THE RELATIONSHIP OF SLEEP PROBLEMS, BEDTIME ROUTINE, AND HOURS OF SLEEP TO ADHD AMONG ELEMENTARY SCHOOL AGED CHILDREN

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ABSTRACT

Insufficient sleep is often associated with symptoms similar to those of ADHD. Prior studies have suggested that children with ADHD are more likely to have problems with sleep compared to non-ADHD peers. This study investigated whether children with ADHD experienced more sleep problems, had less effective bedtime routines and got less sleep than their peers without ADHD, and examined the correlations among significant findings. Participants included 51 parents of children with ADHD, and 73 parents of children without ADHD. They completed questionnaires regarding their child’s diagnosis of ADHD, sleep habits, sleep problems, bedtime routine, and amount of sleep. MANCOVA and Mann-Whitney U results found that sleep onset delay, daytime sleepiness, sleep duration, and total sleep score were statistically significantly worse in the ADHD group. The results of MANCOVA also found that children with ADHD used fewer adaptive activities before bedtime than children without ADHD, and also got statistically significantly less sleep than children without ADHD. The covariates of age and gender were controlled. Furthermore, the correlation results showed that in the ADHD group, children’s sleep problems, bedtime routine, and amount of sleep were interrelated. This study demonstrates that children with ADHD get less sleep than children without ADHD while also exhibiting more sleep problems and less effective bedtime routines. These results suggest that parents of children with this disorder should get their children screened for sleep problems, implement a positive bedtime routine, and follow age-appropriate sleep recommendations. Professionals should incorporate both daytime and nighttime interventions into a comprehensive treatment plan.
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Dedication

I dedicate my dissertation to my beloved grandmother, Lola Friedman, OBM.
Table of Contents

Title page.................................................................1
Abstract.......................................................................2
Acknowledgments.....................................................3
Table of Contents.....................................................4

Introduction..............................................................7
Attention Deficit Hyperactivity Disorder: Definition...............8
Prevalence....................................................................8
Symptoms and the School Setting.................................9
Etiology.......................................................................11
Diagnosis......................................................................13
Contributing Factors..................................................14
The Relevance of Sleep Problems and ADHD...................14
Purpose and Usefulness of this Study..............................17

Review of the Literature.............................................20
ADHD.........................................................................20
Comorbidity..................................................................20
Prevalence....................................................................21
Treatment.....................................................................21
Costs............................................................................21
Etiology.......................................................................22
Brain systems affected by ADHD.................................22
Genes and the environment..........................................23

Sleep..........................................................................23
Why is sleep needed?..................................................23
How much sleep do children need?...............................25
Studies on sleep..........................................................26
Cultural sleep studies..................................................28
Neuropsychological/Brain systems of sleep.....................30
Brain systems for both ADHD and sleep.......................30
Childhood Injury.........................................................31
Theory of hypoarousal................................................31
Neurofeedback..........................................................32
Current practice- pediatricians, clinicians and the APA.....33

ADHD and Sleep........................................................34
History........................................................................34
Introduction to research studies: factors to consider.........35
Common sleep problems for children with ADHD .......................................................... 36
Obstructive Sleep Apnea (OSA)/ Sleep Disordered Breathing (SDB) .................................. 36
Restless Leg Syndrome (RLS) and Periodic Limb Movement Disorder (PLMD) .................. 38
Daytime sleepiness ............................................................................................................ 38
Increased motor activity at night .................................................................................... 40
Other sleep problems ...................................................................................................... 41
Medication ....................................................................................................................... 42

Research studies on sleep and ADHD: Subjective and Objective Studies ........................... 43
Sleep and ADHD studies: Metastudies ........................................................................... 47
Do children with ADHD need more sleep than other children? ....................................... 50

Research on the Effects of Interventions ....................................................................... 50
Medical ......................................................................................................................... 50
Parental sleep hygiene ................................................................................................. 53

Summary .......................................................................................................................... 53

Method ............................................................................................................................. 55
Research Design ............................................................................................................. 55
Participants ...................................................................................................................... 56
Inclusion Criteria ............................................................................................................ 56
Participant groups .......................................................................................................... 57
ADHD group ................................................................................................................... 57
Non-ADHD group .......................................................................................................... 58

Participant recruitment ................................................................................................. 58
Ethical concerns .............................................................................................................. 59
Informed consent and process ....................................................................................... 60
Participant Expectations ............................................................................................... 60

Questionnaires .................................................................................................................. 61
1.) Demographic Questionnaire ....................................................................................... 61
2.) The ADHD Rating Scale-IV ...................................................................................... 61
3.) Children’s Sleep Habits Questionnaire- Abbreviated Version (CSHQ) .................. 61
4.) Bedtime Routines Questionnaire (BRQ) .................................................................. 61

Independent Variables: Participants with a child with ADHD versus a comparison group .... 61
Demographic Questionnaire ........................................................................................... 61
ADHD Rating Scale-IV .................................................................................................... 62

Sleep variables ............................................................................................................... 65
Children’s Sleep Problems ............................................................................................ 65
CSHQ ............................................................................................................................... 65
Validity .............................................................................................................................. 67
Reliability..................................................................................................................68

Children’s Bedtime Routine.....................................................................................69
BRQ..........................................................................................................................69
Reliability..................................................................................................................70
Validity......................................................................................................................70

Research Hypotheses and Data Analysis..................................................................71

Results.......................................................................................................................75
Hypothesis (1.)............................................................................................................75
Hypothesis (2.)............................................................................................................75
Hypothesis (3a.)...........................................................................................................75
Hypothesis (3b.)...........................................................................................................75
RQ4..............................................................................................................................76

Descriptive Statistics..............................................................................................76
Data Analysis..............................................................................................................83
Analysis for Research Question One: Sleep problems...............................................85
Analysis for Research Question Two: Bedtime routine..............................................91
Analysis for Research Question Three: Bedtime and amount of sleep......................98
Analysis for Research Question Four: Significant relationships for ADHD group.......102

Summary.................................................................................................................104

Discussion...............................................................................................................105
Limitations of the current study.................................................................................112
Summary and Recommendations..............................................................................115
Future Research........................................................................................................117

References...............................................................................................................119

Appendices..............................................................................................................133
Appendix 1: Demographic Questionnaire................................................................133
Appendix 2: NSF Permission......................................................................................135
Appendix 3: ADHD Rating Scale...............................................................................136
Appendix 4: ADHD Rating Scale Copyright permission.............................................137
Appendix 5: CSHQ......................................................................................................139
Appendix 6: BRQ........................................................................................................141
Appendix 7: Unsigned Informed Consent.................................................................143
Introduction

An often overlooked influence on a child’s school performance is the role of adequate sleep. The 2004 Sleep in America poll (National Sleep Foundation, 2004) revealed that many children in America are not getting enough sleep. Sleep is crucial for health, growth, alertness, and memory. Furthermore, lack of sleep negatively impacts cognition, motor performance and mood (National Sleep Foundation, 2006). Stickgold (2006) reports that sleep is needed to “process, consolidate and retain new memories and skills.”

According to the 2004 Sleep in America poll (National Sleep Foundation, 2004) only one in ten parents perceives that his/her child has a sleep problem, whereas 69% of children in the poll have symptoms of a sleep related problem. In addition, while 79-85% of parents believe that their children get the right amount of sleep, the poll findings suggest that only 22-44% actually do. For example, according to the National Sleep Foundation, children aged 5-12 should get 10-11 hours of sleep a night. Parents often do not realize that their children’s sleep problems need to be addressed. In all, 37% of students in kindergarten through fourth grade have at least one sleep-related problem (National Sleep Foundation, 2004). Undiagnosed sleep disorders are extremely common in child populations, yet this problem is often not addressed appropriately by physicians (Chervin, Archbold, Panahi, & Pituch, 2001).

Sleep problems manifest in amount, quality, and consistency of sleep. Sleep problems may include difficulty falling asleep, nighttime waking, restless leg syndrome, chronic sleep-disordered breathing, periodic limb movements during sleep, insomnia, and excessive daytime sleepiness (National Sleep Foundation, 2004). As a result, children who do not get an appropriate amount of sleep have symptoms such as inattention, hyperactivity, and irritability, which are also
associated with the diagnosis of attention deficit hyperactivity disorder (ADHD) (Kravitz, 2004). Therefore, it is beneficial to understand more about the relationship between sleep problems and the symptoms of children with ADHD.

Attention Deficit Hyperactivity Disorder: Definition

ADHD is “a persistent pattern of inattention and/or hyperactivity or impulsivity that is more frequent and severe than is typically observed in individuals at a comparable level of development” (DSM-IV; American Psychiatric Association [APA], 2000). Symptoms appear before the age of seven, last for at least six months, are present, and cause impairment in, at least two different environments (e.g. school and home).

The central problems of ADHD are inattention, hyperactivity, and impulsivity. (DSM-IV; APA, 2000). There are three categories described in the DSM-IV-TR (APA, 2000): the predominantly hyperactive-impulsive type (which does not include significant inattention), the predominantly inattentive type (which does not include significant hyperactive-impulsive behavior), and the combined type, which exhibits both inattentive and hyperactive-impulsive symptoms. Features that are often also affected in children include: working memory, internalization of self-directed speech, self-regulation of mood, motivation, and level of arousal and reconstitution (Barkley, 1998).

Prevalence

ADHD has become the most commonly diagnosed disorder in children (Wilens, Biederman, & Spencer, 2002). Previous reports from the National Institute of Mental Health (2003) state that between 3-5% of school aged children have ADHD. More recently, studies found occurrence at 7.5% (Barbaresi, 2002), and 8.7% were found to meet DSM-IV criteria for ADHD (Froehlich et al., 2007). In the United States, approximately two million children have
been diagnosed with ADHD (National Institute of Mental Health, 2003). It is estimated that there is at least one child with ADHD in every classroom (Barkley, 2000).

ADHD has been noted in every ethnicity studied (Barkley, 1998). Generally, boys are three to six times more likely to be diagnosed with this disorder compared to girls (Barkley, 1998). ADHD has been so widely studied that there are approximately 30 articles a month on the topic published in scientific journals (Barkley, 2000). Between 30 and 70 percent of children with ADHD continue to have ADHD as adults (Silver, 2000).

Symptoms and the School Setting

ADHD is classified under the disruptive behavior disorders in the DSM-IV-TR (APA, 2000). Behavior difficulties present because these children may have problems inhibiting impulsive motor responses and lack self-control (Barkley, 1998). Behaviors in the school setting may include: motor restlessness, not remaining seated, calling out in class, talking excessively, interrupting or intruding upon others, inappropriate touching, or fidgeting with objects (Barkley, 2000; DSM-IV; American Psychiatric Association, 1994). Elementary school teachers find students with ADHD more stressful to teach than students without ADHD (Greene, Beszterczey, Katzenstein, Park, & Goring, 2002).

Children who are hyperactive and impulsive often have academic and behavioral issues that impede their success and may require additional attention from teachers and staff members. However, children who have attention problems without the hyperactivity or impulsivity may not be as readily diagnosed because they are not disruptive (National Institute of Mental Health [NIMH], 2003). Nonetheless, these children may miss crucial pieces of school assignments because of their attention difficulties, which may result in lowered academic achievement and learning difficulties (NIMH, 2003). There appears to be a strong relationship
between inattention and academic problems (Wheeler & Carlson, 1994). There may also be a higher level of learning disabilities among ADHD inattentive type (Goodyear & Hynd, 1992). Studies show that formal education is the greatest stress to the ADHD child and parents (Barkley, R., Fischer, M., Edelbrock, C. S., & Smallish, L. 1990).

Consequently, teachers need additional support in order to manage their classes and attend to the needs of children with ADHD. This adds substantially to the cost of education, whether it is for special teacher trainings, additional aides in the classrooms, or more social workers in the school. ADHD involves significant costs; the educational cost of ADHD is approximately $3.5-4 billion annually, which accounts for only those receiving special education services (Center for Disease Control [CDC], 1999). The average annual health care cost of ADHD children is $4306, more than twice that of children without ADHD, at $1,944 (Leibson, Katusic, Barbaresi, Ransom, & O'Brien, 2001). One national study reported that in 2000 the total cost of ADHD in the US exceeded $31 billion (Birnbaum et al., 2005).

Children with ADHD may also suffer from a variety of comorbid disorders. Fifty percent of children with ADHD have learning disorders; this, combined with difficulty paying attention, makes it especially difficult for these students to be successful in school. Bartholomew and Owens (2006) suggest that comorbidity rates are 65%, including ODD with a rate of 40-60%, learning disabilities at a rate of 40%, anxiety disorders at a rate of 30%, conduct disorders at a rate of 14% and motor tic disorders at a rate of 11%. Given that the majority of children with ADHD have a comorbid disorder, this needs to be taken into consideration when diagnosing and treating each child.

Social relationships are also more difficult for children with ADHD (Evans et al., 2001). These children often have difficulty making and keeping friends. Pelham and Bender
(1982) estimated that more than 50% of ADHD children have difficulty with peer relationships. Hyperactive and aggressive children have the most difficulty. As a result these children are often treated in a controlling, negative, or rejecting way by their peers.

**Etiology**

A number of causal factors may be involved in ADHD. Studies of identical twins show a strong genetic influence in the incidence of the disorder (Faraone & Biederman, 1998). These twin studies show a heritability of .80 which demonstrates that genes play a large role in ADHD (Faraone, 2000). Furthermore, adoption studies show that biological relatives of ADHD children are more likely than adoptive relatives to have ADHD (Faraone & Biederman, 1998). Other studies indicate that 25% of close relatives in families of ADHD children also have ADHD, compared to 5% in the general population (Biederman, Faraone, Keenan, Knee, Tsuang, 1990 in NIMH, 2004). Faraone (2000) attempted to differentiate between ADHD that persists into adolescence and ADHD that remits. For those siblings for whom ADHD continued into adolescence, sibling rates were found to be 24.4%, and for the siblings who remitted in adolescence, sibling rates were 4.6%. Therefore, this causes speculation that ADHD that persists into adolescence may have a greater genetic predisposition than ADHD that remits (Faraone, 2000). At the same time, it is difficult to tease apart genetics from environmental influences in many family studies (Faraone et al, 1999). Although genes apparently strongly influence the etiology of this disorder for many children, the environment, or the interaction of genes and environment may also play a role (Faraone & Biederman, 1998).

Non-genetic biological factors may include prenatal conditions, such as maternal smoking and alcohol use. For example, the NIMH (2003) reports a possible correlation between mothers who smoke and/or drink during pregnancy and risk of ADHD for the baby. Children
with high levels of lead in their tissues also have a higher risk of ADHD (NIMH, 2003). Adler, Chua, Rotrosen, & Resnick, (2004), provide support for a significant correlation between ADHD and PTSD, though the mechanism and direction of the association is not clear. In addition, certain kinds of brain injury have been associated with ADHD, though the percentage of children with ADHD who have had a traumatic brain injury is low (NIMH, 2003).

There are regions of the brain that are associated with the symptoms of ADHD. Attention, hyperactivity and impulsivity may involve the frontal lobe, prefrontal cortex, caudate nucleus, globus pallidus, basal ganglia, and the cerebellum (Aman et al., 1998). Dopamine may also play a role in ADHD (Faraone et al., 1999).

Environmental factors that have been researched include food/diet and excessive television watching, or video game playing (Hunt, 2001). Whereas five percent of children with ADHD were helped by diet restrictions, these findings included primarily children with food allergies. Research presented at the National Institutes of Health scientific consensus conference in 1982 and subsequent studies (Jacobson & Schardt, 1999) showed that limiting sugar and food additives did not significantly ease symptoms of ADHD (NIMH, 2003). Although there are many anecdotal reports by parents who claim that certain food additives contribute to hyperactivity in their children, a review of the research by Jacobson and Schardt (1999) does not support this theory.

