moderate range (M=14.31; SD=8.51).

2.3.2 Relationship Between Sleep and Mental Health

There was a significant difference in symptoms of depression between participants depending on the number of measures for which they met or exceeded the clinical cut-off [$F(2,2357)=220.39$, $p<.0005$, $d=1.25$], with a dose-response relationship demonstrated. Participants who met or exceeded the cut-off score for all three sleep measures (PSQI, ISI, and ESS) reported significantly higher scores on the HADS-Dep (M=9.22, SE=.28) than those who met the cut-off score for two of the three sleep measures (M=7.09,

SE=.16). This group of participants in turn had significantly higher HADS-Dep sores than those who met or exceeded the clinical cut-off of just one of the sleep metrics (*M*=4.97, *SE*=.11). The participants who did not meet or exceed clinical cut-offs for either the PSQI, ISI, or ESS reported the lowest HADS-Dep scores overall (*M*=3.15, *SE*=.12).

There was also a significant difference in symptoms of anxiety between participants depending on the number of sleep measures for which they met or exceeded the clinical cut-off [$F(2,2357)=190.58$, $p<.0005$, $d=1.12$]. A dose-response relationship was also evident in this analysis: Participants who met or exceeded the cut-off score for all three sleep measures reported significantly higher scores on the HADS-Anx (*M*=13.66, *SE*=.27) than those who met the cut-off score for two of the three sleep measures (*M*=11.21, *SE*=.19). This group of participants in turn had significantly higher HADS-Anx sores than those who met or exceeded the clinical cut-off of just one measure (*M*=9.10, *SE*=.14). The participants who did not meet or exceed clinical cut-offs for any of the sleep metrics reported the lowest HADS-Anx scores of all groups (*M*=6.52, *SE*=.17)

Finally, the difference in symptoms of global distress between participants depending on the number of sleep measures for which they met or exceeded the clinical cut-off was also significant [$F(2,2223)=256.57$, $p<.0005$, $d=1.47$], with a dose-response relationship demonstrated: Participants who met or exceeded the cut-off score for all three sleep measures reported significantly higher scores on the K10 (*M*=23.91, *SE*=.52) than those who met the cut-off score for two of the three sleep measures (*M*=18.26, *SE*=.36). This group of participants in turn had significantly higher K10 sores than those who met or exceeded the clinical cut-off of just one of the three sleep metrics (*M*=13.46, *SE*=.28).

The participants who did not meet or exceed clinical cut-offs for any of the sleep metrics reported the lowest K10 scores of all groups (*M*=9.09, *SE*=.28). The differences between sleep disturbance symptomology and reported levels of depression, anxiety, and mood are depicted in Figure 2.1.

2.4 Discussion

The results of this study demonstrate high rates of sleep disturbance and mental health symptomology within this YA population. Specifically, almost 70% of participants reported experiencing poor quality sleep. Nearly one in five participants met or exceeded the cut-off score for insomnia disorder, while over half of the sample reported some insomnia symptoms. Finally, one quarter of the sample (25.3%) met the cut-off criteria for excessive daytime sleepiness. Almost 45% of participants exceeded the cut-off score on one sleep measure, one in five (22.4%) did so on two sleep measures, while 8.1% exceeded the cut-off on all three sleep measures. One quarter of the sample did not report any significant sleep disturbance whatsoever. The sample also demonstrated significant levels of psychological concerns, with 27.9% and 61.7% of the sample in the clinically significant range of depression and anxiety, respectively. Overall, psychological distress was in the mild to moderate range.

Using the same cut-off criteria on the PSQI as in the present study, research investigating population- and community-based samples suggest that poor sleep is generally endorsed to a lesser degree than in our YA sample. As previously outlined in Section 1.1, poor sleep tends to occur at a rate closer to about 30% (APA, 2013). Our results also suggest a greater prevalence rate of poor sleep than that reported among most other YA samples. While the Lund et al. study of 1,125 American college students

showed that about 66% of students reported poor quality sleep on the PSQI (2010), other North American samples have demonstrated average PSQI scores that exceed the cut-off in only about 50% of participants (Brick, Seely, & Palermo, 2010; Vargas, Flores, & Robles, 2014). Interestingly, Brick et al. investigated a sample comprised exclusively of medical students, a group known to experience high levels of stress, and sleep schedule irregularity (Frank, Carrera, Elon, & Hertzberg, 2006; Hull, DiLalla, & Dorsey, 2008).

Our sample also reported insomnia symptoms at a greater prevalence than the general population (over 55%, compared to about one-third; APA, 2013), though the consistency of the research depends on the measurement tools used to evaluate insomnia. Using more stringent criteria for the evaluation of insomnia (i.e., sleep diaries plus validated self-report instruments), one study estimated that only about 9.5% of 1,074 students surveyed had chronic insomnia, while approximately one-third had insomnia symptoms that fell short of clinical significance (Taylor et al., 2013). The information gathered by sleep diaries in particular permits the evaluation of the diagnostic criteria of insomnia disorder, including SOL, WASO, early morning awakenings, and SE, facets of sleep that our assessment did not probe.

The reasons for the greater-than-expected prevalence rates of sleep disturbance and insomnia observed within our particular study population are unknown. The location of the university from which the sample was drawn is at a northern latitude and is characterized by a relatively harsh and lengthy winter climate. Research has shown that time in bed tends to be significantly longer in the winter than in the summer, but that sleep duration remains unchanged over the course of the year (O'Connell, Griffiths, & Clemes, 2014). This means that during the winter months, SE deteriorates, which is a

marker of poor sleep quality. Although study recruitment occurred throughout the calendar year, it is possible that climate had an impact on responses, especially those from participants who completed the survey during the winter. Additionally, the demographic characteristics of participants meeting or exceeding the clinical cut-off on none or multiple sleep measures appears to be inconsistent. For instance, 18 to 20-year-old YAs represented the majority of participants meeting or exceeding the cut-off on all three sleep measures (48.5%), while the proportion of those in this age range who did not meet the cut-off on any of the sleep measures was more modest and similar to that of participants of other ages (36%). Gender also appeared to be influential: Males and females were roughly equally represented among those participants meeting or exceeding the clinical cut-off on none or just one sleep measure, while female participants comprised the strong majority of those who met or exceeded the cut-off on two (87%) or all three sleep measures (92.5%). Further investigation into these matters is warranted.

This study also suggests that there is a dose-response relationship between symptoms of sleep disturbance and deterioration in mental health. It was shown that as participants exceeded the clinical cut-offs on one, two, or three of the sleep measures included (the PSQI, the ISI, and the ESS), there was a concomitant increase in the severity of anxious, depressive, and global distress symptoms, such that those who exceeded the cut-off on all three sleep measures demonstrated the most severely symptomatic psychological profile. The effect sizes for these analyses (*d* ranging from 1.12 to 1.47) exceeded Cohen's convention for a large effect (1988).

While there is a wide body of research that has demonstrated a dose-response relationship between sleep disturbance or sleep restriction and cognitive performance on

such tasks that involve psychomotor vigilance (Belenky et al., 2003; Dinges et al., 1997), working memory (Van Dongen, Maislin, Mullington, & Dinges, 2003), and driving a vehicle (Otmani, Pebayle, Roge, & Muzet, 2005), the method of triangulation of sleep symptoms employed in this study in order to determine association with mental health is novel. Given what is known about sleep disturbance and mental health, previously discussed above (Gould et al., 2015; Lund et al., 2010; Morin, LeBlanc, et al., 2011; Morphy et al., 2007), it is unsurprising that as severity of sleep disturbance increases, so too do levels of anxiety, depression, and distress.

This study had several limitations that should be acknowledged. First, self-report measures of sleep were used, which introduces the possibility of inaccurate reporting. That said, sleep quality and sleep-related experiences, like daytime sleepiness, are subjective by nature, making participant-reported outcomes the most appropriate (and most commonly-used) method of measurement (Buysse et al., 2010). It is possible, too, that due to the recruitment strategy, selection bias may have occurred with respect to the students who participated. In other words, it may be that students experiencing poor sleep were more likely to complete the survey, biasing the results. Next, the cross-sectional design does not allow for the inference of causality or the ability to determine the direction of significant associations. It can only be said that a relationship exists between sleep and mental health, but whether poor sleep is responsible for anxious, depressive, and distress symptoms, or if such mental health issues cause sleep disturbance, is unclear. The decision to use a categorial approach to classify participants on sleep disturbance could have resulted in a decrease in statistical sensitivity, however as the ultimate goal of this study is to inform a knowledge translation project and on-campus interventions,

creating categories of participants was likely a more acceptable strategy. A moderate proportion of the sample failed to complete all of the measures, resulting in a nonresponse rate than ranged from about 20 to 30%. It is likely that this is due in part to the length of the survey. Future efforts could improve on this limitation by providing a briefer survey, and by randomizing the order in which participants complete the measures. Lastly, the proportion of female students was greater than male students and the sample was not diverse in terms of race or ethnicity. Although the number of male students in the sample was large enough to capture relevant differences, future efforts should be made to recruit gender-, racially-, and ethnically-diverse samples. As the literature is mixed with respect to the impact of race on sleep (Bixler, Vgontzas, Lin, Vela-Bueno, & Kales, 2002; Riedel, Durrence, Lichstein, Taylor, & Bush, 2004; Rocha, Guerra, & Lima-Costa, 2002), our racially homogenous sample did not permit further exploration in this regard.

The primary strength of this study was its large and mostly representative sample. Findings can be expected to generalize to the majority of members of this population, making the data set a useful tool for designing and implementing targeted programs to prevent and/or ameliorate sleep and mental health problems among YAs. The study also employed valid and reliable measures of sleep and mental health symptoms, which include clinical cut-off scores that are empirically supported. This not only allows the findings to be interpreted with confidence, but also facilitates comparison to other studies that have used the same instruments, as explored above. Measures like these provide context for the results and permit an enriched discussion of the clinical significance of the findings. Although not carried out in this study, future replications of the methods used

here study may investigate whether one of the three sleep measures employed is more strongly related to decrements in psychological well-being than the others.

The pervasive nature of both sleep disturbance and psychological symptomology in this sample is troubling indeed, signalling a need for greater prevention and intervention initiatives among YAs. One way this can be achieved is through more thorough training in sleep within medical programs and clinical psychology. Evidence shows that medical students in North America receive just over three hours of education on sleep during their training, with institutions citing too little time, lack of qualified faculty, low priority, and irrelevance as barriers to sleep education (Mindell et al., 2011). Clinical psychology training programs do not appear to fare much better: Of 212 doctoral and residency programs surveyed in North America, only 6% offered sleep-related coursework, while about one-third provided training in the treatment of sleep disorders (Meltzer, Phillips, & Mindell, 2009). Additionally, only 16% of the programs that participated employed faculty with specialization in sleep. These findings suggest that there are few opportunities for medical and psychology trainees to receive both didactic and clinical experiences with sleep that are provided by experienced faculty members.

A perhaps less lofty ideal may be to make these types of data freely accessible to YAs in the form of psychoeducational seminars on university campuses, or webinars promoted through social media, with an emphasis on practical strategies YAs can use for themselves to improve their sleep and mental well-being. As discussed in Section 1.1, there appears to be a gap between to provision of sleep education and meaningful change in sleep behaviours among YAs (Brown et al., 2002), however initiatives that also teach basic behavioural skills could mitigate the pressure placed on already over-taxed

counselling services. The impact of a psychoeducational sleep hygiene workshop such as this on college students' sleep beliefs and sleep quality was recently investigated (Kloss et al., 2016). One hundred and twenty students, with a mean age of 21 years, were randomly assigned to one of two groups: a sleep-monitoring control condition, or a sleep hygiene condition that was comprised of two 90-minute educational workshops. The sleep hygiene group was provided education on sleep stages, daytime consequences of poor sleep, tips for sound sleep hygiene practices, and cognitive and behavioural strategies for improving sleep. Compared to participants in the control condition, those who attended the sleep hygiene workshop endorsed fewer maladaptive beliefs about sleep, and reported shortened SOL. This suggests that brief and cost-effective courses may prove fruitful in alleviating sleep problems within the student population. Additionally, there has been a call from researchers for physicians and/or nurses to integrate sleep behaviour assessments into their examinations with university students and YAs generally (Owens, Christian, & Polivka, 2017). Assuming adequate training on the part of the healthcare provider, this would afford students the opportunity to receive information on appropriate strategies to mitigate sleep concerns, and even to receive referrals to professional services. While no intervention was investigated in the present study, future research could investigate the impact of efforts like the ones outlined above.

Interventions to jointly address sleep and mental health have been researched within different populations, with varying degrees of success, many of which are founded in mindfulness approaches. One study in particular examined the impact of movement-based physical education courses on mindfulness, mood, and sleep. One hundred and sixty-six college students participated in one of three exercise courses, and completed the

Five Facet Mindfulness Questionnaire (FFMQ), the Four Dimensional Mood Scale, the Perceived Stress Scale – 4, and the PSQI, over a 15-week semester (Caldwell, Harrison, Adams, Quin, & Greeson, 2010). The authors found that although mean PSQI scores did not improve by the end of the semester, partial correlations for change scores on subscales of the FFMQ showed that increases in mindfulness were related to improved sleep quality. Further analyses also showed that mood and stress scores mediated the relationship between mindfulness and sleep quality. A recent meta-analysis of RCTs that examined the impact of mindfulness meditation on sleep quality offered further support for this approach in improving sleep (Rusch et al., 2018). Here, 18 RCTs including over 1,600 total participants were examined, with the evidence suggesting a moderate effect size for mindfulness interventions compared to nonspecific active controls (such as time- and/or attention-matched groups), both immediately post-intervention, and at follow-up. Findings such as these suggest that mindfulness-based interventions are unequivocally more effective at resolving sleep disturbance than receiving no active treatment at all, but more research is needed to determine how it compares to other evidence-based interventions like cognitive behavioural therapy for insomnia (CBT-I). Given what is known about the positive impact of mindfulness on mood and anxiety (Rodrigues, Nardi, & Levitan, 2017), such mindfulness-based interventions may be a parsimonious approach to address both sleep and mental health concerns among YAs.

