SLEEP PROBLEMS, SLEEP HYGIENE, AND ATTENTION-DEFICIT/HYPERACTIVITY DISORDER (ADHD) SYMPTOMATOLOGY IN YOUNG ADULTS

by

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Abstract

Currently, little is known about the relationship between sleep problems and ADHD in adulthood because most research has focused either on children, or on a very narrow range of sleep variables (e.g., insomnia, nocturnal movements). Moreover, these studies have failed to take into account lifestyle choices that are inconsistent with the maintenance of good sleep quality, and daytime functioning. These lifestyle choices (collectively known as sleep hygiene) include behaviours such as substance abuse and poor sleep scheduling that have been reported by adults with ADHD. The central hypothesis of this research was that ADHD symptoms in young adults would be associated with sleep problems and sleep hygiene, and that poor sleep hygiene may account for the sleep problems of young adults with ADHD symptoms.

The first chapter of this dissertation provides an overview of ADHD in adulthood, and a review of the literature that has associated ADHD and sleep problems. This chapter also highlights the need to develop a valid and reliable instrument to assess sleep hygiene. The second chapter presents a manuscript which outlines the development of a new self-report measure of sleep hygiene in young adults. Exploratory and confirmatory factor analyses were used to develop two sleep hygiene scales (substance abuse and poor sleep scheduling) and overall results indicated that the new instrument has sound psychometric properties, as well as good construct and convergent validity. The third chapter presents a manuscript which outlines two empirical studies that examined the associations between sleep problems, sleep hygiene and ADHD symptoms in young adults. Results indicated that young adults with elevated ADHD symptoms reported more sleep problems (specifically insomnia and sleepiness) and poorer sleep hygiene
(specifically substance abuse and poor sleep scheduling) than young adults without elevated ADHD symptoms. Young adults with ADHD also reported more sleep problems even after accounting for substance abuse and poor sleep scheduling, suggesting that poor sleep hygiene is not responsible for the sleep problems of young adults with ADHD. The fourth chapter presents a summary of the research findings, as well as a discussion of the methodological limitations and directions for future research.
Statement of Originality

I hereby certify that all of the work described within this thesis is the original work of the author. Any published (or unpublished) ideas and/or techniques from the work of others are fully acknowledged in accordance with the standard referencing practices.

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CHAPTER 1

General Introduction

Overview of ADHD in Adults

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurobehavioral disorders of childhood. The American Psychiatric Association's Diagnostic and Statistical Manual (DSM-IV-TR) estimates that between 3% and 7% of school-aged children suffer from ADHD (American Psychiatric Association, 2000). ADHD is characterized by chronic problems with inattention and/or hyperactivity and impulsivity which interfere with daily functioning in different settings (e.g., at work or school), and with social interactions (American Psychiatric Association, 2000; Barkley, 1990, 1997; Hallowell & Ratey, 1994).

Although ADHD is classified in the DSM-IV-TR as a disorder of infancy, childhood and adolescence, it is generally accepted that symptoms of ADHD can persist into adulthood. Clinicians first described ‘adult hyperactives’ and patients with ‘attention deficit disorder, leaving a residue’ in the 1970s. It is now estimated that between 50% and 60% of children with ADHD continue to manifest symptoms as adults (Wender, 1998), however, estimates as low as 30%, and as high as 70% have been reported (American Psychiatric Association, 1994; Barkley, 1990; Searight, Burke, & Rottnek, 2000). As compared to the plethora of literature on ADHD in children, relatively less research has focused on ADHD in adults (Weiss & Hechtman, 1986; Weiss, Hechtman, & Weiss, 1999).
Three ADHD subtypes are identified in the DSM-IV-TR according to which symptoms are strongest in the individual. The predominantly inattentive subtype has difficulty finishing tasks, paying attention to details, and following conversations. The predominantly hyperactive-impulsive subtype fidgets, is physically restless, and talks a lot. These individuals find it hard to sit still, feel restless and are impulsive. They interrupt others, find it hard to wait their turn, and listen to directions. The combined subtype has symptoms of both the inattentive and hyperactive-impulsive subtypes. If one of the two types is predominant, the individual is identified as either predominantly-inattentive type, or predominantly hyperactive-impulsive type (American Psychiatric Association, 2000). To receive an ADHD diagnosis, an individual must have at least six of nine symptom criteria for either the inattentive or hyperactive-impulsivity subtypes. A combined diagnosis requires six symptoms across both inattentive and hyperactive-impulsive symptom domains. The symptoms must also have been present for at least six months, cause functional impairments in two or more settings, and have their onset in childhood before seven years of age (American Psychiatric Association, 2000).

ADHD in adulthood is currently conceptualized as a continuation of the childhood disorder, and the diagnosis requires a childhood history (Barkley, 1990). The symptoms are similar in adults and children, with a few notable differences. Hyperactivity symptoms appear to decrease with age, and adults report more “restlessness” than hyperactivity. Adults with ADHD claim that they are “always on the go”. Others may describe these individuals as “draining” because they are unable to take a moment to relax (Weiss et al., 1999). Symptoms of inattention in adults with ADHD may present as forgetting to pay bills or taxes, or finishing other important paperwork.
Further, adults with ADHD are careless with their personal items and often forget their keys, wallets, or purses; they even lose their children in some situations. Symptoms of impulsivity in adults with ADHD may include inappropriate spending, quitting jobs, substance abuse, or sudden lifestyle changes (Weiss et al., 1999). Arguably, the expression of impulsivity varies more in adults than children, because adults have more behavioural options in which they can choose to engage.

Adults with ADHD also have deficits in social and emotional competencies, and they have difficulty maintaining healthy interpersonal relationships (Spencer, Biederman, & Mick, 2007). They are often described by others as rude, impolite and impatient (Barkley, 1990). Weiss and Hechtman (1986) reported that 75% of adults with ADHD have particular difficulty with heterosocial assertiveness, and social interactions. Their interpersonal problems also extend into academic and occupational settings. Because they lack concentration and organizational skills, adults with ADHD typically underachieve in school, and at work. In school, they get lower grades, fail more classes, and are more likely to drop out than other students (Weiss & Hechtman, 1986). On average, adults with ADHD have two fewer years of high school education compared to their non-disabled peers (Weiss et al., 1999). On the job, they have more problems with co-workers, absenteeism, and lateness. Employers also rate them as less competent and less able to work unsupervised relative to their co-workers. They change jobs and residences frequently, and are often of lower socio-economic status (Barkley, 1990). In short, adults with ADHD have impairments in several areas of interpersonal, academic and occupational functioning.
To date, most of the literature on sleep and ADHD has focused on children (Corkum, Tannock, & Moldofsky, 1998). Evidence from self-report measures indicates that children with ADHD have more difficulty falling asleep, staying asleep, and getting up in the morning than normal children. They also have a higher incidence of restless sleep, nightmares, night terrors and daytime sleepiness. Higher nocturnal motor activity in ADHD children has also been demonstrated using actigraphy and nocturnal polysomnography (LeBourgeois, Avis, Mixon, Olmi, & Harsh, 2004; Tirosh, Sadeh, Munvez, & Lavie, 1993). Variable sleep latency, increased total sleep time, poor sleep efficiency, and alterations in REM sleep have also been reported in children with ADHD (Kirov et al., 2004; Palm, Persson, Bjerre, Elmqvist, & Blennow, 1992; Ramos-Platon, Vela-Bueno, Espinar-Sierra, & Kales, 1990). Increased slow-wave sleep and sleep spindles have also been found in a small number of studies (Kiesow & Surwillo, 1987; Ramos-Platon et al., 1990). Corkum, Moldofsky, Hogg-Johnson, Humphries, and Tannock (1999) argued that most of the research with children has been limited by small sample sizes, inconsistent diagnostic criteria, and flawed methodology. The relationship between ADHD and sleep is further confounded by the common use of stimulants (e.g., methylphenidate) to treat children with this disorder (Corkum et al., 1999; Stein et al., 2002). The side-effects of stimulant treatment on the sleep of children with ADHD may include delayed sleep onset, increased nocturnal awakenings, and shortened sleep duration (Corkum et al., 1999; Mick, Biederman, Jetton, & Faraone; Owens, 2005).

Some researchers believe that ADHD involves a disregulation in arousal, which results in sleep disturbances, specifically increased nocturnal movements and arousals.
during sleep (see Owens, 2005 for review). However, this hypothesis is not universally accepted. Other researchers have argued that ADHD symptoms are secondary to a primary sleep disorder (Dahl, Pelham, & Worsen, 1991; Picchietti & Walters, 1994; Sheldon et al., 1991) and therefore can be eliminated if the sleep disorder is effectively treated. Furthermore, Barkley (1990) speculated that sleep disturbances lead to sleep deprivation that exacerbates daytime symptoms of inattention, impulsivity and hyperactivity. At present, it is not known if ADHD results in sleep disturbance, or if sleep problems result in the expression of ADHD symptoms.

Some self-report measures of ADHD have items related to sleep disturbance. One of the most commonly used scales for children is the Conners Parent Rating Scales (Conners, 1997), which requires that parents indicate if their child is bothered by “problems with sleep” (e.g., “can’t fall asleep, up too early, and up in the night”). The Child Behavior Checklist Parent Form (Achenbach & Edelbrock, 1993) has items related to daytime sleepiness, nightmares, sleep quantity (e.g., “sleeps less than most children”), and nocturnal enuresis (e.g., “wets the bed”). The Adult Self-Report Inventory-4 (Gadow, Sprafkin, & Weiss, 1998) has items that assess daytime sleepiness (e.g., “I fall asleep when I don’t want to”), sleep quantity (e.g., “I need very little sleep”), nightmares (e.g., “I have frightening dreams”), and sleep quality (e.g., “I have trouble sleeping”).

Clinicians have also reported sleep disturbances in adults with ADHD (Barkley, 1990). For example, Brown and McMullen (2001) noted difficulty falling asleep, difficulty awakening in the morning, and daytime sleepiness in adults with ADHD. Adults with ADHD often report feeling drowsy, even when they appear to have had adequate sleep. They fall asleep easily during quiet, or un-stimulating activities (e.g.,
sitting in a lecture, reading a book, monotonous driving). They take frequent breaks, move around, or do something stimulating to avert falling asleep during boring activities. Brown and McMullen (2001) suggested that adults with ADHD have particular difficulty sustaining arousal and attention in un-stimulating environments.

One of the first empirical studies to examine sleep problems in adults with ADHD was conducted in the Netherlands (Dodson & Zhang, 1999). Of 219 adults with ADHD surveyed, 83% reported restless sleep. Sleep onset difficulties and difficulty awakening were reported in 72% and 70% of respondents, respectively (Dodson & Zhang, 1999). These findings suggest that ADHD may be associated with insomnia because sleep onset difficulties and restless sleep (as well as feeling tired in the morning) are central features of the latter disorder. However, it is difficult to speculate as to the underlying cause of the general sleep complaints assessed in the Dodson and Zhang (1999) study because the symptoms are characteristic of several sleep disorders (e.g., sleep apnea, narcolepsy, insomnia) and are reported frequently by patients with other mental and physical illnesses (e.g., depression, anxiety disorders, fibromyalgia).

Recently, Schedl, Alm, and Sobanski (2008) examined the association between ADHD and self-reported sleep complaints in a sample of adults with ADHD ($N = 120$) who were receiving treatment at an outpatient clinic. Patients completed three sleep questionnaires and a German translation of the Brown Attention Deficit Disorder Scales (BADDs; Brown, 1996) to measure ADHD symptoms. As compared to non-ADHD controls, ADHD patients reported more sleep problems including insomnia (poor sleep quality, nocturnal awakenings, increased sleep latency), problems with sleep wake pattern, parasomnias, movement disorders, and sleepiness (tiredness during the day,
feeling unrefreshed in the morning). ADHD symptom severity was significantly associated with symptoms of insomnia (including increased sleep latency, nocturnal awakenings, and poor sleep quality) and sleepiness (feeling un-refreshed in the morning, tiredness during the day). These associations between ADHD symptoms severity and sleep symptoms were significant even after partilling out the variance accounted for by age, gender, and depression. Schredl et al. (2008) concluded that their findings support that ADHD may be genuinely associated with sleep disorders in adults, and that ADHD symptomatology is most strongly related to reduced sleep quality and feeling unrefreshed in the morning following nocturnal sleep.

However, this study has noteworthy limitations. First, sleep problems were operationalized using self-report measures that have unknown psychometric properties and questionable reliability and validity. Second, the authors failed to report the correlations among the various independent variables entered into the regression analyses, and many of these variables appear to be highly related (e.g., feeling unrefreshed in the morning, tiredness during the day, poor sleep quality). Regression should be conducted with independent variables that are strongly correlated to the dependent variable, but uncorrelated with other independent variables. Independent variables that are too highly correlated to one another can inflate the regression coefficients, and also signal violations of the statistical assumptions for conducting multiple regression (Tabachnick & Fidell, 1996). Furthermore, a regression should be conducted with the fewest variables that are necessary to predict a dependent variable because the resulting solution is extremely sensitive to the combination of variables that were included in it (Tabachnick & Fidell, 1996). Schredl et al. entered several covariates
(e.g., medication intake, current substance abuse, age, smoking, ADHD in a family member) into the regressions without explaining the need to partial out their variance, and without first establishing that these variables contributed any significant variance to the solution. However, despite these limitations, findings provided preliminary evidence that adults with ADHD have sleep problems, in particular symptoms of insomnia, and daytime sleepiness.

The association between ADHD symptomatology and sleep complaints has also been investigated in non-clinical samples. Kass, Wallace, and Vodanovich (2003) examined the relationship between ADHD symptoms, sleep complaints and boredom proneness in 148 university students (the mean age of the sample was 22.70 years). Scores on the Epworth Sleepiness Scale (ESS) and the Athens Insomnia Scale (AIS) as well as the Boredom Proneness Scale (BPS) were used to predict Adult Behaviour Checklist (ABC) scores. The ABC is an 18-item measure that assesses the DSM-IV symptoms of inattention and hyperactivity that are relevant to an adult diagnosis of ADHD. Regression analyses were conducted separately with the inattention and hyperactivity subscales of the ABC as the dependent variables. The ESS scores ($r = .61$) and AIS scores ($r = .47$) were significant predictors of the inattention subscale of the ABC. The ESS scores were also a significant predictor of the hyperactivity scores of the ABC ($r = .53$).

In addition, Gau et al. (2007) recently examined the association between sleep disorders and related problems and ADHD symptoms in a large sample ($N = 2284$) of Taiwanese students in their first year of university. Using an unvalidated questionnaire to assess sleep disorders, Gau et al. (2007) found that students with elevated ADHD scores
reported higher rates of current and lifetime sleep disorders (including insomnia, nightmares, sleep terrors and sleepwalking) than students without elevated ADHD scores. Students with elevated ADHD scores also reported a higher need for sleep to maintain optimal functioning and a greater discrepancy between obtained and needed sleep; findings that suggest sleepiness and poor sleep quality in this group.

The findings from Kass et al. (2003) and Gau et al. (2007) demonstrated an important relationship between ADHD symptoms and sleep problems in non-clinical samples. However, the methods were correlational, and causation cannot be inferred from the findings. For example, one might speculate that ADHD is the underlying cause of the association between inattention and insomnia symptoms; however the reverse is also possible. It is also possible that an underlying sleep disorder such as sleep apnea or periodic limb movements is responsible for the both inattention and insomnia symptoms. The relationship can also be caused or mediated by some other factor that has not yet been indentified. Moreover, it is difficult to generalize across the two studies because they each assessed slightly different sleep-related variables. Arguably, few conclusions about ADHD can be reached from studies using self-reported symptoms and non-clinical samples alone. However, the examination of ADHD symptoms in non-clinical groups is an important component of the research process because it provides a convenient and efficient way to investigate the underlying processes which may account for the associations between ADHD symptoms and sleep problems.

It is important to note that ADHD symptoms overlap with symptoms of several sleep disorders, including sleep apnea, narcolepsy and periodic limb movement disorder (Brown & McMullen, 2001). Ball, Wooten, and Crowell (1999) addressed the similarities
between daytime symptoms of breathing-related disorders, such as obstructive sleep apnea (OSA) and ADHD. Like adults with ADHD, patients with OSA have cognitive deficits such as inattention, difficulty concentrating and planning, and impaired memory function. Patients with OSA also report restlessness, irritability, and affect lability. In addition, both adults with ADHD and OSA patients have increased rates of motor vehicle crashes (Ball et al., 1999).

In a recent study, Sangal and Sangal (2004) examined snoring, sleepiness, and ADHD symptoms in 56 adults that had been referred to a sleep center for assessment. All patients in their sample reported snoring and sleepiness complaints, and eighteen patients had a childhood history of inattention. Although they found that sleepiness (as assessed by the Epworth Sleepiness Scale; ESS) was higher in the patients with breathing-related sleep disorders compared to adults with a childhood history of inattention, ESS scores were significantly related to inattention ($r = .49$) and hyperactivity/impulsivity ($r = .36$) symptoms. These findings suggest that ADHD symptoms in adults are related to increased daytime sleepiness, and risk of dozing off in a variety of situations (e.g., sitting and reading, watching TV, as a passenger in a car).

The overlap between ADHD symptoms and breathing-related sleep disorders has also been discussed in a few case reports. For example, Ball et al. (1999) presented case reports of six male patients (20-50 years of age) who were being treated for ADHD prior to receiving a diagnosis and treatment for obstructive sleep apnea (OSA) from a sleep centre. All of the patients reported improved ADHD symptoms following treatment for OSA, which included continuous positive airway pressure (CPAP) therapy. Specifically,
irritability and sleepiness decreased and concentration and memory improved following OSA treatment.

More recently, Nasseem, Chaudhary, and Collop (2004) presented case reports of three adults with ADHD with co-morbid obstructive sleep apnea. Of particular relevance are the two patients (one man, one woman) who were being treated for ADHD with methylphenidate prior to receiving treatment for OSA. These patients were started on CPAP treatment for their breathing-related disorder, and also showed significant subjective improvement in ADHD symptoms (daytime sleepiness and short attention span). Moreover, both patients were weaned from methylphenidate within a year of starting on CPAP therapy.

Polysomnographic studies of adults with ADHD

Only a few studies have used objective measures such as nocturnal polysomnography to assess the sleep of adults with ADHD. Polysomnography is usually conducted in a sleep laboratory, and includes three measures to assess state and determine sleep stages: electro-encephalogram (EEG), electro-occulogram (EOG), and submental electromyogram (EMG). During a typical polysomnogram, respiratory effort, airflow at the nose and mouth, oxyhemoglobin saturation, electro-cardiogram (ECG), and leg movements are also assessed continuously throughout the night. Additional sensors may be used to monitor carbon dioxide (CO$_2$), snoring, and intrathoracic pressure, as well as audio and video equipment to assess body position and monitor the behaviour of a patient (or research participant).

A polysomnographic study was conducted by Lindberg et al. (2004) and compared the sleep of 14 men with ADHD symptoms and anti-social personality disorder
to that of healthy controls, using conventional sleep-stage scoring and EEG sleep spectral analysis. The participants were incarcerated repeat violent offenders who were sent for pre-trial psychiatric evaluations at a university psychiatric hospital in Finland. Lindberg et al. (2004) found a strong positive correlation between subjects’ retrospective reports of childhood ADHD symptoms (as assessed by the Wender-Utah Rating Scale for ADHD; WURS) and the amount and percentage of age-adjusted Stage 4 sleep. The ADHD group also had significantly higher EEG delta and theta power than the control group. The Lindberg et al. (2004) findings support the view that ADHD symptomatology may be related to sleep architecture abnormalities, at least in adults with co-morbid antisocial personality disorder. However, this study is limited by a very small sample of men that were repeat violent offenders. Based on the methodology used, Lindberg et al. (2004) were unable to determine if sleep EEG abnormalities are a result of ADHD, antisocial personality disorder, or some other factor. The participants in the experimental group also met the DSM IV criteria for Cloninger type 2 alcoholism, but were abstinent for several months due to incarceration. In addition, this study is limited by the use of the WURS, an instrument that does not assess current ADHD symptoms, but requires respondents to recall childhood experiences and symptomatology.