A study by Hunt (2001) regarding children with ADHD reports that television watching and video game playing seem to be associated with ADHD but do not seem to cause it (Hunt, 2001).

There have been many studies conducted over the years to evaluate parenting with regard to ADHD children (Hinshaw, 2002; Johnston, 1996; Johnston, Murray, Hinshaw, Pelham,
Hoza, 2002; Monastra, Monastra & George, 2002). For example, authoritarian parenting may be associated with ADHD in girls (Hinshaw, 2002). Environmental factors include a lack of adequate parental monitoring, and inconsistent parenting. Monastra, Monastra & George (2002) found that parenting style can have a moderating effect on behavior at home but not at school. Parents of children with ADHD reported reacting more negatively to their children and using fewer positive parenting practices (Johnston, 1996). However, mothers were more negative to their sons when they had CD or ODD with ADHD, but not when they had only ADHD (Johnston et al., 2002; Seipp et al., 2005).

Diagnosis

The diagnosis of ADHD is becoming more common, but it is complex for several reasons. There is no definitive test for ADHD; different types of professionals are providing the diagnosis, and ADHD symptoms also may be indicative of other disorders. Other problems or disorders that may be associated with symptoms of ADHD, or are highly correlated with ADHD include: iron deficiency anemia, trauma, high blood levels of lead, neurological problems, and other psychological disorders.

The childhood disorders that are associated with ADHD presentation may complicate diagnosis for many reasons. For example, children with depression may present with ADHD-like symptoms, so that the true diagnosis and symptoms may be hard to determine. Children with ADHD may indeed have co-morbid depression. However, it is also possible that children with depression present symptoms that can be misdiagnosed as ADHD, such as decreased concentration, the inability to finish tasks, and agitation that can be mistaken for hyperactivity. Children with sensory integration disorder may also seem similar to ADHD (Kranowitz, 1998). These two disorders may be comorbid, but also may be distinct. Presentation
It is also important to note that if a child has symptoms that meet the DSM-IV criteria for ADHD, then it is the appropriate diagnosis because it is a collection of symptoms without attribution to a specific cause. However, it is helpful to understand any relevant ecological circumstances, causes, and/or other comorbid disorders when formulating treatment plans.

Contributing Factors

There appear to be many causal pathways that lead to ADHD behavior; therefore, it is necessary to examine multiple possible sources that may or may not contribute to the symptoms of ADHD. By broadening the lens with which ADHD symptoms are viewed, behaviors can be understood in a larger context, which in turn can inform treatment modalities. One such relevant factor is the role of sleep.

The Relevance of Sleep Problems and ADHD

Although it is widely accepted that ADHD affects children during waking hours, research suggests that the disorder may also affect children while they sleep (Smolensky & Lamberg, 2001). Similarly, research suggests that a lack of sleep has an impact on ADHD symptoms. For example, children with periodic limb movements (PLM) that have more nighttime arousals have more severe symptoms of ADHD than those with PLM without arousals (Shatkin, 2007).

Numerous studies indicate that there is a strong correlation between sleep and ADHD (Barkley, 1998; Bartholomew & Owens, 2006; Chervin et al., 2002; Silver, 2001; Weissbluth, 2005). Fifty percent of children with ADHD have sleep problems (Barkley, 1998), compared to approximately 25 percent of all children with a sleep problem (Shatkin, 2007). Children with sleep disorders are almost twice as likely to suffer from ADHD compared to children without ADHD (Chervin et al., 2002). For example, Kravitz (2004) found that children with sleep apnea
are more likely to have ADHD. Children who have poor sleep often have symptoms similar to ADHD (Chervin et al., 2002); conversely, those children who get enough sleep are less likely to have some of the behavior problems associated with ADHD (National Sleep Foundation, 2005).

Corkum, Moldofsky, Hogg-Johnson, Humphries, & Tannock (1999) conducted studies to assess what causes children with ADHD to have difficulty with sleep and found that the relationship is very complex and needs to take into account the type of sleep problem, comorbid factors, and medication issues. Sleep disordered breathing, such as obstructive sleep apnea and snoring, may be associated with 25% of ADHD children (Bartholomew & Owens, 2006). Symptoms resulting from sleep apnea may include behavioral problems, learning problems, hyperactivity, and inattentiveness (National Sleep Foundation, 2005). This makes it especially challenging for these students to be successful in school.

Parents of ADHD children report that they have problems with their children at bedtime (Corkum et al., 1999) and often describe difficulty in overall compliance with their children, which may be a symptom of their ADHD, or comorbid disorders. Silver (2001) found that many ADHD children do not go to sleep easily because of various thoughts still going through their minds, restlessness, and the inability to tune out sounds from the house. Bedtime problems also may be present due to medication that contributes to wakefulness, comorbid disorders (Bartholomew & Owens, 2006), or the child’s sleep and arousal cycle (Brown & McMullen, 2001).

Gruber, Sadeh, and Raviv (2000) investigated the stability of the sleep-wake system and found significantly more instability in sleep onset, sleep duration, and true sleep in children with ADHD as compared to the control group. Objective sleep tests such as polysomnography and actigraphy studies may not measure a significant difference in sleeping patterns between ADHD
and non-ADHD children (Bartholomew & Owens 2006). However, the ADHD group may show more physical movement while they sleep, and this finding along with the instability of the sleep patterns in this group reveal the greatest difference between the ADHD and non-ADHD group (Bartholomew & Owens, 2006). Consequently, this would affect arousal; as a result, the ADHD children actually may be sleepier than others.

Daytime sleepiness has been found in children with ADHD (Golan, Shahar, Ravid, & Pillar, 2004) and it may be that sleepiness is responsible for hyperactive behavior in some ADHD children (Bartholomew & Owens, 2006). Hyperactivity may be the body’s way of combating or reacting to hypoarousal, or drowsiness (Owens, 2009).

It is also informative to look at brainwaves in children with ADHD to better understand quality of sleep. EEG studies of children with ADHD suggest that they are sleepier or more overactive and less attentive than non-ADHD children, show “low levels of arousal in frontal brain areas” and have a surplus of theta waves (associated with sleepiness, daydreaming, light sleep, or “during thoughtless, restless overactivity”) and a shortage of beta waves (found when one is actively engaged, concentrating or problem solving) (Monastra et al., 2005; Monastra, Monastra and George, 2002; National Resource Center for ADHD, 2008). Thus, it seems that children with ADHD have differences in sleep and arousal compared to children without ADHD.

Despite these previously noted studies regarding sleep, common diagnostic tools or interventions for ADHD do not reflect or explore this relationship. For example, while the DSM-IV (APA, 1994) lists poor sleep as a symptom of many disorders, it does not include this for ADHD. It is possible that sleep problems, which may cause insufficient sleep, in turn may exacerbate ADHD symptoms, or, that ADHD signals an undiagnosed sleep problem.

Besides medically-based sleep disorders, parental bedtime routine needs to be further
explored because the way that a parent puts a child to sleep, or parental sleep hygiene, may affect how the child sleeps (Medical College of Wisconsin, 2006). The National Sleep Foundation (NSF) reports that sleep hygiene “is a variety of different practices that are necessary to have normal, quality nighttime sleep and full daytime alertness” (Thorpy, 2008, in NSF). A poor bedtime routine and the extent to which it is established and implemented may be antecedents to a lack of sleep. In turn, this might contribute to ADHD symptoms.

From an ecological perspective, it seems most likely that a combination of factors influences the etiology of sleep problems and should be considered for each child and family when proposing treatment. Given a biologically-based predisposition, environmental factors may have an important effect for these children, either increasing or reducing the likelihood of ADHD because of the interaction between the child’s biological predisposition and the environment: parents, siblings, peers, and the broader social milieu.

In summary, there are many dimensions to the relationship between some children with ADHD and sleep. It is not clear whether sleep problems contribute to ADHD symptoms, or if the presence of ADHD causes sleep disorders, or if both may reflect a common underlying factor. Moreover, insufficient sleep in ADHD children may be due to sleep disorders, the quality of bedtime routines, few hours of sleep, or medications used to treat ADHD that may interfere with sleep, or an interaction of all of these issues.

Purpose and Usefulness of this study

While ADHD in the DSM IV-R is not attributed to a specific etiology, often this disorder is treated as though it were a neurological or genetic condition, without regard to other potential factors, such as environmental and/or other biological contributants. This study intends to examine one possible contributant factor, lack of sleep, to examine its impact on
ADHD. Because insufficient sleep is often associated with symptoms similar to those of ADHD, sleep lends itself to another way of theoretically understanding ADHD, which is a broader way of viewing this disorder. Additionally, this study can lead to a better theoretical understanding of ADHD because the theory of hypoarousal regarding ADHD explains that daytime sleepiness may lead to hyperactivity in order to stimulate arousal (Weinberg & Harper, 1993; Cortese, Caraone, Konofal, & Lecendreux, 2009). Therefore, it is important to study why some children experience daytime sleepiness.

It is critical to further explore the relationship between ADHD and insufficient sleep. When children do not get enough sleep, learning and behavior suffer. Signs of sleep deprivation include inattention, hyperactivity, impulsivity and behavioral problems—symptoms also associated with ADHD. The rate of diagnosis of ADHD is rapidly increasing, which implies an impact on more children, teachers and families every year (Barbaresi, Katusic, & Colligan, 2002).

Learning more about this relationship could create another tool for treatment. The data from this study would be useful to clinicians, educators, school psychologists, and parents. It would contribute to the field of education and psychology by highlighting sleep’s impact on learning, education, and behavior, and by helping ADHD families incorporate appropriate sleep recommendations into their children’s treatment plan. Such an approach might be used in addition to the other research-based interventions, such as behavior modification and medication.

The focus of this study is to examine the relationship of sleep to ADHD and non-ADHD in elementary school aged children. The purpose of this study will be to specifically explore three areas of sleep: sleep problems, bedtime routine, and number of sleep hours to help identify potential differences between children with and without ADHD. In addition, if there is a
The Relationship of Sleep to ADHD Among Elementary School Aged Children

statistically significant difference in the ADHD group, the relationship between the significant variables will also be explored. By analyzing the aforementioned areas, the study will take into consideration medical sleep difficulties, behavioral issues, and hours of sleep, which will provide both a comprehensive and meaningful way to compare both groups. Furthermore, these three variables are connected because they potentially affect the amount and quality of sleep, which may contribute to the presence of ADHD symptoms, and in turn would advance our theoretical understanding of this disorder. By investigating this relationship further, it may be possible to improve the prognosis for these children.

It is hypothesized that children with ADHD will have more sleep problems compared to non-ADHD children. In addition, it is hypothesized that the quality of a bedtime routine for children with ADHD will be less than non-ADHD children. It is also hypothesized that children with ADHD will sleep fewer hours per night compared to non-ADHD children.

If these hypotheses are supported, the findings might lead to theoretical advancements in ADHD and practical implications for treatment: 1) revealing sleep problems that may be treated medically, 2) behaviorally improving bedtime routine so children can get longer and more restful sleep, and 3) encouraging and educating parents about the recommended number of sleep hours per night, and 4) further understanding the relationship between these variables.
Review of the Literature

While ADHD in the DSM is not attributed to a specific etiology, often this disorder is treated as though it were a neurological or genetic condition, without regard to other potential factors, such as environmental and/or other biological contributors. This study intends to examine one possible contributing factor, lack of sleep, to examine its potential impact on ADHD. Because insufficient sleep is often associated with the same characteristics as ADHD, an understanding of the relationship of ADHD and sleep may further our theoretical understanding of ADHD.

ADHD Comorbidity

Children with ADHD may also suffer from a variety of comorbid disorders including: learning disorders, oppositional defiant disorder, conduct disorder, Tourette’s syndrome, anxiety, depression, and bipolar disorder (Bartholomew & Owens 2006). Children with ADHD also suffer from social problems with peers (Evans et al., 2001). Pelham and Bender (1982) estimated that more than 50% of ADHD children have difficulty with peer relationships.

Studies also show that children with ADHD may perform lower than their non-ADHD peers on intelligence and achievement tests (Barkley, Dupaul, & McMurray, 1990; Brock & Knapp, 1996; Cantwell & Satterfield, 1978; Casey, Rourke, & Del Dotto, 1996; Dykman & Ackerman, 1992; Fischer et al., 1990; Semrud-Clikeman et al., 1992 in Barkley, 1998). Preschool children with ADHD who are getting ready to enter formal schooling already have a disadvantage because of the disorder. These children are less ready to learn in school and may also lack pre-academic skills (Mariani & Barkley, 1997; Shelton et al., 1998). As a result, they
are at high risk for academic failure (Barkley, 1998). Their performance may also be impacted by their inability to control their behavior in the classroom. Both the academic and social pressures at school are difficult, and homework is an additional challenge for these children, because they often have comorbid learning disorders (Barkley, 1998).

Prevalence

The National Resource Center on ADHD (2008) reports that the prevalence of ADHD in the United States is five to eight percent and that 60% of these children continue to have ADHD in adulthood. Generally, boys are 3 to 6 times more likely to be diagnosed with this disorder compared to girls (Barkley, 1998). Around the world, prevalence ranges from 1.7% to 17.8%; this highly discrepant rate may be accounted for by different cultures, treatments and diagnostic impressions (Elia, Ambrosini & Rapoport, 1999).

Treatment

Current treatment relies on either behavior therapy and/or medication that are designed to help children concentrate for longer periods and increase self-control (Evans, et al., 2001). Parent and teacher training are used to implement behavior modification strategies and increase appropriate social skills.

Costs

Health care costs for children with ADHD are approximately $479.00 more per year for a child with ADHD than for children in the general pediatric population and somewhat more than the costs for children with asthma (Chan, Zhan & Homer, 2002) probably because of the many services that children with ADHD are given in the schools (Chan et al., 2002).

Emotional costs are evident in that many parents report feeling very stressed and have a decreased sense of competence as a parent and decreased self-esteem (Anastopoulos,

Etiology

Brain systems affected by ADHD

There is no neurological marker for ADHD (Hynd, Hern, Voeller, & Marshall, 1991). However, there have been several studies discussing which brains systems seem to be involved with ADHD. Attention, hyperactivity, and impulsivity may involve the frontal lobe, prefrontal cortex, caudate nucleus, globus pallidus, basal ganglia, and the cerebellum (Aman et al., 1998; Castellanos et al., 1996). Dopamine may also play a role in ADHD (Faraone et al., 1999). These may include the D4 dopamine receptor, which receives signals, or the dopamine transporter which reuses released dopamine (Barkley, 1998).

In a study of ADHD boys both on and off medication and a control group to assess differences in the frontal lobe and right parietal lobe, the following results were found. Boys with ADHD who were not on medication did worse on tasks involving both frontal and parietal lobes compared with controls, and did worse on tasks requiring the frontal lobes compared to the parietal lobes. ADHD boys taking medication performed better than ADHD boys who were not on medication. (Aman et al., 1998).

MRI data suggests that although the brains of ADHD children demonstrate no abnormality, compared to children in the control group who exhibit asymmetry (the right frontal lobe is greater than the left frontal lobe), ADHD children have symmetrical frontal lobes (Hynd et al., 1991). Hynd et al. (1991) reports that frontal lobes and subcortical systems related to arousal and motor regulation are related to ADHD. Frontal lobes are involved in planning, decision making, motor activities, and behavior (Hynd et al., 1991). Furthermore, children with
ADHD may have a lower level of metabolism in the caudate, which would affect motor regulation. The subcortical area is connected to the frontal lobes. It seems as if the neurotransmitters projecting to the frontal lobes may not work optimally. Therefore, brain systems and neurotransmitters may all have a role in ADHD behavior, but more research is needed.