Despite research that has piloted sleep interventions within universities and colleges, there still exists a gap in the actual implementation of such programs. In order to interrupt the perpetuation of sleep disturbance that occurs with age (Dregan & Armstrong, 2010; Fatima et al., 2017), post-secondary institutions would do well to prioritize

providing the opportunity for treatment to their students. Not only might this result in a healthier student body, but, over time, a healthier populace as well.

Table 2.1. Demographic characteristics of participants

		N	%
		3167	**100**
Demographic characteristics	**Age, years (M=22.21; SD=3.73)**		
	18-20	1283	40.6
	21-23	987	31.2
	24-35	889	28.1
	Gender		
	Female	2235	70.6
	Male	882	27.8
	Other	50	1.6
	Race		
	White	2659	84.9
	Non-white	473	15.1
	Tuition Status		
	Domestic	2735	88.6
	International	353	11.4
	Level of Study		
	Undergraduate	2544	82.4
	Graduate	544	17.6
	Student Status		
	Full-time	2844	92.1
	Part-time	244	7.9
	Faculty		
	Business Administration	384	12.1
	Education	148	4.7
	Engineering & Applied Science	391	12.3
	Human Kinetics and Recreation	105	3.3
	Humanities & Social Sciences	645	20.4
	Medicine	154	4.9
	Science	793	25.0
	Marine Institute	68	2.1
	School of Graduate Studies	102	3.2
	School of Music	41	1.3
	School of Nursing	203	6.4
	School of Pharmacy	34	1.1
	School of Social Work	84	2.7
	Undeclared	198	6.3

Table 2.2. Proportion of sample reporting clinically significant sleep disturbance on one or more sleep metrics

	Sleep Disturbance		**No Sleep Disturbance**	
	n	**%**	**n**	**%**
PSQI	1729	68.8	785	31.2
ISI	428	17.8	1970	82.2
ESS	613	25.3	1809	74.7
PSQI+ISI	421	17.1	2048	82.9
PSQI+ESS	519	20.9	1967	79.1
ISI+ESS	204	8.4	2214	91.6
PSQI+ISI+ESS	199	8.0	2283	92.0

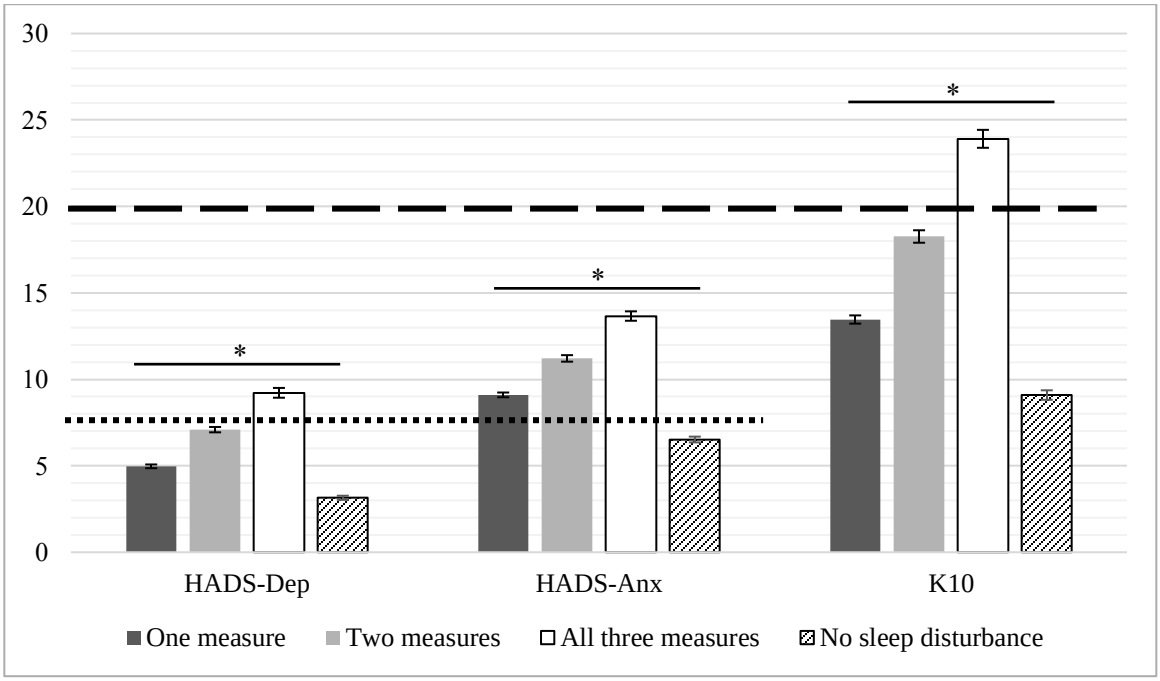
Note: Participants whose scores exceeded clinical cut-offs were classified as having sleep disturbance; PSQI = Pittsburgh Sleep Quality Inventory; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale.

Table 2.3. Demographic characteristics of participants who met or exceeded the clinical cut-off score on one, two, three, or none of the sleep measures.

	One measure		**Two measures**		**Three measures**		**None**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Age								
18-20	435	40.5	233	42.7	96	48.5	222	36.0
21-23	357	33.2	184	33.7	55	27.8	192	31.1
24-35	283	26.3	129	23.6	47	23.8	203	33.0
Gender								
Male	299	41.8	101	11.5	29	6.2	209	55.0
Female	402	56.2	766	87.0	433	92.5	164	44.2
Other	14	2.0	13	1.5	6	1.3	7	1.8
Level of Study								
Undergraduate	895	83.0	472	86.3	175	87.9	465	75.2
Graduate	184	17.0	75	13.7	24	12.1	153	24.8

Note: Sleep measures included PSQI, ISI, and ESS.

Figure 2.1. Average score on mental health measures for participants who met or exceeded clinical cut-offs on one or more sleep metrics



Note: Sleep disturbance indicated by the PSQI, the ISI, and the ESS. The dotted horizontal line represents the clinical cut-off for the HADS; the dashed horizontal line represents the clinical cut-off for the K10. * p<.0005

Chapter 3:

Night Owls and Early Birds: The Impact of Chronotype on Mental Health

3.0 Abstract

INTRODUCTION: Circadian preference, or chronotype, is related to mental health, with evening chronotypes being more susceptible to psychological disorders than intermediate and morning types. The present study investigated the relationship between chronotype, mental health, mindfulness, and social support in Canadian YAs.

METHODS: We surveyed 3,167 university students aged 18-35. Participants completed the Morningness-Eveningness Questionnaire (MEQ); the HADS; the K10; the Medical Outcomes Study – Social Support Survey (MOS-SSS); and the Mindful Attention Awareness Scale (MAAS). We conducted separate Bonferroni-corrected one-way ANCOVAs with post-hoc paired comparisons to determine the relationship between chronotype and mental health variables, adjusted for the effect of age.

RESULTS: 55.6% of participants were classified as intermediate type, with 33.9% of sample being evening type, and 10.4% being morning type. There was a significant difference in depression scores [$F(2,2350)=37.47$, $p<.0005$, $d=.36$], with intermediates reporting greater levels of depression than morning types, and evening types reporting greater depression scores than morning and intermediate types. The relationship between anxiety and chronotype was also significant [$F(2,2350)=17.972$, $p<.0005$, $d=.33$], with evening types more likely to report greater levels of anxiety than intermediate and morning types. Finally, intermediates were more likely than morning types, and evening types were more likely than both intermediates and morning types to report greater levels of distress [$F(2,2216)=41.76$, $p<.0005$, $d=.47$]. Chronotype and social support shared a significant relationship [$F(2,2262)=9.66$, $p<.0005$, $d=.17$], with intermediate types reporting greater levels of social support than evening types, and morning types more

likely to report greater levels of social support than their intermediate and evening counterparts. The relationship between chronotype and mindfulness was also significant [$F(2,2148)=10.68$, $p<.0005$, $d=.23$]: Morning types and intermediates were more likely than evening types to report greater levels of mindfulness.

CONCLUSION: This study supports the relationship between evening chronotype, depressive symptoms, anxiety, and psychological distress among university students. It also demonstrates further evidence for the association between morningness and the constructs of social support and mindfulness. Education and/or intervention is warranted to help those with an evening chronotype manage the negative impact of their circadian rhythm, as well as to cultivate a greater sense of social support and mindfulness among evening types.

3.1 Introduction

Circadian preference, or chronotype, describes an individual's diurnal rhythmicity based on biological characteristics. In more colloquial terms, chronotypes categorize individuals as "early birds" or "night owls." Each category of chronotype shows variability in physiological factors, including core body temperature (Baehr et al., 2000), cortisol levels (Randler & Schaal, 2010), and sleep quality as measured by EEG (Mongrain, Carrier, & Dumont, 2005). The fluctuation among these variables result in morning types and evening types demonstrating peak cognitive and physical performance at different times throughout the day: Morning types tend to feel at their best earlier in the day, while evening types do so later in the day (Horne & Ostberg, 1976).

Approximately one-quarter of the adult population is classified as morning type and one-quarter as evening type, while the other 50% falls under the classification of intermediate, with no strong predisposition toward an advanced or delayed sleep phase (Taillard, Philip, Coste, Sagaspe, & Bioulac, 2003). Those with an intermediate chronotype maintain a typical sleep window of about 11:00 PM to 7:00 AM. Evening types are likely to feel sleepy around 3:00 – 4:00AM and wake up feeling refreshed at 11:00AM – 12:00 noon. As a result, these individuals tend to experience trouble waking up early in the morning, and don't reach peak physical and mental performance levels until the evening. Morning types adopt an opposite pattern, with a preferred bedtime of 8:00 – 10:00PM, and waking up from 4:00 – 6:00AM. Morning types typically have difficulty staying up late, and reach optimal physical and mental performance in the late morning (Taillard et al., 2003).

While the above distributions have been replicated and demonstrated as consistent across cultures (Paine et al., 2006), evening chronotypes are more common among YAs (Dagys et al., 2012). This is because adolescents experience a shift toward eveningness during puberty, which is followed by a subsequent shift back towards a more intermediate rhythm beginning in the early 20s (Skeldon et al., 2016). Although eveningness is a temporary state for many teens and young adults, there are physical and psychological consequences of a delayed sleep phase that may persist into the middle age. Dregan and Armstrong (2010) found that the presence of sleep disturbance in adolescence predicted the presence of sleep disturbance at age 42, even after controlling for such factors as family, environmental, and personal characteristics. Sleep disturbance has also been linked to the dysregulation of hormones like ghrelin and leptin, which puts individuals at greater risk for developing such chronic health encumbrances as diabetes (Drummond & McKenna, 2009).

Apart from the effects on physical health, eveningness is also associated with a multitude of negative psychological outcomes. Not only is the standard 9:00AM – 5:00PM workday misaligned with the natural preference of evening types (Wittmann et al., 2006), night owls also tend to demonstrate lower positive affect (Hasler et al., 2010), greater depressive symptoms (Hidalgo et al., 2009; Selvi et al., 2007), and increased suicidality (Selvi et al., 2011), as well as novelty seeking and neurotic personality traits (Hsu, Gau, Shang, Chiu, & Lee, 2012). Given the higher preponderance of night owls among YAs, these troublesome findings likely impact many among this population.

As much research as has been done on the adverse effects of different chronotypes, there exists a smaller body of evidence connecting chronotype with positive

psychological outcomes. One particular positive psychological construct is that of mindfulness. It has been shown that morningness is positively correlated with mindfulness, as measured by the Mindful Attention Awareness Scale (MAAS), and that this relationship is mediated by sleep quality (Howell, Digdon, Buro, & Sheptycki, 2008). Another study (Carciofo, Yang, Song, Du, & Zhang, 2016) confirmed these results, and also found that the connection between morning chronotype and mindfulness was partially mediated by the personality trait of self-discipline, a facet of conscientiousness. Seeing as chronotype, mood, and personality traits are closely affiliated, the relationships between these constructs ought to be further explored so as to delineate more clearly the connections they share.

While there is a dearth of research on the relationship between chronotype in particular and social support, there is much to be surmised about the potential relationship between these two constructs, especially given what has already been discussed regarding the negative psychological outcomes of evening chronotype. The literature has demonstrated that individuals with depression are more likely to report low levels of perceived social support (PSS; George et al., 1989; Peirce et al., 2000), while high levels of PSS seem to moderate the relationship between stress and mental health (Cobb, 1976; Cohen & Wills, 1985). Since night owls are known to experience greater levels of depression and anxiety, as discussed above, it seems intuitive that PSS may influence the relationship between chronotype and mental health (perhaps especially among evening types), which justifies the inclusion of this construct in the present study.

Given that the YAs fall within the critical age range at which chronotype begins to shift, characterizing the relationship between chronotype and mental health variables

within this group is of great interest. This has yet to be studied on such a large scale in Canada. The objectives of this study were to:

1. Characterize the prevalence of each chronotype within the same large representative sample of YAs examined in Study 1.
2. Examine the association between chronotype and psychological well-being.