Philipsen et al. (2005) conducted a controlled polysomnographic study and compared the sleep of 20 adult patients with ADHD with gender and age-matched controls. Participants spent two consecutive nights in the laboratory and standard polysomnographic parameters were calculated. Participants also completed two self-report sleep measures, including a German translation of the Pittsburg Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman & Kupfer, 1989) and an unpublished
German sleep questionnaire that assessed sleep quality, the restorative value of sleep, evening mood, fatigue in the evening, and psychosomatic symptoms at sleep onset (e.g., palpitations, leg movements). Sleep efficiency was also calculated using self-reported estimates of sleep latency and nocturnal wake time after initial sleep onset.

Philipsen et al. (2005) found no significant differences in sleep architecture (e.g., sleep latency, stages of sleep, sleep efficiency, total sleep time) between ADHD patients and non-ADHD controls. The only objective difference between groups was higher periodic limb movements with and without arousals in ADHD patients as compared to controls. With respect to self-reported sleep parameters, the ADHD group reported lower sleep quality, restorative value of sleep, and evening mood, and more sleepiness and psychosomatic symptoms at sleep onset than non-ADHD controls. Philipsen et al. (2005) argued that their data support the view that individuals with ADHD suffer from a sleep state misperception (i.e., reduced sleep quality and relatively normal objective physiological sleep parameters). However, this conclusion may be unjustified given that they found higher nocturnal movements and arousal in ADHD patients compared to controls. Although movements and arousals are not structural differences, they can decrease sleep quality, and thereby explain the higher self-reported sleep complaints reported in the ADHD group. In addition, the ADHD groups did not differ on several sleep parameters that would be expected with sleep-state misperception. For instance, the ADHD groups did not differ on self-reported estimates of sleep efficiency, sleep onset latency, and wake time after onset (Morin & Espie, 2003). Conclusions can also be challenged because the ADHD group was composed of individuals with several co-
morbid mental disorders (e.g., depression, substance abuse, anxiety, eating disorders) that may have influenced results.

In a more recent study, Sobanski et al. (2008) compared the polysomnographic sleep records of 34 unmedicated patients with ADHD and 34 age and gender matched controls in an open-label study of sleep effects of drug treatment with methylphenidate (Ritalin). Untreated patients with ADHD had lower sleep efficiency, more awakenings, and higher periodic limb movements than controls. With respect to sleep architecture, untreated patients had less REM sleep and lower REM density than controls, as well as more stage 1 (i.e., light sleep) and wake time after initial sleep onset. Contrary to earlier findings reported by Lindberg et al. (2004), the ADHD groups did not differ in amount of stages 3 and 4 (i.e., deep sleep). Group differences were also found on self-reported sleep measures, and the ADHD group reported significantly longer sleep latencies and more frequent awakenings during the night than the control group. Unlike previous findings reported by Schredl et al. (2008), there were no differences in self-reports of sleep quality or feeling refreshed in the morning between the ADHD and control groups. Taken together, these findings suggest that patients with ADHD have lower sleep efficiencies than healthy controls as a result of elevated movements and awakenings during the night, which may account for the higher sleep complaints reported by ADHD patients. However, these findings must be interpreted cautiously because this study was conducted with a relatively small sample, and several patients had comorbid mental disorders that may have affected the results.

To summarize, adults with elevated ADHD symptomatology have reported sleep complaints, including symptoms of insomnia (e.g., difficulty falling asleep and staying
asleep) and daytime sleepiness (e.g., difficulty awakening in the morning, daytime drowsiness, falling asleep during un-stimulating activities). The few polysomnographic studies that have examined the sleep of adults with ADHD have failed to identify structural sleep abnormalities (e.g., sleep stages, distribution) that might account for elevated self-reported sleep complaints in adults with ADHD. However, these studies provided some evidence of more nocturnal awakenings, movements and arousal in adults with ADHD. It is possible that these nocturnal events cause some sleep disruption which translates into subjective feelings or having slept poorly and increased daytime sleepiness in adults with ADHD.

Sleep Hygiene and ADHD

A notable limitation in the literature on sleep and ADHD is that it has failed to take into account the influence of sleep hygiene in the development and maintenance of sleep problems. Sleep hygiene refers to a collection of behaviours and environmental conditions that are consistent with the maintenance of good quality sleep, and daytime alertness. The International Classification of Sleep Disorders Diagnostic and Coding Manual (ICSD) identified two broad categories of sleep hygiene: behaviours and environmental conditions that increase arousal, or are inconsistent with the principles of sleep organization (American Sleep Disorders Association, 1997). Examples of behaviours that increase arousal include using stimulants (e.g., caffeine, nicotine) and drinking alcohol. Examples of behaviours that are inconsistent with the principles of sleep organization are poor sleep scheduling, excessive time in bed, and disrupted routines (American Sleep Disorders Association, 1997; Cheek, Shaver, & Lentz, 2004; Lacks & Rotert, 1986; Morin, 1993; Morin & Espie, 2003).
Although classified in the ICSD as an extrinsic dysomnia, poor sleep hygiene is conceptualized as a primary cause of, or contributing factor to, the maintenance of various sleep disorders. For this reason, education about sleep hygiene is often included in behavioural treatment for sleep disorders; most commonly with insomnia (Bootzin & Rider, 1997; Morin, 1993). Factors are identified that may contribute to an individual’s insomnia (e.g., caffeine intake, excessive time in bed) and interventions implemented to reduce their impact on sleep. The effectiveness of sleep hygiene education to treat insomnia has been debated (e.g., Cheek, Shaver, & Lentz, 2004; Harvey, 2000; Lacks & Morin, 1992; Lacks & Rotert, 1986; Schoicket, Bertelson, & Lacks, 1988). However, it is difficult to generalize across these studies because of the different methodologies, samples and the lack of an objective or reliable measure of sleep hygiene. Clinicians continue to recommend using sleep hygiene education as part of a multifaceted treatment plan (Bilsbury & Rajda, 2004; Brown, Buboltz, & Soper, 2002; Ellis, Hampson, & Cropley, 2002; Harvey, 2000).

In non-clinical samples, there is evidence that sleep hygiene is involved in the development and maintenance of sleep problems in young adults. For example, Brown et al. (2002) found that sleep hygiene practices were associated with self-reported poor sleep quality in a large sample of university students. Interestingly, although sleep hygiene was correlated with sleep quality, knowledge of sleep hygiene was not related to sleep quality. This suggests that even though young adults know what behaviours can improve their sleep, they do not necessarily engage in them. Likewise, they may continue to engage in behaviours they know can disrupt their sleep.
To date, there are no published studies that address whether sleep hygiene is involved in the sleep problems of adults with ADHD. Brown and McMullen (2001) noted that patients with ADHD frequently had inadequate sleep routines, or they lacked “wind-down” time in the evening. For example, adults with ADHD were easily distracted at nighttime by stimulating activities that were inconsistent with sleeping (e.g., surfing the internet, socializing). Some patients reported a lifelong pattern of alertness and feeling more energized, and ready to work or socialize in the evening, rather than in the daytime. The authors did not speculate as to what may have caused this pattern of nocturnal arousal in individuals with ADHD, which could be related to intrinsic factors (e.g., delayed phase circadian rhythm) or extrinsic factors (e.g., poor sleep scheduling).

Brown and McMullen (2001) noted that ADHD patients also self-medicated with alcohol (or drugs) to facilitate sleep onset, or to reduce sleep disruption. However, using alcohol as a strategy to promote sleep is generally ineffective, because drinking alcohol significantly disrupts sleep (Landolt, Roth, Dijk, & Borbely, 1996). Because adults with ADHD are more likely to smoke, abuse alcohol and other substances (e.g., marijuana, cocaine) they may be at particular risk for alcohol or drug-related or sleep disturbances (Biederman et al., 1995; Faraone, Biederman, Wilens, & Adamson, 2007; Wilens, 2004). Currently, only Brown and McMullen (2001) have specifically discussed the sleep hygiene of adults with ADHD, and empirical studies have not yet been conducted to support their clinical observations. Therefore, the research presented in this dissertation provides an important contribution to the ADHD literature by investigating the relationships between sleep hygiene, sleep problems and ADHD symptoms in young adults.
The central hypothesis of this research was that ADHD symptoms in young adults would be associated with self-reported sleep problems and poor sleep hygiene, and that poor sleep hygiene may be responsible for the sleep problems of young adults with elevated ADHD symptoms. The hypothesis was based on the theory that sleep problems may not be intrinsic to ADHD, but rather may result from extrinsic factors, and specifically in young adults, poor sleep hygiene behaviours. It was predicted that adults with elevated ADHD symptoms would report more sleep problems and poorer sleep hygiene than adults without elevated levels of ADHD symptoms. Furthermore, because sleep hygiene has been conceptualized to cause and contribute to the maintenance of various sleep problems, it was predicted that poor sleep hygiene would account for the sleep symptoms in adults with elevated ADHD symptomatology.

Presently, there are no established measures of sleep hygiene. Therefore, in order to examine the relationship between sleep hygiene, sleep problems and ADHD symptoms, a valid and reliable instrument needed first to be developed to assess sleep hygiene. The second chapter of this dissertation presents a manuscript which outlines the development of a new self-report measure of sleep hygiene in young adults. Items were generated using ICSD criteria and exploratory factor analyses were used to develop a model of sleep hygiene in young adults. Young adults were used to develop the instrument because the overall goal was to assess the relationship between sleep problems, sleep hygiene and ADHD symptoms in young adults, and therefore a representative sample was needed to derive the initial measurement model. The study also examined whether the factor model could be replicated using confirmatory factor
analysis in a second, independent sample of young adults, as well as the concurrent and predictive validity of the new sleep hygiene scales.

The third chapter of this dissertation presents a manuscript that outlines two empirical studies that were conducted to examine whether ADHD symptoms were associated with self-reported sleep problems and poor sleep hygiene. In the first study, the analyses focused on the associations between sleep hygiene, sleep problems and ADHD symptomatology in a large non-clinical sample of young adults. Furthermore, because the symptom domains assessed by the Conners Adult ADHD Rating Scales (CAARS; Conners, Erhart, & Sparrow, 1998) are not specific to ADHD, but are also associated in some degree with a variety of other disorders (e.g., anxiety disorders, substance abuse disorders, post-traumatic stress-disorders), it was important to replicate the findings in a clinical sample of adults with a confirmed ADHD diagnosis. In the second study, sleep hygiene and sleep problems were examined in a clinical sample of young adults with ADHD that were receiving counseling and treatment services at a university health and counseling centre.

Unlike previous research that used unpublished instruments with questionable psychometric structures, we used the Sleep Problems Inventory (SPI; Bauermann, Parker, & Smith, 2000; Bauermann et al., 2002), a multidimensional sleep measure that allowed us to examine the specific influence of symptoms of insomnia, sleepiness, nightmares and sleepwalking. An additional benefit of the current methodology was the use of the CAARS to assess ADHD symptoms. This measure has demonstrated good reliability and validity, (Conners et al., 1999; Erhardt, Epstein, Parker, & Sitarenios, 1999), and also
allowed us to examine the link between sleep problems and sleep hygiene and separate dimensions of inattention and hyperactivity/impulsivity symptomatology.

The fourth chapter of this dissertation provides a general discussion of the key findings of this research in the broader context of the existing literature on sleep and ADHD. This chapter also outlines methodological limitations and directions for future research, based on the findings presented in this dissertation.


CHAPTER 2

Measuring Sleep Hygiene in Young Adults: Scale Development and Construct Validation of the Sleep Problems Inventory (SPI) Sleep Hygiene Scales

Acknowledgments

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Abstract

This study presents the creation and validation of a new brief self-report measure of sleep hygiene for young adults. Young adults ($N = 363$) completed an initial pool of sleep hygiene items and exploratory factor analysis of their responses demonstrated two unique sleep hygiene factors: substance abuse and poor sleep scheduling. The two-factor model of the 14 sleep hygiene items was replicated using confirmatory factor analysis in a second independent sample of young adults ($N = 367$). Convergent validity for the new instrument was provided by the significant relationships between the sleep hygiene scales and insomnia and sleepiness symptoms. Overall, the new instrument demonstrated good psychometric properties, and shows promise as research and clinical tool to assess sleep hygiene in young adults.
Sleep problems affect more than one third of the adult population. The detrimental effects of sleep problems cost billions in health care expenses, and lost productivity annually (Hossain & Shapiro, 2002; Lamberg, 2004; Neylan, Reynolds, & Kupfer, 2003). Individuals with sleep problems make more visits to doctors and emergency rooms, and use more medications than do good sleepers (Hatoum, Kong, Kania, Wong, & Mendelson, 1998). Sleep problems, whether the direct result of a sleep disorder or a comorbid condition, have been associated with substantial work-related costs, including lower job performance, and higher absentee and injury rates (Kuppermann et al., 1995; Roth et al., 2006). The social and financial costs are even greater when one considers the many mental and physical problems that produce or exacerbate sleep problems (e.g., mood and anxiety disorders, substance abuse, chronic pain, fibromyalgia, etc.) and motor vehicle crashes attributed to sleep disorders (Benca, Obermeyer, Thisted, & Gillin, 1992; Goldsmith, Casola, & Varenbut, 2006; Leger, 1994; Pack & Pien, 2004; Sassani, et al., 2004).

Given these elevated social and economic costs, it is not surprising that increased attention has been directed towards factors that contribute to the development and maintenance of sleep problems. Inadequate sleep hygiene has been conceptualized as a primary cause of, or contributing factor to, the maintenance of various sleep disorders. Sleep hygiene refers to a collection of behaviours and environmental conditions that are consistent with the maintenance of good quality sleep, and daytime alertness. The International Classification of Sleep Disorders Diagnostic and Coding Manual (ICSD) identified two broad categories of sleep hygiene: behaviours and environmental
conditions that increase arousal, or conditions that are inconsistent with the principles of sleep organization. Examples of behaviours that increase arousal include using stimulants (e.g., caffeine, nicotine) and drinking alcohol. Examples of factors that are inconsistent with the principles of sleep organization are poor sleep scheduling, excessive time in bed, and disrupted routines (American Sleep Disorders Association, 1997; Cheek, Shaver, & Lentz, 2004; Lacks & Rotert, 1986; Morin, 1993).

In both clinical and non-clinical samples, there is evidence that sleep hygiene is involved in the development, and maintenance of sleep problems. For example, Brown, Buboltz, and Soper (2002) found that poor sleep hygiene practices were associated with self-reports of poor sleep quality \( r = .49 \) in 124 university students. Education about sleep hygiene is often included in behavioural treatment for sleep disorders, most commonly with insomnia (Bootzin & Rider, 1997; Morin, 2000; Morin & Espie, 2003). Factors are identified that may contribute to an individual’s insomnia (e.g., caffeine intake, excessive time in bed) and interventions are suggested to reduce their impact on sleep. The direct effect of sleep hygiene on sleep is unknown, and the effectiveness of sleep hygiene education to treat insomnia has generated debate in the literature (e.g., Cheek et al., 2004; Harvey, 2000; Hoch et al., 2001; Lacks & Morin, 1992; Lacks & Rotert, 1986; Schoicket, Bertelson, & Lacks, 1988). It is difficult to generalize across studies because of diverse samples and methodologies, and many clinicians continue to recommend using sleep hygiene education as part of a multifaceted treatment plan for insomnia (Bilsbury & Rajda, 2004; Brown et al., 2002; Ellis, Hampson, & Cropley, 2002; Harvey, 2000).
At the present time, there are no established measures of sleep hygiene. Most researchers have employed structured interviews, sleep diaries or unpublished instruments to screen patients or document sleep hygiene behaviors. The lack of methodological rigor in the area of sleep hygiene assessment is regrettable, particularly the lack of empirical validation and the unknown psychometric properties of the questionnaires (Bauermann, 2001; Bauermann, Parker, & Smith, 2000).

Based on a review of the literature, only three sleep hygiene instruments have published psychometric properties: The Sleep Hygiene Awareness and Practices Scale (SHAPS; Lacks & Rotert, 1986), The Sleep Hygiene Self-Test (Blake & Gomez, 1998) and the Sleep Hygiene Index (Mastin, Bryson, & Corwyn, 2006). However, each of these measures has problematic features, and questionable reliability and validity. First, the authors of these measures have failed to provide a clear rationale for item selection. Second, all three of the sleep hygiene measures have failed to demonstrated adequate internal reliability, and the alpha estimates for the SHAPS (.47), the Sleep Hygiene Self-Test (.54) and the Sleep Hygiene Index (.66) were all below .70, the established lower limit for demonstrating adequate internal consistency using item analysis (Cronbach, 1951; Cronbach & Meehl, 1955; Nunnally, 1978). Moreover, the Sleep Hygiene Self-Test has not been shown to correlate with any external measure of sleep quality, and validation for the SHAPS and Sleep Hygiene Index is limited to single studies demonstrating moderate associations ($r = .48$, and $r = .49$, respectively) between these measures and the Pittsburg Sleep Quality Index (Brown et al., 2002; Mastin et al., 2006).

Currently, our knowledge and understanding of the role of sleep hygiene in the development and maintenance of sleep problems is limited, and arguably influenced by
the lack of valid and reliable assessment tools. At present, there is debate as to whether the assumption that poor sleep hygiene causes sleep problems is true, and inconsistent findings with respect to which factors and behaviors have significant influence on sleep quality. Furthermore, valid and reliable instruments are needed to identify individuals in clinical settings with sleep complaints that may be caused, or exacerbated by, inadequate sleep hygiene. Given that sleep problems are common in a variety of mental and physical health problems, recognizing poor sleep hygiene behaviors may also be important in planning effective treatment strategies.

The purpose of the present study was to develop a brief self-report measure of sleep hygiene for young adults. The creation and validation of the new measure involved two phases. In the first phase, items were generated based on ICSD criteria and exploratory factor analysis (EFA) was used to develop a model of sleep hygiene in young adults; in the second phase, confirmatory factor analysis (CFA) was used to explicitly test the model in a second independent sample of young adults. Floyd and Widaman (1995) suggested that EFA is most appropriate in the initial stages of model development, whereas CFA provides a more powerful tool in the second stage of research when a model has already been established. Finally, we examined the convergent and discriminant validity of the factorial model by examining whether the new sleep hygiene dimensions predicted self-reported sleep problems.
Method

Participants

The total sample was composed of 730 young adults (340 men; 390 women) attending a medium sized university in central Ontario, Canada. The mean age of the sample was 20.19 ($SD = 3.62$). Ninety-five percent of the participants were single, 3% were married or living common-law with a partner, and the remaining 2% of participants indicated they were widowed or divorced. With respect to ethnicity, 88% of the participants identified themselves as “White”, 6% as “Asian”, 1% as “Black”, 1% as “Native/Aboriginal”, and 4% identified themselves as “Other” ethnic background.

Two random samples were drawn without replacement from the total sample; Sample A ($N = 363$) was used for EFA and Sample B ($N = 367$) for the CFA, and validity analyses.

Materials

An initial item pool of 19 items was used in the EFA to generate the first model of sleep hygiene. The items were generated by the study authors (which included two sleep experts) to assess behaviours commonly associated with poor sleep hygiene using the International Classification of Sleep Disorders Diagnostic and Coding Manual (ICSD) diagnostic criteria. The ICSD conceptualizes poor sleep hygiene as an extrinsic dysomnia, and identifies two broad categories of sleep hygiene: behaviours and environmental conditions that increase arousal, or are inconsistent with the principles of sleep organization (American Sleep Disorders Association, 1997). The response format for each item ranged from 1 (not true of me) to 4 (very true of me). Participants were asked to respond to the items with respect to sleep behaviours and sleep problems they
“may have experienced in the last month”. The response format and instructions were modeled after the Sleep Problems Inventory (SPI; Bauermann, 2001; Bauermann, Parker, & Smith, 2000; Bauermann, et al. 2002) to be consistent for respondents, and facilitate data collection and statistical analyses using both measures.