**Genes and the environment**

It is possible that instead of being a unitary disorder, ADHD could be comprised of many disorders from “genetic and nongenetic etiologies” (Faraone, 2000). Twin studies show that genetics greatly influence this disorder (.80) (Faraone, 2000). There also seems to be evidence of a stronger genetic contribution to ADHD that persists into adolescence than for remitting ADHD (Faraone, 2000). However, there are inconsistent studies documenting which genes and pathways are responsible for the disorder.

Therefore, ADHD can be affected by both genetic and environmental agents. If this is the case, then treatment itself needs to be varied and multidimensional. Therefore, medical and environmental fields need to be considered in this search. One such environmental factor is the role of sleep. Insufficient sleep often shares similar symptoms to ADHD making it worthy of investigation. In this study, the literature on the effects of sleep problems and the association to ADHD and ADHD-like symptoms will be presented.

**Sleep**

*Why is sleep needed?*

It is unknown why we physiologically need sleep, but it is more than a time of replenishment or rest (Dahl, 1998). Sleep is very important for health, growth, alertness, memory, and performance (National Sleep Foundation, 2006). Stickgold (2006) reports that
sleep is needed to “process, consolidate and retain new memories and skills.” Also according to the National Sleep Foundation (2006) sleep is vital for memory and attention, complex thought, motor response, and emotional control. Sleep is critically important during the early years of development (Dahl, 1998). Furthermore, lack of sleep negatively impacts cognition, motor performance, and mood.

Sleep is so vital that rats died when subjected to prolonged sleep deprivation (Everson, Bergmann & Rechtschaffen, 1989; Rechtschaffen, Bergmann, Everson, Kushida & Gilliland, 1989). Sleep disturbance has also been associated with most psychiatric disorders (Walker, as cited in Swaminathan, 2007).

Clinical observations of children with sleep deprivation reveal difficulty with focused attention, irritability, emotional lability, and a low-threshold for frustration and distress (Dahl, 1998). Students who show symptoms of sleep disorders had lower academic grades compared to students who did not show these symptoms. Math, reading, and writing grades suffered the most (American Academy of Sleep Medicine, 2007).

In a review of the literature, Sadeh (2007) found that consequences for insufficient sleep in children include daytime sleepiness and fatigue and reduced alertness. There are additional problems with working memory, executive functioning, and attention, poor academic achievement, behavioral problems, temperament, negative mood and poor emotional regulation. Experimental studies, although sparse, reveal difficulties in complex tasks such as executive functioning and attention (Sadeh, 2007). Researchers concluded from a review of the literature that insufficient sleep leads to daytime sleepiness in children and sleepiness leads to problems with attention regulation, working memory, and executive function (Corkum, 2009; Sadeh, 2007).
The result of research on children who were referred to a doctor for a medical problem (adenotonsillar hypertrophy with possible obstructive sleep apnea) found that although tonsil size was not relevant, snoring history, sleep efficiency, sleep latency and race could predict behavior and cognitive function (Suratt et al., 2006).

In addition to sleep disorders, there are environmental reasons that children do not get enough sleep. Early school start times are also a cause of sleep deprivation because the reduced hours of sleep lead to daytime sleepiness, and difficulty with attention and concentration (Epstein, Chillage & Lavie, 1998).

How much sleep do children need?

The National Sleep Foundation recommends school aged children get between 10-11 hours of sleep (National Sleep Foundation, 2006). Similarly, a longitudinal study assessing how much sleep children receive from infancy to adolescence reported that the mean hours of sleep children aged 5 to 10 slept was 11.1 and 9.9, respectively. Furthermore, the authors also reported that the need for sleep varies by age and by individual (Iglowstein, Jenni, Molinari & Largo, 2003).

Not only do children need different amounts of sleep, but also children react differently to having insufficient sleep (Voila et al., 2007). According to the Sleep in America Poll, (National Sleep Foundation, 2004) 22-44% of children in America whose parents were polled do not get the recommended hours of sleep. So, although many children get insufficient sleep, it may be that certain children react differently to sleep deprivation. It is possible that children with ADHD are getting insufficient sleep and are more prone to being negatively affected.

There is sparse research on individual sleep needs. A study at the University of Surrey analyzed how different people responded to sleep deprivation. Researchers discovered that a
gene named PERIOD3 has two different variations, a long and short form which makes some people more vulnerable to the effects of sleep deprivation than others (Voila et al., 2007). The different forms were previously reported to correspond to individuals who have higher activity at morning or night. The longer version corresponded with the “morning lark” and the shorter version corresponded to the “night owl” and delayed-sleep-phase syndrome (DSPS) (Archer et al., 2003). In the 2007 study, 24 individuals from a pool of 404 were divided by long and short forms and were sleep deprived for 48 hours. Two important findings were reported. The long version, or “morning larks” did poorly on tests for attention and working memory while sleep deprived and staying up all night, most prominently between 4 and 8am compared to the short version, or “night owls.” This also is similar to the time that shift workers have sleepiness related accidents. Also, when participants were finally able to sleep, the “larks” spent 50% more time in deep sleep, indicating that they were more sleep deprived. Thus it appears that some people may have a genetic predisposition to be more vulnerable to the effects of sleep deprivation than others, and this may also affect attention and working memory (Voila et al., 2007). As a result, the relationship between insufficient sleep and the presence of ADHD symptoms is likely to differ from child to child.

Studies on sleep

Research on sleep deprivation in adults has demonstrated that sleep deprivation negatively affects executive control (Sadeh, Gruber & Raviv, 2003). However, there are few studies analyzing sleep deprivation in children (Sadeh et al., 2003). The following studies review studies regarding sleep deprivation in children.

Sadeh et al., (2003) studied three consecutive nights of sleep in Israel using objective and subjective tests to study the effect that either adding or reducing sleep by one hour, or keeping
sleep the same would have to fourth and sixth graders. Because sleep deprivation can be further broken down into acute (lack of sleep one night) and accumulative loss of sleep (lack of sleep for consecutive nights), three nights were chosen to represent accumulative loss of sleep and an hour was chosen to reflect natural differences versus extreme sleep deprivation. This hour would be manipulated at bedtime, and wake time would stay the same. Measures included objective and subjective tests. Results indicated that the extended time (an average of 35 minutes of more sleep each night) led to decreased sleep quality which included more night wakings and a decrease in sleep percent. Those who lost sleep (an average of 41 minutes nightly) had better sleep quality because of a compensatory mechanism. However, even with better sleep quality, there were many differences. These children reported feeling more tired at night and fell asleep faster after sleep was restricted compared to the group that had sleep extended. The group that got more sleep performed better on cognitive posttests compared to their baseline test and better compared to both the restricted group and the group that had no change in sleep in tests of memory, attention, response inhibition and motor speed. These tests can be correlated with behaviors and testing at school. The results of this study are that even small amounts of additional sleep can be beneficial, and that small amounts of sleep deprivation can have a negative impact (Sadeh et al., 2003).

Another study on sleep deprivation found healthy children who slept fewer hours had a lower IQ and lower academic performance compared to healthy children who slept longer (Gruber et al., 2010). Differences in behavioral problems between the groups were not found (Gruber et al., 2010).

In a study assessing children with insomnia by parent report, a long wake time after sleep onset predicted more daytime sleepiness, which in turn predicted social problems regardless of
total sleep time and number of night waking. Shorter overall sleep duration predicted greater behavioral and concentration problems (Velten-Schurian, Hautzinger, Poets & Schlarb, 2010).

_Cultural sleep studies_

One study compared the sleeping habits of American and Chinese children (Liu, Liu, Owens & Kaplan, 2005) in grades 1 to 4. In this parent-only reported study, areas that both countries had in common included: difficulty falling asleep, a fear of sleeping in the dark, sleep talking, restless sleep, teeth grinding, and daytime sleepiness. Also, older children went to sleep later and therefore slept less. The differences found were that Chinese children slept one hour less each night compared to US children, because they went to bed later and woke up earlier. Chinese parents also reported that their children had more sleep problems. Further differences between countries that affected sleep were environmental and cultural. For example, Chinese schools started earlier, prompting earlier wake times. These children also shared a bed or room with their parents more often than US children, which could affect night and wake times. Another factor that was not recorded as part of the data collection is the propensity for children in China to take naps. Therefore it is possible that naps affect these children’s bedtime, and parents recorded their child’s nighttime sleep, not their 24 hour total sleep. That would make overall sleep between the two groups similar.

Even with differences between two groups, daytime sleepiness affected both groups. Interestingly, the cause appears different. Short sleep duration was the main predictor of daytime sleepiness as well as teeth grinding and awakening screaming in Chinese children. Restless sleep, snoring, and sleep-onset delay, and fear of sleeping in the dark were predictors of daytime sleepiness for American children. The results suggest that cultural differences need to be further understood when analyzing sleep practices and creating recommendations (Liu et al., 2005).
Furthermore, by studying different cultures, various reasons are revealed why children get insufficient sleep. This helps investigators understand cultural differences in both assessment and treatment of sleep problems.

In a study comparing infant and toddler sleep in Asian countries and Caucasian countries which included a total of 17 countries, Mindell, Sadeh, Wiegand, How, & Goh, (2010) used a parent questionnaire. Significant results were that children from Asian countries had later bedtimes, shorter sleep, greater parental perception of sleep problems, and shared a room more often compared to children from Caucasian countries (Mindell, et al., 2010).

Other cultural studies have found differences between 11 different countries in the 11-16 year old age groups with students in Israel getting the shortest amount of sleep and children in Switzerland getting the greatest amount of sleep (Tynjala, Kannas, & Valimaa, 1993). However, Israeli children did not go to sleep the latest, but woke early due to early school times (Tynjala et al., 1993). In previous studies on sleep, bedtimes were adjusted because school times were the same.

Epstein, Chillag & Lavie (1998) wanted to assess the start time of schools would impact daytime functioning and sleep. Eight hundred and eleven fifth graders from 18 different schools throughout Israel participated. There were no differences between students who started school at 7:15am and earlier, and 8:00am in age, sex ratio and geographical region. The results indicated that there were significant differences between those students who started school at 7:15 for at least two days a week compared to 8:00 six days a week. The earlier group compared to the later group had decreased (an average of 24 minutes less) total sleep time, complaints about daytime sleepiness during the school week, (not weekends), difficulties with attention and concentration, and reported feeling more tired during their first class compared to their last (it was the opposite
for the later school time group) and fell asleep more often in class. These are all symptoms of sleep deprivation (Epstein et al., 1998). Interestingly, for the early group, self-reports of daytime sleepiness were independent of hours of sleep received. In the later group, daytime sleepiness was more dependent on hours slept. Also, difficulties in concentration and attention were reported independent of hours slept for both groups (8 hours in the early group and 10 hours or more in the later group). Girls slept more hours than boys in both groups. Even in the later group, 8:00 is still an early start time compared to many other countries. It is interesting to further understand that independent of hours of sleep, the earlier start time was related to more daytime complaints.

**Neuropsychological/Brain systems of sleep**

The prefrontal cortex is associated with sleep, and sleep deprivation negatively impacts executive function (Muzur, Pace-Schott & Hobson, 2002). The amygdala, which helps regulate emotions, is negatively impacted by sleep deprivation. A study which required adults ages 18-30 to stay awake for 35 hours demonstrated that the amygdala reacted 60% more strongly in these participants compared to those who were not sleep deprived (American Academy of Sleep Medicine, 2007).

**Brain systems for both ADHD and sleep**

There may be evidence that the same mechanisms in the brain may be responsible for regulating sleep, attention and arousal, which is why these symptoms may correspond (Owens, 2009). The central nervous system also may be involved. Neurotransmitter pathways including noradrenergic and dopaminergic systems may be involved. Dopamine may play a role in ADHD (Faraone et al., 1999). For example, restless leg syndrome may be associated with decreased dopamine and when these children are treated with dopamine, it seems to help with sleep and
also with ADHD symptoms whereas stimulant medication was not effective (Bartholomew & Owens, 2006).

The prefrontal cortex is another area that affects both attention and sleep. Owens (2009) hypothesizes that there is a circadian disruption, which may be caused by the timing of the brain to release melatonin, the brain’s sleepiness cue, or an individual’s ability to respond appropriately to the environment (Owens, 2009).

**Childhood Injury**

Children with ADHD are more likely to injure themselves as compared to non-ADHD children (CDC, 1999). In a parent-report study, Owens et al., (2000) found that children with ADHD slept fewer hours than children without ADHD. A study on the relationship between sleep and injury revealed that boys are more likely to get injured when they get less sleep than when they get adequate sleep (Valent, Brusaferro & Barbone, 2001). Specifically, when boys slept less than 10 hours, they had an 86% increased injury between the hours of 4pm and midnight. Also, injury was associated to being awake at least 8 hours. The more hours that children are awake, the more prone they are to injury (Valent et al., 2001).

**Theory of hypoarousal**

There are also studies suggesting that children with ADHD have daytime sleepiness, compared to controls and that the hyperactivity that presents is the body’s way of combating or reacting to hypoarousal or drowsiness (Owens, 2009). For example, Lecendreux et al., (2000) study suggests that children with ADHD, even after getting similar amounts of sleep as controls, have more daytime sleepiness compared with non-ADHD children, which may indicate a problem with alertness.

This theory of hypoarousal regarding ADHD explains that daytime sleepiness may lead
to hyperactivity, as a way to stimulate arousal (Cortese et al., 2009; Konofal, Lecendreux & Cortese, 2010; Weinberg & Harper, 1993). In their review, Bartholomew and Owens, (2006) conclude that ADHD children may have hypo, not hyperarousal, and therefore behave hyperactively in order to combat their daytime sleepiness. ADHD children may therefore be sleepier than non-ADHD children (Bartholomew & Owens, 2006; Lecendreux et al., 2000).

Golan, Shahar, Ravid & Pillar (2004) also found that children with ADHD compared to controls had significantly more daytime sleepiness, although sleep latency, sleep time and sleep efficiency were similar between the ADHD and control groups. Golan et al., (2004) report that the effective use of psychostimulants in ADHD treatment, which increases alertness and decreases motor activity, provides further evidence for this theory.

Similarly, Weinberg’s syndrome, also called a disorder of vigilance, defined as a disorder of alertness, wakefulness and arousal, includes motor restlessness, tiredness and inattentiveness (Brumback, 2000; Weinberg & Harper, 1993). It is characterized by underarousal; children then try to keep themselves alert with active, restless behavior to continue tasks, or they may lose concentration, attention, daydream or fall asleep (Weinberg & Harper, 1993).

**Neurofeedback**

Neurofeedback is sometimes used as alternative therapy for children with ADHD; the theory behind this is that many people with ADHD show “low levels of arousal in frontal brain areas” and have a surplus of theta waves and a shortage of beta waves (National Resource Center for ADHD, 2008; Monastra et al., 2005; Monastra, Monastra & George, 2002). According to these studies, neurofeedback is used to help train the brain to raise the levels of arousal, resulting in the brain recording an increase of beta waves and a decrease in theta waves which would therefore diminish the symptoms of ADHD. Data suggests that 75% of patients studied showed
significant clinical improvement with neurofeedback, but further studies of the effectiveness of neurofeedback need to be implemented (Monastra et al., 2005). It is also interesting to further study why ADHD children have more theta waves and what these theta waves indicate. It is possible that these children are sleep deprived, suffer from sleeping disorders, non-restful sleep, insufficient sleep for their age, or that ADHD children need even more sleep than a non-ADHD child.

*Current practice: pediatricians, clinicians and the APA*

Members of the National Sleep Foundation's Poll Task Force expressed concern about the need for pediatric healthcare practitioners to ask their patients (or their parents) about their sleep. Although many parents or caregivers say their child's doctor asked them about their child's sleep (from 38% for school-aged children to 60% for toddlers), fewer have been asked by the doctor if their child snores. In 2002, the American Academy of Pediatrics recommended screening every child for snoring; however, only 28% of poll participants for school-aged children reported being asked about snoring (Chervin, NSF, 2004). Sleep is still not getting the attention that it needs (Carskadon, 2004).