It was hypothesized that our sample would demonstrate a higher prevalence rate of evening chronotype, and a lower prevalence rate of morning chronotype, than in the general population. It was also thought that evening chronotype would be associated with poorer psychological well-being (as indicated by higher scores on the HADS and K10).

3.2 Methods

3.2.1 Participants

The sample used for this study is the same as that used in Study 1. Please see Section 2.2.1 for a detailed description of participants and recruitment methods.

3.2.2 Study Variables

Chronotype was determined using the Morningness-Eveningness Questionnaire (MEQ; Horne & Ostberg, 1976). The MEQ is a well-validated 19-item measure, widely used for the estimation of chronotype. Participant scores can range from 16 to 86, with five categorical outcomes: extreme eveningness, moderate eveningness, intermediate, moderate morningness, and extreme morningness. Lower scores are indicative of extreme eveningness, with higher scores indicative of extreme morningness. Items probe individual preference for sleep and wake times, as well as times of peak mental and physical performance throughout the day. The MEQ has shown sound test-retest reliability, and adequate construct validity when compared to biomarkers of chronotype,

like body temperature rhythms, and salivary cortisol levels (Di Milia, Adan, Natale, & Randler, 2013). Internal consistency for the MEQ is estimated by Cronbach's alpha as .86.

Mindfulness was measured using the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003). The 15 items on the MAAS measure "the presence or absence of attention to, and awareness of, what is occurring in the present moment" (p. 824). Items are scored on a 6-point Likert scale, with a global score found by calculating the mean across all items. A higher score is indicative of greater mindfulness. Convergent and discriminant validity, as well as test-retest reliability have been demonstrated, and internal consistency, estimated by Cronbach's alpha, is .87.

Social support was measured in this survey using the Medical Outcomes Study – Social Support Survey (MOS-SSS; Sherbourne & Stewart, 1991). The MOS-SSS is a brief, 19-item measure designed to capture various dimensions of social support, including subscales of emotional support, tangible support, affectionate support, and positive social interaction. Items are scored on a 5-point Likert scale, with global and subscale scores determined by calculating the mean of responses. Higher scores suggest greater levels of PSS. Cronbach's alpha for subscales and the overall measure exceed .90 (Sherbourne & Stewart, 1991).

The HADS and K10 were used to measure symptoms of anxiety, depression, and global distress. A discussion of the psychometric properties of these measures can be found in Section 2.2.2.

3.2.3 Analyses

Frequencies were tabulated to characterize the sample based on demographic information. We conducted separate Bonferroni-corrected one-way analyses of covariance (ANCOVAs) with post-hoc paired comparisons to determine the relationship between chronotype and mental health variables. Effect size was estimated by Cohen's *d*. Chronotype was represented as a categorical variable: Participants who were classified as either extreme or moderate evening types were grouped together for statistical analyses to represent the evening group. The same method was used to group participants who demonstrated either an extreme or moderate morning chronotype. Those participants who scored in the intermediate chronotype represented the third and final chronotype group in the statistical analyses. This method of grouping participants based on MEQ scores is common in the literature (Hidalgo et al., 2009; Merikanto et al., 2013; Selvi et al., 2007). HADS and K10 scores were treated as continuous variables. Age was included as a covariate in each analysis. Significance level was set at $p < .05$. Data were analyzed using SPSS statistical software (Version 24.0; IBM Corp., 2016). Missing data varied by measure, ranging from 14.7% on the MEQ to 29.7% on the K10. No statistical analyses to compensate for these missing data (i.e., case deletion, multiple imputation) were completed in the present study.

3.3 Results

3.3.1 Demographic & Clinical Characteristics

Demographic characteristics of the sample are reported in Table 2.1 and are discussed in depth in Section 2.3.1. Relevant clinical characteristics of the sample can be found in Table 3.1. With respect to chronotype, 55.6% of participants were classified as

intermediate, 33.9% were evening type, and 10.4% were morning type. The demographic characteristics of participants according to chronotype are presented in Table 3.2.

3.3.2 Relationship Between Chronotype and Mental Health

After adjusting for age, there was a significant difference in symptoms of depression between chronotype [$F(2,2350)=37.47$, $p<.0005$, $d=.36$], with intermediate types reporting greater symptoms of depression (M=5.09, SE=.10) than morning types ($M=4.06$, $SE=.24$), and evening types reporting greater symptoms ($M=6.24$, $SE=.14$) than both morning and intermediate types. All pairwise comparison p-values were < .0005. Age was not a significant covariate. The relationship between anxiety and chronotype was also significant [$F(2,2350)=17.972$, $p<.0005$, $d=.33$], with evening types being more likely to report greater levels of anxiety ($M=10.13$, $SE=.17$) than both intermediate ($M=9.00$, $SE=.13$) and morning types ($M=8.48$, $SE=.30$). The covariate of age was significantly negatively related to anxiety levels [$F(1,2350)=23.56$, $p<.0005$, $d=.09$], such that increased age was associated with lower anxiety. Finally, intermediates ($M=13.52$, $SE=.23$) were more likely than morning types ($M=11.88$, $SE=.54$), and evening types ($M=16.60$, $SE=.32$) were more likely than both intermediates and morning types, to report greater levels of distress [$F(2,2216)=41.76$, $p<.0005$, $d=.47$]. Age was a significant covariate [$F(1,2216)=26.30$, $p<.0005$, $d=.07$] and again, increased age was associated with lower distress. The differences between chronotype on symptoms of depression, anxiety, and distress are depicted in Figure 3.1.

With respect to positive psychological variables, chronotype and mindfulness shared a significant relationship [$F(2,2148)=10.68$, $p<.0005$, $d=.23$]. Both morning types ($M=3.90$, $SE=.07$) and intermediate types ($M=3.74$, $SE=.03$) were more likely than

evening types (*M*=3.58, *SE*=.04) to report greater levels of mindfulness. The covariate of age was significantly related to mindfulness levels [$F(1,2148)=6.85$, $p=.009$, $d=.03$], with increased age related to higher levels of mindfulness. The relationship between chronotype and PSS was also significant [$F(2,2262)=9.66$, $p<.0005$, $d=.17$], with intermediate types (*M*=3.89, *SE*=.03) reporting greater levels of social support than evening types (*M*=3.77, *SE*=.04), and morning types (*M*=4.07, *SE*=.06) more likely to report greater levels of social support than both their intermediate and evening counterparts. Age was not a significant covariate. The differences between chronotypes on levels of mindfulness and PSS are depicted in Figure 3.2.

3.4 Discussion

Our results demonstrate that evening chronotype is associated with greater symptoms of depression, anxiety, and global distress compared to intermediate and morning types. In contrast, morning types were more likely to report greater levels of social support and mindfulness. The effect sizes for the impact of chronotype on mental health fell in the small range (Cohen, 1988). Our data show an inconsistent effect of age. While age did not impact the relationships between chronotype and depression, or chronotype and PSS, it was a significant covariate in the analyses with anxiety, distress, and mindfulness. Older students with an evening chronotype were less likely than younger evening types to report anxiety and distress, while older morning types were more likely than their younger counterparts to report greater levels mindfulness. Effect sizes for the covariance analyses suggest a very small a protective effect of age within this sample (Sawilowsky, 2009). Age was included as a covariate in this study because of the strong effect of age on chronotype, as discussed in Sections 1.5 and 3.1. Future

research could include other demographic factors, such as gender, as covariates to identify other significant relationships.

Previous research has also demonstrated an association between chronotype and depression. In a sample of 24 adolescents, those who identified as evening types on a subjective measure of chronotype demonstrated less positive affect and lower positivity ratings than the participants categorized as morning types (Dagys et al., 2012). Another study, which included over 300 adolescents, showed that after adjusting for potentially confounding factors, evening chronotype independently predicted depression (Alvaro et al., 2014). Finally, a study by Antypa et al. (2016) found that within a large adult cohort of 1,944 participants, eveningness was related to major depressive disorder even after adjusting for various clinical, health, and sociodemographic factors.

The literature in this area has postulated that the connection between chronotype and mood may be partially due to evening types' reduced exposure to light. Many evening types likely experience less exposure to light through the day, accompanied with greater exposure to artificial light in the evening, a pattern which has been shown to negatively impact mood (Tonetti, Fabbri, & Natale, 2009). Additionally, evening types are more likely to demonstrate personality traits that are known risk factors for developing psychopathology, including neuroticism and impulsivity (Russo, Leone, Penolazzi, & Natale, 2012). It is possible, then, that a combination of disruptive exposure to light and predisposing personality traits is partly responsible for the relationship between chronotype and mood.

In addition to the impact of light and pre-existing personality traits, evening types are also more likely to engage in an array of health-impairing behaviours. A large study

of 2,565 Hungarian students examined the relationship between chronotype and health impairing behaviours (Urban, Magyarodi, & Rigo, 2011). Not only were evening types more likely to smoke cigarettes and to drink alcohol, they also spent more time being sedentary and playing video games. There is a known association between lack of physical activity and poor mental health, including anxious and depressive symptoms (De Mello et al., 2013; Dinas, Koutedakis, & Flouris, 2011; Ströhle, 2009).

Previous research on chronotype and anxiety has been inconsistent. For example, a 2008 study revealed a significant though gendered relationship between evening chronotype and anxiety (Díaz-Morales & Sánchez-Lopez). The authors surveyed the circadian preference of 559 male and female participants and found a negative correlation between morningness and anxiety levels among the women only, such that female participants with a morning chronotype reported lower levels of anxiety. Similar findings have been demonstrated within a sample of 264 adolescent females, where eveningness was associated with higher trait anxiety (Pabst et al., 2009). However, contradictory evidence also exists: The Alvaro study discussed previously failed to find a relationship between anxiety and chronotype (2014), while another study reported that although evening chronotype was shown to be related to having a current depressive and/or anxiety disorder within a cohort sample of 1,944 participants, this association was no longer significant when examining individual anxiety disorders *independent* of depressive disorders (Antypa et al., 2016). This study adds to the literature by supporting the position that anxiety is indeed related to chronotype, specifically that those with an evening chronotype are more likely than others to experience anxiety. It should also be noted that participants were free to access the online survey at any time of day. Because of this, the

impact of participants completing the survey outside of their preferred circadian window should have been minimized. However, in the event that, say, an evening type participant completed the survey in the early morning, it is possible that responses to the mental health measures may have been exaggerated (i.e., reporting more severe symptomology than would be expected if completing the measures during a time of optimal cognitive performance).

The associations observed in this study appear to be affected differently by age; that is, increasing age seems to be a protective factor among evening types in relation to some, but not all, mental health variables measured. Our findings are consistent with some previous research, which has demonstrated that the relationship between evening chronotype and depression is indeed independent of age (Hidalgo et al., 2009; Merikanto et al., 2013). However, there is also evidence to the contrary, which suggests that age does in fact moderate the relationship between chronotype and depressive symptoms. In a sample of 361 participants aged 19 to 79 years (Kim et al., 2010), a U-shaped relationship was revealed, such that the youngest and oldest participants were more likely to report depressive symptoms if they were evening types, while this was not true of middle-aged participants. Given that our participants were exclusively YAs, it may simply be that the sample was not diverse enough in age so as to capture such a relationship. As noted above, previous research has shown that mindfulness is associated with morning chronotype (Carciofo et al., 2016; Howell et al., 2008). This was also demonstrated in the present study and elaborated upon through the evidence that age is a significant covariate in this relationship.

Because of the limited existing research, the results here allow for foundational theoretical development concerning the relationship between social support and chronotype demonstrated. Since evening types were more likely to report lower levels of PSS regardless of age, it may be due in part to the diminished opportunities for relationship development available to evening types when they are awake late into the night, while most others are asleep. It is important to note that, in their phrasing, items on the MOS-SSS make reference to people who share close geographic proximity with the person completing the measure. Consequently, this precludes participants from considering supportive friends and family that are physically removed from themselves (i.e., family or friends who live far away, friendships that develop and/or are maintained through online communication), as well as those who are "temporally" removed *per se* – those whose own chronotype differs to the point that it interferes with their ability to connect with evening type participants (i.e., family and friends who have a morning chronotype and subsequently operate on a schedule that it opposite to that of the evening type person). It is probable that the lower levels of social support are also related to the increased depressive symptoms reported by evening types. It may be that evening types are likely to experience a negative cognitive bias such that, despite the presence of adequate social supports, they may be less able to recognize, or feel capable of accessing, these supports. Further exploration of the association between chronotype and PSS is warranted and may inform both sleep- and mood-oriented interventions with individuals of evening chronotype.

Of particular concern with this population is the impact of chronotype, as well as depression and anxiety, on academic performance. It has been repeatedly shown that

depression and anxiety negatively impact academic performance (Andrews & Wilding, 2004; Deroma, Leach, & Leverett, 2009; Owens, Stevenson, Hadwin, & Norgate, 2012). However, evening chronotype is also independently related to poor academic achievement, with night-owls being more likely to report decreased in-class attention (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002), more frequent class failure, and lower grade point average than their morning type counterparts (Gomes, Tavares, & de Azevedo, 2011). Interestingly, these evening type students are more likely to perceive their sleeping patterns as negatively impacting their academic performance (Gomes et al., 2011), suggesting that despite their awareness of the problematic nature of their sleeping habits, evening types remain at an academic disadvantage compared to morning types. Additionally, there is evidence to suggest that sleep phase delays during undergraduate study are associated with shortened time in bed, poorer sleep quality, and increased depressive symptoms in the year following graduation (Asaoka et al., 2014). This suggests that evening types, who are prone to later bedtimes and later morning awakenings, may be particularly vulnerable to challenges once they enter the workforce full-time, as there is generally less opportunity for flexibility in work schedules than there is in academic study. These findings demonstrate the need to cater specific interventions to evening type students so as to target the academic disparity that an evening chronotype, and related anxious and depressive symptoms, may cause, as well as to help prepare university students for a more advanced sleep schedule upon graduation.