The Sleep Problems Inventory (SPI; Bauermann, 2001; Bauermann, Parker, & Smith, 2000; Bauermann et al., 2002) is a multidimensional sleep measure that assesses symptoms associated with insomnia (seven items), sleepiness (seven items), nightmares (seven items), and sleepwalking (seven items). The factor structure of the SPI has been replicated in large samples of undergraduate university students, community-based adults, and sleep disorder patients (Bauermann, Parker, Smith, & Wood, submitted for publication; Bauermann et al., 2000, 2002). Bauermann, Parker and Taylor (2008) reported internal reliability coefficients (Cronbach’s alpha) that ranged from .79 to .88 for the SPI subscales in a large sample of undergraduates. Preliminary validation has been demonstrated by higher SPI sleep problem scores in sleep disordered patients than community-based adults and by high agreement on sleep disorder items from cohabiting couples (Bauermann et al., submitted for publication).

Procedure

The participants were undergraduates who were recruited by their course instructor to participate “in a study on sleep, emotion and health” at the end of a regularly scheduled lecture. Research assistants distributed the questionnaires, and participants completed them in approximately 20 minutes. Course credit was provided as an incentive to participate, and the response rate was approximately 90%.

1 Estimation based on enrollment. Because attendance was not taken, the exact number of students that were present for the lecture is not known.
completed questionnaires to research assistants as they exited the auditorium. Two
months later, the experimenters recruited students from two classes who had participated
in the earlier testing session to complete the measures again. Of approximately 80
students in the classes, 65 (5 men, 60 women) volunteered to complete the questionnaire
a second time (81% response rate). The study protocol was approved by the university
ethics committee. All participants gave informed consent and were treated in accordance
with American Psychological Association ethical guidelines for conducting research with
human participants.

Results

_Exploratory Factor Analysis (EFA)_

An exploratory principal components analysis was conducted using Statistica, 6.1
software (Statsoft, 2004) on the 19 initial sleep hygiene items to examine the latent
structure of the measure in young adults (Sample A). Using a scree test and Kaiser’s
(1960) criteria, results indicated a maximum of three factors could be retained with
eigenvalues greater than 1. Based on an initial examination of communality estimates and
unrotated factor loadings, five items were eliminated because they did not load on any of
the three factors and generated relatively little common variance ($h^2 < .20$) to any of the
possible 3 factor solutions. Further analyses focused on the 14 remaining candidate items.
Kaiser-Meyer-Olkin’s measure of sampling adequacy$^2$ was .81, indicating that the factor
analysis should yield distinct and reliable factors. Bartlett’s test of sphericity$^2$ was
significant, $\chi^2 (91) = 1969.25$, $p <.001$, indicating that the correlation matrix was not an
identity matrix, and that it was appropriate to proceed with EFA.

$^2$ Kaiser-Meyer-Olkin’s and Bartlett’s test of sphericity are not available using Statistica and were obtained using SPSS 17.0 software
One, two and three-factor solutions were examined, using orthogonal (varimax) rotations because we wanted to maximize the dispersion of the loadings within factors (Tabachnick & Fidell, 1996). The resulting solutions were examined for interpretability and the best structure was demonstrated by two factors. Parallel analysis (Horn, 1965) based on either mean or 95th percentile eigenvalues also converged to indicate the retention of two factors. The two factors accounted for 47.52% of the variability in the 14 items. The first factor, with an eigenvalue of 4.50 and items such as “I drink alcohol before going to bed” and “Most of my social activities include drinking (alcohol) or taking drugs” appeared to represent an alcohol and substance abuse dimension. The second factor, with an eigenvalue of 2.15 and items such as “During the work week, I go to bed at roughly the same time each night”, and “My work (or school) responsibilities keep me up late at night”, appeared to represent a sleep scheduling dimension.

The rotated factor loadings for each item, eigenvalues, and percent of variance values are presented in Table 1. According to Comrey and Lee (1992), loadings greater than .71 are considered excellent, .63 are very good, .55 are good, .45 are fair, and loadings less than .32 are poor and should not be interpreted. On average, the sleep scheduling loadings were good (.60) and the substance abuse loadings were very good (.70), however, the two items “social activities keep me up late” and “I party late into the night” were complex, loading primarily on the substance abuse factor, but also moderately on the sleep scheduling factor. This result likely reflects the nature of the university sample and the link between drinking alcohol and social life on most university campuses (Gliksman, Newton-Taylor, Adlaf, & Giesbrecht, 1977; Kuo, Adlaf,
Lee, Gliksman, Demers, & Wechsler, 2002). The explained variance was 32% for the substance abuse factor and 15% for the sleep scheduling factor.

**Internal Consistency, Test-Retest Reliability and Gender Differences**

Two sleep hygiene scales were created based on the two-factor structure demonstrated by the exploratory factor analyses. Table 2 presents the means and standard deviations, internal reliability coefficients (Cronbach’s alpha) for the substance use and sleep scheduling scales. Although an orthogonal rotation was used, the relationship between the two scales was moderate ($r = .31$). The internal reliability estimates were good for the substance abuse (.85) and sleep scheduling scales (.77). Moderate test-retest correlations between Time 1 and Time 2 were demonstrated for the substance abuse ($r = .64$) and sleep scheduling scales ($r = .54$). To further support the multidimensional nature of the sleep hygiene items, the test-retest correlations were higher than the correlation between the substance abuse at Time 1 and sleep scheduling at Time 2 ($r = .30$) and substance abuse at Time 2 and sleep scheduling at Time 1 ($r = .36$). Some preliminary construct validation was also provided by the gender difference (with men scored higher than women) on the substance abuse scale, $t(361) = 2.28$, $p = .004$.

**Confirmatory Factor Analysis (CFA)**

CFI analyses were conducted using Statistica 6.1 software (Statsoft, 2004) to examine the stability of the two-factor model derived from the EFA, in an independent sample of young adults (Sample B). The hypothesized model consisted of two first-order latent variables representing the subscales of substance abuse (seven items), and sleep scheduling (seven items). To evaluate the overall fit of the model we used multiple indices because each goodness of fit index has different strengths and weaknesses in
assessing fit (Anderson & Gerbing, 1984; Cole, 1987; Marsh, Balla, & McDonald, 1988). Although the chi-square statistic ($\chi^2$) is often reported in CFA analysis, it is not recommended when sample sizes exceeds 200 cases, or when the data demonstrates significant deviations from normality (Marsh, Balla, & McDonald, 1988; Marsh, Balla, & Hau, 1996; March, Hau, & Wen, 2004; Tabachnick & Fidell, 1996). Because several of the substance abuse items were significantly skewed and transformations were unsuccessful at reproducing normality, the chi-square is reported, but was not used to evaluate model fit.

The overall fit of the model was evaluated using a combination of absolute, relative and parsimony indices. The absolute indices were the Goodness of Fit Index (GFI; Joreskog & Sorbom, 1986) and the Root Mean Square (RMS; Joreskog & Sorbom, 1989); relative indices were the Comparative Fit Index (CFI; Bentler, 1990) and Normed Fit Index (NFI; Bentler & Bonnet, 1980), and parsimonious indices were the Adjusted Goodness of Fit Index (AGFI; Joreskog & Sorbom, 1989) and root mean square error of approximation (RMSEA; Steiger & Lind, 1980). The criteria for assessing model fit were the following: GFI $> .90$, RMS $< .10$, CFI $> .90$, NFI $> .90$, AGFI $> .90$, and RMSEA $< .10$ (Tabachnick & Fidell, 1996).

Confirmatory factor analysis revealed that the two-factor model was found to have good fit to the data in sample B ($\chi^2 = 324.94$, GFI = .96, RMS = .08, CFI = .92, NFI = .93, AGFI = .95, RMSEA = .07). As indicated in Table 3, the parameter estimates for all sleep items were acceptable and significant (ranging .38 to .85) with the exception of the item, “My work (or school) responsibilities keep me up late at night”, with a
somewhat low parameter estimate (.30). The relationship between the substance abuse and sleep scheduling latent variables was moderate (.45).

CFA experts warn against testing only one model when conducting CFA and structural equation modeling analyses because multivariate data sets often contain multiple models that could explain the data, and researchers are susceptible to confirmation biases when testing only a single model (MacCallum & Austin, 2000; McDonald & Ho, 2002). Therefore, we compared the fit of the two-factor model with a single-factor, and three-factor model that would be theoretically plausible (inconsistent sleep/wake pattern, delayed phase sleep pattern, and substance use) to examine whether the two-factor model provided a significantly better fit than the one-factor and three-factor models in Sample B.

The two-factor model had better fit than the one-factor model ($\chi^2 = 698.77$, GFI = .91, RMS = .12, CFI = .88, NFI = .83, AGFI = .88, RMSEA = .09). Although the goodness of fit for a three-factor model also suggested reasonable fit to the data ($\chi^2 = 286.32$, GFI = .95, RMS = .09, CFI = .93, NFI = .90, AGFI = .93, RMSEA = .07), an examination of the parameter estimates indicated that two items on the alcohol factor were unacceptably low (.29 and .26). Taken together, the CFA results indicated that the sleep hygiene items were best explained by two factors (substance abuse and poor sleep scheduling).

*CFA invariance by gender.* As a preliminary test of model invariance by gender, CFA was conducted testing the two-factor model for men and women separately. CFA revealed that the two-factor model was found to have good fit to the data for both men ($\chi^2 = 223.23$, GFI = .94, RMS = .08, CFI = .93, NFI = .90 AGFI = .93, RMSEA = .09), and
women ($\chi^2 = 205.15$, GFI = .96, RMS = .08, CFI = .96, NFI = .94, AGFI = .95, RMSEA = .07). The parameter estimates for women were all acceptable and significant, ranging from .34 to .83. The parameter estimates for men ranged from .36 to .81, with the exception of the item, “My work (or school) responsibilities keep me up late at night”, which had poor parameter estimate (.24) for men only. The relationship between the substance abuse and sleep scheduling latent variables was moderate and stronger for women (.52) than men (.34).

Convergent and Discriminant Validity

Convergent validity refers to the degree to which a measure is correlated with other measures with which it is theoretically associated (Cronbach & Meehl, 1955; John, & Benet-Martinez, 2000). To examine the convergent validity of the new measure, the associations between the new sleep hygiene scales and SPI sleep problems scales were examined. Because sleep hygiene is conceptualized to cause, or contribute to insomnia and poor sleep quality (as evidenced by daytime sleepiness), the substance abuse and sleep scheduling scales were predicted to correlate significantly with the SPI insomnia and sleepiness scales. However, because sleep hygiene is classified as an extrinsic dysomnia (i.e., sleep problem associated with initiating and maintaining sleep) in the ICSD, there is little theoretical reason to expect it would be related to parasomnias or movement disorder symptoms. Therefore, it was predicted that the substance abuse and sleep scheduling scales would not correlate significantly with the SPI nightmare and sleepwalking scales.

Table 4 presents the correlations between the sleep hygiene and the SPI sleep problems scales in the replication sample (Sample B). The new sleep hygiene scales were
correlated with the SPI sleep problem scales in the predicted directions and magnitude, providing convergent and discriminant validity for the new measure. Specifically, sleep scheduling scores were significantly correlated with sleepiness and insomnia, and were not correlated with nightmares and sleepwalking scores. Substance abuse scores were more strongly correlated to sleepiness and insomnia scores than to nightmares and sleepwalking scores.

A series of multiple regression analyses were conducted to determine how well the newly developed hygiene scales (substance abuse and sleep scheduling) predicted self-reported sleep problems in the replication sample. For each analysis, the predictors were the sleep hygiene scales (substance abuse and sleep scheduling) and the criterion variables were each of the SPI scales (insomnia, sleepiness, nightmares and sleepwalking), separately. As outlined above, sleep hygiene should primarily be associated with problems initiating and maintaining sleep and therefore convergent validity would be demonstrated if the sleep hygiene scales predicted SPI insomnia and sleepiness scale scores. Furthermore, if the sleep hygiene items actually comprise two underlying factors, the substance abuse and sleep scheduling scales should each be significant individual predictors of the criterion variables (SPI insomnia and sleepiness scores) as evaluated by the significance test for the \( t \) value associated with each parameter (Bryant, Yarnold, & Grimm, 1996).

The sleep hygiene scales significantly predicted insomnia scores, \( F(2, 364) = 26.41, p < .0001 \). The multiple correlation coefficient \( (R) \) was .36, indicating that approximately 13% of the variance in insomnia symptoms can be accounted for by the linear combination of sleep scheduling and substance abuse scores. In terms of the
relative strength of the individual predictors, both sleep scheduling and substance abuse were significant individual predictors of insomnia scores. Specifically, sleep scheduling predicted insomnia, controlling for substance abuse, beta = 0.34, $t(364) = 6.58$, $p < .0001$, and substance abuse predicted insomnia symptoms, controlling for sleep scheduling, beta = 0.09, $t(364) = 2.40$, $p = .017$.

The sleep hygiene scales also significantly predicted sleepiness scores, $F(2, 364) = 61.40$, $p < .0001$. The multiple correlation coefficient ($R$) was .50, indicating that approximately 25% of the variance in sleepiness symptoms can be accounted for by the linear combination of sleep scheduling and substance abuse scores. In terms of the relative strength of the individual predictors, both sleep scheduling, beta = 0.42, $t(364) = 8.80$, $p < .0001$, and substance abuse, beta = 0.16, $t(364) = 3.25$, $p < .0001$, were significant individual predictors of sleepiness symptoms. The sleep hygiene scales did not predict the SPI nightmare and sleepwalking scale scores.

Discussion

The two sleep hygiene scales, labeled substance abuse (seven items) and sleep scheduling (seven items) defined by the EFA results demonstrated good internal consistency, and adequate test-retest reliability. The two-factor structure accounted for almost 50% of the variability in the sleep hygiene items, and was thematically consistent with the ICSD conceptualization of poor sleep hygiene behaviours.

The results of the CFA analyses provided support for the two-factor model of the sleep hygiene items and provided construct validity for the new measure in three specific ways: the model fit from a CFA was good, the model fit of the two-factor model was superior to that of a one- and three-factor models, and the model was consistent between
men and women when the CFA was conducted separately by gender. Construct validity was also demonstrated by the gender difference on the substance abuse scale, with men scoring higher than women, a finding that is consistent with prior research and epidemiological studies that have found that men drink more than women, and are more likely to be substance abusers than women (Anthony & Echeagaray-Wagner, 2000; Romans, 2000). Furthermore, the scores on the new sleep hygiene scales correlated with the SPI sleep problems scales, in the predicted directions. The multiple regressions demonstrated that the new sleep hygiene scales predict sleep problems, specifically insomnia and sleepiness, providing convergent validity for the new measure. Taken together, these findings are encouraging and suggest that the new measure has good psychometric properties that warrant additional research.

Our goal was to create a brief self-report measure that can be used in combination with the SPI sleep problem scales to assess sleep hygiene in young adults, and thereby provide a more comprehensive sleep profile than would be generated by measuring sleep problems alone. Assessing sleep hygiene in combination with sleep problems is important in determining whether an individual’s sleep symptoms are indicative of a sleep disorder, or reflect lifestyle choices that cause reduced quantity or quality of sleep.

The substance abuse scale assesses drinking alcohol and behaviours that are associated with substance abuse in young adults. Drinking alcohol at bedtime is included in the ICSD description of poor sleep hygiene because many people erroneously believe that having a drink at bedtime (a “nightcap”) will help them sleep, when in fact, it disrupts sleep. Although alcohol may have an initial sedating effect and reduce initial sleep latency, arousals and wake time during the sleep period is actually increased as the
body metabolizes the alcohol (Landolt, Roth, Dijk, & Borbely, 1996; Roehrs, Papineau, Rosenthal, & Roth, 1999; Vitiello, 1997). The sleep disruption resulting from alcohol ingestion has been linked to excessive daytime sleepiness, memory deficits, impaired social and occupational functions, accidents, and motor vehicle crashes (Aldrich, Brower, & Hall, 1999). The sedation effect and reduced sleep latency may encourage continued use of alcohol at bedtime among individuals with insomnia (Ford & Kamerow, 1989), which can lead to dependence, tolerance and a vicious cycle of poor sleep quality. Furthermore, drinking alcohol can exacerbate symptoms of other sleep disorders, such as increased risk of adverse breathing events, and increased severity of hypoxemia in individuals with obstructive sleep apnea (OSA), as well as increased risk of stroke and cardiovascular abnormalities (Aldrich et al., 1999).

The sleep scheduling scale focuses on the timing and scheduling of sleep, and includes items that assess maintaining a consistent sleep-wake cycle, and staying up late because of work, or school responsibilities. Sleep scheduling is also included in the ICSD descriptions of poor sleep hygiene and may be particularly relevant to the assessment of sleep problems in young adults. Undergraduates are notorious for poor sleep scheduling behaviours such as staying up late to socialize, and undergraduates may even stay up all night (i.e., pulling all-nighters) in order to finish assignments or study for exams (Brown, et al. 2002; Bubultz, Brown, & Soper, 2001). The negative impact of poor sleep scheduling is not limited to undergraduates however, and is also well-documented in other non-clinical populations, such as shift-workers. Working night shifts and rotating shifts desynchronizes the body’s sleep-wake schedule, which can lead to several negative consequences, including difficulties initiating and maintaining sleep, lower sleep
efficiency, and poor sleep quality. Over time, these nocturnal symptoms can lead to sleep
deprivation as evidenced by excessive daytime sleepiness, and various associated
cognitive, physical and emotional impairments (Monk, 1989; Pilcher, Lambert, &
Huffcutt, 2000; Scott, 2000).

The two-factor model developed in the current study should be considered a core,
rather than comprehensive model of sleep hygiene in young adults. We acknowledge that
there may be other important dimensions not addressed in the current model, however the
current findings represents the first step towards the development of a multi-dimensional
measure of sleep hygiene. Future research will be directed towards broadening the scope
of behaviors assessed, and revisions in the pursuit of a more comprehensive model of
sleep hygiene. It is important to note that validating psychometric instruments is a
continuous process, and may include several studies to determine validity, including
examining content, construct, criterion, convergent, and discriminant validity (Cohen,

There are a number of potentially important research implications associated with
developing a psychometrically sound measure of sleep hygiene. The new scales will
increase our knowledge and understanding of the role of sleep hygiene in the
development and maintenance of sleep problems. One of the most common strategies for
improving sleep is to decrease poor sleep hygiene behaviours, despite a lack of empirical
evidence supporting the association between sleep hygiene and sleep quality. Therefore,
using the new scales as independent variables, researchers can examine whether
improving sleep hygiene improves sleep quality, as well as determine what sleep
problems, if any, are influenced by sleep hygiene. A major benefit of the two-factor
model is that the influence of substance abuse and sleep scheduling dimensions can be examined independently, and the relative contribution of each to sleep problems can be determined. Also, because sleep hygiene has been conceptualized as a potential mediator (or moderating variable) in the relationship between sleep problems and other outcome variables, the new scales also can be used in investigations of these types of mediation models.

The new sleep hygiene scales may also have promise as a clinical tool, particularly in terms of brief, feedback-based motivational interventions. For example, in a commonly used two-session intervention model, a client completes a number of assessments in the first session, and then receives personalized feedback from the clinician in the second session (e.g., reinforcing good sleep hygiene behaviours and exploring strategies to decrease poor sleep hygiene behaviours). Because the behaviours assessed on the SPI are consistent with common experiences, the resulting intervention strategies would be tangible and easy to implement. Charting changes in one’s use of specific behaviors could also be a useful marker for individual treatment improvements. Although we believe that the measure has potentially useful implications for clinicians conducting sleep hygiene related interventions and treatments, we do not recommend clinical use of the SPI until more studies have been conducted on the scale.