Owens & Dalzell (2005) created a simple five item sleep screener called the BEARS in order to encourage pediatricians to inquire about sleep as part of a standard history and physical. The screener includes questions regarding: bedtime issues, excessive daytime sleepiness, snoring, nighttime awakenings, and regularity and duration of sleep. In the pilot study, when BEARS were put into the patient’s charts for a well check, pediatricians inquired about sleep more often compared to the previous well visit. They also identified more sleep problems as well. This could be an efficient and effective strategy to screen for sleep problems as part of a well visit (Owens & Dalzell, 2005).
However, because clinicians are not consistently inquiring about sleep issues (especially in the elementary school age and older), and there are fewer pediatrician well visits in this age group compared to infant and toddler visits, perhaps teachers could be educated about the effects and presentation of poor sleep and encouraged to report on students in their classroom that appear sleep deprived (Owens et al., 2000).

**ADHD and Sleep**

*History*

The Diagnostic and Statistical Manual of Mental Disorders (3rd ed.; DSM–III; American Psychiatric Association, 1980) reported sleep disturbance as a characteristic of ADHD with hyperactivity (ADD-H) (Ball & Koloian, 1995; Kaplan et al., 1987). However, with the publishing of the revised DSM, (DSM–III–R, APA, 1987); this characteristic was no longer mentioned (Ball & Koloian, 1995; National Resource Center on ADHD, 2008). Perhaps this is the reason that information regarding sleep problems in ADHD children is scarce in ADHD resources for parents. For example, Understanding ADHD: Information for Parents About Attention-Deficit/ Hyperactivity Disorder (American Academy of Pediatrics, 2001) does not list sleep problems in its parenting guide. However, parent reports indicate that their ADHD children have difficulty with sleep, and there is more accumulating data that these children have more problems with sleep than children without ADHD (National Resource Center on ADHD, 2008). More recently, there is an increased interest in the field of ADHD and sleep (Cortese et al., 2009).

Children often exhibit sleepiness in different ways than adults and adolescents. Carskadon (1980) and Carskadon and Dement, (1987) report that on the Multiple Sleep Latency
Test, an objective measure of daytime sleepiness, prepubescent children show less daytime sleepiness than adolescents and adults. Instead of appearing tired or sleepy, they may have the following effects: irritability, crankiness, low-frustration tolerance, and short attention span. Clinicians reported that these changes are similar to ADHD (Dahl, 1998).

Introduction to research studies: factors to consider

The studies that will be reviewed in this chapter regarding ADHD and sleep often provide conflicting or contradictory results, for a number of reasons. The intersection of sleep problems and ADHD is particularly complex, because of the variations of each disorder. For example, as discussed previously in this chapter, there are different types of ADHD, and also high comorbidity rates with other disorders (APA, 2000). Also, there are various types of medication that are taken for ADHD, as well as children with ADHD who do not take medication. Another aspect that needs to be considered is that some studies rigorously assess for an ADHD diagnosis, while others merely ask the parent if their child has ADHD with little or no other corroborating evidence (Pearl, 2003).

Similarly, there are many different types of sleep disorders that will be reviewed in this chapter. Within sleep disorders, there are disorders that affect the quality of sleep (i.e. interrupted sleep, snoring), and disorders or environmental factors affecting the quantity of sleep received (i.e. bedtime resistance, bedtime hour).

The assessment itself of sleep disorders varies. There are subjective measures (i.e. parent, child, teacher questionnaires) and objective tests that are given in a lab or at home (i.e. polysomnogram, actigraphy) (Bartholomew and Owens, 2006). Polysomnography is a sleep study used to gain information on sleep stages and sleep problems which uses electrodes to read brain waves, muscle movements, eye movements, breathing, snoring, heart rate and leg
movements (The Cleveland Clinic, 2009). Actigraphy, non-invasive procedure, involves wearing a device on one’s wrist that senses activity, which in turn gives information about sleep-wake cycles, including circadian rhythms, sleep disturbance, and activity (Sitnick, Goodlin-Jones, & Anderson, 2008). Video monitoring is another mode used. Also, each assessment measure is most efficient and effective at analyzing distinct aspects of sleep. For example, actigraphy alone is not as reliable polysomnography at measuring nocturnal awakenings (Sitnick et al., 2008). Also, even objective data of one lab may not be comparable to another because parameters used may differ (Cortese et al., 2009). Also, comparing objective studies is challenging because there are various modes (polysomnogram, actigraphy and video monitoring). In addition, subjective data needs to consider the rater (parent, teacher, child) when comparing studies.

No single study can include all the variables, and the differing foci of research means that it is hard to compare studies to each other. Nonetheless, there are a number of studies that examine the intersection of ADHD and sleep disorders, as well as some that provide meta-analyses.

**Common sleep problems for children with ADHD:**

The most common sleep problems associated with children with ADHD include: obstructive sleep apnea/sleep disordered breathing, restless leg syndrome or periodic leg movements during sleep falling asleep, daytime sleepiness, motor activity during sleep and other sleep problems such as falling asleep, staying asleep, and unstable sleep patterns (National Resource Center on ADHD, 2008; Sung et al., 2008). Side effects from medication may also occur (Barkley et al., 1990; Wilens & Biederman, 1992 in Wilens, Biederman, & Spencer, 1994).

*Obstructive Sleep Apnea (OSA)/ Sleep Disordered Breathing (SDB)*
This disorder, which affects 1-3% of children (Chervin, 2002), includes a spectrum of disorders, from snoring, to choking, to temporarily not breathing, so that the sleeper wakes up in order to breathe. These arousals may happen frequently without the sleeper’s awareness. In turn, the arousals impede quality of sleep, because of the constant awakenings, which contributes to daytime sleepiness (Owens, 2009).

There are studies that both support and refute the connection of SDB and ADHD (Owens, 2009). In a PSG study, Sangal, Owens & Sangal (2005) did not find a connection between ADHD and obstructive sleep disorder (OSA) or periodic leg movement disorder/restless leg syndrome (PLMD/RLS). The only difference was that ADHD children had longer REM sleep latency and a smaller percentage of REM sleep and OSA and PLMD on polysomnography. The authors conclude that although children with sleeping problems and those with ADHD share symptoms, children with moderate or severe ADHD do not have symptoms caused by OSA or PLMD and therefore, they are clinically different disorders (Sangal et al., 2005). However, Chervin (2005) questions the cut-offs used in this study in defining OSA and PLMD, because there are mild and severe forms of both disorders.

Furthermore, other studies support the connection and that 25% of children with ADHD may have SDB (Chervin & Archbold, 2001; Owens, 2009). Guilleminault et al., (1992) found that children with obstructive sleep apnea with fragmented sleep displayed symptoms of ADHD. When the fragmented sleep, caused by sleep disordered breathing, was treated, the ADHD symptoms dissipated.

Chervin et al., (2002) reported that there is a strong association between SDB and ADHD symptoms and that SDB is more common in hyperactive children. Habitual snoring was related to a higher prevalence of ADHD (Chervin et al., 2002). In younger children (aged 2-8), snoring
and hyperactive behavior were more strongly correlated than in older children. (Chervin et al., 2002). Chervin et al., (2006) found 50% of children who were diagnosed with ADHD did not meet the ADHD criteria one year after removing their adenoids and tonsils. This may be further evidence that some ADHD is secondary to a sleep disorder (Golan et al., 2004).

**Restless Leg Syndrome (RLS) and Periodic Limb Movement Disorder (PLMD)**

Restless leg syndrome is defined as: “a neurological condition that is characterized by the irresistible urge to move the legs (RLS Foundation, 2010). PLMD involves ‘rhythmic leg flexions detectable on PSG which often accompany RLS and result in sleep fragmentation’ (Owens, 2009). Studies have found a relationship with ADHD to RLS and/or PLMD, with 44% of ADHD children having RLS symptoms and 26% of patients with RLS with ADHD symptoms (Cortese et al., 2005; Owens, 2009). It is possible that dopamine deficiency is a shared issue for RLS and ADHD. In one study, symptoms of ADHD and RLS improved with dopamine therapy (Owens, 2009; Walters et al., 2000). Walters et al., (2000) suggest that either by improving RLS, ADHD symptoms also improved because the sleep disturbance dissipated, or perhaps both syndromes share a deficit of dopamine. A high incidence of PLMD in ADHD compared to the general population may also suggest that ADHD is secondary to PLMD, at least for some children (Golan et al., 2004).

**Daytime sleepiness**

Lecendreux, Konofal, Bouvard, Falissard & Mouren-Simeoni (2000) in a study of 33 children with and 23 without ADHD, found that although the ADHD group and non-ADHD group seemed to have the same quality of nighttime sleep, assessed by polysomnogram and MSLT, the ADHD group had more daytime sleepiness, and had a deficit in alertness. Sleep onset latency was similar in the ADHD group (mean=14.44 minutes) compared to a control group
The Relationship of Sleep to ADHD Among Elementary School Aged Children

(mean = 12.68 minutes). Although quality and quantity of overnight sleep was similar, the ADHD group fell asleep more during the day compared to controls during the Multiple Sleep Latency Test (MSLT). In this test, which allows multiple opportunities for falling asleep during the day, 21 out of 26 ADHD children fell asleep compared to 8 out of 21 non-ADHD children. There were significant differences at 10 am (p < .01), 12 noon (p < .05) and 2 pm (p < .05), but no significant differences at 4 pm. Interestingly, children in the ADHD (hyperactive-impulsive subtype) group were less willing to go to sleep during the day, but once in bed fell asleep very quickly. The inattentive group fell asleep more (three or four times during the day). The combined type slept twice. These children had daytime sleepiness or sleep deprivation, although they received similar sleep than the controls. This study suggests that children with ADHD are more likely to have daytime sleepiness compared with non-ADHD children even when there is no significant differences in overnight sleep which may indicate a problem with alertness for some ADHD children (Lecendreux et al., 2000). Similar results were found by Golan, Shahar, Ravid & Pillar, (2004).

Golan et al., (2004) compared Israeli ADHD children (who typically take medication, but went off of their medication for the study) to non-ADHD controls, using objective measures (PSG) of sleep. The study found no significant difference in sleep latency, total sleep time and sleep efficiency between ADHD and controls; however, children in the ADHD group demonstrated significantly more daytime sleepiness compared to controls. During the Multiple Sleep Latency Test (MSLT) which gives children an opportunity to fall asleep at multiple times during the day, 96% of the ADHD children fell asleep at least once during the day compared to 65% of the control group. Sleep latency during the MSLT was significantly shorter in the ADHD group 4 out of 5 times; meaning children in the ADHD group fell asleep much faster.
Furthermore, although 50% of children in the ADHD group had either SDB or PLMD, within the ADHD group, there was no difference in sleepiness between the children with the sleep disorders and those without. Therefore, the daytime somnolence of ADHD children in this study did not seem to be connected to the SDB (Golan et al., 2004). These results may explain why many ADHD children respond well to psychostimulants, as it may help with their daytime sleepiness (Golan et al., 2004).

Owens et al., (2009) studied medication free ADHD children and controls with both objective and subjective measures. The objective measures revealed that the ADHD group got less sleep, and had fewer sleep interruptions, but that the total interruptions lasted longer than controls. Subjective measures revealed that the ADHD group had more daytime sleepiness and behavioral problems compared to controls.

Chervin et al., (2002) in a study of children and adolescents who had overactive behavior (though not necessarily a diagnosis of ADHD), found that parents reported a correlation between sleepiness and hyperactivity in children and early adolescents.

Increased motor activity at night

Porrino, Rapoport, Behar, Sceery, Ismond & Bunney, (1983) found that although hyperactive children did not vary from controls at nighttime in terms of: total sleep time, sleep stages, and autonomic activity during sleep, there was a significant difference in terms of higher motor activity in hyperactive children compared with controls. Also, this higher level of activity both during the day and nighttime distinguished hyperactive boys from controls more than an inattention quality using the Continuous Performance Test (CPT) (Porrino et al., 1983).

Owens (2009) summarized the literature by reporting that there were no objective significant differences in ADHD and non-ADHD groups regarding sleep stages. Studies using
actigraphy have not found a difference in sleep onset, sleep duration, sleep efficiency, and night wakings. However, one feature that appears to be consistent from these studies is that ADHD children have high nocturnal motor activity (Kooij, Middelkoop, van Gils, & Buitelaar, 2001; Owens, 2009). Therefore, this feature of movement is displayed higher during the day and night for ADHD children compared to controls.

Parent reports have described restless sleep in more than 50% of ADHD children (Wilens, Biederman, & Spencer, 1994); however, laboratory studies did not demonstrate abnormality (Wilens et al., 1994).

Greenhill et al., (1983) in Kaplan et al., (1987) compared 9 ADHD children with 11 control children and did not find significant differences in sleep including movement during sleep or in rapid eye movement onset latency. However, these numbers may be too small to see a difference because not every child with ADHD has difficulty with sleep.

Other sleep problems

Van der Heijden, Smits, Van Someren, Ridderinkhof, & Gunning, (2005) performed a study comparing children with ADHD with chronic sleep onset insomnia and ADHD children without insomnia. This study showed that there was no difference in the number of night wakings and activity level in the least active sleep period of five hours; however, the insomnia group fell asleep significantly later (p < .001) and woke up later (p = .002). Therefore, the ADHD insomnia group showed a delayed sleep phase and delay in their dim light melatonin onset when the body temperature drops and serotonin is converted to melatonin.

Gruber, Sadeh, & Raviv (2000) compared sleep measures over five consecutive nights with actigraphy. Although sleep parameters such as sleep onset, sleep duration, and actual sleep time were similar between ADHD and non-ADHD groups, greater variability from night to night
in the abovementioned sleep areas were statistically significant (p < .0001) in the ADHD group compared to controls (Gruber et al., 2000). This instability of the sleep-wake cycle could indicate a problem with arousal (Gruber et al., 2000).

Medication

Children with ADHD have been found to have difficulty falling asleep and staying asleep. Medication may play a role in these difficulties. Stimulant medication has varying effects for different children. Sometimes stimulants have an insomniac effect when taken too close to bedtime (Barkley et al., 1990; Wilens et al., 1994). Although medication administered in the afternoon is helpful with concentration during homework hours, the insomnia that may follow a late afternoon dose may necessitate discontinuing the medication (Wilens et al., 1994). Alternatively, if children do not take their medication in the late afternoon to avoid this problem, they may be restless and therefore taking the stimulant medication helps them to settle down for sleeping (Hart, 2001).

Day & Abmayr, (1998) used a 40-question structured interview assessing sleep disturbances with 20 parents of children with ADHD taking stimulant medication, 20 parents of children with some other psychiatric diagnosis, and 20 nonclinical control children. Parents of the ADHD group reported significantly more difficulties than the other groups including: settling and going to sleep, disruptions during sleep, and morning activities (Day & Abmayr, 1998).

Conflicting studies regarding stimulant use in ADHD children have revealed either delayed sleep onset and increased first rapid eye movement latency in children, or no polysomnographic changes. Other studies have shown an increased sleep period and improved awakening behavior (Dahl & Puig-Antich, 1990; Wilens et al., 1994). It may be that children taking stimulant medication may react differently in regards to sleep; for some children, it may
hinder them from falling asleep, for others it may make no noticeable difference, or may even promote sleep. However, O’Brien et al. (2003) found no reported differences between stimulant medicated and non-medicated ADHD children in subjective and objective sleep measures.

Stein et al. (2002) studied both medicated (MPH) and non medicated adolescent boys with ADHD and a control group using parental, teacher, and self report questionnaires regarding ADHD symptoms, sleep disturbance, anxiety, and depression. The study did not find differences in nonmedicated ADHD children compared to controls regarding sleep disturbance but did find a significant difference between medicated ADHD children and nonmedicated adolescents with regard to sleep disturbance and symptoms of ADHD, anxiety, and depression.