The primary strength of this study was its large, representative sample size. We acknowledge that the proportion of female students was greater than male students and that the sample was not diverse in terms of race or ethnicity; however, the sample was

still representative of the race and ethnicity of the population being studied, and is consistent with the known difficulty in recruiting males to participate in psychological survey research (Porter & Whitcomb, 2005; Sax, Gilmartin, & Bryant, 2003). Further, the use of self-report measures relies on participants to provide an honest appraisal of their current state, which introduces the possibility of response bias. That said, the confidential nature of the survey should have allowed participants to feel as comfortable as possible when responding to personal questions, and the MEQ has been shown to correspond to objective measures of circadian preference (Di Milia et al., 2013). The large sample size precluded the use of interviews or objective measures (in the case of chronotype); however, the instruments employed have been validated against clinical interviews.

As mentioned in Section 2.4, a significant proportion of the sample failed to complete every measure, resulting in missing data. As this was likely due to the length of the survey, future research of this kind should seek to require more brief responses, collect only complete responses, and/or present the measures in random order to each participant so as to counterbalance the effect of missing data. The cross-sectional design also does not allow for inference of causality or the determination of the direction of significant associations. Further research should endeavour to recruit gender-, racially- and ethnically-diverse samples, and employ designs that allow researchers to deduce with more certainty the nature of the relationship between chronotype and mental health: whether one's circadian preference determines one's mental health, vice-versa, or whether there are mediating or moderating variables yet to be uncovered. Lastly, and as outlined in Section 2.4, using a categorical approach to classifying participants by chronotype may have been related to a decrease in statistical sensitivity, however

categorizing participants by chronotype is the most commonly used method in the literature (Hidalgo et al., 2009; Merikanto et al., 2013; Selvi et al., 2007).

The measurement of circadian preference through the use of validated and reliable measures in this study provides further support for the development of clinical interventions that address chronotype and mental health (e.g., mood and anxiety concerns) directly. Existing intervention studies that have included chronotype have primarily focused on concepts related more closely to sleep specifically. For example, students' learning strategies and how they relate to chronotype has been investigated (Ruffing, Hahn, Spinath, Brünken, & Karbach, 2015), suggesting that morning and evening types acquire knowledge differently, even when accounting for the known personality correlates of learning. These findings provide the foundation for academic counselling that is tailored to chronotype. Additionally, it has been found that attending a sleep education program is effective in developing more accurate sleep beliefs among adolescents aged 11 to 16 years, especially among those with an evening chronotype (Díaz-Morales, Prieto, Barreno, Mateo, & Randler, 2012). The authors posit that such an improvement in sleep beliefs may be beneficial in promoting good sleep hygiene. Beyond related studies such as these, there has been no intervention research addressing impact of chronotype specifically on mental health. An improved understanding of the reasons for the relationship between chronotype and depression, anxiety, and global distress will allow for the development of targeted prevention and intervention initiatives to reduce the impact of circadian rhythm on mental health at the YA and population levels.

The ramifications of an evening chronotype are significant indeed, especially for YAs. Considering the fact that, for a significant proportion of the population (and for an

even greater proportion of YAs), delayed sleep phase is an immutable fact of life, taking care of the mental health and sleep consequences should be prioritized.

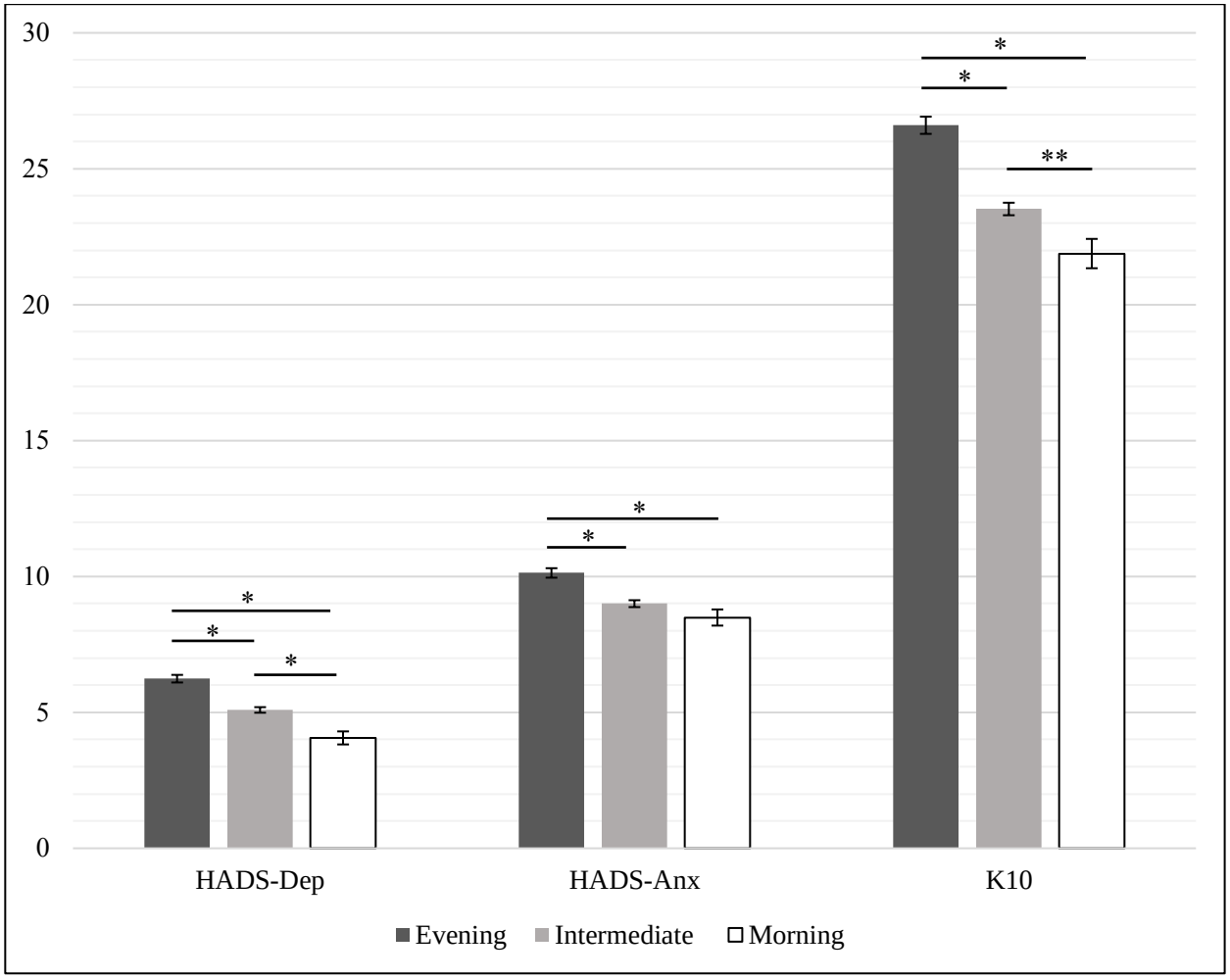
Table 3.1. Clinical characteristics of participants

		N	%
		3167	**100**
Clinical characteristics	**Chronotype**		
	Morning (59-86)	281	10.4
	Intermediate (42-58)	1498	55.6
	Evening (16-41)	913	33.9
		M (SD)	**Range**
	Perceived Social Support	3.87 (.96)	1.00-5.00
	Mindfulness	3.71 (.98)	1.00-6.00

Table 3.2. Demographic characteristics of participants by chronotype

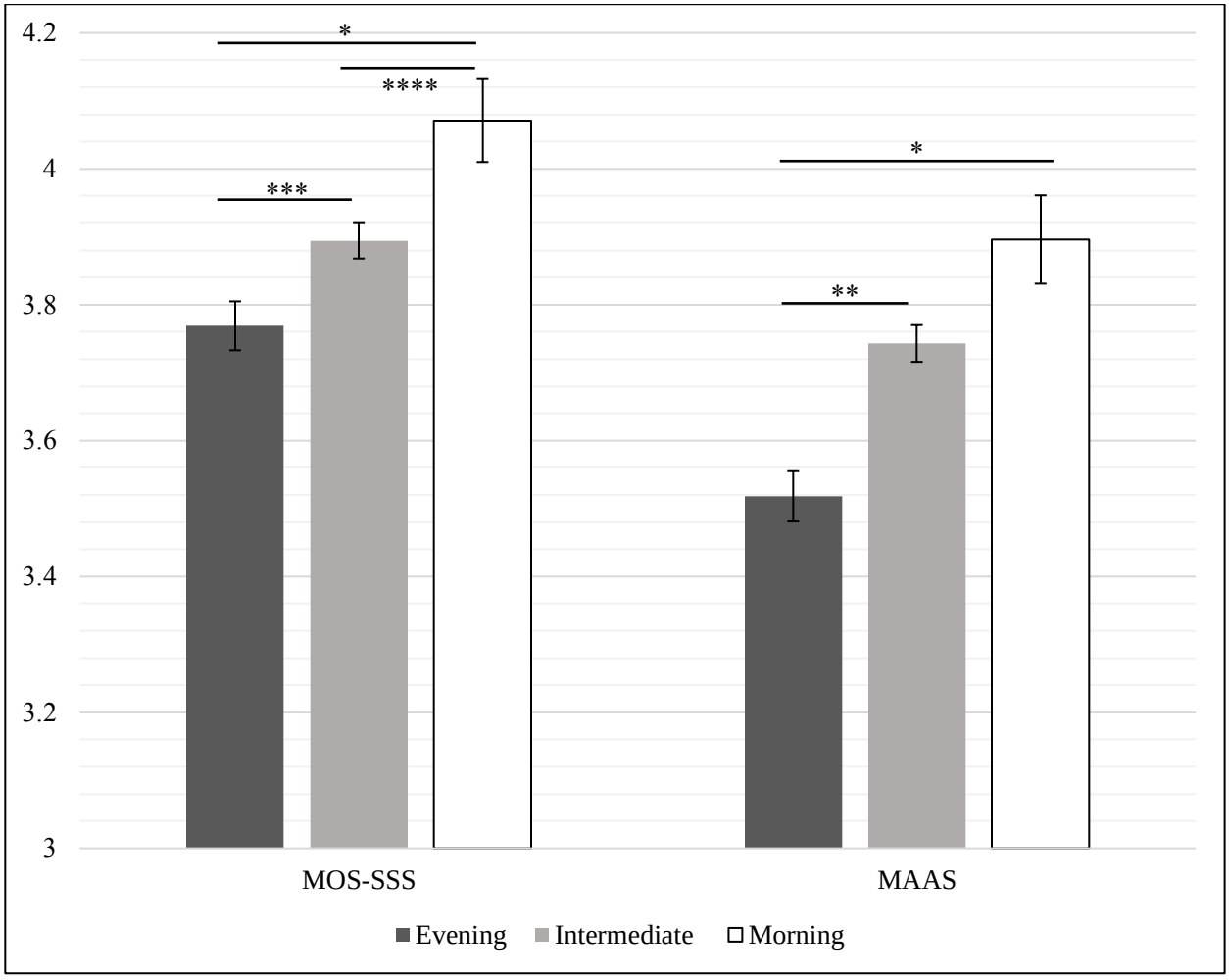
	Evening		Intermediate		Morning	
	n	**%**	**n**	**%**	**n**	**%**
Age						
18-20	419	46.1	608	40.6	68	24.3
21-23	287	31.6	480	32.1	88	31.4
24-35	202	22.2	408	27.3	124	44.3
Gender						
Male	257	28.1	394	26.3	71	25.3
Female	631	69.1	1089	72.7	208	74.0
Other	25	2.7	15	1.0	2	0.7
Level of Study						
Undergraduate	786	86.1	1223	81.6	203	72.2
Graduate	127	13.9	275	18.4	78	27.8

Figure 3.1. Association between chronotype and mental health variables as measured by the HADS and K10.



Note: HADS-Dep = Hospital Anxiety and Depression Scale – Depression subscale; HADS-Anx = Hospital Anxiety and Depression Scale – Anxiety subscale; K10 = Kessler Psychological Distress Scale; *p<.0005; **p=.015

Figure 3.2. Association between chronotype and positive psychological variables as measured by the MOS-SSS and MAAS.



Note: * p<.0005; ** p=.002; *** p=.015; **** p=.023

Chapter 4:

Overall Summary and Conclusions

4.0 Summary of Main Findings

The results of these studies show that significant portions of our sample of YAs experience disturbed sleep and the associated daytime consequences on energy levels and mood. An overwhelming majority (68.8%) reported poor subjective sleep quality, one fifth endorsed moderate to severe insomnia symptoms, and one quarter reported greater than typical levels of daytime sleepiness. Mental health findings were equally significant: 28% and 62% of the sample endorsed clinically significant depression and anxiety symptoms, respectively, while average global distress was in the mild to moderate range.

Chapter 2 focused on the relationship between sleep disturbance and mental health. Here, it was demonstrated that the greater the number of sleep metrics for which participants exceeded the clinical cut-off scores, including the ISI, PSQI, and ESS, there was an associated increase in mental health symptom severity on the HADS and the K10. There was a dose-response relationship, such that those who exceeded the cut-off on just one sleep measure reported less severe anxious, depressive, and distress symptoms than those who exceeded the cut-off on two sleep measures, who in turn reported less severe mental health symptoms than those who exceeded the cut-off score on all three measures. The participants who did not exceed the clinical cut-off score on any of the sleep measures demonstrated the most favourable mental health profile.