There are some noteworthy limitations in the current study. First, the sample was composed of undergraduates from the same geographic location, attending the same university, which limits the generalizability of the findings to other populations and age groups. We also did not obtain health histories, and therefore were unable to control for confounding medical conditions or concurrent diagnosis that may have influenced results.
In addition, because data were collected with only self-report questionnaires, the veracity of the responses could not be determined. Despite the promise of confidentiality, it is possible that participants did not respond truthfully on personally sensitive items, such as items that assessed substance abuse. However, research using self-report measures of similar alcohol-related variables have generally been shown to be reliable and valid (e.g., Babor, Steinberg, Anton, & del Boca, 2000; Miller et al., 2002).

Nevertheless, we believe that the strengths of the measure outweigh these limitations and that the SPI shows promise as both a research and clinical tool. The present study provides psychometric support for the new sleep hygiene scales to be used in combination with the SPI sleep problem scales in young adults. We encourage researchers to continue to conduct psychometric analyses of the SPI with different respondent samples, in particular with older adults and individuals currently experiencing sleep problems. Future research should also focus on testing the utility of the measure in clinical and treatment-oriented studies, as well as examining whether the new sleep hygiene scales can explain some of the variance associated with sleep complaints in mental and physical health conditions (e.g., ADHD, alexithymia, chronic pain, etc.).
Table 1

Factor Loadings from a Principal Components Extraction and Varimax Rotation of the 14 Sleep Hygiene Items in the Derivation Sample

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>$h^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1: Substance Abuse</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drink more than I should</td>
<td>.86</td>
<td>.08</td>
<td>.75</td>
</tr>
<tr>
<td>Social activities include drinking/drugs</td>
<td>.80</td>
<td>.10</td>
<td>.65</td>
</tr>
<tr>
<td>Drink before bed</td>
<td>.74</td>
<td>.08</td>
<td>.55</td>
</tr>
<tr>
<td>Drink everyday</td>
<td>.76</td>
<td>.02</td>
<td>.58</td>
</tr>
<tr>
<td>Party late into the night</td>
<td>.65</td>
<td>.38</td>
<td>.56</td>
</tr>
<tr>
<td>Worry about drinking and drugs</td>
<td>.64</td>
<td>.00</td>
<td>.41</td>
</tr>
<tr>
<td>Social activities keep me up late</td>
<td>.51</td>
<td>.33</td>
<td>.37</td>
</tr>
<tr>
<td><strong>Factor 2: Sleep Scheduling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Go to bed later</td>
<td>.26</td>
<td>.75</td>
<td>.63</td>
</tr>
<tr>
<td>An irregular sleep schedule</td>
<td>.05</td>
<td>.68</td>
<td>.46</td>
</tr>
<tr>
<td>I am a “night-owl”</td>
<td>.24</td>
<td>.65</td>
<td>.49</td>
</tr>
<tr>
<td>Sleep-in later</td>
<td>.09</td>
<td>.62</td>
<td>.40</td>
</tr>
<tr>
<td>Wake up at same time</td>
<td>.03</td>
<td>.55</td>
<td>.31</td>
</tr>
<tr>
<td>Go to bed at same time</td>
<td>.10</td>
<td>.54</td>
<td>.30</td>
</tr>
<tr>
<td>Work/school keeps me up late</td>
<td>-.07</td>
<td>.46</td>
<td>.21</td>
</tr>
</tbody>
</table>

**Eigenvalue**

4.50 2.15

**Explained Variance %**

32.18 15.34

*Note. N = 363; $h^2$ = communalities*
Table 2
Descriptive Statistics for the Two Sleep Hygiene Scales in Derivation Sample

<table>
<thead>
<tr>
<th>Scale</th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
<th>t</th>
<th>p</th>
<th>Alpha</th>
<th>Test-Retest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance Abuse</td>
<td>M = 12.04</td>
<td>M = 12.72</td>
<td>M = 11.41</td>
<td>2.53</td>
<td>.004</td>
<td>.85</td>
<td>.65</td>
</tr>
<tr>
<td>(7-items)</td>
<td>SD = 4.37</td>
<td>SD = 4.65</td>
<td>SD = 4.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Scheduling</td>
<td>M = 16.39</td>
<td>M = 16.63</td>
<td>M = 16.18</td>
<td>1.09</td>
<td>.275</td>
<td>.77</td>
<td>.54</td>
</tr>
<tr>
<td>(7-items)</td>
<td>SD = 3.92</td>
<td>SD = 3.80</td>
<td>SD = 4.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Total = Total sample; *M* = Mean, *SD* = Standard deviation, *Alpha* = Cronbach’s alpha
Table 3.
Parameter Estimates for the CFA Testing a Two-Factor Model of the Sleep Hygiene Items in the Replication Sample

<table>
<thead>
<tr>
<th>Item</th>
<th>Total Sample</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substance Abuse</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Party late into the night</td>
<td>.73</td>
<td>.67</td>
<td>.75</td>
</tr>
<tr>
<td>Social activities include drinking/drugs</td>
<td>.76</td>
<td>.72</td>
<td>.79</td>
</tr>
<tr>
<td>Drink more than I should</td>
<td>.76</td>
<td>.73</td>
<td>.80</td>
</tr>
<tr>
<td>Social activities keep me up late</td>
<td>.62</td>
<td>.58</td>
<td>.64</td>
</tr>
<tr>
<td>Drink before bed</td>
<td>.62</td>
<td>.61</td>
<td>.63</td>
</tr>
<tr>
<td>Drink everyday</td>
<td>.55</td>
<td>.56</td>
<td>.54</td>
</tr>
<tr>
<td>Worry about drinking and drugs</td>
<td>.48</td>
<td>.43</td>
<td>.52</td>
</tr>
<tr>
<td><strong>Sleep Scheduling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Go to bed later</td>
<td>.85</td>
<td>.81</td>
<td>.83</td>
</tr>
<tr>
<td>I am a “night-owl”</td>
<td>.70</td>
<td>.60</td>
<td>.74</td>
</tr>
<tr>
<td>Irregular sleep schedule</td>
<td>.58</td>
<td>.59</td>
<td>.62</td>
</tr>
<tr>
<td>Sleep-in later</td>
<td>.56</td>
<td>.60</td>
<td>.44</td>
</tr>
<tr>
<td>Wake up at same time</td>
<td>.40</td>
<td>.36</td>
<td>.34</td>
</tr>
<tr>
<td>Go to bed at same time</td>
<td>.38</td>
<td>.44</td>
<td>.44</td>
</tr>
<tr>
<td>Work/school keeps me up late</td>
<td>.30</td>
<td>.24</td>
<td>.42</td>
</tr>
</tbody>
</table>
Table 4
Relationships among the Sleep Hygiene and SPI Sleep Problem Scales in the Replication Sample

<table>
<thead>
<tr>
<th>Scale</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SPI-Insomnia</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SPI- Sleepiness</td>
<td>.48</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. SPI-Nightmares</td>
<td>.46</td>
<td>.20</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. SPI- Sleepwalking</td>
<td>.27</td>
<td>.17</td>
<td>.28</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Substance Abuse</td>
<td>.18</td>
<td>.31</td>
<td>.12</td>
<td>.13</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Sleep Scheduling</td>
<td>.35</td>
<td>.48</td>
<td>.09 \text{ns}</td>
<td>.00 \text{ns}</td>
<td>.35</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>7. Total Hygiene</td>
<td>.31</td>
<td>.48</td>
<td>.13</td>
<td>.08 \text{ns}</td>
<td>.80</td>
<td>.84</td>
<td>---</td>
</tr>
</tbody>
</table>

\textit{Note.} ns = not significant; \( r \geq .12 \) are significant, \( p < .05 \)
References


CHAPTER 3

Sleep Problems, Sleep Hygiene and Attention-Deficit/Hyperactivity Disorder

(ADHD) Symptomatology in Young Adults

Acknowledgments

This study was supported by a doctoral research grant from the Social Sciences and Humanities Research Council of Canada (SSHRC). I would like to thank Dr. Allyson G. Harrison for providing access to her clients with ADHD from the Regional Assessment and Resource Centre (Queen’s University), as well as Sarah Majeski, Laura M. Wood, Patricia Kbosterman, Jenny Eastabrook, and Dr. James D.A. Parker and his team of researchers from the Emotional Health Research Laboratory (Trent University) for their help with collecting the data used in this study.
Abstract

Two studies were conducted to examine the association between sleep problems, sleep hygiene and ADHD symptoms in young adults. The Conners Adult ADHD Rating Scales (CAARS) were used to assess ADHD symptoms and the Sleep Problems Inventory (SPI) was used to assess sleep problems and sleep hygiene in 713 undergraduates in Study 1, and 39 young adults with ADHD and age and gender matched controls in Study 2. Results indicated that ADHD symptoms were associated with sleep problems and poor sleep hygiene. Specifically, young adults with elevated ADHD symptoms reported higher insomnia and sleepiness levels, even after controlling for substance abuse and poor sleep scheduling. Findings suggest a genuine association between elevated ADHD symptoms and sleep complaints that may reflect the underlying presence of sleep disturbances in young adults with ADHD symptomatology.
Attention-Deficit/Hyperactivity Disorder (ADHD) is characterized by a persistent pattern of inattention and/or hyperactivity and impulsivity which interferes with daily functioning, and with social interactions (American Psychiatric Association, 2000; Barkley, 1990; 1997). Although ADHD is classified as a disorder of infancy, childhood and adolescence, it is generally accepted that symptoms of ADHD can persist into adulthood, and at least 50% of children with ADHD continue to manifest symptoms as adults (Barkley, 1990, 1997; Barkley, Fisher, Smallish, & Fletcher, 2002; Wender, 1998). To receive a diagnosis of ADHD in adulthood, a person must demonstrate persistent symptomatology that causes impairment in at least two different settings (e.g., work and school), and a childhood history of ADHD symptoms that began before seven years of age. The prevalence rate of ADHD in adults is estimated to be about 3-5% of the population (Kessler et al., 2006; Murphy & Barkley, 1996).

Sleep problems are common in children with ADHD (see Cohen-Zion & Ancoli-Israel, 2004; Owens, 2005 for reviews). Studies that used subjective methods (e.g., parental reports) have consistently found children with ADHD have more sleep problems including restless sleep, insomnia, daytime sleepiness, and poor sleep quality. Studies that used more objective methods (e.g., polysomnography or actigraphy) reported more nocturnal movements, awakenings and arousal during sleep in children with ADHD as compared to controls. Some researchers hypothesized that ADHD causes increased movements (e.g., periodic limb movements) and arousal which disrupts sleep, and in turn leads to higher daytime sleepiness and subjective sleep complaints. However, at present, it is not known if ADHD causes sleep disturbances, or if sleep problems result in the
expression of ADHD symptoms. Certainly, sleep disturbances can lead to sleep deprivation that exacerbates daytime symptoms of inattention, impulsivity and hyperactivity (Barkley, 1990; Cohen-Zion & Ancoli-Israel, 2004; Owens, 2005). The relationship between ADHD and sleep problems in children may also depend on the type of sleep problem assessed, as well as confounding factors such as comorbidity and stimulant medication treatment. Specifically, parasomnias were found to be similar in clinical and nonclinical children, whereas dysomnias were found to be related to confounding factors (i.e., comorbid disorders and stimulant medication) rather than ADHD (Corkum, Moldofsky, Hogg-Johnson, Humphreis, & Tannock, 1999; Corkum, Tannock, & Moldofsky, 1998).

Adult patients with ADHD also report sleep complaints, including difficulty falling asleep, difficulty awakening in the morning, and daytime sleepiness (Brown & McMullen, 2001). Dodson and Zhang, (1999) surveyed 219 adults with ADHD and reported restless sleep, sleep onset difficulties and difficulty awakening in 83%, 72%, and 70% of respondents, respectively. Similarly, Schredl, Alm, and Sobanski (2007) found that 120 ADHD patients (free of medications, without comorbidity or substance abuse) reported more symptoms of insomnia, sleepiness, parasomnias and movement disorders, than non-ADHD controls, even after controlling for age, gender, and depression. ADHD symptom severity was most strongly associated with symptoms of insomnia (including increased sleep latency, nocturnal awakenings, and poor sleep quality) and sleepiness (feeling un-refreshed in the morning, tiredness during the day).

The association between ADHD symptomatology and sleep complaints has also been demonstrated in non-clinical samples. Kass, Wallace, and Vodanovich (2003) found
that self-reported sleepiness \((r = .61)\) and insomnia \((r = .47)\) were significant predictors of inattention and hyperactivity symptoms in university students. Gau et al. (2007) also found that students with elevated ADHD scores reported higher rates of current and lifetime sleep disorders (including insomnia, nightmares, and sleepwalking) than students without elevated ADHD scores. Students with elevated ADHD scores reported a higher need for sleep to maintain optimal functioning and a greater discrepancy between obtained and needed sleep, findings which suggest a relationship between ADHD symptoms and sleepiness and poorer sleep quality. However, it is difficult to generalize across these two studies because they assessed different sleep variables, and the psychometric properties and validity of the sleep questionnaires are not known.

To date, only a few studies have used polysomnography or actigraphy to assess sleep in adults with ADHD. Theses studies provide some evidence that increased nocturnal movements and arousal during sleep may underlie the self-reported sleep complaints of adults with ADHD. For example, Kooij, Middelkopp, Van Gils, and Buitelaar (2001) found more nocturnal movements in a small sample of adults with ADHD using actigraphy monitors. Philipsen et al. (2005) also reported more nocturnal periodic leg movements with and without arousals in 20 patients with ADHD using polysomnography. Recently, Sobanski, Schredl, Kettler, and Alm (2008) found more frequent awakenings, lower sleep efficiency, and reduced REM sleep in adult patients with ADHD than in non-ADHD controls. These findings must be interpreted cautiously because the studies were conducted with very small samples, and many patients had comorbid mental and physical disorders that may have affected the results.
A notable limitation in the literature on sleep and ADHD is the failure to take into account the influence of sleep hygiene in the development and maintenance of sleep problems. Poor sleep hygiene refers to behaviours and environmental conditions that increase arousal or interfere with sleep organization, such as drinking coffee and alcohol before bedtime, excessive time in bed, inconsistent sleep scheduling, etc. (American Sleep Disorders Association, 1997; Cheek, Shaver & Lentz, 2004; Lacks & Rotert, 1986; Morin, 1993). Sleep hygiene has been conceptualized to cause, or contribute to the maintenance of various sleep disorders. For this reason, clinicians often recommend using sleep hygiene education as part of a multifaceted treatment plan for sleep disorders, most commonly with patients with insomnia (Bilsbury & Rajda, 2004; Bootzin & Rider, 1997; Brown, Bubultz, & Soper, 2002; Ellis, Hampson, & Cropley, 2002; Morin, 2000; Schoicket, Bertelson, & Lacks, 1988).

To date, no empirical studies have examined whether sleep hygiene contributes to the sleep problems of adults with ADHD. Brown and McMullen (2001) noted that patients with ADHD frequently had inadequate sleep routines, and lacked a “wind-down” time in the evening. For example, they were also easily distracted at nighttime by stimulating activities that were inconsistent with sleeping (e.g., surfing the internet, socializing). Some patients also reported a lifelong pattern of alertness and feeling more energized, ready to work or socialize in the evening, rather than in the daytime. Brown and McMullen (2001) also noted that ADHD patients self-medicated with alcohol (or drugs) to facilitate sleep onset, or to reduce sleep disruption. Furthermore, because adults with ADHD are more likely to abuse alcohol and illicit drugs (Biederman et al., 1995;
Faraone, Biederman, Wilens, & Adamson, 2007; Wilens, 2004) they may be at particular risk for alcohol or drug-related sleep disturbances.

The purpose of the present research was to examine the relationships between sleep hygiene, sleep problems and ADHD symptomatology in young adults. Young adults were used as participants in an effort to minimize the potential impact of age-related effects. Although the prevalence of ADHD appears to decrease with age, it is unclear at the present time how much change occurs between early adulthood and later adulthood (Barkley, Fischer, Edelbrock, & Smallish, 1990; Barkley, Fischer, Smallish, & Fletcher, 2002). The central hypothesis was that ADHD symptoms in young adults would be associated with sleep problems and poor sleep hygiene. Two studies were conducted to test this hypothesis.

Study 1 examined the relationships between ADHD symptoms, sleep problems and sleep hygiene in a large sample of young adults. First, regression analyses were used to test whether sleep problems and sleep hygiene scores predicted ADHD symptoms. Second, sleep problems and sleep hygiene scores were compared across groups of individuals with elevated levels of ADHD symptomatology. Consistent with our hypothesis, it was predicted that young adult with elevated ADHD symptoms will report more sleep problems and poorer sleep hygiene than adults without elevated levels of ADHD symptoms. Because poor sleep hygiene can cause and contribute to various sleep symptoms, sleep hygiene was also predicted to account for the sleep problems reported by young adults with elevated ADHD symptomatology.

Study 2 examined the association between ADHD and sleep problems and sleep hygiene was examined in a clinical sample of young adults who were diagnosed with
ADHD, and receiving accommodations through their university health and counseling centre. Sleep problems and sleep hygiene symptoms were compared between young adults with a confirmed ADHD diagnosis and non-ADHD controls. Consistent with the our hypothesis, it was predicted that young adult with ADHD will report more sleep problems and poorer sleep hygiene than non-ADHD controls, and that poor sleep hygiene would account for the sleep problems reported by young adults with ADHD.

In an effort to overcome of the limitations of the previous research that used unpublished questionnaires with unknown psychometric structures, we used the Sleep Problems Inventory (SPI; Bauermann, Parker, & Smith, 2000; Bauermann et al., 2002), a multidimensional sleep measure that allowed us to examine the specific influence of symptoms related to insomnia, sleepiness, nightmares and sleepwalking. An additional strength of the current methodology was the use of the Conners Adult ADHD Rating Scales (CAARS; Conners, Erhart, & Sparrow, 1998) to assess ADHD symptomatology. This measure has demonstrated good reliability and validity, and also provides cut-off scores based on normative data to identify individuals with elevated and clinically relevant scores on the DSM-IV inattentive, hyperactivity/impulsive and combined inattentive and hyperactive/impulsive symptom domains. To our knowledge, this study is the first to examine sleep problems and sleep hygiene across the three DSM-IV ADHD subtypes (primarily inattentive, primarily hyperactive, and combined inattentive and hyperactive/impulsive) in young adults.
Study 1: The Relationships Between Sleep Problems and Sleep Hygiene and ADHD Symptoms in Young Adults

Method

Participants

The first sample consisted of 713 young adults (269 men and 444 women) attending a moderate sized university in central Ontario, Canada. The mean age of the participants was 20.80 years ($SD = 4.82$). Eighty-seven percent of the sample indicated their ethnicity was White/Caucasian, and 94% percent indicated their marital status was single.

In an effort to examine sleep problems and sleep hygiene in individuals with clinical levels of ADHD symptomatology, respondents were categorized into four non-overlapping symptom groups (inattentive group, hyperactivity/impulsive group, combined ADHD group, and non-ADHD controls) using the cut-off scores on the DSM-IV ADHD scales from the CAARS scoring manual (Conners, Erhardt, & Sparrow, 1998). Respondents with clinically elevated scores on the inattentive scale constituted the high inattentive ADHD group; respondents with clinically elevated scores on the hyperactivity/impulsivity scale constituted the high hyperactivity/impulsivity group; respondents with clinically elevated scores on both the inattentive and hyperactivity/impulsivity scales constituted the combined ADHD group; respondents with standard scores (T-scores) of 50 or less were classified as non-ADHD controls. The high inattentive group consisted of 63 adults (31 men and 32 women); the high hyperactivity/impulsivity ADHD group consisted of 55 adults (21 men and 34 women);
the combined ADHD group consisted of 29 adults (18 men and 11 women); the non-ADHD controls consisted of 222 adults (56 men and 166 women).