Research studies on sleep and ADHD: Subjective and Objective Studies

There is an increased interest in the field of ADHD and sleep (Cortese et al., 2009). Parents often report that their ADHD children have problems with sleep. However, data from parent reports may conflict with data from sleep labs (Ball & Koloian, 1995). Subjective parent reports include difficulties with bedtime resistance and delayed onset sleep, staying asleep and restlessness (Day & Abmayr, 1998; Sung, Hiscock, Sciberras, & Efron, 2008). Wilens, Biederman, and Spencer (1994) concluded from parent report that bedtime resistance and fewer hours of sleep are often reported. Daytime sleepiness, tiredness when waking and nightmares are also reported in higher frequency than control groups (Sung et al., 2008).

Kaplan et al (1987) analyzed parents of non-ADHD children and parents of ADHD children who did not seek or receive clinical services for their children. The data revealed that parents of the ADHD boys who were not on medication reported that their children had shorter naps, longer sleep at night, bedwetting, night sweats, and awaken twice as much during the night compared to parent reports of non-adhd children (Kaplan et al., 1987; Ball & Koloian, 1995).
A parent-report subjective study found that more ADHD children compared to controls took longer than 30 minutes to fall asleep and were tired when they woke in the morning (Trommer, Hoeppner, Rosenberg, Armstrong, & Rothsteing, 1988 in Ball & Koloian, 1995).

Ring et al. (1998) studied the sleep of children with ADHD compared to those of their non-ADHD siblings. The study included 13 ADHD children, who were taking a single morning dose of methylphenidate (MPH) for at least a month and 16 non-ADHD siblings, using a sleep questionnaire and Connors Parents Rating Scale (CRS). Children with ADHD were rated as having statistically significant more sleep disorders than their siblings (Chi square=5.1, p < .02), although the small sample size makes the results questionable. The CRS was statistically significant for hyperactivity in the ADHD group but not the sibling group. The mean scores for the CRS for the ADHD group was statistically significant compared to the sibling group (Chi square=50.1, p < .001). There were no significant findings for either the sleep questionnaire or the CRS score for the two groups. However, according to the authors, the CRS only assessed daytime behavior, not nighttime behavior, which they felt should be further studied (Ring et al., 1998). Another finding is that both groups displayed more sleep problems than community samples, which the authors attribute to familial sleep patterns (Ring et al., 1998).

In a similar study in India comparing medication-free ADHD children with their non-ADHD sibling, sleep problems were reported by parents in 65.62% of ADHD children and 30% in sibling children (Bhargava & Sethi, 2005). However, overall hours of sleep between the two groups were similar. Significant sleep differences were found in later sleep onset (chi-square 6.03) and later awakening (6.77) for the ADHD group. The authors conclude by supporting the notion that an unstable sleep-wake system is present with ADHD children.
A recent study (Mayes et al., 2008) attempted to take into consideration many factors involving sleep and ADHD. Although the study only used subjective test measures (i.e. parent reported measures), it divided the ADHD group into ADHD-inattentive type (ADHD-I) and ADHD-combined type (ADHD-C). In addition, the study took comorbidity into consideration as well as medication or medication-free ADHD children. As a result, the results were able to distinguish the relationship between various sleep problems and ADHD type, comorbidity, and medication. For example, ADHD-C was related to higher levels of movement during sleep. Additional results indicated that: ADHD-C had sleep problems, but ADHD-I had significantly more daytime sleepiness than did ADHD-C and the control group. ADHD-C’s daytime sleepiness was similar to controls; however, the ADHD-C group slept less than the control group and also had more sleep problems (Mayes et al., 2008). The authors further found that children who had comorbid depression and anxiety had more sleep problems, while those with ODD did not.

More severe symptoms of ADHD were related to more sleep problems. However, when the study controlled for ADHD severity, medicated children were not associated with: waking at night, restlessness, nightmares, walking and talking during sleep, enuresis, waking too early, and sleeping less than typical. The authors conclude that it was the ADHD, and not the medication, that was associated with the sleep problems. The only exception was that medication prolonged sleep onset (Mayes et al., 2008).

Limitations discussed in this study were that objective sleep measurements were not made. Also, the results from a psychiatric clinic may or may not generalize to ADHD in a pediatric clinic. (Mayes et al., 2008).

In parent reports, there are many differences cited between children with ADHD and non-
ADHD including: difficulty falling asleep, night wakings, and restless sleep (Bartholomew & Owens, 2006). These sleep problems may be due to side effects from medication, such as psychostimulants that are taken to treat ADHD. It may be that the medication itself keeps children awake, or when the medication wears off, it has a stimulating effect (Bartholomew & Owens, 2006).

Besides possible side effects from stimulants, and comorbid problems that lead to bedtime resistance, some ADHD children have difficulty settling down for sleep at night possibly because of other reasons such as “hyperarousal” at bedtime, or a melatonin-mediated, circadian-based sleep phase delay, or sleep-wake cycle that delays bedtime sleepiness (Bartholomew & Owens, 2006).

Studies regarding objective data are mixed. Sung et al., (2008) in his review, reported that studies relying on objective measures, including polysomnography (PSG), actigraphy and video monitoring, often find that ADHD children have a longer sleep latency, fewer rapid eye movement sleep percentages, and higher motor activity. Golan et al., (2004) using PSG and MLST found children with ADHD to be sleepier in the daytime compared to controls. Ball & Koloian, (1995), in their review of polysomnogram studies, found no difference between ADHD and non-ADHD children when overnight testing was done. Ball & Koloian, (1995) also pointed out that there were only about 100 ADHD children that were studied by polysomnography to date. Furthermore, children’s perceptions about their own sleep were not taken (Ball & Koloian, 1995).

Corkum, Tannock, Moldofsky, Hogg-Johnson & Humphries, (2001) compared parental reports to actigraphy and found that the subjective and objective reports only overlapped in the
domain of bedtime resistance. The authors surmise that bedtime resistance may be related to oppositional behavior rather than a sleep disorder.

O’Brien et al. (2003) studied the parental surveys and polysomnograms of a community sample of ADHD children, a sleep clinic sample of ADHD children, and a control group. They found that there were statistically significant differences between groups. For the parental questionnaires, both ADHD groups compared to controls had more difficulty in the following sleep problems: initiating sleep (p < .001), restless sleep (p < .0001), nightmares (p < .05), and daytime sleepiness (p=.0002). The ADHD clinical group compared to controls had statistically significant differences in the same areas (p < .01). In the PSG study, there were also statistically significant differences. REM sleep latency was longer in the ADHD clinical group (p=.003) and the ADHD community group (p=.004) compared to controls, and the percentage of REM time was significantly lower in both ADHD groups compared to controls (p < .001).

Gruber et al. (2008) did the first in-home polysomnography study with medication-free ADHD children without comorbidity and a control group. The study also found that children with ADHD had decreased REM sleep and also slept less compared to controls.

Sleep and ADHD studies: Metastudies

Greenhill (1983) in Kaplan et al. (1987) studied 10 published reports reviewing 63 ADHD children and reported that these children have restless sleep (it was reported that these children have more movement during sleep) and prolonged rapid eye movement onset latency (Kaplan et al., 1987).

Cortese, Caraone, Konofal & Lecendreux, (2009) reviewed studies on sleep in children with ADHD and a control group. In total, 16 studies met the criteria set forth for this review, which included: children with ADHD who were diagnosed with standardized DSM criteria, both
subjective and objective studies, and studies with children with comorbid ODD because of its high prevalence (Cortese et al., 2009). It excluded children taking medicine or with comorbid anxiety/depression. Analyses revealed that there was a significantly higher rate of sleep problems in the ADHD groups compared to control groups. In parent reported studies, ADHD children compared to controls had significantly greater bedtime resistance, more difficulties with sleep-onset, night awakenings, morning awakenings, and sleep disordered breathing and daytime sleepiness. There was no significant difference regarding parasomnias, restless sleep and sleep duration. In the objective studies using actigraphy, ADHD children were found to have later sleep onset, and more severe sleep apnea. Evaluation by polysomnogram also yielded results for a lower sleep efficiency for ADHD children but did not show a significant difference for onset of sleep. ADHD children fell asleep faster during the day than controls as part of the MSLT assessment, therefore suggesting the likelihood of more daytime sleepiness in this group. The percentage of time in each stage of sleep assessed by PSG did not significantly differ between the groups, and sleep efficiency and night wakings assessed by actigraphy also did not differ. However, actigraphy measures movements and is not sensitive enough to measure cortical wakings (Cortese et al., 2009).

In summary, in the subjective assessments, the ADHD group had significantly higher daytime sleepiness and SDB. There were not enough studies in this analysis to comment on restless sleep or RLS. In summary of the objective studies, the results regarding sleep onset latency were not clear, because this latency was reported as a difference on actigraphy, but sleep onset latency may be less reliable on actigraphy (Cortese et al., 2009). There was no difference as measured by PSG. Objective measures would need to continue for more than a few nights to gather these data. Some parents report later sleep onset for their children because of possible
sleep-onset variability that an overnight study would not be able to measure because these
studies are limited to one or two nights and therefore cannot assess variability over many nights.
Parents also may be more likely to recall later nights (Cortese et al., 2009).

Bartholomew & Owens, (2006) reviewed the literature on ADHD and sleep and reported
that polysomnogram generally does not reveal any significant differences in the stages of sleep
and in sleep patterns between ADHD and non-ADHD groups. In actigraphy studies, there do not
appear to be differences in areas such as sleep onset, sleep duration, sleep efficiency, and night
waking. Although these objective tests do not report significant differences in these sleep areas,
the literature reviewed by Bartholomew & Owens (2006) points to a number of differences
between ADHD and non-ADHD groups. Children with ADHD seem to have more and longer-
lasting movement while sleeping (Bartholomew & Owens, 2006; Konofal, Lencendreux,
Bouvard & Mouren-Simeoni, 2001). Also, instability of sleep patterns may be present and
attributed to a problem with arousal for some children with ADHD (Bartholomew & Owens,
2006; Gruber, Sadeh & Raviv, 2000). Furthermore, although nocturnal sleep is similar, children
with ADHD seem to be sleepier than non-ADHD children.

Bartholomew & Owens, (2006) also discussed the growing evidence of comorbidity of
sleep disorders with ADHD. Common disorders include: obstructive sleep apnea, snoring, RLS
and PLMD, and narcolepsy. Research assessing the effects of sleep loss on children and
adolescents found that sleep loss is associated with problems with: sleepiness, attention, reaction
time, memory, problem-solving, and creativity (Bartholomew & Owens, 2006). When children
have tonsillectomies to treat obstructive sleep disorders or sleep disordered breathing, this
surgery seems to effectively treat snoring, which then also improves daytime sleepiness,
behavior, academic performance, and attention. Furthermore, neuropsychological assessments of
attention, vigilance and reaction time, and cognitive functions show improvement (Bartholomew & Owens, 2006). Obstructive sleep apnea symptoms are present in many children under evaluation or already diagnosed with ADHD (Bartholomew & Owens, 2006).

Do children with ADHD need more sleep than other children?

Corkum, Tannock, Moldofsky, Hogg-Johnson, & Humphries, (2001) found that in their laboratory study, ADHD children slept longer than non-ADHD children, though not longer than the recommended amount of sleep for their age. In their previous review article, the authors (Corkum, Tannock, & Moldofsky, 1998) reported that their results differed and instead indicated that ADHD children slept less (Corkum, 2009). However, ADHD children do experience more daytime sleepiness as measured on the MLST (Corkum, 2009; Lecendreux et al., 2000). In Chervin et al., (2002) inattentive and hyperactive children without SDB slept less than non-inattentive and hyperactive children, but inattentive and hyperactive children with SDB slept longer than non-inattentive and hyperactive children. It is possible that these children needed more sleep because the quality of their sleep was interrupted. Furthermore, if ADHD groups sleep less than non-ADHD children at night, yet present with daytime sleepiness, it does not imply that they need less sleep, instead, it implies a sleep deficit. This also elucidates the need to further separate ADHD children into categories because the causes of sleepiness, hyperactivity and inattention can be different (Chervin et al., 2002; Lecendreux et al., 2000).

Research on the Effects of Interventions

Medical

Chervin et al. (2002) followed children with ADHD and obstructive sleep apnea who had tonsillectomies a year after the surgery and found that 11 out of 22 children no longer met the criteria for ADHD, suggesting that surgery was able to help half of the children in this study,
whose ADHD may have been secondary to poor sleep.

Chervin et al. (2006) researched behavior and cognition after surgically removing adenoids and tonsils in children with sleep disordered breathing. Assessments were conducted before surgery and a year later. The group that had surgery compared to a control group were more hyperactive in parent rating scales, inattentive on cognitive testing, sleepy on the MSLT, and more likely to have ADHD as diagnosed by a child psychiatrist. A year later, there were no significant differences between groups; the control stayed the same on the assessments and the surgery group improved in all areas. Half of the children diagnosed with ADHD no longer met the requirements for this disorder. Even with improvement in all areas, there was no evidence of cause and effect except for sleepiness which lead researchers to believe that better measures or understanding of these mechanisms are needed (Chervin et al., 2006).

Walters et al. (2000) analyzed children with ADHD and restless leg syndrome. The medication levodopa was given to treat restless leg syndrome and the resultant sleep problems. In all seven children treated, their ADHD symptoms also improved as measured by the Conners' and Child Behavior Checklist (Walters et al., 2000). This result may be an effect of levodopa or due to the improvement of RLS symptoms. The dopaminergic system may be helpful in understanding a common and potential underlying cause of sleep problems and ADHD. Both Levodopa and Ritalin, a common medication prescribed for children with ADHD increase dopamine (Walters et al., 2000).

Kooij, Middelkop, van Gils, & Buitelaar, (2001) studied medication free ADHD adults. Participants were tested at baseline for six nights using subjective means with a sleep log, and objective tests using wrist actigraphy. The assessment measured total time in bed, sleep latency time, number of awakenings and nocturnal motor activity (Kooij et al., 2001). Afterwards, they
were put on stimulant medication three times a day, and tested three weeks later also for six consecutive nights. Compared to baseline, the total time in bed, sleep latency time, and number of awakenings were all the same; however, the self-report sleep quality increased and nocturnal motor activity decreased (Kooij et al., 2001). The authors surmise that the stimulant medication helps treat ADHD symptoms during the day, which also helps sleep at night. Also, stimulants may treat problems with arousal that may be associated with ADHD. Alternatively, the effects of the stimulant medication may affect the brain, resulting in better sleep (Kooij et al., 2001).

Weiss, Wasdell, Bomben, Rea & Freeman (2006) studied an intervention of sleep hygiene and melatonin for children and adolescents with ADHD who had initial insomnia and were taking stimulant medication. Combined, they helped children fall asleep faster. Another study analyzed the effects of melatonin on sleep, behavior and cognition in ADHD children and discovered that melatonin helped with sleep, but not with behavior and cognition (Van der Heidjen et al., 2007). Furthermore, the same authors did a long term study using a parent questionnaire and analyzed children with ADHD and chronic sleep onset insomnia (Hoebert, Van der Heijden, van Geijlswijk & Smits, 2009). They reported that melatonin was effective for sleep onset insomnia in 88% of the children, and behavior (71%) and mood improvement (61%) were also reported (Hoebert et al., 2009).

Because there is growing evidence between the relationship of sleep to some children with ADHD, children with ADHD symptoms should be screened for sleep problems (Bartholomew & Owens, 2006; Mindell & Owens, 2003; Owens et al., 2000; Silvestri et al., 2009).
Parental sleep hygiene

In addition to sleep disorders affecting children, parental sleep hygiene needs to be further explored. It is possible that strategies for sleep management may make a considerable difference to ADHD children (Wilens et al., 1994; Konofal et al., 2010).