Chapter 3 examined the relationship between chronotype and mental health variables, and data analyses demonstrated gradient relationships: Evening types reported higher levels of depression, anxiety, and distress than both their intermediate and morning counterparts, while intermediate types in turn scored higher on the HADS and K10 than the morning type participants. Age was a significant covariate in the relationship between

chronotype and both anxiety and distress, such that increased age had a protective effect on mental health for evening types. In contrast, morning types reported greater levels of perceived social support and mindfulness than both intermediates and evening types. Age was a significant covariate in the relationship between chronotype and mindfulness only, whereby increased age predicted even greater levels of mindfulness among morning types

4.1 Challenges and Limitations of the Current Work

It is important to acknowledge several limitations. First, self-report measures were used, which introduces the possibility of inaccurate reporting, whether simply due to poor recollection, or intentional response bias. The sheer size of the sample (over 3,100 students) precluded the use of interviews or objective measures, like actigraphy or salivary cortisol levels; however, the instruments used have been validated against clinical interviews, with the MEQ in particular having been shown to correspond to objective measures of circadian preference (Di Milia et al., 2013). Sleep-related experiences, including daytime sleepiness, are also subjective by nature, making participant-reported outcomes the most appropriate (and most commonly-used) method of measurement (Buysse et al., 2010). Results of one study demonstrated that when daily ratings were compared to 3-, 7-, and 28-day retrospective ratings on the PSQI and ESS, research participants were generally able to provide accurate ratings of sleep experiences (Broderick, Junghaenel, Schneider, Pilosi, & Stone, 2013). Additionally, research suggests that subjective self-assessment of sleep, including time in bed, sleep duration, and TST, tends to be consistent with objective actigraphy data (Arora, Broglia, Pushpakumar, Lodhi, & Taheri, 2013; Campanini et al., 2017). The confidential nature of the survey should also have allowed participants to feel as comfortable as possible when

responding to sensitive personal questions (Gnambs & Kaspar, 2015), reducing the risk of socially desirable reporting. Taken together, the use of subjective self-report measures was an appropriate choice for this project.

Next, despite the large size of the sample, it was not representative of gender, nor were many participants of diverse race or ethnicity. However, the sample was representative of the race and ethnicity of the Atlantic-Canadian student population being studied, and representative in terms of MUN faculty distribution. Additionally, our inability to recruit a representative proportion of male participants is consistent with much other psychological research and has been supported by the literature as a legitimate challenge for most studies of this kind. At both the general population and university student levels, females are significantly more likely to engage in surveys than are males, and female are also less likely to drop out of research once participation has begun (Porter & Whitcomb, 2005). This appears to be true regardless of the type of information being gathered in the survey. Not only are females more likely than males to participate in survey research, they are also more likely to do so across different survey delivery platforms: Female university students tend to participate at a significantly higher rate than males on paper-only surveys, web-only surveys, paper-and-web combination delivery, as well as with and without response incentive (Sax et al., 2003). With this in mind, it seems to be expected that there was difficulty recruiting a representative proportion of male participants in the present study. Efforts should be made to determine the ways in which male participation in psychological survey studies may be augmented so as to help researchers recruit more representative samples.

The cross-sectional design of our survey also does not allow for the inference of causality or the ability to determine the direction of significant associations. It can only be said that a relationship exists between sleep/chronotype and mental health, but whether poor sleep/evening circadian preference is responsible for anxious, depressive, and distress symptoms, or vice-versa, is unclear.

4.2 Strengths of the Current Work

The primary strength of this study was its large and academically representative sample. Most studies in this vein that have used samples comprised of students from a single university generally have a much smaller *n* that tends to fall closer to about 500 participants, and rarely exceeds 1,500 (Becker et al., 2014; Gellis et al., 2014; Gress-Smith et al., 2015; Kenney et al., 2012; Lund et al., 2010; Orzech et al., 2011). These samples also frequently fail to exceed a 20% population response rate, a proportion that is considered an adequately proportional response rate within survey research (Kaplowitz, Hadlock, & Levine, 2004; Nulty, 2008; Sheehan, 2001). Additionally, very few researchers have attempted to stratify their samples by academic faculty, which limits the generalizability of any significant findings to students from that particular faculty. In fact, much sleep research with university students is intentionally limited to undergraduate students in the psychology department (Gellis et al., 2014; Gress-Smith et al., 2015), as researchers are frequently able to provide course credit for these participants, therefore easing the burden of recruitment. Given our efforts to ensure a response ratio that was representative of all undergraduate and graduate faculties at MUN, our data can be expected to generalize to most members of the student body, making the data a useful tool

for designing and implementing future programs to prevent and/or ameliorate sleep and mental health problems among students.

The study also employed valid and reliable measures of sleep and mental health symptoms that include clinical cut-off scores that are empirically supported. The ISI, PSQI, and MEQ are considered the gold standard self-report measures of insomnia, sleep quality, and chronotype, respectively (Buysse et al., 2010; Di Milia et al., 2013; Morin, Belleville, Belanger, & Ivers, 2011), while the ESS and HADS are also highly regarded and frequently employed in the sleep literature and beyond (Bjelland et al., 2002; Kendzerska, Smith, Brignardello-Petersen, Leung, & Tomlinson, 2014). Using measures like these provides context for the results and permits an enriched discussion of the clinical significance of the findings. This not only allows the findings to be interpreted with confidence, but also facilitates comparison to other studies that have used the same instruments, as explored in previous chapters. In this way, our data can be compared to those from other YA populations, to uncover any similarities and/or differences that may exist.

The methodology of using three discrete, though related, sleep measures to determine associations with mental health symptomology also appears to be novel. Many studies employ one or two self-report measures of sleep (Alsaggaf, Wali, Merdad, & Merdad, 2016; Bakotic et al., 2017; Becker et al., 2018; Schlarb et al., 2017; Wallace et al., 2017), or use sleep diaries alone or in combination with sleep measures (Levenson et al., 2016; Orzech, Grandner, Roane, & Carskadon, 2016) – if, that is, validated measures of sleep are used at all (Hartmann & Prichard, 2018). Our particular approach reveals an avenue for future research: Using triangulation data, a more in-depth investigation could

determine if one particular facet of sleep disturbance (be it sleep quality, insomnia symptoms, or daytime sleepiness) contributes more to mental health than the others. This may further inform clinical interventions by indicating where therapeutic efforts would be best directed: by working with patients to improve subjective sleep quality, by increasing sleep duration, by combatting daytime sleepiness, or some combination of the above.

4.3 Implications and Directions for Future Research

The pervasive nature of both sleep disturbance and psychological symptomology in this sample is troubling indeed, signalling a need for greater prevention and intervention initiatives on Canadian university campuses, particularly in Newfoundland and Labrador and other universities in Atlantic Canada. One way this can be achieved is simply to make the type of information gleaned from studies such as this one freely accessible to post-secondary students in the form of on-campus informational seminars, with an emphasis on practical strategies students can use for themselves to improve their sleep and mental well-being. Initiatives like this would mitigate the pressure placed on already over-taxed counselling services.

While there is much ongoing research concerning the complex relationship between sleep and mental health, there remains much to be done in terms of prevention and intervention among the university student population. The Kloss et al. study discussed in Section 2.4 demonstrated promising results for an in-person sleep hygiene program, and efforts have also been made to develop and test the effectiveness of online interventions to improve scalability. Authors have developed an online sleep course that includes material on sleep physiology; the relationship between sleep, mood and performance; the impact of poor sleep on health; and sleep-disrupting substances, caffeine

in particular (Quan & Ziporyn, 2017). Eight-hundred and four university student participants attended this 45-60-minute course and were asked to report on their knowledge and potential changes in behaviour post-course. It was shown that 79% of participants acknowledged knowing more about sleep following the course, 82% reported knowing more about caffeine, 47% noted being less likely to pull and all-nighter, and 60% said they were less likely to drive while drowsy. As discussed in Section 3.3.2, age was found to be a significant covariate in the relationship between chronotype and mental health. Intervention research may therefore be supplemented by investigations into additional potentially relevant factors, like gender, in order to develop more highly efficacious education initiatives and treatments that are tailored to participant demographics.

Additional research has been conducted on the effectiveness of online sleep interventions, with one study in particular providing education tailored to participants' chronotype (Hershner & O'Brien, 2018). Here, participants completed the ESS and MEQ to receive their "sleep personality profile," as well as a battery of measures regarding mental health symptoms. Following this, participants in the intervention condition watched two videos on the topics of sleep hygiene and the impact of sleep on cognition, as well as received information on napping, daytime alertness, and studying that was linked to their specific sleep personality. Control participants did not receive the sleep program. Intervention participants were 1.5 times more likely than controls to stop using electronic devices earlier than at baseline, 1.6 times more likely to keep a more regular sleep schedule, 2.4 times more likely to have an earlier weekday rise time, and were less

likely to have insufficient sleep prior to writing exams. The intervention group also demonstrated greater improvement in sleep quality and depression scores.

Not only have studies such as the ones described above shown promise in the scalable implementation of interventions to improve sleep among university students, there is also recent evidence for the impact of similar interventions on general physical and mental wellness too. In a pilot RCT of a novel, combination sleep intervention, fifty-six university students (mean age = 25 years) were randomized to the intervention condition or a wait-list control group (Friedrich, Claßen, & Schlarb, 2018). The students who received the sleep intervention attended six sessions with four to eight other group members, and learned traditional CBT-I approaches, like stimulus control and cognitive restructuring, along with hypnotherapy techniques, like imagery and trance sessions. Compared to those on the wait-list, the students in the intervention condition reported having a more positive physical state immediately post-intervention, while at three-month follow-up, noted less anxiety, fewer somatic complaints, and better quality of life. Findings such as these suggest that brief programs may be effective in ameliorating sleep disturbance, and physical and mental health among YAs, and that chronotype-specific interventions can be implemented as well.

Why, then, does there still exist a lack of services and/or accommodations on university campuses across North America? Despite keen interest on the part of students to have access to health information concerning sleep, this need often goes unfulfilled (ACHA, 2017), as discussed in Section 1.2. One aspect of this issue may be lack of awareness on the part of university administration. As the body of evidence supporting later class start times for adolescents continues to build (Bowers & Moyer, 2017; Kelley,

Lockley, Foster, & Kelley, 2014; Minges & Redeker, 2016), the practice has slowly begun to be adopted by some high schools, with encouraging results for sleep quality, academic performance, and mental health (Chan et al., 2017; Cole, 2016; Dunster et al., 2018). Beyond the formal implementation of the types of interventions discussed here, university administration could also offer additional afternoon and evening class options, and/or delay the earliest classes by an hour or two. It is probable that, for YA students who are in the midst of a developmentally appropriate sleep phase delay, less sleep disturbance, and the negative effects therein, would be observed in this population following such a change.

In sum, this survey study of sleep and mental health is the largest of its kind in Canada. We examined the prevalence rates of mental health symptomology and sleep disturbance, and investigated the relationship between sleep and mental health. We also examined the prevalence rates of chronotype among YAs, and the relationship between chronotype and symptoms of anxiety, depression, and global distress, as well as the positive psychological constructs of mindfulness and perceived social support. This research further demonstrates the high prevalence of disordered sleep and mood and anxiety concerns among YAs, and proposes future directions for intervention within this population.

References

ACHA. (2017). American College Health Association – National College Health Assessment (ACHA-NCHA Ilc). Retrieved from http://www.acha-ncha.org/reports_ACHA-NCHAIIc.html

Alsaggaf, M.A., Wali, S.O., Merdad, R.A., & Merdad, L.A. (2016). Sleep quantity, quality, and insomnia symptoms of medical students during clinical years. Relationship with stress and academic performance. *Saudi Medical Journal, 37*, 173-182. doi:10.15537/smj.2016.2.14288

Alvaro, P.K., Roberts, R.M., & Harris, J.K. (2014). The independent relationships between insomnia, depression, subtypes of anxiety, and chronotype during adolescence. *Sleep Medicine, 15*, 934-941. doi:10.1016/j.sleep.2014.03.019

Andrews, B., & Wilding, J.M. (2004). The relation of depression and anxiety to life-stress and achievement in students. *British Journal of Psychology, 95*, 509-521.

Andrews, G., & Slade, T. (2001). Interpreting scores on the Kessler psychological distress scale (K10). *Australian and New Zealans Journal of Public Health, 25*, 494-497. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11824981.

Antypa, N., Vogelzangs, N., Meesters, Y., Schoevers, R., & Penninx, B.W.J.H. (2016). Chronotype associations with depression and anxiety disorders in a large cohort study. *Depression and Anxiety, 33*, 75-83.

APA. (2000). *Diagnostic and statistical manual of mental disorders, text revision* (4th ed.). Washington, DC: American Psychiatric Association.