**Materials**

The Conners Adult ADHD Rating Scale (CAARS; Conners et al., 1998) is commonly used to assess ADHD symptoms in adults. It contains three DSM-IV symptom subscales: Inattention (nine items), hyperactivity/impulsivity (nine items) and a third, which is the combined total of these two subscales. Participants respond to each item using a 4-point Likert scale ranging from 0 (not at all/never) to 3 (very much/very frequently). The instrument takes about 15 minutes to complete and has demonstrated good reliability and validity (Conners et al., 1999; Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999). The CAARS manual provides the scoring criteria and cut-off scores\(^1\) for the DSM-IV ADHD scales that were used to identify individuals currently experiencing clinically elevated levels of ADHD symptomatology.

The Sleep Problems Inventory (SPI; Bauermann, Parker, & Smith, 2000; Bauermann et al., 2002) is a multidimensional sleep measure that assesses symptoms associated with common sleep problems including, insomnia (seven items), sleepiness (seven items), nightmares (seven items) and sleepwalking (seven items). The SPI also has two scales that assess sleep hygiene behaviours: a substance abuse scale (seven items) and a sleep scheduling scale (seven items). The factor structure of the SPI has been replicated in large samples of undergraduate university students, community-based adults, and sleep disordered patients (Bauermann, Parker, Smith, & Wood, submitted for publication). Bauermann, Parker, and Taylor (2008) reported internal reliability

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\(^1\) For further information on scoring the CAARS, contact Multi-Health Systems (www.mhs.com).
coefficients (Cronbach’s alpha) that ranged from .79 to .88 for the SPI subscales in a large sample of undergraduates ($N = 2045$). Preliminary validation has been demonstrated by higher SPI scores in sleep disordered patients than community-based adults and by high agreement on sleep disorder items from cohabiting couples (Bauermann et al., submitted for publication).

Table 1 presents the internal reliability coefficients (Cronbach’s alpha) for the SPI scales for the total sample in the current study. The estimates were good for the sleep problems scales (.81 to .90) and the substance abuse scale (.84), although somewhat questionable (.70) for the sleep scheduling scale of the SPI.

**Procedure**

The participants were recruited by their course instructor to participate “in a study on sleep, emotion and health” at the end of a regularly scheduled lecture. Research assistants distributed the consent forms and questionnaires and participants completed them within 20 minutes. Course credit was provided as an incentive to participate, and the response rate was approximately 90% (estimated based on enrolment). Participants returned their completed questionnaires to research assistants as they exited the auditorium. The study protocol was approved by the university ethics committee. All participants gave informed consent and were treated in accordance with American Psychological Association ethical guidelines for conducting research with human participants.
Results

Descriptive Statistics

Descriptive statistics and inter-correlations for the CAARS and the SPI scales for the total sample are shown in Table 1. Table 2 presents means and standard deviations for CAARS and SPI scales for men and women separately. Men reported higher levels of ADHD symptoms on the CAARS scales, which is consistent with prior research and normative data (Conners, Erhardt, Epstein et al., 1999). Women scored higher than men on the SPI nightmare scale, which is consistent with prior research that indicated that nightmares are more common in women, and are associated with sleep onset difficulties, increased awakenings during the night and anxiety following poor nocturnal sleep (Ohayon et al., 1997; Pagel, 2000; Wood & Bootzin, 1990). Men scored higher than women on the substance abuse scale, which is consistent with prior research and epidemiological studies that have found that men drink more than women and are more likely to be substance abusers than women (American Psychiatric Association, 2000; Anthony & Echeagaray-Wagner, 2000).

To rule out gender differences in the pattern of intercorrelations among CAARS and SPI scales, the equality of the covariance matrices for men and women was tested using Statistica 6.1 (Statsoft, 2004). As recommended by Tabachnick and Fidell (1996) multiple criteria were used to assess the equality of the matrices. The criteria for equivalence was a Steiger-Lind RMSEA index (RMSEA; Steiger & Browne, 1984) less than .10, a population gamma index (PGI; Tanaka & Huba, 1989) greater than .90, and an adjusted PGI (APGI) greater than .90 (Tabachnick & Fidell, 1996). The results indicate that the pattern of intercorrelations for men and women were virtually identical, RMSEA
ADHD symptoms, sleep problems and sleep hygiene in the total sample

To examine whether ADHD symptoms were associated with sleep problems, three standard multiple regression analyses were performed with each of the CAARS inattention, hyperactivity/impulsivity, and combined ADHD scales as the criterion variables and the four SPI sleep problem scales (insomnia, sleepiness, nightmares, and movement) as the predictor variables. Table 3 presents the results of the standard multiple regression analyses.

The SPI sleep problem scales predicted CAARS inattention scores, $F(4, 708) = 54.23, p < .0001$, and indicated that approximately 23% of the variability in inattention symptomatology was accounted for by self-reported sleep problems. Sleepiness, insomnia and nightmares scores were each significant individual predictors of inattention scores ($p < .05$). The strongest individual predictor was sleepiness, accounting for 19% of the variance in inattention symptoms.

The SPI sleep problem scales also predicted CAARS hyperactivity/impulsivity scores, $F(4, 708) = 20.57, p < .0001$, and indicated that approximately 10% of the variability in hyperactivity symptomatology was accounted for by self-reported sleep problems. Sleepiness, insomnia and sleepwalking scores were each significant individual predictors of hyperactivity/impulsivity scores ($p < .01$). The strongest individual predictor was sleepiness, accounting for 5% of the variance in hyperactivity/impulsivity symptoms.

The SPI sleep problem scales also predicted CAARS combined ADHD scores, $F(4, 708) = 47.68, p < .0001$, indicating that approximately 21% of the variability in
combined ADHD symptomatology was accounted for by self-reported sleep problems. The sleepiness and insomnia scales were significant individual predictors of combined ADHD symptoms \((p < .001)\). The strongest individual predictor was sleepiness, accounting for 15% of the variance in combined ADHD symptoms.

To test whether ADHD symptoms were associated with sleep hygiene, three separate standard multiple regression analyses were performed with each of the CAARS inattention, hyperactivity/impulsivity, and combined scales as the criterion variables and the two SPI sleep hygiene scales (substance abuse and sleep scheduling) as the predictor variables. These analyses are also summarized in Table 3.

The SPI sleep hygiene scales predicted CAARS inattention scores, \(F(2, 710) = 27.77, p < .0001\), hyperactivity/impulsivity scores \(F(2, 710) = 26.24, p < .0001\), and combined ADHD scores, \(F(2, 710) = 36.31, p < .0001\). The SPI sleep hygiene scales accounted for approximately 7% of the variability in both inattention and hyperactivity/impulsivity scores and 9% of the variability in combined ADHD scores. Substance abuse and sleep scheduling were each significant individual predictors of inattention, hyperactivity/impulsivity and combined ADHD symptomatology \((p < .0001)\).

**ADHD symptoms and sleep problems, controlling for sleep hygiene**

A series of hierarchical regressions were conducted to test whether sleep hygiene accounted for the relationship between sleep problems and ADHD symptoms in the total sample. Each analysis examined whether the SPI sleep problem scales predicted CAARS scales, above and beyond the variance accounted for by sleep hygiene scales. With CAARS inattention, hyperactivity/impulsivity and combined ADHD scores as the criterion variables, the sleep hygiene scales (substance abuse and sleep scheduling) were
entered in the first step, followed by the SPI sleep problems scales (insomnia, sleepiness, nightmares and sleepwalking) as predictors in the second step. The sleep problems scores predicted inattention, $R^2$ change = .17, $F(4, 706) = 38.61$, $p < .0001$, hyperactivity/impulsivity, $R^2$ change = .06, $F(4, 706) = 11.38$, $p < .0001$, and combined ADHD scores, $R^2$ change = .13, $F(4, 706) = 30.23$, $p < .0001$, above and beyond the variance accounted for by the sleep hygiene scales. After controlling for substance abuse and sleep scheduling, insomnia and sleepiness continued to contribute significant unique variance to the predictions of inattention, hyperactivity and combined ADHD symptoms. Because the sleep problem scales continue to contribute significantly to the prediction of ADHD symptoms after the sleep hygiene variance was accounted for, sleep hygiene does not fully account for the association between sleep problems and ADHD symptoms.

Sleep problems and sleep hygiene in elevated ADHD symptoms vs. non-ADHD groups

In the following analyses, study predictions were examined by comparing levels of sleep symptoms across groups of individuals with clinically elevated levels of ADHD symptoms (inattentive vs. hyperactive/impulsive and combined ADHD groups) and non-ADHD controls.

A series of two-way ANOVAs were conducted with gender (men vs. women) and ADHD symptom group (inattentive vs. hyperactive/impulsive vs. combined ADHD vs. non-ADHD groups) as the independent variables and each of the SPI scales (insomnia, sleepiness, nightmares, sleepwalking, substance abuse and sleep scheduling), as the dependent variables. Effect sizes are indicated by partial eta$^2$, $SS$ effect /($SS$ effect + $SS$ error). Conventional cut-offs for small, medium and large effect size are defined as .01, .06, and .14, respectively (Tabachnick & Fidell, 1996). Table 4 presents the means and
standard deviations on the SPI scales for the elevated ADHD symptom groups (inattentive, hyperactive/impulsive and combined ADHD) and the non-ADHD group.

For the SPI sleep problem scales, the main effect for ADHD symptoms group was significant for insomnia, $F(3, 361) = 18.66, p < .00001$, partial $\eta^2 = .13$, and sleepiness, $F(3, 361) = 54.89, p < .00001$, partial $\eta^2 = .31$, nightmares, $F(3, 361) = 4.45, p = .0044$, partial $\eta^2 = .04$, and sleepwalking, $F(3, 361) = 3.19, p = .0237$, partial $\eta^2 = .02$. Post-hoc analyses (Tukey HSD) revealed that all three elevated ADHD symptom groups (inattentive, hyperactive/impulsive and combined ADHD) were significantly higher than the non-ADHD group on the insomnia and sleepiness scales. On the nightmare scale, the only significant difference was between the inattentive group and the non-ADHD group. On the sleepwalking scale, the hyperactive/impulsive and combined ADHD groups were higher than non-ADHD group. There were no significant main effects for gender and no gender by group interactions on the sleep problem scales.

For the SPI sleep hygiene scales, there were main effects for ADHD symptom group on the substance abuse, $F(3, 361) = 8.17, p = .00003$, partial $\eta^2 = .06$ and sleep scheduling scales, $F(3, 361) = 12.29, p < .00001$, partial $\eta^2 = .09$. Post-hoc analyses (Tukey HSD) revealed that all three elevated ADHD symptom groups (inattentive, hyperactive/impulsive and combined ADHD) were significantly higher than the non-ADHD group on the substance abuse ($p < .001$) and sleep scheduling scales ($p < .02$). There was a significant main effect for gender (with men scoring higher than women) on the substance abuse scale only, $F(1, 361) = 9.21, p = .0026$, partial $\eta^2 = .02$. There were no significant interactions on the sleep hygiene scales.
Sleep problems and sleep hygiene in elevated ADHD symptoms vs. non-ADHD groups, controlling for hygiene

The ANOVA results indicated that the ADHD symptom groups had higher self-reported sleep problems than the non-ADHD group, most notably insomnia and sleepiness. The ANOVA results also indicated that ADHD symptoms groups had poorer sleep hygiene than the non-ADHD group, specifically higher substance abuse and sleep scheduling scale scores. Because poor sleep hygiene may cause, or contribute to sleep problems, it is possible that the significant effects of ADHD symptoms on the SPI sleep problem scales were confounded by poor sleep hygiene. Therefore, in order to examine whether sleep hygiene accounted for the higher sleep problems in adults with elevated ADHD symptomatology, two one-way ANCOVAs were conducted with group (elevated ADHD symptoms vs. non-ADHD) as the independent variable and insomnia and sleepiness as the dependent variables and substance abuse and sleep scheduling as the covariates. Insomnia and sleepiness were used as dependent variables because these were the only SPI sleep problem scales that accounted for significant variance in ADHD symptomatology.

The independent variable was limited to two levels (elevated ADHD symptoms vs. non-ADHD) with the elevated ADHD symptoms group containing all participants with elevated ADHD symptoms, regardless of their subtype. The inattentive, hyperactive/impulsive and combined ADHD symptom groups were combined because the ANOVA results indicated there were minimal differences across ADHD symptom groups. Limiting the ADHD group to two levels also increased the sample sizes within
each level of the group independent variable, and reduced the potential violations to the statistical assumptions for conducting ANCOVA (Tabachnick & Fidell, 1996).

Before conducting the ANCOVAs, the homogeneity-of-slopes assumption was also tested to rule out any group by covariate interactions on the dependent variables (insomnia and sleepiness). The relationship between insomnia and alcohol, \( F(1, 361) = .39, p = .5306 \), and insomnia and sleep scheduling, \( F(1, 361) = .20, p = .1567 \), did not differ as a function of ADHD group, suggesting the homogeneity-of-slopes assumption was met for conducting the ANCOVAs with insomnia as the dependent variable and substance abuse and sleep scheduling as the covariates. The relationship between sleepiness and alcohol, \( F(1, 361) = .79, p = .3732 \), and sleepiness and sleep scheduling, \( F(1, 361) = 1.12, p = .2916 \), also did not differ as a function of ADHD group, suggesting the homogeneity-of-slopes assumption was met for conducting the ANCOVA with sleepiness as the dependent variable and substance abuse and sleep scheduling as the covariates.

The ANCOVAs revealed a significant main effect of ADHD group for insomnia, \( F(1, 365) = 23.69, p < .00001 \), partial \( \eta^2 = .06 \), and sleepiness, \( F(1, 365) = 89.67, p < .00001 \), partial \( \eta^2 = .20 \). The elevated ADHD symptom group reported higher levels of insomnia and sleepiness than the non-ADHD group, even after controlling for substance abuse and sleep scheduling.

Discussion

Consistent with predictions, and regardless of whether ADHD dimensions of inattention and hyperactivity/impulsivity were operationalized as continuous or categorical variables, ADHD symptomatology was associated with self-reported sleep
problems. The four SPI sleep problem scales accounted for 21% of the variability in total ADHD symptoms in non-clinical young adults. Although the SPI nightmares and sleepwalking scales contributed to the variance in ADHD symptoms, only insomnia and sleepiness were significant individual predictors, with sleepiness accounting for 15% of the variance in total ADHD symptoms.

When the analysis compared mean scores on the SPI sleep problems scales across the clinically elevated ADHD symptom groups and non-ADHD controls, similar results emerged. The clinically elevated ADHD symptom groups (inattentive, hyperactive/impulsive and combined ADHD symptom groups) had higher scores than non-ADHD controls across all SPI sleep problem scales (insomnia, sleepiness, nightmares and sleepwalking), however only insomnia and sleepiness demonstrated large effect sizes. Items on the insomnia scale assess poor sleep quality, and symptoms and cognitions related to difficulties with initiating and maintaining sleep. Items on the sleepiness scale assess subjective feelings of sleepiness, as well as problems with maintaining wakefulness (e.g., falling asleep at inappropriate times), and reduced daytime functioning (e.g., meeting morning obligations, focusing on work/schoolwork). These findings suggest that regardless of ADHD subtype, adults with elevated ADHD symptoms have more sleep problems than adults without elevated ADHD symptoms, and ADHD symptomatology is mostly associated with difficulties with initiating and maintaining sleep and maintaining daytime alertness and functioning.

The present findings are consistent with similar studies that have examined ADHD symptoms and sleep problems in non-clinical adult samples. For example, Kass et al. (2003) found that inattention and hyperactivity symptoms were also significantly
associated with self-reports of insomnia and excessive sleepiness. Gau et al. (2007) found that Taiwanese students with elevated ADHD scores reported higher rates of sleep disorders (including insomnia, nightmares, sleep terrors and sleepwalking) than students without elevated ADHD scores. Students with elevated ADHD scores also reported a higher need for sleep to maintain optimal functioning and a greater discrepancy between obtained and needed sleep. Although these studies used different measures to assess ADHD and sleep symptoms, their findings are thematically consistent with the current findings, and taken together, suggest important associations between ADHD symptoms in young adults and insomnia and excessive sleepiness.

Consistent with predictions, ADHD dimensions of inattention and hyperactivity/impulsivity were also associated with poor sleep hygiene. The substance abuse and disrupted routines scales of the SPI accounted for 9% of the variability in ADHD symptomatology in young adults. The elevated ADHD symptoms groups also had higher mean scores on the SPI substance abuse and sleep scheduling scales, findings that supported clinical reports of higher substance abuse in adolescents and young adults with ADHD (Brown & McMullen, 2001; Faraone et al., 2007; Wilens, 2004). Evaluating sleep hygiene is important in determining whether sleep symptoms are associated with an underlying sleep problem or whether they better reflect poor lifestyle behaviors. For example, drinking alcohol (even in moderation) before going to bed is known to influence the distribution of the sleep stages, and to disturb sleep (Landolt, Roth, Dijk, & Borbely, 1996). Drinking alcohol tends to reduce initial sleep latency, but wake time in the latter half of the sleep period as the alcohol is metabolized. Alcohol ingestion results
in more frequent awakenings, and increased fragmentation in REM and sleep stage transitions (American Sleep Disorders Association, 1997; Vitiello, 1997).

However, the sleep hygiene dimensions of substance abuse and poor sleep scheduling did not account for the higher sleep problems in adults with elevated ADHD symptomatology in the current study. The regression analyses indicated that the sleep problem scales accounted for variability in ADHD symptoms above and beyond what is accounted for by the sleep hygiene scales. The elevated ADHD symptom groups reported higher insomnia and sleepiness symptoms, even after controlling for substance abuse and sleep scheduling. Therefore, the current results do not suggest that sleep hygiene is responsible for the elevated sleep complaints in adults with elevated ADHD symptomatology. Rather, these findings suggest a genuine association between ADHD symptoms and self-reported sleep complaints that may reflect either the presence of underlying sleep problems, or a preoccupation with sleep-related symptomatology, for which there may or may not be an associated physiological sleep disturbance.

However, there are some noteworthy limitations in the current study. First, the study was conducted with young adults, which therefore limits the generalizability of the findings to older age groups. Second, the current study focused primarily on symptomatic description in a non-clinical sample. Elevated symptoms of inattention, hyperactivity and impulsivity may reflect the underlying presence of ADHD, however it is possible that these symptoms result from some other factor, or condition not assessed in the current study. The symptom dimensions assessed by the CAARS are not specific to ADHD alone, but are also associated in some degree with a variety of other disorders, including substance abuse disorders, mood and anxiety disorders, post-traumatic stress disorder,
organic brain disease, etc. Although symptoms of inattention, hyperactivity/impulsivity characterize the disorder, extreme placement on these dimensions does not guarantee a diagnosis of ADHD. Diagnosis of ADHD is a complex process, with emphasis on clinical judgment of functional impairment, as well as assessment of the onset, chronicity, and stability of the symptom pattern. Furthermore, a diagnosis of ADHD remains a qualitative phenomenon in which the disorder is either present or absent based on clinical assessment of DSM-IV criteria. Therefore, the next step was to cross-validate the current findings in a clinical sample of adults with a confirmed diagnosis of ADHD.