Although many families have difficulty with sleep, ADHD children may exhibit noncompliance associated with comorbid factors that exacerbates problems with sleep (Bartholomew & Owens, 2006).

Getting extra sleep can be beneficial. Normal children who slept an hour more then they typically do, did better on performance tests compared to their previous baseline and compared to a group that received less sleep than typical (Sadeh et al., 2003). This study also demonstrated that children were able to adjust their sleep, by going to sleep earlier or later than their typical schedule. Similarly, parents can help their children get extra sleep which may improve their neurobehavioral functioning. More research is needed on parental sleep hygiene interventions (Konofal, et al. 2000).

Summary

There is an increased interest in the field of ADHD and sleep (Cortese et al., 2009). However, research on the association of sleep problems and ADHD is mixed. A number of studies present findings that correlate ADHD with sleep problems (Barkley, 1998; Wilens et al., 1994; Lecendreux et al., 2000). Studies may conflict due to the nature of the study (Owens, 2009).

In subjective studies, parents report 25-50% of ADHD children have problems with sleep (Corkum et al., 1998; Owens, 2009). Reported difficulties include: transitioning to bedtime, falling asleep, staying asleep, sleep quality, sleep duration, fewer total hours spent sleeping, and
daytime sleepiness. (Bartholomew & Owens, 2006; Lecendreux et al., 2000; Wilens et al., 1994). Additional problems include: activity during sleep, obstructive sleep apnea, restless legs/periodic leg movements during sleep, and unstable sleep patterns. These sleep disorders and sleep deprivation that result from chronic sleep problems contribute to ADHD symptoms (Wilens et al., 1994).

Objective studies vary and some find differences between ADHD groups compared to controls, while others do not (Bartholomew & Owens, 2006). Even in studies that show no objective difference in sleep, more ADHD children may be sleepier during the day than controls (Lecendreux et al., 2000). Children with ADHD also may be difficult at bedtime which can prolong sleep causing them to sleep less (Corkum et al., 2001). Insufficient sleep is the biggest cause of daytime somnolence (Gruber et al. 2000) which can cause difficulties in behavior and attention (Owens, 2009). More research is needed on parental sleep hygiene interventions (Konofal et al., 2010).

Bhargava & Sethi, (2005) found that sleep onset was delayed in ADHD children, yet these children slept longer which would therefore net a similar amount of sleep in sleep labs. However, this may not translate to a naturalistic setting because children need to be awake for prescribed times for school, therefore, this later sleep onset would result in less sleep.

It is possible that insufficient sleep may contribute to ADHD symptoms. Treatment of sleep problems may ameliorate daytime behavior problems (Owens, 2009). If poor sleep negatively affects hyperactivity, impulsivity, and distractibility, than the literature suggests that 1) treating sleep problems may decrease ADHD symptoms (Dahl & Puig-Antich, 1990; Owens, 2009) and 2) if children go to sleep at a consistent time and sleep for a longer duration, behavioral descriptors of AHDH may decrease in severity.
Method

The purpose of this study is to investigate whether children with ADHD experience more sleep problems, explore the quality of bedtime routines, and get less sleep than their peers without ADHD. This research will compare the sleep problems experienced, the bedtime routines, and hours of sleep of children between the ages of five to ten with and without ADHD. If, as expected, children with ADHD sleep fewer hours each night than those without ADHD, the potential reasons for this will be explored, such as a later bedtime, sleep problems, and the quality of bedtime routines. Consistent with these purposes, this study will analyze responses of parent participants to answer the following research questions:

Are there differences between children with and without ADHD in:

1. Sleep problems
2. Bedtime routines
3. Number of hours of sleep

And, if so, what is the nature of these differences?

If multiple sleep variables from the above research questions are found to be statistically significant between the two groups, then the relationship among sleep variables within the group of ADHD children will be examined:

4: What is the relationship among statistically significant sleep variables (i.e. sleep problem, bedtime routines and number of sleep hours) for the group of ADHD children?

Research Design

A quantitative ex post facto design will be used to determine whether there are differences between the parent reports about sleep and bedtime of children who are and who are
not diagnosed with ADHD. Parents will be used as informants because they are most likely to be in a position to observe their child’s sleep habits and bedtime routine. Because the data will be collected from parents whose children have already been diagnosed with ADHD, and it is not practical to observe the bedtime routines of their children, the ex post facto research design is appropriate for this proposed study (Cohen, Manion & Morrison, 2000).

Participants

Participants will be selected on the basis of their having a child in elementary school between the ages of 5 and 10. This narrow age range will increase the comparability and generalizability of the findings to these specific age groups. Single parents, divorced parents, and intact families will be included. There will be two groups of participants: (a) parents who have a child with ADHD and (b) a comparison group of parents with a child without ADHD. Demographic data will be collected for both groups of participants. These data will include the age of the child and the parent, the marital status of the parent, gender of the child, racial/ethnicity, zip codes and the number of children in the family. The demographic data will be compared through ANOVA to determine whether there is a significant difference between the two groups. Every attempt will be made to ensure that the two groups be similar in order to minimize the impact that demographic factors might have on the findings of this study. However, if there is a statistically significant difference on any of the demographic factors between the participants between the two groups, then those factors will be included as covariates in the analyses that test the hypotheses.

Inclusion Criteria

Inclusion criteria for the ADHD group will be parents: (a) who report that their child has been diagnosed with ADHD by a psychologist, psychiatrist, or pediatrician on the demographic
The Relationship of Sleep to ADHD Among Elementary School Aged Children

questionnaire (description below); and (b) who give a rating on the ADHD scale (description below) that qualifies as a significant score for the child’s age and gender (ADHD Rating Scale-IV, 1998). Both criteria should be met in order to ensure that the children are diagnosed as having ADHD and that they show the characteristics of children with ADHD.

Inclusion criteria for the non-ADHD comparison group will include parents of children: (a) without an ADHD diagnosis, and (b) with a non-significant score for their child’s age and gender on the ADHD scale (ADHD Rating Scale-IV, 1998).

Parents who report that their child has anxiety, depression, a medical diagnosis of mental disorder or a significant cognitive impairment will be disqualified from either group and will not be used in the data analysis, because these factors could affect the child’s sleep (Owens, Spirito, & McGuinn, 2000). Parents who rate their child in the significant range in the ADHD scale but did not report that their child has ADHD nor provide the type of professional who gave the diagnosis will not be used in either group. These guidelines are intended to minimize ambiguity as to how these children should be classified regarding this study. Moreover, in order to meet the criteria to participate, the children need to reside with the parent, and the parent participant has to be the primary caregiver or share childcare equally. These will be part of the demographic data that will be collected from the parent participants.

Demographic variables will be collected from each participant. Apart from age and gender of the child, these will also include information regarding any medication their child could be taking, and how long the child has been on the medication.

Participant groups:

ADHD group:
Parents attending chapters of Children and Adults with Attention Deficit Disorder, CHADD, a non-profit national organization that serves as an education and support group to parents of children with ADHD, will be asked to participate in the proposed study. This group was chosen for the ADHD sample because they represent parents with ADHD children. They also meet in a similar geographic area as the comparison group, so the ADHD group and comparison group are likely to similar demographics for this study.

**Non-ADHD group:**

The comparison group will be recruited from the Parenting Center, a non-profit local organization that educates and supports parents, because these parents also are seeking additional parenting skills, education and support. This group is similar to CHADD because they are seeking out parenting support and education, without the emphasis on ADHD. They also represent a similar geographic area or neighborhood that serves as an appropriate comparison group for this study.

**Participant recruitment:**

This researcher will attend local meetings of CHADD and local groups at the Parenting Center. The parents will be told about the purpose of the study as well as be provided with the researcher’s contact information if they wish to ask further questions in the future. Those parents willing to participate will be asked to read an unsigned informed consent form and then complete the survey instruments and return the completed materials that same day. The duration of the recruitment efforts is anticipated to be three months in order to collect data from as many participants as possible because different participants may attend each monthly meeting. This would maximize the chances of collecting data that would be appropriate for this study.

A priori power analysis was conducted using G*Power 3.1.0® to determine the total
number of participants that should be included in the study. Considering ANCOVA analysis with two groups and at most two covariates, the minimum sample size was determined. An effect size of .3 with a .05 significance level was used. The effect size of .3 ensures that the statistical analysis provides a moderate strength in identifying relationships between variables. This resulted in a minimum total sample size of 90 participants or a minimum of 45 for each group. This statistical power of this sample size is 80.36%. In order to ensure that sufficient number of participants is gathered, an allowance of 10% will be used to account for participants who will provide incomplete data as well as those who will provide outlier data. Therefore, a total of 100 participants or 50 for each group will be sampled.

The researcher will protect the anonymity of the respondents. There will be no personal information included on the documents. The raw data from the survey instrument will be uploaded and saved in a password-protected computer file in a room to which only the researcher will have access. The responses provided to each of the questions on the survey instruments will be imported into SPSS software. Each of the participants who complete the survey instruments will be assigned a unique control number. This control number will be used to specify which responses correspond to the particular participants in the study.

*Ethical concerns:*

Each participant will go through the process of informed consent. This is to ensure that participants know that they are filling out questionnaires voluntarily and that there are no negative effects for not participating, or in stopping the study at any time. In addition, through the informed consent process every answer will be anonymous. This may alleviate the problems that may be associated with parents filling out questionnaires regarding their children. Parents may experience a certain amount of anxiety about answering some of these questions. Although
these questions are not of a personal matter, parents may perceive that their parenting is being judged and this perception may lead them to wonder what the “correct” answer is supposed to be. Therefore, an unsigned informed consent will be used, so the parent participants will not have to give their name anywhere on the study.

Informed consent and process

Both informed consent forms and questionnaires will be approved by the Institutional Review Board at Northeastern University in Boston, Massachusetts and will also be approved through the Parenting Center, and CHADD’s Professional Advisory Board Research Subcommittee. The informed consent and all questionnaires are located in the appendix. The researcher’s email and phone number will be made available to all participants, in case they have questions. The unsigned informed consent form will also include information regarding the purpose of the study, the rights of the individuals as participants, as well as making the participants aware that they can discontinue their involvement at anytime. Prior to completing the survey instruments at the Parenting Center and at CHADD, the participants will be asked to read and keep the unsigned informed consent form. Then, the participant will be given the survey instrument to complete. After the study is completed, information regarding the results of the study will be emailed to the directors of the Parenting Center and CHADD to be distributed to its members. Any parents with specific questions about ADHD will be encouraged to address the questions to their child’s pediatrician.

Participant Expectations

Parents will be asked to fill out anonymous surveys for one or more of their children. Parents will be instructed to read the unsigned informed consent form, and if in agreement will fill out the questionnaires at the time and return them to the researcher. The participation of each
The Relationship of Sleep to ADHD Among Elementary School Aged Children

parent will be voluntary. If they agree to participate, they will be asked to answer a survey, which explores the sleep issues of their children who are between 5 and 10 years old. If the parent has several children who qualify in the criteria for inclusion in this study, the researcher will instruct the parent to fill it out for either their older or younger child. In order to ensure that the parent does not self-select on whether the questionnaire is for the older or younger child, the researcher will take turns at each testing location to instruct the parent to fill it out for either their older or younger child.

**Questionnaires:**

1.) Demographic Questionnaire. This questionnaire was created by the researcher and is designed to obtain demographic information and possible previous Diagnostic and Statistical Manual of Mental Disorders (DSM) - IV diagnoses.


3.) Children’s Sleep Habits Questionnaire- Abbreviated Version (CSHQ) (Owens, Spirito, & McGuinn, 2000)

4.) Bedtime Routines Questionnaire (BRQ) (Henderson & Jordan, 2009)

**Independent Variables: Participants with a child with ADHD versus a comparison group**

The independent variable is ADHD status. All subtypes of ADHD will be included in the ADHD group. To determine the ADHD status, information from the Demographic Questionnaire, which asks parents to report children’s ADHD diagnosis and the type of professional who provided the diagnosis as well as data from the ADHD Rating Scale IV (1998) will be used. The inclusion status as mentioned above also needs to be satisfied.

**Demographic Questionnaire:**
This researcher will use a demographic questionnaire (DQ) in order to collect demographic and diagnostic information. In addition, there are questions on the DQ to be used in conjunction with the ADHD rating scale (see below) to determine if a participant qualifies for the ADHD or non-ADHD comparison group (See Appendix 1). The researcher created the questions involving the demographic characteristics of participants, while some were drawn with permission from the National Sleep Foundation (NSF) 2004 Sleep in America Poll (National Sleep Foundation, 2004). The entire NSF questionnaire will not be administered to the participants; instead, only those questions which relate to this study. NSF has granted permission to use all or parts of the questionnaire for this study (See Appendix 2).

The Sleep in America Poll (2004) is a parent report questionnaire that covers demographics, mental disorder diagnoses, and children’s sleep habits. There are no reliability or validity data for this survey. Therefore, only some demographic questions from this survey will be used and two sleep inventories with reliability and validity information will also be utilized for this study (described later in this chapter).

The responses of participants to the demographic questionnaire will be converted into numeric codes which represent each group of participants classified according to age, gender, and race/ethnicity. If applicable, this coding scheme will be tested for reliability to determine if this would provide meaningful results for the study (Townsend, 2009). The demographic questionnaire will include open-ended questions, yes/no questions, and questions with a variety of pre-established options. The demographic questionnaire will allow a comparison to examine possible demographic differences between the groups.

**ADHD Rating Scale-IV (1998)**
The ADHD Rating Scale-IV and the ADHD questions on the DQ together will be used to identify the ADHD and non-ADHD status of the child. To identify the children to be classified in the ADHD group, it is necessary that both the parent’s response on the DQ and the ADHD Rating Scale indicate that the child has ADHD. The ADHD scale was created to reflect the diagnostic criteria of the two subtypes of ADHD listed in the DSM-IV (1994), and is made up of subscales that measure and provide scores for inattention, hyperactivity-impulsivity and also a total score. It consists of 18 items, nine for each subscale and uses a Likert-type scale.

The ADHD Rating Scale-IV (1998) (See Appendices 3 & 4) was developed by DuPaul, Power, Anastopoulos, & Reid, (1998). The following information regarding reliability and validity and other relevant information about this rating scale was obtained from the ADHD Rating Scale-IV: Checklists, Norms, and Clinical Interpretation (DuPaul et al., 1998). According to the manual (DuPaul et al., 1998), it is appropriate to use this scale for children between the ages of 5 and 18. For this study, the home version (parent reported measure) will be used.

The sample that was used to identify the subscales of the questionnaire included 4,860 children aged 4-20, representing a national sample of 22 school districts, kindergarten through 12th grade. Data were complied for 4,666 participants. The participants included 2470 girls, 2134 boys, and 62 of unspecified sex. There were 3,999 Caucasians, 318 African Americans, 105 Latinos, 99 Asian Americans, 13 Native Americans, 61 others, and 71 unspecified. The responses of these participants were analyzed through factor analyses to identify the subscales that were measured by the questionnaire.

Reliability and validity have both been established for children in the five to ten year age groups (DuPaul, Power, Anastopoulos, & Reid 1998). This rating scale has high levels of internal consistency and test-retest reliability. Internal consistency for the home version of the
The Relationship of Sleep to ADHD Among Elementary School Aged Children

scale has the following alpha coefficients: Total score = .92, Inattention = .86, and Hyperactivity-Impulsivity = .88. Test-retest reliability used a Pearson product-moment correlation and the following scores were obtained: Total score = .85, Inattention = .78, and Hyperactivity-Impulsivity = .86.