APA. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Arora, T., Broglia, E., Pushpakumar, D., Lodhi, T., & Taheri, S. (2013). An investigation into the strength of the association and agreement levels between subjective and objective sleep duration in adolescents. *PloS One, 8*, e72406. doi:10.1371/journal.pone.0072406

Asaoka, S., Komada, Y., Aritake, S., Morita, Y., Fukuda, K., & Inoue, Y. (2014). Effect of delayed sleep phase during university life on the daytime functioning in work life after graduation. *Sleep Medicine, 15*, 1155-1158. doi:10.1016/j.sleep.2014.05.017

Baehr, E.K., Revelle, W., & Eastman, C.I. (2000). Individual differences in the phase and amplitude of the human circadian temperature rhythm: With an emphasis on morningness-eveningness. *Journal of Sleep Research, 9*, 117-127. doi:jsr196

Bakotic, M., Radosevic-Vidacek, B., & Koscec Bjelajac, A. (2017). Morningness-eveningness and daytime functioning in university students: The mediating role of sleep characteristics. *Journal of Sleep Research, 26*, 210-218. doi:10.1111/jsr.12467

Bastien, C.H., Vallières, A., & Morin, C.M. (2001). Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Medicine, 2*, 297-307.

Becker, S.P., Jarrett, M.A., Luebbe, A.M., Garner, A.A., Burns, G.L., & Kofler, M.J. (2018). Sleep in a large, multi-university sample of college students: Sleep problem prevalence, sex differences, and mental health correlates. *Sleep Health, 4*, 174-181. doi:10.1016/j.sleh.2018.01.001

Becker, S.P., Luebbe, A.M., & Langberg, J.M. (2014). Attention-deficit/hyperactivity disorder dimensions and sluggish cognitive tempo symptoms in relation to college

students' sleep functioning. *Child Psychiatry & Human Development, 45*, 675-685. doi:10.1007/s10578-014-0436-8

Belenky, G., Wesensten, N.J., Thorne, D.R., Thomas, M.L., Sing, H.C., Redmond, D.P., . . . Balkin, T.J. (2003). Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: A sleep dose-response study. *Journal of Sleep Research, 12*, 1-12. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/12603781.

Bernert, R.A., Merrill, K.A., Braithwaite, S.R., Van Orden, K.A., & Joiner Jr, T.E. (2007). Family life stress and insomnia symptoms in a prospective evaluation of young adults. *Journal of Family Psychology, 21*(1), 58.

Bixler, E.O., Vgontzas, A.N., Lin, H.M., Vela-Bueno, A., & Kales, A. (2002). Insomnia in central Pennsylvania. *Journal of Psychosomatic Research, 53*, 589-592. doi:S0022399902004506

Bjelland, I., Dahl, A.A., Haug, T.T., & Neckelmann, D. (2002). The validity of the hospital anxiety and depression scale: An updated literature review. *Journal of Psychosomatic Research, 52*(2), 69-77.

Bowers, J.M., & Moyer, A. (2017). Effects of school start time on students' sleep duration, daytime sleepiness, and attendance: A meta-analysis. *Sleep Health, 3*, 423-431. doi:10.1016/j.sleh.2017.08.004

Brennan, C., Worrall-Davies, A., McMillan, D., Gilbody, S., & House, A. (2010). The hospital anxiety and depression scale: A diagnostic meta-analysis of case-finding ability. *Journal of Psychosomatic Research, 69*(4), 371-378. doi:10.1016/j.jpsychores.2010.04.006

Brick, C.A., Seely, D.L., & Palermo, T.M. (2010). Association between sleep hygiene and sleep quality in medical students. *Behavioural Sleep Medicine, 8,* 113-121. doi:10.1080/15402001003622925

Broderick, J.E., Junghaenel, D.U., Schneider, S., Pilosi, J.J., & Stone, A.A. (2013). Pittsburgh and Epworth sleep scale items: Accuracy of ratings across different reporting periods. *Behavioural Sleep Medicine, 11,* 173-188. doi:10.1080/15402002.2012. 654549

Brown, F.C., Buboltz, W.C., & Soper, B. (2002). Relationship of sleep hygiene awareness, sleep hygiene practices, and sleep quality in university students. *Behavioural Medicine, 28,* 33-38. doi:10.1080/08964280209596396

Brown, K.W., & Ryan, R.M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84,* 822-848.

Buysse, D.J., Reynolds, C.F., 3rd, Monk, T.H., Berman, S.R., & Kupfer, D.J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28,* 193-213. doi:0165-1781(89)90047-4

Buysse, D. J., Yu, L., Moul, D. E., Germain, A., Stover, A., Dodds, N. E., . . . Pilkonis, P. A. (2010). Development and validation of patient-reported outcome measures for sleep disturbance and sleep-related impairments. *Sleep, 33*(6), 781-792. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/20550019.

Cacioppo, J.T., Hawkley, L. C., Berntson, G.G., Ernst, J.M., Gibbs, A.C., Stickgold, R., & Hobson, J.A. (2002). Do lonely days invade the nights? Potential social

modulation of sleep efficiency. *Psychological Science, 13,* 384-387. doi:10.1111/1467-9280.00469

Caldwell, K., Harrison, M., Adams, M., Quin, R.H., & Greeson, J. (2010). Developing mindfulness in college students through movement-based courses: Effects on self-regulatory self-efficacy, mood, stress, and sleep quality. *Journal of American College Health, 58,* 433-442. doi:10.1080/07448480903540481

Campanini, M.Z., Lopez-Garcia, E., Rodríguez-Artalejo, F., González, A.D., Andrade, S.M., & Mesas, A.E. (2017). Agreement between sleep diary and actigraphy in a highly educated Brazilian population. *Sleep Medicine, 35*, 27-34. doi:10.1016/j.sleep.2017.04.004

Carciofo, R., Du, F., Song, N., & Zhang, K. (2013). Chronotype and time-of-day correlates of mind wandering and related phenomena. *Biological Rhythm Research, 45,* 37-49.

Carciofo, R., Du, F., Song, N., & Zhang, K. (2014). Mind wandering, sleep quality, affect and chronotype: An exploratory study. *PloS One, 9,* e91285 .doi:10.1371/journal.pone.0091285

Carciofo, R., Yang, J., Song, N., Du, F., & Zhang, K. (2016). Psychometric evaluation of Chinese-language 44-item and 10-item big five personality inventories, including correlations with chronotype, mindfulness and mind wandering. *PloS One, 11,* e0149963. doi:10.1371/journal.pone.0149963

Carmody, J., Reed, G., Kristeller, J., & Merriam, P. (2008). Mindfulness, spirituality, and health-related symptoms. *Journal of Psychosomatic Research, 64,* 393-403.

Carney, C.E., Edinger, J.D., Meyer, B., Lindman, L., & Istre, T. (2006). Daily activities and sleep quality in college students. *Chronobiology International, 23,* 623-637. doi:10.1080/ 07420520600650695

Chan, N.Y., Zhang, J., Yu, M.W., Lam, S.P., Li, S.X., Kong, A.P., . . . Wing, Y.K. (2017). Impact of a modest delay in school start time in Hong Kong school adolescents. *Sleep Medicine, 30,* 164-170. doi:10.1016/j.sleep. 2016.09.018

Cho, H.J., Lavretsky, H., Olmstead, R., Levin, M.J., Oxman, M.N., & Irwin, M.R. (2008). Sleep disturbance and depression recurrence in community-dwelling older adults: A prospective study. *American Journal of Psychiatry, 165,* 1543-1550. doi:10.1176/appi.ajp.2008. 07121882

Cobb, S. (1976). Social support as a moderator of life stress. *Psychosomatic Medicine, 38*(5), 300-314. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/981490.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* (2nd ed.). New York, NY. Lawrence Erlbaum Associates.

Cohen, S., Janicki-Deverts, D., & Miller, G.E. (2007). Psychological stress and disease. *Journal of the American Medical Association, 298,* 1685-1687. doi:10.1001/jama.298.14.1685

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychologial Bulleetin, 98,* 310-357. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/3901065.

Cole, J.S. (2016). Do later wake times and increased sleep duration of 12th graders result in more studying, higher grades, and improved SAT/ACT test scores? *Sleep and Breathing, 20,* 1053-1057. doi:10.1007/s11325-016-1341-0

Crowley, S.J., Acebo, C., & Carskadon, M.A. (2007). Sleep, circadian rhythms, and delayed phase in adolescence. *Sleep Medcine, 8*, 602-612. doi:10.1016/j.sleep.2006.12.002

Cunnington, D., Junge, M.F., & Fernando, A.T. (2013). Insomnia: Prevalence, consequences and effective treatment. *Medical Journal of Australia, 199*, S36-40. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/24138364.

Dagys, N., McGlinchey, E.L., Talbot, L.S., Kaplan, K.A., Dahl, R.E., & Harvey, A.G. (2012). Double trouble? The effects of sleep deprivation and chronotype on adolescent affect. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 53*, 660-667. doi:10.1111/j.1469-7610.2011.02502.x

De Mello, M.T., Lemos Vde, A., Antunes, H.K., Bittencourt, L., Santos-Silva, R., & Tufik, S. (2013). Relationship between physical activity and depression and anxiety symptoms: A population study. *Journal of Affective Disorders, 149*, 241-246. doi:10.1016/j.jad.2013.01.035

Del Angel, J., Cortez, J., Juárez, D., Guerrero, M., García, A., Ramírez, C., & Valdez, P. (2015). Effects of sleep reduction on the phonological and visuospatial components of working memory. *Sleep Science, 8*, 68-74. doi:10.1016/j.slsci.2015.06.001

Deroma, V.M., Leach, J.B., & Leverett, J.P. (2009). The relationship between depression and college academic performance. *College Student Journal, 43*, 325-335.

Di Milia, L., Adan, A., Natale, V., & Randler, C. (2013). Reviewing the psychometric properties of contemporary circadian typology measures. *Chronobiology International, 30*, 1261-1271.

Díaz-Morales, J.F., Prieto, P.D., Barreno, C.E., Mateo, M.J.C., & Randler, C. (2012). Sleep beliefs and chronotype among adolescents: The effect of a sleep education program. *Biological Rhythm Research, 43*, 397-412.

Díaz-Morales, J.F., & Sánchez-Lopez, M.P. (2008). Morningness-eveningness and anxiety among adults: A matter of sex/gender? *Personality and Individual Differences, 44*, 1391-1401.

Dietch, J.R., Taylor, D.J., Sethi, K., Kelly, K., Bramoweth, A.D., & Roane, B.M. (2016). Psychometric evaluation of the PSQI in U.S. college students. *Journal of Clinical Sleep Medicine, 12*, 1121-1129. doi:10.5664/jcsm.6050

Dinas, P.C., Koutedakis, Y., & Flouris, A.D. (2011). Effects of exercise and physical activity on depression. *Irish Journal of Medical Science, 180*, 319-325.

Dinges, D.F., Pack, F., Williams, K., Gillen, K.A., Powell, J.W., Ott, G.E., . . . Pack, A.I. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep, 20*, 267-277. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/9231952.

Dregan, A., & Armstrong, D. (2010). Adolescence sleep disturbances as predictors of adulthood sleep disturbances--A cohort study. *The Journal of Adolescent Health, 46*, 482-487. doi:10.1016/j.jadohealth.2009.11.197

Drummond, S., & McKenna, B.S. (2009). Sleep deprivation/restriction: Human studies. In C.J. Amlaner & P.M. Fuller (Eds.), *Basics of Sleep Guide* (Second ed., pp. 249-256): Sleep Research Society.

Dunster, G.P., de la Iglesia, L., Ben-Mano, M., Nave, C., Fleischer, J.G., Panda, S., & de la Iglesia, H.O. (2018). Sleepmore in Seattle: Later school start times are associated with more sleep and better performance in high school students. *Science Advances, 4*(2), eaau6200.

Espie, C.A. (2002). Insomnia: Conceptual issues in the development, persistence, and treatment of sleep disorder in adults. *Annual Review of Psychology, 53*, 215-243. doi:10.1146/annurev. psych.53.100901.135243

Fatima, Y., Doi, S.A.R., Najman, J.M., & Al Mamun, A. (2017). Continuity of sleep problems from adolescence to young adulthood: Results from a longitudinal study. *Sleep Health, 3*(4), 290-295. doi:10.1016/j.sleh.2017.04.004

Forquer, L.M., Camden, A.E., Gabriau, K.M., & Johnson, C.M. (2008). Sleep patterns of college students at a public university. *Journal of American College Health, 56*, 563-565. doi:10.3200/JACH.56.5.563-565

Frank, E., Carrera, J.S., Elon, L., & Hertzberg, V.S. (2006). Basic demographics, health practices, and health status of U.S. medical students. *American Journal of Preventive Medicin, 31*, 499-505. doi:10.1016/j.amepre.2006.08.009

Friedrich, A., Claßen, M., & Schlarb, A.A. (2018). Sleep better, feel better? Effects of a CBT-I and HT-I sleep training on mental health, quality of life and stress coping in university students: A randomized pilot controlled trial. *BMC Psychiatry, 18*(1), 268. doi:10.1186/s12888-018-1860-2

Galambos, N.L., Vargas Lascano, D.I., Howard, A.L., & Maggs, J.L. (2013). Who sleeps best? Longitudinal patterns and covariates of change in sleep quantity, quality,

and timing across four university years. *Behavioral Sleep Medicine, 11*(1), 8-22. doi:10.1080/15402002.2011.596234

Gaultney, J.F. (2010). The prevalence of sleep disorders in college students: Impact on academic performance. *Journal of American College Health, 59*, 91-97. doi:10.1080/07448481.2010.483708

Gellis, L.A., Park, A., Stotsky, M.T., & Taylor, D.J. (2014). Associations between sleep hygiene and insomnia severity in college students: Cross-sectional and prospective analyses. *Behaviour Therapy, 45*, 806-816. doi:10.1016/j.beth.2014.05.002

George, L.K., Blazer, D.G., Hughes, D.C., & Fowler, N. (1989). Social support and the outcome of major depression. *The British Journal of Psychiatry, 154*, 478-485. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/2590779.