Study 2: Sleep Problems and Sleep Hygiene in Young Adults with ADHD

Method

Participants

Thirty-nine young adults with a confirmed ADHD diagnosis (21 men, 18 women) were recruited from the Queen’s University Regional Assessment and Resource Center, Kingston, Ontario. ADHD diagnosis had been made previously by a team of specialists, including a licensed psychologist at a university-affiliated ADHD diagnostic clinic. Diagnostic criteria from the DSM–IV were used, including a positive history of ADHD symptoms in childhood, as well as current fulfillment of the DSM-IV diagnostic criteria (American Psychiatric Association, 1994). Participants were excluded if there was evidence of Axis 1 or 2 disorders or other comorbid disorders. Current level of ADHD symptoms was also assessed using the CAARS DSM-IV ADHD ratings scales. The ADHD group had significantly higher scores than age and gender matched control on the inattention $t(76) = 14.42, p < .00001$, hyperactivity/impulsivity, $t(76) = 9.73, p < .00001$
and combined ADHD $t(76) = 14.69, p < .00001$ symptoms scales. The mean age of the sample was 21.85 ($SD = 3.96$). Ninety-two percent of individuals indicated their ethnicity was White/Caucasian, and 90% percent indicated their marital status was single.

Thirty-nine age and gender matched controls (21 men, 18 women) were randomly selected from the undergraduates from Study 1 for the non-ADHD comparison group. The mean age of sample 2 was 21.88 years ($SD = 4.02$). Ninety percent of individuals indicated their ethnicity was White/Caucasian, and 88% indicated their marital status was single.

**Materials**

The CAARS and SPI were used and are described in detail in Study 1.

**Procedure**

Individuals with ADHD who were receiving academic accommodations for their disability through the Queen’s University Regional Assessment and Resource Centre were recruited by a licensed psychologist to participate in a study on “sleep and ADHD”. The nature of the study was explained to patients and they were invited to participate at the end of a regularly scheduled counseling session. Patients who agreed to participate either completed the measures immediately, or were given a package to take home that contained a description of the study, a consent form, the CAARS and the SPI questionnaires, and a debriefing form. If participants completed the questionnaires at home, then they returned the package to the clinic at their convenience, usually when they arrived for their next scheduled appointment.
Thirty-nine individuals in the control group were selected from the large sample of undergraduates in Study 1 that were matched on age and gender to the young adults with ADHD. Participants in the non-ADHD control groups did not undergo any formal psychiatric assessment; however, they provided current levels of ADHD symptoms using the CAARS DSM-IV rating scales.

Results

In the following analyses, study predictions were examined by comparing levels of sleep problems and sleep hygiene as assessed by the SPI scales between young adults that had a confirmed diagnosis of ADHD (clinical ADHD group) and non-ADHD controls (non-ADHD group). Table 5 presents the means and standard deviations on the SPI scales for the clinical ADHD group and non-ADHD controls, arranged by gender.

A series of two-way ANOVAs were conducted with gender (men vs. women) and ADHD group (clinical ADHD group vs. non-ADHD group) as the independent variables and each of the SPI sleep problem and sleep hygiene scales (insomnia, sleepiness, nightmares, sleepwalking, substance abuse and sleep scheduling), as the dependent variables. Effect sizes are indicated by partial $\eta^2 = \text{SS effect / (SS effect + SS error)}$. Conventional cut-offs for small, medium and large effect size are defined as .01, .06, and .14, respectively (Tabachnick & Fidell, 1996).

On the SPI sleep problem scales, the clinical ADHD group scored higher than the non-ADHD group on the insomnia, $F(1, 74) = 34.43, p < .00001$ partial $\eta^2 = .32$, and sleepiness scales, $F(1, 74) = 46.00, p < .00001$ partial $\eta^2 = .38$. The clinical ADHD group also had higher scores than non-ADHD group on the nightmare, $F(1, 74) = 6.04, p = .0163$ partial $\eta^2 = .07$ and sleepwalking scales, $F(1, 74) = 6.69, p = .0117$, partial $\eta^2$.
The only significant gender effect (with women scoring higher than men) was on the nightmare scale, $F(1, 74) = 9.77, p = .0025$, partial $\eta^2 = .12$. There was no significant gender by group interactions on the sleep problems scales of the SPI.

On the SPI sleep hygiene scales, the clinical ADHD group scored higher than non-ADHD group on the substance abuse, $F(1, 74) = 13.08, p = .0006$, partial $\eta^2 = .15$ and sleep scheduling scales, $F(1, 74) = 12.91, p = .0006$, partial $\eta^2 = .15$ scales. There was a significant main effect for gender (with men scoring higher than women) on the substance abuse scale only, $F(1, 74) = 15.42, p = .0002$, partial $\eta^2 = .17$. There was no significant group by gender interactions on the sleep hygiene scales of the SPI.

Sleep Problems in Clinical ADHD group vs. Non-ADHD controls, controlling for sleep hygiene

Because the ADHD groups differed on the SPI sleep hygiene scales, and poor sleep hygiene can cause or contribute to sleep problems, it is possible that the significant effects of ADHD symptoms on the SPI sleep problem scales were confounded by sleep hygiene. Therefore, two one-way ANCOVAs were conducted with insomnia and sleepiness as the dependent variables (i.e., nightmares and sleepwalking scales were not used because they accounted for only a small proportion of variance in ADHD symptomatology). Gender and ADHD group (clinical ADHD group vs. non-ADHD controls) were the independent variables, and substance abuse and sleep scheduling scores were the covariates.

Preliminary analyses evaluating the homogeneity of slopes assumption indicated that the relationships between the covariates and the dependent variables did not differ as a function of the independent variables. Specifically, the relationship between insomnia
and alcohol, $F(1, 62) = 1.62, p = .5708$, and insomnia and sleep scheduling, $F(1, 62) = 3.96, p = .0593$, did not differ as a function of ADHD group, suggesting the homogeneity-of-slopes assumption was met for conducting the ANCOVAs with insomnia as the dependent variable and substance abuse and sleep scheduling as the covariates. The relationship between sleepiness and alcohol, $F(1, 62) = 1.95, p = .2796$, and sleepiness and sleep scheduling, $F(1, 62) = 1.52, p = .2222$, also did not differ as a function of ADHD group, suggesting the homogeneity-of-slopes assumption was met for conducting the ANCOVA with sleepiness as the dependent variable and substance abuse and sleep scheduling as the covariates.

The ANCOVAs revealed significant main effects for ADHD group on the insomnia, $F(1, 72) = 18.86, p < .00001$, partial $\eta^2 = .21$, and sleepiness scales, $F(1, 365) = 24.11, p < .00001$, partial $\eta^2 = .25$, indicating that the clinical ADHD group reported higher levels of insomnia and sleepiness than the non-ADHD group, even after controlling for substance abuse and sleep scheduling.

**Discussion**

Consistent with predictions, young adults with ADHD reported more sleep problems, than non-ADHD controls. Specifically, the ADHD group scored higher than the non-ADHD group on the SPI insomnia, sleepiness, nightmares and sleepwalking scales, however only insomnia and sleepiness demonstrated large effect sizes. Also consistent with predictions, young adults with ADHD reported poorer sleep hygiene than non-ADHD controls. The ADHD group scored higher on the SPI substance abuse and sleep scheduling scales than the non-ADHD group. However, contrary to predictions, sleep hygiene did not account for the sleep problems reported by adults with ADHD.
Adults with ADHD reported more insomnia and sleepiness symptoms than non-ADHD controls, even after controlling for substance abuse and poor sleep scheduling.

The finding that adults with ADHD reported more sleep symptoms related to insomnia and sleepiness than non-ADHD controls was consistent with the results of Study 1, and the few prior studies that have examined the sleep complaints of adults with ADHD. For example, Schredl et al. (2007) also found that patients with ADHD reported more insomnia and sleepiness symptoms than non-ADHD controls. ADHD symptom severity was significantly associated with symptoms of insomnia (including increased sleep latency, nocturnal awakenings, and poor sleep quality) and sleepiness (feeling un-refreshed in the morning, tiredness during the day). Furthermore, Schredl et al. reported that the associations between ADHD symptoms severity and sleep symptoms were significant even after partialling out the variance accounted for by age, gender, and depression. The similarity between results reported by Schredl et al. and the present study are not surprising given the overlapping items on the sleep instruments and methodology used in both studies. Taken together, these findings suggest an important association between ADHD and self-reported sleep problems, in particular, symptoms of insomnia and daytime sleepiness.

The finding that adults with ADHD had higher substance abuse and poor sleep scheduling scores on the SPI than non-ADHD controls was also consistent with the results of Study 1 and prior clinical reports of poor sleep hygiene in adults with ADHD (Brown & McMullen, 2001). Therefore, it appears that young adults with ADHD may be more likely to report engaging in lifestyle behaviours that have the potential to disrupt sleep than young adults without ADHD. However, substance abuse and poor sleep
scheduling did not account for the elevated insomnia and sleepiness symptoms in the present study. Therefore, current findings do not support the claim that sleep complaints in adults with ADHD may simply reflect poor sleep hygiene. It is important to note that the assessment of sleep hygiene was limited to poor sleep scheduling and substance abuse dimensions, and it is possible that a broader scope of sleep hygiene behaviours may lead to alternative findings. It is also possible that sleep hygiene did not affect sleep problems due to the young age of the participants. Younger participants are generally healthier and physically more resilient to sleep disruption than older adults, and sleep hygiene effects may be more likely to be detected in samples of older adults.

The present findings provide additional support for a genuine association between ADHD and sleep symptoms and may indicate a comorbidity of ADHD with insomnia because sleep onset difficulties and restless sleep (as well as feeling tired in the morning) are the primary symptoms of this sleep disorder. However, it is difficult to speculate as to the underlying cause of the sleep complaints in the current study because the sleep symptoms assessed on the SPI insomnia and sleepiness scales are central features of several sleep disorders, and are also reported frequently by patients with other mental and physical illnesses (e.g., depression, anxiety disorders, fibromyalgia) (Ford & Kramerow, 1989; Roth, Jaeger, Jin, Kalsekar, Stang, & Kessler, 2006). It has also been suggested by some researchers that primary sleep disorders may sometimes be misdiagnosed as ADHD (Naseem, Chaudhary, & Collop, 2001; Oosterloo, Lammers, deNoord, & Kooij, 2006; Sangal & Sangal, 2004). They observed that daytime behaviors of individuals with a wide variety of sleep disorders (e.g., insomnia, sleep apnea, periodic leg movements of sleep) can mimic ADHD by manifesting symptoms of inattention, hyperactivity, and
impulsivity. It remains to be determined whether the overlap in symptomatology of ADHDs and sleep disorders is due to misdiagnosis or a genuine comorbidity of ADHD with these various disorders of sleep, or to a common pathophysiology of the mechanisms for self-regulation of sleep and waking-time behaviors.

Physiological sleep disturbances and nocturnal awakenings are often associated with self-reports of poor sleep quality, and daytime symptoms of sleepiness, irritability, and emotional lability (Akerstedt, Hume, Minors, & Waterhouse, 1994). Furthermore, recent polysomnographic studies have found evidence of insomnia (reduced sleep efficiency, increased nocturnal awakenings), and increased movements and arousals caused by periodic limb movements in adults with ADHD (Philipsen et al., 2005; Sobanski et al., 2008). Therefore, it is possible that the higher levels of insomnia and sleepiness symptoms found in the current study also reflect these types of underlying sleep disturbances in young adults with ADHD symptoms.

There are some noteworthy limitations in the current study. First, generalizability of these results to the larger population of adults with ADHD may be limited. The participants were relatively high-functioning, well-educated adults with access to specialized health care services on an elite university campus. As such, the results may not represent the general population of persons with ADHD, most of whom attain far lower levels of academic achievement than the participants in the current study. Also, we did not obtain health histories and therefore were unable to control for confounding medical conditions or concurrent psychiatric diagnosis that may have influenced results. Finally, the findings are limited by the use of a single measure for each key variable and therefore results need to be replicated using multiple measures of key variables.
Particular emphasis should be placed on using a broader range of assessment methodologies for measuring insomnia, including comprehensive clinical interview (Morin, 2000). We also encourage the use of polysomnographic measures of sleep parameters (e.g., the multiple sleep latency test) in future research.
Table 1
Descriptive Statistics and Intercorrelations Among the Study Variables in Total Sample

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<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<td>2. Hyperactive</td>
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<td>3. Combined ADHD</td>
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<td>.30</td>
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<td>5. Sleepiness</td>
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<td>.46</td>
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<td>6. Nightmares</td>
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<td>.12</td>
<td>.44</td>
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<td>.29</td>
<td>.06</td>
<td>.04</td>
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<td>9. Schedule</td>
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<td>.26</td>
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<td>Mean</td>
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<td>.70</td>
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</tbody>
</table>

Note. N=713; 1-3 are CAARS subscales; 4-9 SPI scales; \( r \geq .08 \) are significant, \( p < .05 \).
Table 2  
Means and Standard Deviations for Study Variables, Arranged by Gender

<table>
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<tr>
<th>Scale</th>
<th>Men Mean</th>
<th>Men SD</th>
<th>Women Mean</th>
<th>Women SD</th>
<th>t</th>
<th>p</th>
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</thead>
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<td>&lt; .00001</td>
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<td>4.13</td>
<td>8.56</td>
<td>3.91</td>
<td>2.56</td>
<td>.0107</td>
</tr>
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<td>Combined ADHD</td>
<td>19.60</td>
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<td>17.03</td>
<td>7.22</td>
<td>4.40</td>
<td>&lt; .00001</td>
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<td>14.34</td>
<td>4.80</td>
<td>0.22</td>
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<td>4.47</td>
<td>0.54</td>
<td>.7114</td>
</tr>
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<td>3.48</td>
<td>12.27</td>
<td>5.13</td>
<td>2.86</td>
<td>.0044</td>
</tr>
<tr>
<td>Sleepwalking</td>
<td>8.01</td>
<td>2.03</td>
<td>7.92</td>
<td>2.45</td>
<td>0.46</td>
<td>.6462</td>
</tr>
<tr>
<td>Substances</td>
<td>13.14</td>
<td>4.78</td>
<td>10.99</td>
<td>3.57</td>
<td>6.86</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td>Schedule</td>
<td>16.77</td>
<td>3.77</td>
<td>15.31</td>
<td>3.65</td>
<td>5.08</td>
<td>&lt; .00001</td>
</tr>
</tbody>
</table>

*Note. N = 713 (269 men, 444 women); SD = Standard deviation*
Table 3
Summary of Regression Results for Sleep Variables Predicting ADHD in Total Sample

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Predictor</th>
<th>beta</th>
<th>B</th>
<th>SE</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td>Insomnia</td>
<td>.12</td>
<td>.12</td>
<td>.04</td>
<td>2.94</td>
<td>.0033</td>
</tr>
<tr>
<td></td>
<td>Sleepiness</td>
<td>.44</td>
<td>.47</td>
<td>.04</td>
<td>11.84</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td></td>
<td>Nightmares</td>
<td>-.07</td>
<td>-.07</td>
<td>.04</td>
<td>-2.04</td>
<td>.0412</td>
</tr>
<tr>
<td></td>
<td>Sleepwalking</td>
<td>.00</td>
<td>.00</td>
<td>.07</td>
<td>.03</td>
<td>.9787</td>
</tr>
<tr>
<td></td>
<td>Substances</td>
<td>.14</td>
<td>.16</td>
<td>.04</td>
<td>3.52</td>
<td>.00046</td>
</tr>
<tr>
<td></td>
<td>Schedule</td>
<td>.19</td>
<td>.24</td>
<td>.05</td>
<td>4.90</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td></td>
<td>F(4,708) = 54.23, p &lt; .0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = .48, R^2 = .234</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F(2,710) = 27.77, p &lt; .0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = .27, R^2 = .073</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactive</td>
<td>Insomnia</td>
<td>.12</td>
<td>.10</td>
<td>.04</td>
<td>2.78</td>
<td>.0055</td>
</tr>
<tr>
<td></td>
<td>Sleepiness</td>
<td>.22</td>
<td>.19</td>
<td>.04</td>
<td>5.41</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td></td>
<td>Nightmares</td>
<td>.00</td>
<td>.00</td>
<td>.04</td>
<td>.10</td>
<td>.9204</td>
</tr>
<tr>
<td></td>
<td>Sleepwalking</td>
<td>.09</td>
<td>.16</td>
<td>.06</td>
<td>2.53</td>
<td>.0116</td>
</tr>
<tr>
<td></td>
<td>Substances</td>
<td>.16</td>
<td>.16</td>
<td>.04</td>
<td>4.23</td>
<td>.00003</td>
</tr>
<tr>
<td></td>
<td>Schedule</td>
<td>.16</td>
<td>.17</td>
<td>.04</td>
<td>4.00</td>
<td>.00007</td>
</tr>
<tr>
<td></td>
<td>F(4,708) = 20.57, p &lt; .0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = .32, R^2 = .104</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F(2,710) = 26.24, p &lt; .0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = .26, R^2 = .066</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined ADHD</td>
<td>Insomnia</td>
<td>.14</td>
<td>.22</td>
<td>.07</td>
<td>3.37</td>
<td>.0008</td>
</tr>
<tr>
<td></td>
<td>Sleepiness</td>
<td>.39</td>
<td>.66</td>
<td>.06</td>
<td>10.29</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td></td>
<td>Nightmares</td>
<td>-.05</td>
<td>-.08</td>
<td>.06</td>
<td>-1.21</td>
<td>.2266</td>
</tr>
<tr>
<td></td>
<td>Sleepwalking</td>
<td>.04</td>
<td>.16</td>
<td>.12</td>
<td>1.43</td>
<td>.1538</td>
</tr>
<tr>
<td></td>
<td>Substances</td>
<td>.17</td>
<td>.31</td>
<td>.07</td>
<td>4.46</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td></td>
<td>Schedule</td>
<td>.20</td>
<td>.41</td>
<td>.08</td>
<td>5.20</td>
<td>&lt; .00001</td>
</tr>
<tr>
<td></td>
<td>F(4,708) = 47.69, p &lt; .0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = .46, R^2 = .212</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F(2,710) = 36.31, p &lt; .0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R = .30, R^2 = .093</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 713; beta = Standardized regression coefficient, B = Unstandardized regression coefficient, SE = Standard error of B.
Table 4
Means and Standard Deviations for the Elevated ADHD Symptoms Groups on the SPI Scales.

<table>
<thead>
<tr>
<th>SPI Scales</th>
<th>Inattentive</th>
<th>Hyper/Impulsive</th>
<th>Combined</th>
<th>Non-ADHD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Insomnia</td>
<td>17.44</td>
<td>4.84</td>
<td>15.09</td>
<td>5.54</td>
</tr>
<tr>
<td>Sleepiness</td>
<td>19.00</td>
<td>3.67</td>
<td>16.37</td>
<td>4.08</td>
</tr>
<tr>
<td>Nightmares</td>
<td>13.14</td>
<td>5.63</td>
<td>13.00</td>
<td>5.64</td>
</tr>
<tr>
<td>Sleepwalking</td>
<td>8.01</td>
<td>2.11</td>
<td>8.45</td>
<td>2.39</td>
</tr>
<tr>
<td>Substances</td>
<td>12.89</td>
<td>4.87</td>
<td>12.74</td>
<td>4.31</td>
</tr>
<tr>
<td>Schedule</td>
<td>17.76</td>
<td>3.60</td>
<td>16.24</td>
<td>3.83</td>
</tr>
</tbody>
</table>

*Note. n = 63 for Inattentive, n = 55 for Hyper/Impulsive; n = 29 for Combined and n = 222 for Non-ADHD controls; SD = Standard Deviation*
Table 5
Means and Standard Deviations on the SPI Scales for the Clinical ADHD Group and Age and Gender matched non-ADHD Controls.