The authors provide evidence of the instrument’s discriminant validity. Parent ratings were significantly higher (i.e., children were rated as more inattentive) in the inattentive and combined group than the non-clinical control group. Parent ratings of hyperactivity-impulsivity were also significantly higher in the inattentive and combined group compared to the control group. Ratings on the scale also differentiated between the two ADHD subtypes, and between children with ADHD and children who were referred to a clinic who did not have ADHD.

Predictive validity of the scale was demonstrated by using logistic regression analyses to use the mean scores of each subtype to predict the difference between groups in a future analysis. In the school population using parent ratings, the following predictions were calculated in the inattention subscale: in the ADHD, inattentive type, logistic regression was able to successfully differentiate children with ADHD, inattentive type compared to the control group by 76%; the ADHD, combined type from the control group was 80%. When using the hyperactivity-impulsivity subscale and parent ratings, 82% were differentiated in the ADHD combined group vs. the control group, and in the combined group vs. the ADHD, inattentive group, 79% were differentiated.

In regard to concurrent validity, scores on the ADHD Rating Scale-IV correlate significantly with scores on other ADHD scales, such as the Connors Parent Scales (.68 on the impulsivity-hyperactivity scale; p < .001) (DuPaul, Power, Anastopoulos, & Reid, 1998). The data suggest that this measure is useful in differentiating children with and without ADHD and
distinguishing the subtypes. This measure can be used as part of an overall assessment and has appropriate reliability and validity data for screening and treatment outcome measures.

**Sleep variables:**

The dependent variables will be children’s sleep problems, bedtime routine, and number of hours of sleep. Data from the CSHQ (2000) and BRQ (2009) will be used for this assessment. These consist of the following:

(a) overall score on the Children’s Sleep Habits Questionnaire (CSHQ) and the following subscales including:

1) bedtime resistance
2) sleep onset delay
3) sleep duration
4) sleep-disordered breathing,
5) daytime sleepiness,

(b) the presence or absence of a daily bedtime routine including:

1) consistency of a bedtime routine including routine behaviors and routine environment, and
2) activities before bedtime including adaptive activities and maladaptive activities.

**Children’s Sleep Problems**

Questionnaire: Children’s Sleep Habits Questionnaire- Abbreviated Version (CSHQ) (Owens J, Spirito A, McGuinn M, 2000)

The Children’s Sleep Habits Questionnaire (CSHQ) (2000) will be used to quantitatively
measure the degree of children’s sleep problems (See Appendix 5.). The information gleaned will help answer all three research questions of this study. The overall score and five of the subscale scores of the CSHQ (2000) will be used to measure the dependent variables.

The CSHQ is a parent-reported instrument that screens for sleep problems in children. It provides both a total score and eight subscale scores, which describes, by category, children’s sleep problems. The following information about this questionnaire was obtained from The Children’s Sleep Habits Questionnaire (CSHQ): Psychometric Properties of a Survey Instrument for School Aged Children in the Journal Sleep (Owens J., Spirito A., & McGuinn M., 2000).

This instrument was designed to screen for sleep problems for children between the ages of 4 to 12. It is not used to diagnose sleep disorders but to screen for sleep problems, and further evaluation may be necessary to fully assess this area for a given child. Reliability and validity data were collected from both a community sample and clinical sample. The community sample included 469 elementary children in three public schools in a suburban population. These children are within the age range of 4 to 12 years of age, which encompasses the age range of the proposed sample for this study. Children in each school were administered the instrument in the spring, fall, or winter to control for sleep differences in different seasons. The participants included 229 girls and 240 boys. One hundred fifty-four clinical patients from a pediatric sleep clinic (63 girls, 91 boys) were also included in the study. These patients were diagnosed with a behavioral sleep disorder, (n=43) parasomnia, (n=45) or sleep-disordered breathing (n=66).

Parents are asked to answer questions regarding their child’s typical sleep over the past week, using a three point scale: usually which denotes five to seven times a week, sometimes which denotes two to four times a week and rarely which denotes none to once a week. The 33 items of the scale are divided into eight subscales (two of the questions are used on more than
one subscale): (a) bedtime resistance, (b) sleep onset delay, (c) sleep duration, (d) sleep anxiety, (e) night wakings, (f) parasomnias, (g) sleep-disordered breathing, and (h) daytime sleepiness. Five of the subscales will be dependent variables and will be analyzed separately. These subscales are: (a) bedtime resistance, (b) sleep onset delay, (c) sleep duration, (d) sleep disordered breathing, (e) daytime sleepiness.

Validity

Construct validity was measured by analyzing each item on the instrument and the eight subscales with the use of clinical and community samples. The validity of the instrument determines whether the questions are enough to support the construct of this study. The clinical sample scored higher in the CSHQ. This implies that the clinical samples have worse sleep problems than the community sample on all questions except one. Also, 30 out of 33 items had a statistically significant ($p < .001$) positive correlation between questions which indicate that the sub-items are associated in measuring the construct of sleep problems. The clinical sample was statistically different from the community sample ($p < .001$) in all of the subscales. The eight subscales for three clinical groups (behavioral sleep disorder, parasomnia, and sleep-disordered breathing) were compared to a community group. Statistically significant results were found for each group; clinical samples scored higher than the community samples on each of the eight subscales.

Sensitivity measures the proportion of correctly identified positives, while specificity measures the proportion of correctly identified negatives (Altman & Bland, 1994). The results of the study of Altman and Bland (1994) showed the CSHQ corresponds to sensitivity as .80, specificity as .72 and captures 80% of the clinical sample. The CSHQ appears to accurately differentiate non-sleep disordered children from children who have a suspected sleep disorder.
Reliability

The internal consistency of this instrument for the community sample and clinical sample is .68 and .78 respectively. Since this is near or within the range of the satisfaction level from .7 to .8, this instrument is considered to have adequate internal consistency. However, because some of the subscales are lower, this author is in the process of contacting the authors of this instrument to get permission to adapt the questionnaire if necessary in order to increase the internal reliability. The four subscales with the highest internal consistency in the clinical group were: Sleep Disordered Breathing (Cronbach’s alpha=.93), Sleep Duration (Cronbach’s alpha = .80), Bedtime Resistance (Cronbach’s alpha = .83), and Daytime Sleepiness (Cronbach’s alpha = .70). There were 60 parents from the community sample who volunteered to take the instrument twice within a two-week interval to measure test-retest reliability of the subscales. The correlations of the subscales range from .62 to .79. This supports the reliability of this instrument to measure the children’s sleep habits and sleep problems.

In summary, this instrument was designed to assess a community population in order to screen for sleep habits and sleep disturbances. The subscales for this instrument reflect the most common sleep disorders reported in children this age (Owens et al., 2000). Limitations of this instrument include questions about the accuracy of parent reporting and the difficulties with retrospective reporting. The accuracy of the report depends in part on the extent to which parents know the nuances of their child’s sleep. Thus, this study assumes that parents know about sleep problems of their children. Also, it is unknown if children in the community sample had sleep disorders that were not diagnosed, and therefore not reported. The instrument has no copyright and is shared by the author on her website (KIDZZZSLEEP, 2009) which makes it available for use in this proposed study.
Children’s Bedtime Routine:

Questionnaire: Bedtime Routines Questionnaire (BRQ) (Henderson & Jordan, 2009)

The Bedtime Routines Questionnaire will be used to identify specific information regarding a child’s bedtime routine (See Appendix 6.). It will be used to help answer the second research question about whether or not children with ADHD have different bedtime routines compared to non-ADHD children.

The BRQ is a parent-report measure for children and was developed to assess children’s bedtime routines. The following information regarding the psychometric characteristics of this instrument was gathered from Development and Preliminary Evaluation of the Bedtime Routines Questionnaire (Henderson & Jordan, 2009).

The BRQ was developed to understand sleep and routines through a review of the literature, researching sleep diaries, and using a panel of child development and/or sleep research professionals. The authors used this information to create a list of adaptive and maladaptive activities that children do before bedtime and sent it to the panel of professionals for feedback, revisions and additional information to finalize the BRQ.

This instrument has 31 items in a 5 point Likert-type scale format and includes three scales: consistency (reflecting routine behaviors and environment), a reactivity (a reaction to changes in routine) and activities (comprised of both adaptive and maladaptive activities). The Likert-type scale items for the consistency and activity questions have the following anchor points: (1) almost never, (2) occasionally, (3) half the time, (4) often and (5) nearly always. The reactivity items use the following five-point scale: (1) not at all, (2) a little, (3) moderately, (4) quite a bit, and (5) extremely.
A community sample was used to collect data for BRQ. The following demographics were obtained: the mean age of children was 4.98 with a standard deviation (SD) of 1.92. Children were 54.4% boys. Parents ranged in age from 18 to 64, and the mean was 31.54 with a SD of 7.42. Women represented 86.5% of the sample, whereas married participants were 61.5% of the sample. The study was comprised of 52% Caucasian, and 43.8% African American.

Reliability

Means and SDs were calculated for the sample of 222 participants for the six BRQ subscales. Internal consistency, measured by the coefficient alpha, for these scales was as follows: Routine Behaviors = .90, Routine Environment = .83, Total consistency = .88, Reactivity = .76, Adaptive Activities = .74, Maladaptive Activities = .69.

Validity

The BRQ was compared to the Child Routines Questionnaire (CRQ) Total, the Child Routines Questionnaire-Preschool version (CRQ-P) Total, the Children’s Sleep Hygiene Scale (CSHS) Total, the Children’s Sleep-Wake Scale (CSWS) Total and the Behavior Assessment System for Children, Second Edition (BASC-2) Externalizing t- scores to determine construct validity. The BRQ Consistency scale and subscales and the Adaptive Activities scale were correlated with child routines (r = .48), sleep hygiene (r = .45), and sleep quality (r = .50). However, the BRQ Consistency was not correlated with externalizing behavior.

Discriminative validity of the subscales was assessed by a multivariate analysis of covariance with sleep quality as the group variable and the BRQ scales as the dependent variables. The intent was to assess if the good and poor sleepers could be differentiated with respect to their sleep routines. Participants who get a full night’s sleep, termed the good sleepers, had statistically significantly more consistency and adaptive activities in their routines, and poor
sleepers were reported to have had statistically significantly more reactivity to changes in their routine and more maladaptive activities.

Although the standardization of this instrument was done with parents of children aged two to eight, for the purposes of this study, parents of children aged five to ten will be used. Therefore, an internal reliability analysis of this instrument will be done for parents of children between the ages of 5 to 10 years old through calculating the Cronbach’s alpha for the BRQ subscales.

Research Hypotheses and Data Analysis

Below are listed the hypothesis for each research question and the data analysis procedure necessary to test the hypothesis. Prior to testing the hypotheses, an ANOVA will be conducted to determine whether or not the group of parents with ADHD children statistically differs from the group of parents without ADHD with respect to the following demographic variables: age, gender, and race/ethnicity. If any statistically significant differences are found, then the relevant demographic variable(s) will be included in the analyses of the hypotheses as a covariate or covariates to control for the possible confounding influence on the results.

RQ1: Do ADHD children and non-ADHD children differ with respect to the occurrence of sleep problems?

Hypothesis (1.): Parents of children with ADHD will rate their children statistically significantly higher on the CSHQ subscales than parents of children without ADHD. Higher scores are indicative of more sleep related problems.

RQ2: Do the bedtime routines of ADHD children and non-ADHD children differ?

Hypothesis (2.): Children with ADHD will score lower on the bedtime routine scores than children without ADHD. Lower scores are indicative of worse bedtime routine.
RQ3: Is there a difference between the number of sleep hours of ADHD children and non-ADHD children?

Hypothesis (3a.): Children with ADHD will have a later bedtime than children without ADHD as measured on the CSHQ.

Hypothesis (3b.): Children with ADHD will get fewer hours of sleep than children without ADHD as measured on the CSHQ.

RQ4: Is there a relationship between statistically significant dependent variables (i.e., sleep problem, bedtime routines and number of sleep hours) for the group of ADHD children?

Hypothesis (4.): A statistically significant relationship between dependent variables (i.e. subscales of sleep problems, bedtime routine, and the number of sleep hours) will be found for the group of ADHD children.

The CSHQ instrument measures eight subscales: (a) bedtime resistance, (b) sleep onset delay, (c) sleep duration, (d) sleep anxiety, (e) night wakings, (f) parasomnias, (g) sleep-disordered breathing, and (h) daytime sleepiness. However, this study is concerned with whether or not there is a significant difference between the bedtime resistance, sleep onset delay, sleep duration, sleep disordered breathing and daytime sleepiness of children with ADHD as compared to those without ADHD. Therefore, the data for this analysis will be taken from five subscale scores of the CSHQ instrument. A comparison between the overall score as well as five subscale scores will be made.

To analyze the first research question, either a multiple analysis of variance (MANOVA) or a multiple analysis of covariance (MANCOVA) will be conducted. The MANCOVA will be used if any demographic variables that were found to statistically differentiate the ADHD and non-ADHD groups. The MANOVA or MANCOVA will be used to determine if membership in
ADHD and non-ADHD groups is able to account for the variation in the five CSHQ subscale scores (Tabachnick & Fidell, 2007).

For the second research hypothesis, a comparison between children with ADHD and children without ADHD will be made regarding bedtime routine and will be measured by the BRQ. To analyze the second research question, a multiple analysis of covariance (MANCOVA) will be conducted to determine if there is a statistically significant difference between the ADHD and non-ADHD group with respect to the BRQ subscale scores (Tabachnick & Fidell, 2007). To analyze the difference between the two groups in terms of their overall BRQ score, either an ANCOVA or ANOVA will be conducted because this only involves one dependent variable. A MANOVA or MANCOVA will be used to test for possible statistically significant differences between the two groups on the subscales scores of the BRQ.

To assess the two hypotheses for the third research question, ANCOVA will be conducted with bedtime and number of hours of sleep as the dependent variables. The ANCOVA will be used to determine if there is a statistically significant difference between the ADHD and non-ADHD group with respect to their bedtime and number of hours of sleep (Tabachnick & Fidell, 2007). Post hoc tests will also be conducted to determine whether there is a significant difference between bedtime and number of hours of sleep for ADHD and non-ADHD children to determine if there is a correlation between the time that children wake and the amount of sleep they receive.

For the first three hypotheses, included in the MANOVA, MANCOVA or ANCOVA will be any demographic variables that were found to statistically differentiate between the ADHD and non-ADHD groups. If the results are statistically significant, then it will be concluded that the ADHD and non-ADHD groups explained statistically significant variation in the dependent
variables. Post hoc tests will be conducted to determine on which subscales ADHD and non-ADHD children are statistically different. Least significant Difference (LSD) tests will be conducted for the post hoc analysis because there are only two groups being compared with one another. A positive test statistic will indicate that one group scored statistically significantly higher (p. < .05) than the non-ADHD group, with regard to the dependent variables. The effect sizes and the variances for the dependent variables, which can be attributed to the independent variable, will also be reported to determine the strength of relationship between the two variables in a statistical population.

If multiple dependent variables from the above research questions are found to be statistically significant between the two groups, then the fourth research question will be addressed that examines the relationship among these independent variables within the group of ADHD children. It is important to determine whether these variables are interrelated because this will help define the treatment program necessary to improve on sleep problems of children with ADHD.

To assess the fourth hypothesis, the statistically significant dependent variables that differentiate ADHD from non-ADHD children identified in the first three hypotheses will be used. Pearson’s correlation coefficient will be calculated for statistically significant dependent variables of the group of ADHD children. This will determine whether there is a linear relationship between the dependent variables. A negative correlation will indicate that when one variable increases, the other variable would decrease. In contrast, a positive correlation will indicate that when one variable increases, the other variable will increase as well.
Results

The objective of this research study was to investigate whether children with ADHD experience more sleep problems, practice poorer bedtime routines, and get less sleep than children without ADHD. In order to address this goal, a statistical analysis of four paper and pencil questionnaires administered to 124 parents of children aged 5-11 years old was conducted. The questionnaires aimed at collecting information about the parents’ and children’s demographics (i.e., age, ethnicity, education level, etc.), the diagnosis of ADHD, and the children’s sleep habits, sleep problems, amount of sleep, and bedtime routines as measured through the CSHQ and BRQ instruments. There were four research questions to investigate each of the four hypotheses:

RQ1: Do ADHD children and non-ADHD children differ with respect to the occurrence of sleep problems?