Giannotti, F., Cortesi, F., Sebastiani, T., & Ottaviano, S. (2002). Circadian preference, sleep and daytime behaviour in adolescence. *Journal of Sleep Research, 11*, 191-199.

Gnambs, T., & Kaspar, K. (2015). Disclosure of sensitive behaviors across self-administered survey modes: A meta-analysis. *Behaviour Research Methods, 47*, 1237-1259. doi:10.3758/s13428-014-0533-4

Gomes, A.A., Tavares, J., & de Azevedo, M.H. (2011). Sleep and academic performance in undergraduates: A multi-measure, multi-predictor approach. *Chronobiology International, 28*, 786-801. doi:10.3109/07420528.2011.606518

Gould, C.E., Beaudreau, S.A., O'Hara, R., & Edelstein, B.A. (2015). Perceived anxiety control is associated with sleep disturbance in young and older adults. *Aging & Mental Health, 20,* 850-860. doi:10.1080/13607863.2015.1043617

Greeson, J.M., Juberg, M.K., Maytan, M., James, K., & Rogers, H. (2014). A randomized controlled trial of Koru: A mindfulness program for college students and other emerging adults. *Journal of American College Health, 62*, 222-233. doi:10.1080/07448481. 2014.887571

Gress-Smith, J.L., Roubinov, D.S., Andreotti, C., Compas, B.E., & Luecken, L.J. (2015). Prevalence, severity and risk factors for depressive symptoms and insomnia in college undergraduates. *Stress and Health, 31*, 63-70. doi:10.1002/smi.2509

Hagell, P., & Broman, J.E. (2007). Measurement properties and hierarchical item structure of the Epworth sleepiness scale in Parkinson's disease. *Journal of Sleep Research, 16,* 102-109.

Hartmann, M.E., & Prichard, J.R. (2018). Calculating the contribution of sleep problems to undergraduates' academic success. *Sleep Health, 4*, 463-471. doi:10.1016/j.sleh.2018.07.002

Hasler, B.P., Allen, J.J., Sbarra, D.A., Bootzin, R.R., & Bernert, R.A. (2010). Morningness-eveningness and depression: Preliminary evidence for the role of the behavioral activation system and positive affect. *Psychiatry Research, 176,* 166-173. doi:10.1016/j.psychres.2009.06.006

Hawkley, L.C., Preacher, K.J., & Cacioppo, J.T. (2010). Loneliness impairs daytime functioning but not sleep duration. *Health Psychology, 29,* 124-129. doi:10.1037/a0018646

Hershner, S., & O'Brien, L.M. (2018). The impact of a randomized sleep education intervention for college students. *Journal of Clinical Sleep Medicine, 14,* 337-347. doi:10.5664/jcsm.6974

Hidalgo, M.P., Caumo, W., Posser, M., Coccaro, S.B., Camozzato, A.L., & Chaves, M.L. (2009). Relationship between depressive mood and chronotype in healthy subjects. *Psychiatry and Clinical Neurosciences, 63*, 283-290. doi:10.1111/j.1440-1819.2009.01965.x

Hirshkowitz, M., Whiton, K., Albert, S.M., Alessi, C., Bruni, O., DonCarlos, L., . . . Adams Hillard, P.J. (2015). National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health, 1*, 40-43. doi:10.1016/j.sleh.2014.12.010

Honn, K.A., Hinson, J.M., Whitney, P., & Van Dongen, H.P.A. (2018). Cognitive flexibility: A distinct element of performance impairment due to sleep deprivation. *Accident Analysis and Prevention*. doi:10.1016/j.aap.2018.02.013

Horne, J.A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology, 4*, 97-110.

Howell, A., Digdon, N.L., Buro, K., & Sheptycki, A.R. (2008). Relations among mindfulness, well-being, and sleep. *Personality and Individual Differences, 45*, 773-777.

Hsu, C.Y., Gau, S.S., Shang, C.Y., Chiu, Y.N., & Lee, M.B. (2012). Associations between chronotypes, psychopathology, and personality among incoming college

students. *Chronobiology International, 29*, 491-501. doi:10.3109/07420528.2012.668995

Hull, S.K., DiLalla, L.F., & Dorsey, J.K. (2008). Prevalence of health-related behaviors among physicians and medical trainees. *Academic Psychiatry, 32*, 31-38. doi:10.1176/ appi.ap.32.1.31

IBM SPSS Statistics for Windows (Version 24.0). (2016). Armonk, NY: IBM Corp.

Jiang, X.L., Zheng, X.Y., Yang, J., Ye, C.P., Chen, Y.Y., Zhang, Z.G., & Xiao, Z.J. (2015). A systematic review of studies on the prevalence of insomnia in university students. *Public Health, 129*, 1579-1584. doi:10.1016/j.puhe.2015.07.030

Johns, M.W. (1991). A new method for measuring daytime sleepiness: The Epworth sleepiness scale. *Sleep, 14*, 540-545.

Johns, M.W. (1992). Reliability and factor analysis of the Epworth sleepiness scale. *Sleep, 15*, 376-381.

Johns, M.W. (2000). Sensitivity and specificity of the multiple sleep latency test (MSLT), the maintenance of wakefulness test and the Epworth sleepiness scale: Failure of the MSLT as a gold standard. *Journal of Sleep Research, 9*, 5-11. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/10733683.

Kalmbach, D.A., Pillai, V., Roth, T., & Drake, C.L. (2014). The interplay between daily affect and sleep: A 2-week study of young women. *Journal of Sleep Research, 23*, 636-645. doi:10.1111/ jsr.12190

Kaplowitz, M.D., Hadlock, T.D., & Levine, R. (2004). A comparison of web and mail survey response rates. *Public Opinion Quarterly, 68*, 94-101.

Kelley, P., Lockley, S.W., Foster, R.G., & Kelley, J. (2014). Synchronizing education to adolescent biology: 'Let teens sleep, start school later'. *Learning, Media and Technology, 40*, 210-226.

Kendzerska, T.B., Smith, P.M., Brignardello-Petersen, R., Leung, R.S., & Tomlinson, G.A. (2014). Evaluation of the measurement properties of the Epworth sleepiness scale: A systematic review. *Sleep Medicine Revviews, 18,* 321-331. doi:10.1016/ j.smrv.2013.08.002

Kenney, S.R., LaBrie, J.W., Hummer, J.F., & Pham, A.T. (2012). Global sleep quality as a moderator of alcohol consumption and consequences in college students. *Addictive Behaviours, 37,* 507-512. doi:10.1016/j.addbeh.2012.01.006

Kent de Grey, R.G., Uchino, B.N., Trettevik, R., Cronan, S., & Hogan, J.N. (2018). Social support and sleep: A meta-analysis. *Health Psychology, 37,* 787-798. doi:10.1037/hea0000628

Kessler, R.C., Andrews, G., Colpe, L.J., Hiripi, E., Mroczek, D.K., Normand, S.L., . . . Zaslavsky, A.M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine, 32,* 959-976.

Kessler, R.C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K.R., . . . Wang, P.S. (2003). The epidemiology of major depressive disorder: results from the National Comorbidity Survey Replication (NCS-R). *Journal of the American Medical Association, 289,* 3095-3105. doi:10.1001/jama.289.23.3095

Kim, S.J., Lee, Y.J., Kim, H., Cho, I.H., Lee, J.-Y., & Cho, S.-J. (2010). Age as a moderator of the association between depressive symptoms and morningness–eveningness. *Journal of Psychosomatic Research, 68*(, 159-164.

Kloss, J.D., Nash, C.O., Walsh, C.M., Culnan, E., Horsey, S., & Sexton-Radek, K. (2016). A "Sleep 101" program for college students improves sleep hygiene knowledge and reduces maladaptive beliefs about sleep. *Behavioural Medicine, 42*, 48-56. doi:10.1080/08964289.2014.969186

Kravitz, H.M., Zhao, X., Bromberger, J.T., Gold, E.B., Hall, M.H., Matthews, K.A., & Sowers, M.F.R. (2008). Sleep disturbance during the menopausal transition in a multi-ethnic community sample of women. *Sleep, 31*, 979-990.

Kyriacou, C.P., & Hastings, M.H. (2010). Circadian clocks: Genes, sleep, and cognition. *Trends in Cognitive Sciences, 14*, 259-267. doi:10.1016/j.tics.2010.03.007

Levenson, J.C., Miller, E., Hafer, B., Reidell, M.F., Buysse, D.J., & Franzen, P.L. (2016). Pilot study of a sleep health promotion program for college students. *Sleep Health, 2*, 167-174. doi:10.1016/j.sleh.2016.03.006

Levenson, J.C., Shensa, A., Sidani, J.E., Colditz, J.B., & Primack, B.A. (2017). Social media use before bed and sleep disturbance among young adults in the United States: A nationally representative study. *Sleep, 40*(9). doi:10.1093/sleep/zsx113

Lund, H.G., Reider, B.D., Whiting, A.B., & Prichard, J.R. (2010). Sleep patterns and predictors of disturbed sleep in a large population of college students. *The Journal of Adolescent Health, 46*, 124-132. doi:10.1016/j.jadohealth.2009.06.016

Maslowsky, J., & Ozer, E.J. (2014). Developmental trends in sleep duration in adolescence and young adulthood: Evidence from a national United States sample. *Journal of Adolescent Health, 54*, 691-697. doi:10.1016/j.jadohealth.2013.10.201

Meltzer, L.J., Phillips, C., & Mindell, J.A. (2009). Clinical psychology training in sleep and sleep disorders. *Journal of Clinical Psychology, 65*, 305-318. doi:10.1002/jclp.20545

Merikanto, I., Lahti, T., Kronholm, E., Peltonen, M., Laatikainen, T., Vartiainen, E., . . . Partonen, T. (2013). Evening types are prone to depression. *Chronobiology International, 30*, 719-725.

Millman, R.P. (2005). Excessive sleepiness in adolescents and young adults: Causes, consequences, and treatment strategies. *Pediatrics, 115*, 1774-1786. doi:10.1542/peds.2005-0772

Milojevich, H.M., & Lukowski, A.F. (2016). Sleep and mental health in undergraduate students with generally healthy sleep habits. *PloS One, 11*, e0156372. doi:10.1371/ journal.pone.0156372

Mindell, J.A., Bartle, A., Wahab, N.A., Ahn, Y., Ramamurthy, M.B., Huong, H.T., . . . Goh, D.Y. (2011). Sleep education in medical school curriculum: A glimpse across countries. *Sleep Medicine, 12*, 928-931. doi:10.1016/ j.sleep.2011.07.001

Minges, K.E., & Redeker, N.S. (2016). Delayed school start times and adolescent sleep: A systematic review of the experimental evidence. *Sleep Medicine Reviews, 28*, 86-95. doi:10.1016/j.smrv.2015.06.002

Mongrain, V., Carrier, J., & Dumont, M. (2005). Chronotype and sex effects on sleep architecture and quantitative sleep EEG in healthy young adults. *Sleep, 28*, 819-827.

Morin, C.M., Belleville, G., Belanger, L., & Ivers, H. (2011). The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep, 34*, 601-608.

Morin, C.M., LeBlanc, M., Bélanger, L., Ivers, H., Mérette, C., & Savard, J. (2011). Prevalence of insomnia and its treatment in Canada. *The Canadian Journal of Psychiatry, 56*, 540-548.

Morphy, H., Dunn, K.M., Lewis, M., Boardman, H.F., & Croft, P.R. (2007). Epidemiology of insomnia: A longitudinal study in a UK population. *Sleep, 30*, 274-280.

Murphy, M.J., Mermelstein, L.C., Edwards, K.M., & Gidycz, C.A. (2012). The benefits of dispositional mindfulness in physical health: A longitudinal study of female college students. *Journal of American College Health, 60*, 341-348. doi:10.1080/07448481.2011.629260

Mykletun, A., Stordal, E., & Dahl, A.A. (2001). Hospital Anxiety and Depression (HAD) scale: Factor structure, item analyses and internal consistency in a large population. *The British Journal of Psychiatry, 179*, 540-544.

Noland, H., Price, J.H., Dake, J., & Telljohann, S.K. (2009). Adolescents' sleep behaviors and perceptions of sleep. *Journal of School Health, 79*(5), 224-230.

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: What can be done? *Assessment & Evaluation in Higher Education, 33*(3), 301-314.

Nyer, M., Farabaugh, A., Fehling, K., Soskin, D., Holt, D., Papakostas, G.I., . . . Mischoulon, D. (2013). Relationship between sleep disturbance and depression, anxiety, and functioning in college students. *Depression and Anxiety, 30* 873-880. doi:10.1002/da.22064

O'Connell, S.E., Griffiths, P.L., & Clemes, S.A. (2014). Seasonal variation in physical activity, sedentary behaviour and sleep in a sample of UK adults. Annals of Human Biology, 41, 1-8. doi:10.3109/03014460.2013.827737

Oginska, H., & Pokorski, J. (2006). Fatigue and mood correlates of sleep length in three age-social groups: School children, students, and employees. *Chronobiology International, 23*, 1317-1328.

Ohayon, M.M., Zulley, J., Guilleminault, C., Smirne, S., & Priest, R.G. (2001). How age and daytime activities are related to insomnia in the general population: Consequences for older people. *Journal of the American Geriatric Society, 49*, 360-366. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11347777.