<table>
<thead>
<tr>
<th>SPI Scales</th>
<th>ADHD Group Men</th>
<th>ADHD Group Women</th>
<th>Non-ADHD Group Men</th>
<th>Non-ADHD Group Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Insomnia</td>
<td>15.76</td>
<td>4.80</td>
<td>17.78</td>
<td>4.12</td>
</tr>
<tr>
<td>Sleepiness</td>
<td>17.48</td>
<td>4.71</td>
<td>19.56</td>
<td>3.57</td>
</tr>
<tr>
<td>Nightmares</td>
<td>9.81</td>
<td>2.79</td>
<td>14.33</td>
<td>5.85</td>
</tr>
<tr>
<td>Sleepwalking</td>
<td>8.00</td>
<td>1.79</td>
<td>9.33</td>
<td>3.60</td>
</tr>
<tr>
<td>Substances</td>
<td>14.14</td>
<td>4.14</td>
<td>11.11</td>
<td>2.27</td>
</tr>
<tr>
<td>Schedule</td>
<td>16.71</td>
<td>3.65</td>
<td>16.28</td>
<td>2.72</td>
</tr>
</tbody>
</table>

*Note. ADHD Group = Young adults with a confirmed diagnosis of ADHD (n= 39); Non-ADHD Group = undergraduates/controls (n= 39); SD = Standard deviation*
References


Barkley, R. A. Fischer, M., Smallish, L., & Fletcher, K. (2002). The persistence of attention deficit/hyperactivity disorder into young adulthood as a function of


CHAPTER 4

General Discussion

Summary of Research Findings

Sleep problems have been reported in children and adults with ADHD. In addition, substance abuse and other behaviours associated with poor sleep hygiene have been reported in individuals with ADHD. However, as discussed in Chapter 1 of this dissertation, a notable limitation in the literature on sleep and ADHD is that it has failed to take into account the influence of sleep hygiene in the development and maintenance of sleep problems. One important reason that empirical studies may be lacking in this area is the absence of established measures of sleep hygiene. Thus, the research presented in this dissertation was conducted to accomplished two important purposes:

1) To develop a psychometrically sound, valid and reliable instrument to assess sleep hygiene in young adults.

2) To examine the relationship between sleep hygiene, sleep problems and ADHD symptomatology in young adults.

Chapter 2 outlined the development of a new self-report instrument to assess sleep hygiene in young adults. Items were generated using International Classification of Sleep Disorders (ICSD) criteria and exploratory factor analyses were used to develop a two-factor model of sleep hygiene that assessed substance abuse and poor sleep scheduling dimensions in young adults. The two factor structure of the sleep hygiene items was replicated using confirmatory factor analysis in a second, independent sample of young adults, and preliminary evidence for the concurrent and predictive validity was provided.
Given that the new instrument demonstrated adequate psychometric properties, it was used to examine the associations between sleep hygiene, sleep problems and ADHD symptoms.

Chapter 3 presented two empirical studies that were conducted to examine whether sleep problems and sleep hygiene are associated with ADHD symptoms in young adults. In the first study, analyses focused on the associations between sleep hygiene, sleep problems and ADHD symptomatology in a large non-clinical sample of young adults. In the second study, sleep hygiene and sleep problems were examined in a clinical sample of young adults that were diagnosed with ADHD and receiving treatment and counseling at a university health centre. Regardless of whether ADHD symptomatology was treated as categorical or continuous variable (i.e., diagnostic category vs. symptoms on the CAARS), the findings across the two studies were very consistent. In summary:

1) ADHD was associated with self-reported sleep problems, specifically symptoms of insomnia and daytime sleepiness.

2) ADHD was associated with poor sleep hygiene dimensions of substance abuse and poor sleep scheduling.

3) Young adults with elevated ADHD symptoms (i.e., in both clinical and non-clinical samples) had higher insomnia and sleepiness levels than non-ADHD controls, even after controlling for substance abuse and poor sleep scheduling.

It was predicted that sleep hygiene would account for the sleep problems in young adults with elevated ADHD; however as outlined above, this prediction was not supported. Therefore, findings do not support the claim that poor sleep hygiene might be
responsible for the sleep problems of young adults with ADHD. Rather, findings suggest a genuine association between ADHD and sleep symptoms that may reflect the underlying presence of sleep disturbances in young adults with ADHD.

The following sections discuss each of these findings in the broader context of the existing literature, some of which was published since the initiation of the studies presented in this dissertation. The limitations of the present studies and directions for future research are also addressed.

ADHD and Sleep Problems

In the current studies, ADHD symptoms were associated with insomnia and sleepiness symptoms, and this adds to the growing body of research that has linked ADHD to sleep problems (Cortese et al. 2006; Owens, 2005). It is tempting to conclude that ADHD symptoms cause sleep problems, however the current research methodology was correlational, and causation cannot be implied from the findings. For example, one might speculate that ADHD symptoms cause insomnia symptoms; however the reverse is also possible. The relationship between ADHD symptoms and sleep problems can also be caused by, mediated, or moderated by some other factor that has not yet been identified. It is also possible that an underlying sleep disorder such as sleep apnea or periodic limb movements is responsible for the both ADHD and insomnia symptoms. For instance, new studies published in the last few years have provided polysomnographic evidence of sleep disturbances in adults with ADHD linked to nocturnal limb movements and arousals during sleep (e.g., Philipsen et al., 2005; Sobanski et al., 2008). Also, there is evidence that dopaminergic systems may be involved in the etiology of ADHD and of movement disorders in sleep (Krause, La Fougere, Krause, Ackenheim, & Dresel, 2005; Michaud,
Soucy, Chabli, Lavigne, & Montplaisir, 2002; Wagner, Walters, & Fisher, 2004), and some researchers speculate that both disorders may be caused by common pathophysiological mechanisms (Owens, 2005; Sonuga-Barke, 2003; Volkow et al., 2007). These neuropsychological explanations represent an interesting area for future research, but are beyond the self-report methodology of the present studies.

The present research demonstrated important relationships between ADHD symptoms and insomnia and sleepiness symptoms, as assessed by the Sleep Problems Inventory (SPI). The SPI is not a diagnostic tool, and the symptom domains assessed by the SPI reflect the diagnostic criteria of several sleep disorders. For example, the SPI insomnia scale has items that assess difficulty with initiating and maintaining sleep, and subjective appraisal of poor sleep quality. These are symptoms of primary insomnia, but are also reported by patients with other sleep disorders (e.g., sleep apnea, periodic limb movement disorder) and medical and psychiatric disorders (e.g., fibromyalgia, anxiety, depression) (Ford & Kamerow, 1989; Roth, Jaeger, Jin, Kalsekar, Stang, & Kessler, 2006). The sleepiness scale assesses subjective feelings of sleepiness, as well as problems with maintaining wakefulness (e.g., falling asleep at inappropriate times), and reduced daytime functioning (e.g., meeting morning obligations, focusing on work/schoolwork). A high score on the sleepiness scale could reflect symptoms of sleep disorders that involve sleepiness as a primary symptom (e.g., hypersomnia, narcolepsy), or as a secondary symptom that results from sleep disruption and sleep deprivation caused by conditions such as sleep apnea, and periodic limb movements (Chokroverty, 2000; Martin et al., 1996; Punjabi, Bandeen-Roche, & Young, 2003; Stepanski et al., 1984).
In the present research, the strongest association was between sleepiness and inattention symptoms, and this finding was not surprising given the conceptual overlap between these two constructs (i.e., inattention can be a symptom of sleepiness) (Chervin, Dillon, Bassetti, & Pituch, 1997; Oosterloo, Lammers, Overeem, deNoord, & Kooij, 2006; Touchette et al., 2007). The findings could indicate either a real overlap between ADHD and sleep disorders involving excessive daytime sleepiness, or a lack of specificity in the questionnaires used in the current studies. In clinical practice, the diagnosis of both sleep disorders involving excessive sleepiness and of ADHD may be difficult, even for experts in the respective areas (Oosterloo et al., 2006). One reason that sleepiness assessment is difficult is that, in general, people are poor judges of their own level of sleepiness (Chervin & Aldrich, 1999; Chervin, Aldrich, Pickett, & Guillerminault, 1997; Roth, Roehrs, Carskadon, & Dement, 1989).

To address this limitation in future research, sleepiness could be assessed using more objective measures, such as the Multiple Sleep Latency Test (MSLT; Carskadon & Dement, 1977). The MSLT involves polysomnographic recordings of a participant who is given several opportunities to nap throughout the day in a dark, quiet room after being instructed to try and stay awake. Usually, four napping opportunities of 20 minutes each are scheduled 2 hours apart during the day, after a night of sleep in the laboratory. An average sleep onset (as evidenced by EEG indicators of sleep onset) of less than 5 minutes across testing sessions is considered a pathological level of daytime sleepiness (Carskadon et al., 1986; Kryger, Roth, & Dement, 1989). The MSLT is routinely used in research settings, and to test for excessive daytime sleepiness (EDS) in patients with...
narcolepsy and sleep apnea (Carskadon et al., 1986; Kryger, et al., 1989; Ramar & Guillemiault, 2006; Sangal, Thomas, & Mitler, 1992).

To date, only one published study has used the MSLT to assess sleepiness in children with ADHD (Golan, Shahar, Ravid, & Pillar, 2004). In this study, the 34 children with ADHD had higher daytime sleepiness than controls, a result that is consistent with the current research that found greater self-reported sleepiness in young adults with ADHD. Future research should be conducted to examine whether the elevated sleepiness levels found in the current study (using self-reports) could be verified using MSLT in young adults with ADHD.

Assessing sleep problems with self-reports

In the present research, individuals with elevated ADHD symptoms reported more sleep problems; however it is difficult to determine whether self-reported sleep symptoms actually represent underlying sleep disturbances. It is possible that results reflected a preoccupation with sleep-related symptomatology, or sensitivity to normal sleep disruption which leads to a more negative appraisal of sleep quality in individuals with elevated ADHD symptoms.

Philipsen et al. (2005) argued that the sleep problems reported by adults with ADHD can be explained by sleep state-misperception, a condition which involves subjective appraisal of insomnia or excessive sleepiness that is not verified by objective assessment of sleep physiology using polysomnography or MSLT (McCall & Edinger, 1992; Morin & Espie, 2003; Semler & Harvey, 2005). However, there are a number of problems with the argument that sleep complaints in adults with ADHD arise from sleep state misperception. First, as discussed above, new polysomnographic studies have
demonstrated more nocturnal movements and arousal in adults with ADHD compared to controls. Although movements and arousals are not structural differences, they can decrease sleep quality (Martin et al., 1996; Stepanski et al., 1984), and thereby explain the higher self-reported sleep complaints in adults with ADHD. Second, the only MLST study that has been published found objective evidence of sleepiness in children with ADHD (Golan et al., 2004) and therefore, similar results would be predicted in adults. Finally, sleep state misperception does not apply to cases of malingering, or to symptoms secondary to a diagnosed psychiatric disorder, or other medical condition. Thus, sleep state misperception does not appear to be an appropriate explanation for the self-reported sleep problems in adults with ADHD. Nevertheless, the present research was unable to address the sleep state misperception hypothesis because this would involve comparing self-reports to polysomnography, and the current methodology was limited to self-reports.

Assessing sleep problems with polysomnography

Nocturnal polysomnography is generally viewed as the ‘gold standard’ for identifying sleep disturbances; however it also has important limitations. It is expensive, labour intensive and presents specific challenges because of the artificiality of the environment of the laboratory. The sleep laboratory is a novel situation, involving complex equipment and monitoring devices that can increase nocturnal arousal and disrupt sleep (e.g., first night effects) (Agnew, Webb, & Williams, 1966; Le Bon et al., 2001; Mendels & Hawkins, 1967).

The overall impact of the artificiality of the sleep laboratory is not well understood, but it is possible that this confound presents special challenges for sleep
researchers studying participants with ADHD. For example, the sleeping rooms usually
do not have TVS, computers or other distractions found at home and it is possible that the
artificial conditions in the laboratory may actually facilitate sleep onset in individuals
with ADHD by depriving them of the usual environmental stimuli (Cortese et al., 2006).
The idea that the laboratory environment may interact with ADHD symptoms and
influence sleep processes is an interesting topic for future research, and may help to
explain some of the inconsistency between findings from self-reports and
polysomnographic studies of sleep in adults with ADHD.

The relationship between self-reports and polysomnography is complicated, and
self-reports of sleep symptoms do not always predict poor sleep as measured by
polysomnography (Baker, Maloney, & Driver, 1999; Chervin & Guilleminault, 1996;
Chervin et al., 1997; Morin & Espie, 2003; Rosa & Bonnet, 2000). For example, Rosa
and Bonnet (2000) compared a group of adults who reported chronic difficulty falling
asleep (or being awake for at least 60 minutes after sleep onset) with a group of adults
who had no complaints of insomnia. They found minimal polysomnographic differences,
even though the insomnia group reported longer sleep latencies, more time awake after
sleep onset, more frequent awakenings during the night, and poorer sleep quality.
Similarly, in a study comparing primary insomnia patients with healthy adults, Nofzinger
et al. (2004) found no differences in EEG measures of sleep latency and percentages of
time spent in all stages of sleep even though the healthy subjects reported better sleep
quality; however, functional neuroimaging revealed an association between subjectively
disturbed sleep and greater brain metabolism. These findings suggest that new imaging
techniques may be more sensitive than polysomnography for uncovering the mechanisms
responsible for subjective sleep complaints, and may therefore be particularly useful in future investigations of sleep processes in adults with ADHD.

Furthermore, performance impairments on neuropsychological testing are more strongly associated with self-reports (as measured by daily sleep diaries) than with objective (as measured by polysomnography) sleep disturbances (Morin & Espie, 2003). Therefore, when considering the current findings, it is important to not discount self-reports because the subjective appraisal of sleep problems in adults with ADHD may be more important to daily functioning than the associated physiological sleep disturbance.

Assessing ADHD symptoms with self-reports

ADHD symptoms were also assessed using self-reports and therefore the veracity of responses cannot be determined. Also, some researchers have argued that self-report measures of ADHD symptoms are likely to produce an unacceptably high number of misdiagnoses (because ADHD symptoms are non-specific), and therefore caution should be exercised when using these tools for diagnostic or screening purposes. For example, Harrison (2004) found higher levels of ADHD symptomatology, assessed using the Brown Attention Deficit Disorder Scales for Adults (BADDs), in students presenting at their campus health and counseling centre than would be expected based on the 3-5% prevalence rate for ADHD in the general population. Two-thirds of the students that presented for counseling and psychiatric reasons scored in the clinically significant and at high risk for ADHD range on the BADDs (score of 55 or more), as compared to one third of students that presented for medical reasons.

Other studies have also found high rates of false positives using another self-report measure of ADHD symptoms. For example, McCann and Roy-Byrne (2004)
examined the diagnostic screening utility of the Adult Rating Scale (ARS), Attention Deficit Scales for Adults (ADSA) and a DSM-IV symptom checklist written by the study authors to screen for ADHD in 82 patients who presented for evaluation at an ADHD specialty clinic. Their findings indicated that the three self-report measures had high sensitivity (i.e., correctly identified patients with true ADHD), but also poor specificity (i.e., incorrectly identifying individuals with depression as having ADHD). Although these researchers caution the use of self-reports to screen for ADHD, it is important to note that there are many different instruments available for use today, and some have better psychometric properties than others. Interestingly, these authors acknowledge the validity and reliability studies of the CAARS, but they chose not to use it in their study.

Furthermore, self-reports of ADHD symptoms should be evaluated cautiously when participants are self-referred for assessments because individuals actively seeking treatment may exaggerate symptoms compared to individuals not seeking treatment. For example, patients may exaggerate symptoms in attempts to ensure that their symptoms are identified, and recognized as severe enough to warrant the treatments they seek. In academic settings (e.g., university health and counseling services), students may be motivated to exaggerate symptoms of ADHD because they view attractive benefits associated with diagnoses of ADHD, including academic accommodations (e.g., extended test time, private testing environments, etc.), and obtaining prescriptions for psycho-stimulant medications which can be abused, or distribution to other students for profit (Graff Low & Gendaszek, 2002; Sullivan, May, & Galbally, 2007; Uphadyaya et al., 2005).
In the current studies however, participants had little motivation to exaggerate their symptoms because their reports had no influence on diagnosis and treatment. For instance, in the non-clinical sample, participation was voluntary, anonymous and explicitly for research purposes. The analyses of the clinical data focused on group differences on sleep variables rather than ADHD symptoms, and therefore symptom exaggeration should not have affected the results (i.e., provided the ADHD diagnosis was correct).

The CAARS is not a diagnostic instrument; the scales assess only current symptoms of inattention, and hyperactivity and impulsivity. Because they do not assess the other criteria that are necessary for an ADHD diagnosis, the scales may identify more individuals than may ultimately receive a primary diagnosis of ADHD. However, in the current study, the CAARS did not demonstrate unreasonably high levels of ADHD symptoms in the current studies. For example, of 713 participants, only 63 (8.8%) and 55 (7.7%) obtained scores in the clinically elevated ranges for inattentive and hyperactive symptom scales. Only 29 (4%) participants obtained scores in the clinically elevated range on the combined inattentive and hyperactive/impulsive scale. It is important to highlight that a diagnosis of ADHD also requires clinical judgment of impairment, childhood history and chronicity of the symptom pattern, as well as ruling out other explanations (e.g., medical or other psychiatric disorders, stressful or traumatic life events).

Moreover, there is no single valid scale or test to diagnose ADHD. Any self-report measure should represent only one part of a multi-method assessment protocol that includes data from interviews, questionnaires, and objective records (e.g., school report...
cards, university transcripts, performance evaluations, etc.), ideally obtained from several
different sources, such as parents, teachers, spouse, employer, etc. (Barkley, 1990;
Weisler & Goodman, 2008; Wender, 1998).

Furthermore, the diagnostic criteria for ADHD may require further validation, and
may need to be refined for adults (Barkley, 1990; Faraone, et al., 2006; Weisler &
Goodman, 2008). Specifically, some researchers have questioned whether the number of
symptoms necessary for a diagnosis should be the same for adults as are required for
children (Barkley, 1990; Faraone et al., 2000; Kessler et al., 2005). Another issue is
whether a diagnosis requires childhood onset of symptoms before the age of seven years
because this involves retroactive recall of symptoms which may be biased, and verifying
records (e.g., school report cards, medical records) that may be difficult to obtain after
many years have passed (Faraone et al., 2006; Weisler & Goodman, 2008). With adults,
it can also be more difficult establish significant impairment in two different settings, for
example, symptoms may only cause significant impairment at work. (Barkley, 1990;
Spencer et al., 1998; Weisler & Goodman, 2008).

_Psychiatric comorbidity in adults with ADHD_

Psychiatric comorbidity occurs in more than two-thirds of adults with ADHD
(Barkley, 1990; Biederman, 2004; Sobanski, 2006; Weisler & Goodman, 2008; Wender,
1998). For example, it is estimated that between 35% and 50% of adults with ADHD will
experience one or more depressive episodes, and between 40% and 60% of adults with
ADHD will also be diagnosed with an anxiety disorder (e.g., social phobias, generalized
anxiety disorder, panic disorder) during their lifetime (Biederman, 2004; Kessler et al.,
2006; Spencer et al., 1998).
Given the elevated risk of psychiatric comorbidity, it is also possible that the sleep problems reported by adult with ADHD are better accounted by a comorbid condition, rather than ADHD. Of particular concern are the conditions that are known to cause sleep disruption, such as depression (Vogel et al., 1989). Patients with depression often report complaints of insomnia, including difficulty falling asleep, difficulty remaining asleep, and early morning awakenings (Ohayon & Roth, 2003). Polysomnographic studies of the sleep of depressed patients indicate several types of structural abnormalities. There are sleep continuity disturbances, with prolonged sleep latency (longer time to sleep onset), increased wakefulness during sleep, sleep fragmentation, decreased sleep efficiency, and early-morning awakenings. Decreases in stages 3 and 4 sleep have also been reported in patients in patients with major depression, and much of this deficit is observed in the first half of the night. Reduced REM latency (time to first REM sleep) and prolonged first REM period have been reported with associated increased eye movements and disturbing dream content during the first REM period (Benca, Obermeyer, Thisted, & Gillin, 1992; Goldsmith, Casola, & Varenbut, 2006).

Patients with anxiety disorders often report trouble falling asleep, and poor sleep quality (Chokroverty, 2000; Goldsmith et al., 2006). Many individuals with panic disorder have nocturnal panic attacks, or “sleep panic attacks” and these episodes involve autonomic activation and arousal, sleep awakenings and subjective feelings of nonrestorative sleep. Polysomnographic studies have demonstrated increased sleep latency, and elevated nocturnal awakenings in individuals with generalized anxiety disorder, but have otherwise failed to document consistent structural abnormalities to
account for self-reported symptoms in patients with anxiety disorders (Papadimitriou & Linkowski, 2005; Vogel et al., 1989).

In the current study we did not obtain health histories and therefore were unable to control for confounding medical conditions or concurrent psychiatric diagnosis that may have influenced results. However, the participants in this study were all relatively high functioning young adults that had been accepted to a prestigious university with relatively high admission criteria and academic standards. Although we did not screen for psychopathology or other conditions that may have affected the results, all participants in the non-clinical sample were attending classes on the day of data collection and were therefore unlikely to be experiencing many severe symptoms of mental disorders at the time of data collection.

Substance abuse comorbidity in adults with ADHD

The current findings suggest that individuals with elevated ADHD symptoms may be more likely to engage in behaviours such as substance abuse and poor sleep scheduling that have the potential disrupt sleep, and increase daytime sleepiness. This finding is consistent with previous research that has consistently observed the comorbidity of ADHD and substance use disorders, with up to 50% of adult individuals with ADHD suffering from substance use disorder (Biederman et al., 1995, 1998; Wilens et al., 1997) and 25–35% of patients with substance use disorder reporting elevated ADHD symptoms (Clure, Brady, & Saladin, 1999; Schubiner et al., 2000).

A fundamental question is why there is such a high comorbidity between ADHD symptoms and substance abuse. There is evidence of impaired brain dopamine activity in individuals with ADHD and, interestingly, some of the drugs most frequently abused by
individuals with ADHD (e.g., nicotine, amphetamines, cocaine,) can temporarily raise the concentration of dopamine in the brain, and thereby alleviate ADHD symptoms (Krause, Dresel, Krause, Kung, & Tatsch, 2000; Levin et al., 1996). Some researchers have suggested that individuals with ADHD are more likely to smoke, abuse alcohol and other substances in attempts to self-medicate, specifically to combat their ADHD symptoms (Conners et al., 1996; Wilens, 2004)

Nicotine dependence has been used as an example of self-medication because young adults with ADHD are reported to be twice as likely to smoke as young adults without ADHD (Lambert & Hartsough, 1998; Wilens, 2004). Nicotine is a stimulant with comparable effects on dopaminergic and noradrenergic systems to methylphenidate (a stimulant commonly used to treat ADHD symptoms) and smokers with ADHD report reduced inattention and improved concentration and impulse control when they smoke. It is believed that the nicotine released from smoking cigarettes stimulates the release of specific neurotransmitters (acetylcholine, dopamine and serotonin), that increase attention span and concentration (Levin et al., 1996; Wilens et al., 2008; Wilens & Decker, 2007).

The self-medication hypothesis offers an interesting area for future research. For example, a study could be conducted to investigate whether individuals with ADHD use nicotine (or other substances) to combat their sleepiness symptoms. Another interesting avenue of research is whether the higher substance abuse results from temperamental factors associated with specific ADHD subtypes of the DSM-IV. For example, the combined ADHD types (combined inattentive and hyperactive/impulsive symptoms) are known to derive more pleasure from experimentation and risk taking concerning drugs and alcohol than hyperactive/impulsive and inattentive types (Ohlmeier et al., 2007).
hyperactive/impulsive types were more likely to use nicotine and cocaine than the inattentive types (Saules, Pomerleau, & Schubiner, 2003).

Sleep Hygiene and ADHD

Contrary to predictions, poor sleep hygiene behaviours did not account for the sleep problems of young adults with ADHD. In other words, substance abuse and poor sleep scheduling do not entirely explain the association between ADHD symptoms and insomnia and sleepiness symptoms. The relationship between ADHD symptoms and sleep problems were significant even after partialling out the variance accounted for by the sleep hygiene factors, and therefore, full mediation was not possible (Baron & Kenny, 1986, MacKinnon, Warsi, & Dwyer, 1995). However, the variance in ADHD symptoms accounted for by sleepiness decreased from 15% to 11% when sleep hygiene was taken into account and future research could examine whether this decrease has any clinical relevance. For example, a future research study could test whether a sleep hygiene education and training program can improve sleepiness levels in young adult with symptoms of ADHD.

Another explanation is that hygiene did not account for sleep problems because the participants were young adults, who may be more resilient to the negative impact of poor sleep hygiene than older adults, or clinical populations. In the last twenty years there has been increased recognition of the importance of sleeping well as part of a healthier lifestyle, and there are many articles, books, websites, and television programs that have provided tips on improving sleep hygiene. This increased awareness of the importance of practicing good sleep hygiene may have lead to widespread attitude and behavioural
changes (Harvey, 2000; Morin & Espie, 2003), or perhaps reluctance to admit engaging in unhealthy sleep behaviours.

Limitations of the Sleep Hygiene Model

The current model of sleep hygiene may also have been too narrow, and future research should be devoted to broadening the scope of the sleep hygiene model. The two-factors of substance abuse and poor sleep scheduling represent only a limited range of sleep hygiene behaviours that are relevant to young undergraduate students, and it is possible that a different model would be found if different samples were used. Specifically, the saliency of the substance abuse factor may be a reflection of the prominence of alcohol consumption among students on most Canadian university campuses (Gliksman, Newton-Taylor, Adlaf, & Giesbrecht, 1997; Kuo, Adlaf, Lee, Gliksman, Demers, & Wechsler, 2002). If the model had been developed with young adults in non-academic settings, or older adults in the community, then other factors may have been salient, and a different of model of sleep hygiene would have emerged.

The current research represents one of the first attempts to develop a self-report measure of poor sleep hygiene, and factor analysis was perhaps not the best method for scale development. As discussed by Mastin, Bryson, and Corwyn (2006) sleep hygiene presents a special problem when using classical testing theory and construction methods such as factor analysis, because the construct of sleep hygiene includes any behaviours or conditions that are thought to cause poor sleep quality (i.e., causal indicators), however, these causal indicators may not necessarily be highly related to one another. As a result, important sleep hygiene items that may have had good predictive power in explaining sleep problems were discarded when they did not fit into the factor analysis because they
did not correlate with items that comprised the substance abuse or sleep scheduling factors.

By definition, sleep hygiene includes any behaviours or conditions that reduce sleep quality by increasing arousal and/or because they are inconsistent with the maintenance of sleep organization. Therefore, the list of behaviours and conditions that could be included under the umbrella of sleep hygiene is broad, but few studies have examined which behaviours and conditions actually cause sleep disruption, or reduced sleep quality in good and poor sleepers. As Mastin et al. (2006) highlighted, there is a need for future studies that examine the influence of sleep hygiene behaviours independently, in order to determine their relative contribution to the development and maintenance of sleep problems. Presently, the relative contribution of each behaviour or condition is unknown, because sleep hygiene tended to be operationalized in prior research as a total score on questionnaires that have not been validated, or have unknown psychometric properties.

Moreover, many behaviours that are often targeted in sleep hygiene education programs (e.g., drinking caffeine and exercising close to bedtime, reading, watching TV or doing other tasks in bed, sleeping on an uncomfortable mattress, or sleeping in a room that is too bright) were not associated with sleep quality in a recent study (Gellis & Lichstein, 2009). These findings call into question the current conceptualization of sleep hygiene which may be too broad, and may need to be revised to emphasize behaviours and conditions that have demonstrated significant influence on sleep quality.

Despite these concerns, the new sleep hygiene scales that were developed in this dissertation represent an important step towards establishing a valid measurement model
of sleep hygiene. The substance abuse and poor sleep scheduling scales are relevant to the assessment of sleep hygiene because they predicted sleep problems in young adults. Moreover, a major advantage of the new sleep hygiene scales is that they can easily be administered with the SPI, a multi-dimensional measure of sleep problems that has also demonstrated encouraging psychometric properties. Used in combination, these two sleep instruments are the first comprehensive sleep profile that integrates important dimensions of sleep hygiene into the assessment of sleep problems. Using these newly developed self-report instruments, the present research also demonstrated important associations between ADHD symptoms and sleep problems in young adults, which further contribute to knowledge about ADHD in adulthood.
References


Appendix 1: Study Materials

LETTER OF INFORMATION

Assessment of sleep-related behaviours and sleep problems in adults

This study is being conducted by Tonya Bauermann, M.Sc., RPSGT, a doctoral student in working under the supervision of Dr. Alistair MacLean, Professor of Psychology at Queen’s University in Kingston, Ontario.

Participation in this study involves **completing a series of questionnaires** containing statements related to sleep hygiene, and sleep problems that you may have experienced in the last few months. All together, completing the questionnaires will take approximately 30 minutes. The information obtained should lead to a better understanding of the measurement of sleep hygiene, and how this variable is related to sleep complaints in adults.

Participation in this study is completely voluntary and **you are free to leave at any point** during the course of this study with no effect to your standing in school. We would appreciate it if you would answer all the questions but **you are free to leave any questions unanswered if you feel that the material is objectionable or makes you feel uncomfortable**.

Responses to the questionnaires are kept **confidential**. The data will be stored in a secure location and only the experimenters in the Sleep Laboratory will have access to it. To help ensure confidentiality, please do **not** put your name on any of the questionnaires. The results of the study may be published in conference proceedings or professional journals and the data may subsequently be reanalyzed in light of future findings. In any publication or secondary usage of the data, anonymity and confidentiality will be ensured. Should you be interested, you are entitled to a copy of the findings.

If you have any questions, concerns or complaints, contact Tonya Bauermann at 4tmb@qlink.queensu.ca, or Dr. Alistair MacLean at macleana@post.queensu.ca, 613-533-2448. You may also contact Vernon L. Quinsey, the Head of the Psychology Department, 613-533-2492 or the General Research Ethics Board (GREB) Chair, Dr. Joan Stevenson, at stevensj@post.queensu.ca, 613-533-6288.

**The Queen’s University General Research Ethics Board has approved this study.**
GREB Approval Form # GPSYC-281-05

September 14, 2005

Tanya M. Bauernhann
PhD Student
Psychology
Queen’s University

GREB Ref # GPSYC-281-05
Title: “Sleep Hygiene and Sleep Problems in Adults with Attention-Deficit Hyperactivity Disorder”

Dear Ms. Bauernhann:

The General Research Ethics Board (GREB) has given expedited approval to your proposal entitled “Sleep Hygiene and Sleep Problems in Adults with Attention-Deficit Hyperactivity Disorder”. In accordance with the Tri-Council Guidelines (article D.1.6) and Senate Terms of Reference (article G), your project has been approved for one year. At the end of each year, GREB will ask if your project has been completed and if not, what changes have occurred or will occur in the next year.

You are reminded of your obligation to advise the GREB, with a copy to your unit REB, of any adverse event(s) that occur during this approval period (form is attached). An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that any adverse events must be reported to the GREB within 48 hours.

You are also reminded that all changes that might affect human participants must be approved by the GREB. Examples of required approvals are; changes in study procedures or implementations of new aspects into the study procedures that affect human subjects. These changes must be sent to Linda Frid at the Office of Research Services or fridl@post.queensu.ca prior to implementation. Ms. Frid will seek the approval of the GREB reviewer(s) who originally assessed your application.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

[Signature]

Lyn M. Shulze, PhD
Professor and Member
General Research Ethics Board

cc: Dr. Brian Butler, Chair Unit REB
Dr. Alastair MacLean, Faculty Supervisor
Marie Tooley

Attached: Adverse Events Form
CONSENT FORM

Assessment of sleep-related behaviours and sleep problems in adults

1. I have read the Letter of Information, and have had any questions answered to my satisfaction.
2. I understand that participation in this study involves filling out a series of questionnaires about sleep-related behaviours.
3. I understand that the purpose of this study is to examine the influence of sleep hygiene on sleep problems in adults.
4. I understand that my participation is voluntary, and that I am free to withdraw at any time.
5. I am aware that I can contact Tonya Bauermann, the researcher with any questions, concerns or complaints at any time at 4tmb@qlink.queensu.ca, 613-533-2479.
6. I have been assured that my responses and data will be kept anonymous and confidential in a secure location and accessibly only to the experimenters in the Queen’s University Sleep Laboratory.

If I have any questions, concerns or complaints, I can contact Tonya Bauermann at 4tmb@qlink.queensu.ca, or her supervisor, Dr. Alistair MacLean at macleana@post.queensu.ca or 613-533-2448. I may also contact Vernon L. Quinsey, the Head of the Psychology Department, at 613-533-2492 or the General Research Ethics Board (GREB) Chair, Dr. Joan Stevenson at stevensj@post.queensu.ca, 613-533-6288.

Name (please print): _____________________________

Signature: _____________________________________

Date: _____________________
DEBRIEFING FORM

Assessment of sleep-related behaviours and sleep problems in adults

Thank you for your participation in this study. The purpose of the study was to develop a sleep hygiene questionnaire and examine the influence of sleep hygiene on the sleep problems of adults. Sleep hygiene refers to common daily behaviours, and lifestyle choices that are known to influence sleep. I am interested in examining the role that sleep hygiene plays in the self-reported sleep problems of adults.

There was no deception in this study. However, if you feel uncomfortable or distressed due to the study and would like to be attended to, please contact Tonya Bauermann, 4tmb@ qlink.queensu.ca, and she can guide you to the Student Counseling Services that are open to you.

You are also free to have your data withdrawn from the study at any time by contacting Tonya Bauermann, 4tmb@ qlink.queensu.ca

I would like to assure you that your responses are kept confidential. The data collected will be held in a secure location in the Queen’s University Sleep Laboratory and no names are attached to the data files.

Should you have any questions, concerns or complaints, you can contact Tonya Bauermann at 4tmb@ qlink.queensu.ca, or Dr. Alistair MacLean at macleana@ post.queensu.ca, 613-533-2448. You may also contact Vernon L. Quinsey, the Head of the Psychology Department, 613-533-2492 or the General Research Ethics Board (GREB) Chair, Dr. Joan Stevenson, 613-533-6288 or stevensj@ post.queensu.ca

The Queen’s University General Research Ethics Board has approved the study.

Thank you once again for your participation.
Sleep Study
Biographical Information

A. Your Gender: Male Female (circle one)

B. Age: _______ Height: _________ Weight: __________

C. Ethnicity (circle one):
1. African Canadian/Black
2. Asian Canadian/Oriental
3. European Canadian/Caucasian
4. Hispanic Canadian/Latino
5. Native Canadian or Inuit
6. Other (specify: ____________ )

D. Marital Status (circle one):
1. Single
2. Married
3. Common-law
4. Divorced/Separated
5. Widow/Widower

E. Highest Education Completed (circle one)
1. Elementary
2. High School
3. Technical Diploma
4. Some College or University
5. College or University Degree
6. Advanced Degree (Master, Doctoral)
Sleep Study – SHI

This questionnaire contains various statements about sleep behaviors. For each item, please circle the number that indicates how much you feel the statement applies to you using the following guide:

1 = Not true of me, 2 = Rarely true of me, 3 = Sometimes true of me, 4 = Very true of me

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>During the work week, I go to bed at roughly the same time.</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>2</td>
<td>During the work week, I wake up at roughly the same time</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>3</td>
<td>I go to bed later than most people do</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>4</td>
<td>My work (or schoolwork) responsibilities keep me up late.</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>5</td>
<td>I “party” late into the night</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>6</td>
<td>I exercise regularly</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>7</td>
<td>I drink alcohol just about everyday</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>8</td>
<td>I am a “night-owl”</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>9</td>
<td>I sleep in a room where I am bothered by noise (e.g., traffic)</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>10</td>
<td>Social activities prevent me from going to bed at an acceptable time</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>11</td>
<td>My sleep is altered because of “shift-work”.</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>12</td>
<td>I take stimulants (prescription or over the counter).</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>13</td>
<td>I drink alcohol (or take drugs) more than I should</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>14</td>
<td>I worry about my drinking (or drug taking) behaviour</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>15</td>
<td>I have an irregular sleep schedule</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>16</td>
<td>I drink alcohol before going to bed</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>17</td>
<td>I drink caffeine drinks (coffee, tea, cola) throughout the day</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>18</td>
<td>I take sleeping pills (prescription or over the counter).</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>19</td>
<td>Most of my social activities include drinking alcohol or taking drugs</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>20</td>
<td>I sleep-in later than most people do.</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>21</td>
<td>I eat meals or snacks in bed</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>22</td>
<td>I relax with quiet activities (e.g., reading, listening to soothing music) before going to bed</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>23</td>
<td>My bedroom is comfortable</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>24</td>
<td>Most days I take long naps (more than 1 hour)</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>25</td>
<td>I fall asleep with the radio, stereo or TV on</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>
This questionnaire contains various statements related to sleep behavior and sleep problems you may have experienced in the last month. For each item, please circle the number that indicates how much you feel the statement applies to you using the following guide:

1=Not true of me, 2=Rarely true of me, 3=Sometimes true of me, 4=Very true of me

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I wake up often in the night</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>2. I find it hard to focus on work/schoolwork</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>3. If I wake up during the night, it is hard to get back to sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>4. I have unpleasant recurring dreams</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>5. I worry about not being able to fall sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>6. Most days, I feel sleepy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>7. I have injured myself while asleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>8. I often get a poor night’s sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>9. Others witnessed me sleepwalking</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>10. I fall asleep at inappropriate times</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>11. Bad dreams wake me up at night</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>12. I have racing thoughts when I try to fall asleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>13. I find it hard to meet morning obligations</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>14. I have sudden urges to sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>15. I wake during the night terrified</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>16. I fall asleep during quiet activities (e.g., reading, watching TV)</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>17. Bad dreams prevent a good night’s sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>18. I have a history of sleepwalking</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>19. Despite my efforts, I am unable to wake up on time</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>20. I worry about waking up in the night</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>21. I worry about not staying in bed when I sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>22. I often have frightening dreams</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>23. I consider myself a sleepwalker</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>24. I am often unable to fall sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>25. Sit up in my sleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>26. I am troubled by bad dreams</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>27. I worry about harming my bedpartner while I am asleep</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>28. I remember my bad dreams</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>29. I snore loudly</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>30. I stop breathing (hold breath) in my sleep</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>
Listed below are items concerning behaviors or problems sometimes experienced by adults. Read each item carefully and using the scale provided decide how much each item describes you recently.

0- Not at all, never
1- Just a little, once in awhile
2- Pretty much, often
3- Very much, very frequently

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I lose things necessary for tasks or activities (e.g., to-do lists, pencils, books, tools).</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>2. I talk too much.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>3. I have trouble doing leisure activities quietly.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>4. I leave my seat when I am not supposed to.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>5. I have trouble waiting in line or taking turns with others.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>6. I have trouble keeping my attention focused when working.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>7. I am forgetful in my daily activities.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>8. I have trouble listening to what other people are saying.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>9. I am always on the go.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>10. I fidget (with my hands or feet) or squirm in my seat.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>11. I make careless mistakes or have trouble paying close attention to detail.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>12. I don’t like homework or job activities where I have to think a lot.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>13. I am restless or over active.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>14. I give answers to questions before the questions have been completed.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>15. I have trouble finishing tasks or schoolwork.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>16. I interrupt others when they are working or playing.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>17. I am distracted when things are going on around me.</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>18. I have problems organizing my tasks and activities.</td>
<td>0 1 2 3</td>
</tr>
</tbody>
</table>
ADHD is one of the most common neurobehavioral disorders of childhood. The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria are used to diagnose ADHD. The DSM criteria define ADHD by two main categories: inattention and hyperactivity-impulsivity. Inattention is characterized by difficulties with focusing, remembering, and completing tasks. Hyperactivity-impulsivity is characterized by excessive activity, restlessness, and difficulty waiting or taking turns.