Onyper, S.V., Thacher, P.V., Gilbert, J.W., & Gradess, S.G. (2012). Class start times, sleep, and academic performance in college: A path analysis. *Chronobiology International, 29*, 318-335. doi:10.3109/07420528.2012.655868

Orzech, K.M., Grandner, M.A., Roane, B.M., & Carskadon, M.A. (2016). Digital media use in the 2 h before bedtime is associated with sleep variables in university students. *Computers in Human Behavious, 55*(A), 43-50. doi:10.1016/j.chb.2015.08.049

Orzech, K.M., Salafsky, D.B., & Hamilton, L.A. (2011). The state of sleep among college students at a large public university. *Journal of American College Health, 9*, 612-619. doi:10.1080/07448481.2010.520051

Otmani, S., Pebayle, T., Roge, J., & Muzet, A. (2005). Effect of driving duration and partial sleep deprivation on subsequent alertness and performance of car drivers. *Physiology & Behaviour, 84*, 715-724. doi:10.1016/j.physbeh.2005.02.021

Owens, H., Christian, B., & Polivka, B. (2017). Sleep behaviours in traditional-age college students: A state of the science review with implications for practice. *Journal of the American Association of Nurse Practitioners, 29*, 695-703.

Owens, M., Stevenson, J., Hadwin, J.A., & Norgate, R. (2012). Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory. *School Psychology International, 33*, 433-449.

Pabst, S.R., Negriff, S., Dorn, L.D., Susman, E.J., & Huang, B. (2009). Depression and anxiety in adolescent females: The impact of sleep preference and body mass index. *The Journal of Adolescent Health, 44*, 554-560. doi:10.1016/j.jadohealth.2008.11.012

Paine, S.J., Gander, P.H., & Travier, N. (2006). The epidemiology of morningness/eveningness: Influence of age, gender, ethnicity, and socioeconomic factors in adults (30-49 years). *Journal of Biological Rhythms, 21*, 68-76. doi:21/1/68

Peirce, R.S., Frone, M.R., Russell, M., Cooper, M.L., & Mudar, P. (2000). A longitudinal model of social contact, social support, depression, and alcohol use. *Health*

Psychology, 19, 28-38. Retrieved from https://www.ncbi.nlm.nih.gov/ pubmed/10711585.

Peltzer, K., & Pengpid, S. (2015). Nocturnal sleep problems among university students from 26 countries. *Sleep and Breathing, 19*, 499-508. doi:10.1007/s11325-014-1036-3

Polo-Kantola, P., Laine, A., Aromaa, M., Rautava, P., Markkula, J., Vahlberg, T., & Sillanpää, M. (2014). A population-based survey of sleep disturbances in middle-aged women–Associations with health, health related quality of life and health behavior. *Maturitas, 77*, 255-262.

Porter, S.R., & Whitcomb, M.E. (2005). Non-response in student surveys: The role of demographics, engagement and personality. *Research in Higher Education, 46,* 127-152.

Pressman, S.D., Jenkins, B.N., Kraft-Feil, T.L., Rasmussen, H., & Scheier, M.F. (2017). The whole is not the sum of its parts: Specific types of positive affect influence sleep differentially. *Emotion, 17*, 778-793. doi:10.1037/emo0000256

Quan, S., & Ziporyn, P. (2017). The impact of an online prematriculation sleep course (Sleep 101) on sleep knowledge and behaviours in college freshmen: A pilot study. *Southwest Journal of Pulmonary and Critical Care, 14*, 159-163.

Randler, C., & Schaal, S. (2010). Morningness-eveningness, habitual sleep-wake variables and cortisol level. *Biological Psychology, 85*, 14-18. doi:10.1016/j.biopsycho.2010.04.006

Rasch, B., & Born, J. (2013). About sleep's role in memory. *Physiological Reviews, 93*, 681-766. doi:10.1152/ physrev.00032.2012

Riedel, B.W., Durrence, H.H., Lichstein, K.L., Taylor, D.J., & Bush, A.J. (2004). The relation between smoking and sleep: The influence of smoking level, health, and psychological variables. *Behavioural Sleep Medicine, 2*, 63-78.

Rocha, F.L., Guerra, H.L., & Lima-Costa, M.F. (2002). Prevalence of insomnia and associated socio-demographic factors in a Brazilian community: The Bambui study. *Sleep Medicine, 3*, 121-126. doi:S1389945701001198

Rodrigues, M.F., Nardi, A.E., & Levitan, M. (2017). Mindfulness in mood and anxiety disorders: A review of the literature. *Trends in Psychiatry and Psychotherapy, 39*, 207-215. doi:10.1590/2237-6089-2016-0051

Ruffing, S., Hahn, E., Spinath, F.M., Brünken, R., & Karbach, J. (2015). Predicting students' learning strategies: The contribution of chronotype over personality. *Personality and Individual Differences, 85*, 199-204.

Rusch, H.L., Rosario, M., Levison, L.M., Olivera, A., Livingston, W.S., Wu, T., & Gill, J.M. (2018). The effect of mindfulness meditation on sleep quality: A systematic review and meta-analysis of randomized controlled trials. *Annals of the New York Academy of Sciences, 1445,* 5-16. doi:10.1111/nyas.13996

Russo, P.M., Leone, L., Penolazzi, B., & Natale, V. (2012). Circadian preference and the big five: The role of impulsivity and sensation seeking. *Chronobiology International, 29*, 1121-1126.

Sawilowsky, S.S. (2009). New effect size rule of thumb. *Journal of Modern Applied Statistical Methods, 8,* 26.

Sax, L.J., Gilmartin, S.K., & Bryant, A.N. (2003). Assessing response rates and nonresponse bias in web and paper surveys. *Research in Higher Education, 44*, 409-432.

Schlarb, A.A., Claßen, M., Hellmann, S.M., Vögele, C., & Gulewitsch, M.D. (2017). Sleep and somatic complaints in university students. *Journal of Pain Research, 10*, 1189-1199. doi:10.2147/JPR.S125421

Schutte-Rodin, S., Broch, L., Buysse, D., Dorsey, C., & Sateia, M. (2008). Clinical guideline for the evaluation and management of chronic insomnia in adults. *Journal of Clinical Sleep Medicine, 4*, 487-504. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18853708.

Schwarz, J., Axelsson, J., Gerhardsson, A., Tamm, S., Fischer, H., Kecklund, G., & Åkerstedt, T. (2018). Mood impairment is stronger in young than in older adults after sleep deprivation. *Journal of Sleep Research*, e12801. doi:10.1111/jsr.12801

Scott, K.M., Von Korff, M., Alonso, J., Angermeyer, M., Bromet, E.J., Bruffaerts, R., ... Williams, D. (2008). Age patterns in the prevalence of DSM-IV depressive/anxiety disorders with and without physical co-morbidity. *Psychological Medicine, 38*, 1659-1669. doi:10.1017/S0033291708003413

Selvi, Y., Aydin, A., Atli, A., Boysan, M., Selvi, F., & Besiroglu, L. (2011). Chronotype differences in suicidal behavior and impulsivity among suicide attempters. *Chronobiology International, 28*, 170-175. doi:10.3109/07420528.2010.535938

Selvi, Y., Gulec, M., Agargun, M.Y., & Besiroglu, L. (2007). Mood changes after sleep deprivation in morningness-eveningness chronotypes in healthy individuals. *Journal of Sleep Research, 16*, 241-244. doi:JSR596

Sheehan, K.B. (2001). E-mail survey response rates: A review. *Journal of Computer-Mediated Communication, 6*, JCMC621.

Sherbourne, C.D., & Stewart, A.L. (1991). The MOS social support survey. *Social Science and Medicine, 32*, 705-714. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/2035047.

Simor, P., Zavecz, Z., Pálosi, V., Török, C., & Köteles, F. (2015). The influence of sleep complaints on the association between chronotype and negative emotionality in young adults. *Chronobiol International, 32*, 1-10. doi:10.3109/07420528.2014.935786

Sivertsen, B., Vedaa, Ø., Harvey, A.G., Glozier, N., Pallesen, S., Aarø, L.E., . . . Hysing, M. (2019). Sleep patterns and insomnia in young adults: A national survey of Norwegian university students. *Journal of Sleep Research, 28*, e12790. doi:10.1111/jsr.12790

Skeldon, A.C., Derks, G., & Dijk, D.J. (2016). Modelling changes in sleep timing and duration across the lifespan: Changes in circadian rhythmicity or sleep homeostasis? *Sleep Medicine Reviews, 28*, 92-103.

Smith, M.T., & Wegener, S.T. (2003). Measures of sleep: The insomnia severity index, medical outcomes study (MOS) sleep scale, Pittsburgh sleep diary (PSD), and Pittsburgh sleep quality index (PSQI). *Arthritis Care & Research, 49*, S184-S196

Snaith, R.P., & Zigmond, A.S. (1986). The hospital anxiety and depression scale. *British Medical Journal (Clinical Research Edition), 292*, 344.

Statistics Canada. (2018, November 13). *Canadian Community Health Survey - Annual Component (CCHS).* Retrieved August 10, 2019 from http://www23.statcan.-gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226

Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of Neural Transmission, 116*, 777.

Taillard, J., Philip, P., Chastang, J.F., & Bioulac, B. (2004). Validation of Horne and Ostberg morningness-eveningness questionnaire in a middle-aged population of French workers. *Journal of Biological Rhythms, 19,* 76-86. doi:10.1177/0748730403259849

Taillard, J., Philip, P., Coste, O., Sagaspe, P., & Bioulac, B. (2003). The circadian and homeostatic modulation of sleep pressure during wakefulness differs between morning and evening chronotypes. *Journal of Sleep Research, 12,* 275-282. doi:369

Tavernier, R., & Willoughby, T. (2015). A longitudinal examination of the bidirectional association between sleep problems and social ties at university: The mediating role of emotion regulation. *Journal of Youth and Adolescence, 44,* 317-330. doi:10.1007/s10964-014-0107-x

Taylor, D.J., Bramoweth, A.D., Grieser, E.A., Tatum, J.I., & Roane, B.M. (2013). Epidemiology of insomnia in college students: Relationship with mental health, quality of life, and substance use difficulties. *Behavior Therapy, 44*, 339-348. doi:10.1016/j.beth.2012.12.001

Taylor, D.J., Gardner, C.E., Bramoweth, A.D., Williams, J.M., Roane, B.M., Grieser, E.A., & Tatum, J.I. (2011). Insomnia and mental health in college students. *Behavioural Sleep Medicine, 9*, 107-116. doi:10.1080/15402002.2011.557992

Tinajero, R., Williams, P.G., Cribbet, M.R., Rau, H.K., Bride, D.L., & Suchy, Y. (2018). Nonrestorative sleep in healthy, young adults without insomnia: Associations with executive functioning, fatigue, and pre-sleep arousal. *Sleep Health, 4*, 284-291. doi:10.1016/j.sleh.2018.02.006

Tonetti, L., Fabbri, M., & Natale, V. (2009). Relationship between circadian typology and big five personality domains. *Chronobiology International, 26*, 337-347.

Urbán, R., Magyaródi, T., & Rigó, A. (2011). Morningness-eveningness, chronotypes and health-impairing behaviors in adolescents. *Chronobiology International, 28*, 238-247. doi:10.3109/07420528.2010.549599

Van Dongen, H.P., Maislin, G., Mullington, J.M., & Dinges, D.F. (2003). The cumulative cost of additional wakefulness: Dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep, 26*, 117-126. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/12683469.

Vargas, P.A., Flores, M., & Robles, E. (2014). Sleep quality and body mass index in college students: The role of sleep disturbances. *Journal of American College Health, 62*, 534-541. doi:10.1080/07448481.2014.933344

Wallace, D.D., Boynton, M.H., & Lytle, L.A. (2017). Multilevel analysis exploring the links between stress, depression, and sleep problems among two-year college

students. *Journal of American College Health, 65*, 187-196. doi:10.1080/07448481.2016.1269111

Watson, N.F., Badr, M.S., Belenky, G., Bliwise, D.L., Buxton, O.M., Buysse, D., . . . Tasali, E. (2015). Recommended amount of sleep for a healthy adult: A joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. *Sleep, 38*, 843-844. doi:10.5665/sleep.4716

Whitney, P., Hinson, J.M., Jackson, M.L., & Van Dongen, H.P. (2015). Feedback blunting: Total sleep deprivation impairs decision making that requires updating based on feedback. *Sleep, 38*, 745-754. doi:10.5665/sleep.4668

WHO. (1992). *The ICD-10 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines.* Geneva: World Health Organization.

Wilckens, K.A., Woo, S.G., Kirk, A.R., Erickson, K.I., & Wheeler, M.E. (2014). Role of sleep continuity and total sleep time in executive function across the adult lifespan. *Psychology and Aging, 29*, 658-665. doi:10.1037/a0037234

Wittmann, M., Dinich, J., Merrow, M., & Roenneberg, T. (2006). Social jetlag: Misalignment of biological and social time. *Chronobiology International, 23*, 497-509. doi:TP463290637N5735

Wong, M.L., Lau, E.Y., Wan, J.H., Cheung, S.F., Hui, C.H., & Mok, D.S. (2013). The interplay between sleep and mood in predicting academic functioning, physical health and psychological health: A longitudinal study. *Journal of Psychosomatic Research, 74*, 271-277. doi:10.1016/j.jpsychores.2012.08.014

Yong, L.C., Li, J., & Calvert, G.M. (2017). Sleep-related problems in the US working population: Prevalence and association with shiftwork status. *Occupational and Environmental Medicine, 74*, 93-104. doi:10.1136/oemed-2016-103638

Yoo, S.S., Hu, P.T., Gujar, N., Jolesz, F.A., & Walker, M.P. (2007). A deficit in the ability to form new human memories without sleep. *Nature Neuroscience, 10*, 385-392. doi:10.1038/nn1851