Hypothesis (1.): Parents of children with ADHD will rate their children statistically significantly higher on the CSHQ subscales than parents of children without ADHD. Higher scores are indicative of more sleep related problems.

RQ2: Do the bedtime routines of ADHD children and non-ADHD children differ?

Hypothesis (2.): Children with ADHD will score worse in their bedtime routine scores compared to children without ADHD.

RQ3: Is there a difference between the sleep hours of ADHD children and non-ADHD children?

Hypothesis (3a.): Children with ADHD will have a later bedtime than children without ADHD as measured on the CSHQ.

Hypothesis (3b.): Children with ADHD will get fewer hours of sleep than children
without ADHD as measured on the CSHQ.

RQ4: If two or more of the dependent variables from the previous questions are found to have statistically significant relationships to their respective independent variables, then the following question will be addressed: Are there statistically significant correlations among these dependent variables for the group of ADHD children?

In this chapter, results of the data analysis are presented. The chapter begins with descriptive statistics and frequency tables for the whole sample, followed by the results of the ANOVA test, and then MANOVA and Mann-Whitney U test analyses conducted to test the hypotheses, and Pearson’s correlation tests to discuss the degree of correlations.

Descriptive Statistics

The sample consisted of 124 participants (parents). Each participant filled out one questionnaire per child, so that 124 different parents and children are represented. As can be seen from Table 1, 51 participants (41.1% of the total sample) had a child with ADHD, and 73 participants (58.9%) have a child without ADHD. There were 63 boys (50.8%) and 61 girls (49.2%). There were 102 children (82.3%) who were Caucasian, six children (4.8%) who were African American, four (3.2%) who were Asian, eight (6.5%) who were Latino, and four (3.2%) indicated as “other.” Respondents were 109 mothers (87.8%), and 15 fathers (12.2%). Parent ethnicity included: 108 Caucasian (87.8%), six African American (4.9%), two Asian (1.6%), five Latino (4.1%), and two “other” (1.6%). Parent education levels included: 49 with a post-graduate degree (39.5%), 48 with four years of college (38.7%), 20 attended 1-2 yrs of college (16.1%) and seven attended 9-12th grade (5.6%). Marital status included: 112 married (90.3%), six divorced (4.8%) and six single (4.8%). The children’s age range was between five to 11 years
old with a mean age of seven years and five and a half months. The age range of the parent participants was between 25 and 58 years old, with a mean age of 39 years and eight months.

Table 1

Demographic Composition of Sample

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<th>Variable</th>
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Table 1 (continued)

Demographic Composition of Sample

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<tr>
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<td>1.6</td>
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<tr>
<td>Other</td>
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<td>1.6</td>
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<td>4.8</td>
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<tr>
<td>Standard Deviation</td>
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<tr>
<td>Parent’s Age</td>
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<tr>
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<td>Standard Deviation</td>
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</tr>
<tr>
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</table>

Table 2 compares the demographic composition of the parents and children in regard to the children’s ADHD status. Regarding child gender, there were 37 males (72.5%), and 14 females (27.5%) in the ADHD group, and 26 males (35.6%), and 47 females (64.4%) in the non-
ADHD group. The majority of children in both groups were Caucasian, with 42 (82.4%) in the ADHD group, and 60 (82.2%) in the non-ADHD group. The participants included 45 mothers (88.2%), and six fathers (11.8%) in the ADHD group, and 63 mothers (86.3%) and nine fathers (12.3%) in the non-ADHD group. The majority of parents in both groups were Caucasian with 46 (90.2%) in the ADHD group, and 62 (84.9%) in the non-ADHD group. Parent education levels included 21 (41.2%) with a post-graduate degree, and 16 (31.4%) with four years of college (31.4%) in the ADHD group, and 32 (43.8%) with four years of college, and 28 (38.4%) with a post-graduate degree in the non-ADHD group. The majority of participants in both groups were married with 45 (88.2%) in the ADHD group, and 67 (91.8%) in the non-ADHD group.

Table 2 also includes data on child and parental age. Both groups had children in the five to 11 age range. The ADHD group had a higher mean age ($M=8.66$), than the mean age in the non-ADHD group ($M=6.76$). The parent participant age range in the ADHD group was 27-58 years compared to the age range of 25-50 years in the non-ADHD group. The mean age for the parent participants was higher in the ADHD group ($M=43.08$) than the non-ADHD group ($M=37.17$).

Table 3 summarized the ANOVA results to determine whether the differences were statistically significant. The results showed that the differences observed in child gender ($F(1) = 18.58, p < .001$), child age ($F(1) = 45.47, p < .001$), and parent age ($F(1) = 32.21, p < .001$) were statistically significant. There were no other statistically significant demographic differences between the two groups.
### Table 2

**Demographic Composition of Sample by ADHD Status**

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<th></th>
<th>ADHD Children</th>
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<th>Non-ADHD Children</th>
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<td>Group</td>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
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<tr>
<td><strong>Child Gender</strong></td>
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<tr>
<td>Male</td>
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<tr>
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<td>27.5</td>
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<td>64.4</td>
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<td><strong>Child Ethnicity</strong></td>
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<tr>
<td>Caucasian</td>
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<td>5.9</td>
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<td>1.4</td>
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<tr>
<td><strong>Parent’s Relationship to Child</strong></td>
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<td>86.3</td>
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<td>Father</td>
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<tr>
<td><strong>Parent Ethnicity</strong></td>
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<td>Caucasian</td>
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Table 2 (continued)

**Demographic Composition of Sample by ADHD Status**

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<tr>
<th></th>
<th>ADHD Children Group</th>
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<tr>
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<td>Frequency</td>
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<tr>
<td><strong>Parent Education</strong></td>
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<td></td>
</tr>
<tr>
<td>9-12th grade</td>
<td>6</td>
<td>11.8</td>
</tr>
<tr>
<td>1-2 yrs college</td>
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</tr>
<tr>
<td>4 yrs college</td>
<td>16</td>
<td>31.4</td>
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<tr>
<td>Post-graduate</td>
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<td>41.2</td>
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<tr>
<td><strong>Parent Marital Status</strong></td>
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<tr>
<td>Single</td>
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</tr>
<tr>
<td>Married</td>
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<td>88.2</td>
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<tr>
<td>Mean</td>
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<tr>
<td>Standard Deviation</td>
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<tr>
<td>Min</td>
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<td>5</td>
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<td><strong>Parent’s Age</strong></td>
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</tr>
<tr>
<td>Mean</td>
<td>43.08</td>
<td>37.17</td>
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<tr>
<td>Standard Deviation</td>
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<td>4.94</td>
</tr>
<tr>
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<tr>
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<td>50</td>
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Table 3  
ANOVA Test Result of Mean Difference for each Demographic Variable

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<th>F</th>
<th>p</th>
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<tr>
<td>Child Gender</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Between Groups</td>
<td>4.10</td>
<td>1</td>
<td>4.10</td>
<td>18.58</td>
<td>.001*</td>
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<tr>
<td>Within Groups</td>
<td>26.90</td>
<td>122</td>
<td>0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30.99</td>
<td>123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>108.00</td>
<td>1</td>
<td>108.00</td>
<td>45.47</td>
<td>.001*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>289.80</td>
<td>122</td>
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<tr>
<td>Total</td>
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<td>123</td>
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<td></td>
</tr>
<tr>
<td>Parent Relationship</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Between Groups</td>
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<td>0.00</td>
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</tr>
<tr>
<td>Within Groups</td>
<td>13.17</td>
<td>121</td>
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<tr>
<td>Total</td>
<td>13.17</td>
<td>122</td>
<td></td>
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<tr>
<td>Parent Age</td>
<td></td>
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<tr>
<td>Between Groups</td>
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<td>1036.47</td>
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<td>Total</td>
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<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.98</td>
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<tr>
<td>Within Groups</td>
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<td>122</td>
<td>0.15</td>
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<tr>
<td>Total</td>
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<td>123</td>
<td></td>
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<tr>
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<td>0.05</td>
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<td>0.50</td>
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<td>Within Groups</td>
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<td>121</td>
<td>0.11</td>
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<tr>
<td>Total</td>
<td>13.17</td>
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<td></td>
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<tr>
<td>Parent Education</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Between Groups</td>
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<td>0.14</td>
<td>0.24</td>
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<td>122</td>
<td>0.59</td>
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<td>0.04</td>
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<td>0.04</td>
<td>0.43</td>
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<tr>
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<td>122</td>
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<td></td>
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<tr>
<td></td>
<td>10.84</td>
<td>123</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Data Analysis

A series of MANCOVAs were conducted, with all the outcome variables of interest entered simultaneously. There were 11 variables: six dimensions from the CSHQ (bedtime resistance, sleep onset delay, sleep duration, sleep disordered breathing, daytime sleepiness, and the CSHQ total sleep score), three dimensions from the BRQ (consistency, adaptive activities, and maladaptive activities), the children’s bedtime, and the amount of sleep.

The predictor variables of interest were: ADHD status, child gender, age, and ethnicity, and parent relationship to child (mother or father), age, ethnicity, and education. Because of small sample sizes for some of the variables, some categories were recoded by category:

- Parent and child ethnicity were recoded into two categories: Caucasian and non-Caucasian.
- Parent level of education was recoded into three categories: up to two years of college, four years of college, and post-graduate degree.
- Parent’s marital status was recoded into two categories: married and non-married.

A two-step approach was followed to test the study’s hypotheses. First, an ANOVA test was conducted to determine the significant differences in the demographic data between the two groups. Demographic data that were statistically significantly different in the two groups were included as covariates in the analyses that test the hypotheses.

In the second step, a MANCOVA was conducted using ADHD as the independent group and the significant demographic variables in the first step ANOVA as the covariates. Insignificant demographic variables were not included in this MANCOVA. The MANCOVA determined the impact of each of the independent variables and covariates on the 11 dependent
variables. The MANCOVA also controlled the impact of the covariates in determining the relationship between the dependent variable and independent variable, and removed the effect of one or more covariates. A significant impact meant that the dependent variables differed in the ADHD and non-ADHD group while controlling the impact of child and parent demographic data.

The MANCOVAs were conducted on a sample size of 124 individuals. However, the MANCOVA model detected missing data in some of the 124 participants and excluded the missing data in the model. For example, the MANCOVA to determine differences in children’s sleep problems analyzed 117 data points; while for research question number two, 119 data points were used to determine differences in children’s bedtime routines. The total number was not uniform, since the statistical software excluded missing values that should not be included in the model. Also, the full sample of the ANOVA for each demographic sample differed because some data were incomplete. A 0.05 level of significance was used in the analysis.

Table 3 summarized the ANOVA results for the first step as described above. As can be seen from this table, three demographic variables were significantly different for the ADHD and non-ADHD children. These were child gender \( F(1) = 18.58, p < .001 \), child age \( F(1) = 45.47, p < .001 \), and parent age \( F(1) = 32.21, p < .001 \). The ADHD group included significantly more boys, and children and parents that were significantly older compared to the non-ADHD group. The other demographic variables did not show significant differences. Therefore, child gender and age, and parent age were considered as covariates in the MANCOVA analysis involving the 11 dependent variables.

Based on the ANOVA results, a MANCOVA was conducted to test for possible differences in sleeping problems, bedtime routines, and sleeping hours between the ADHD group
and non-ADHD group, while also considering the impact of the significant demographic variables. The objective of the MANCOVA was to determine whether there were any differences between independent groups on the 11 continuous dependent variables, while controlling the impact of the demographic information of child gender and age, and parent age. In the MANCOVA, predictor variables were ADHD status, child gender, child age, and parent age.

Analysis for Research Question One: Sleep problems

The MANCOVA was used to determine if there were any significant differences between the ADHD and non-ADHD groups regarding children’s sleep problems as measured by the CSHQ total sleep score and five subscales in the areas of 1) bedtime resistance, 2) sleep onset delay, 3) sleep duration, 4) sleep disordered breathing, and 5) daytime sleepiness.

First, the test assumption of homogeneity of covariance, one of the assumptions of MANCOVA, was conducted. It was tested through the Box’s test of equality of covariance matrices. The results showed that the assumption of homogeneity of covariance was violated because the p-value (Box’s M = 102.65, $F(21, 39265.71) = 4.61, p < .001$) was less than the level of significance of 0.05. However, the MANCOVA is robust to violations of the assumption of homogeneity of variances provided the ratio of the largest group variance (the non-ADHD group) is not more than three times the smallest group variance (the ADHD group) (Ito, 1980).

The ratio of the variances of the CSHQ scales of the ADHD and non-ADHD children are summarized in Table 4. The sleep duration subscale, and the CSHQ total have a variance ratio of 3.83, and 3.02, respectively and as a result, the Mann-Whitney U test, a non-parametric test will be conducted instead of the MANCOVA. The rest of the CSHQ subscales have variance ratios less than three between the two groups, so the MANCOVA can be conducted on the CSHQ.
subscals of bedtime resistance, sleep onset delay, sleep disordered breathing, and daytime sleepiness.

Table 4
*Variance Ratio of CSHQ Scales between ADHD and non-ADHD Groups*

<table>
<thead>
<tr>
<th>Subscale</th>
<th>ADHD Group</th>
<th>Variance</th>
<th>Ratio</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bedtime Resistance</strong></td>
<td>ADHD</td>
<td>0.28</td>
<td>2.01</td>
<td>0.53</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Non-ADHD</td>
<td>0.14</td>
<td>0.37</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.21</td>
<td>0.46</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td><strong>Sleep Onset Delay</strong></td>
<td>ADHD</td>
<td>0.81</td>
<td>2.83</td>
<td>0.90</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Non-ADHD</td>
<td>0.29</td>
<td>0.54</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.63</td>
<td>0.79</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td><strong>Sleep Duration</strong></td>
<td>ADHD</td>
<td>0.38</td>
<td>3.82</td>
<td>0.62</td>
<td>49</td>
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<tr>
<td></td>
<td>Non-ADHD</td>
<td>0.10</td>
<td>0.32</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.26</td>
<td>0.51</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td><strong>Sleep Disordered Breathing</strong></td>
<td>ADHD</td>
<td>0.04</td>
<td>0.62</td>
<td>0.21</td>
<td>49</td>
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<tr>
<td></td>
<td>Non-ADHD</td>
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<td>68</td>
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<tr>
<td></td>
<td>Total</td>
<td>0.06</td>
<td>0.24</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td><strong>Daytime Sleepiness</strong></td>
<td>ADHD</td>
<td>0.24</td>
<td>1.85</td>
<td>0.49</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Non-ADHD</td>
<td>0.13</td>
<td>0.36</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.21</td>
<td>0.46</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td><strong>CSHQ Total</strong></td>
<td>ADHD</td>
<td>0.08</td>
<td>3.02</td>
<td>0.27</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Non-ADHD</td>
<td>0.02</td>
<td>0.16</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.06</td>
<td>0.24</td>
<td>117</td>
<td></td>
</tr>
</tbody>
</table>
Table 5 presented the multivariate test involving the independent variable and statistically significant covariates for the MANCOVA for research question one. The multivariate analysis showed that there was a significant overall difference of the dependent variables in the ADHD status of the children (Wilks’ Lambda = .80, $F(6, 107) = 4.40$, $p < .001$). The result suggested that even after adjusting for child gender and age, and parent age, the responses regarding children’s sleep problems were statistically significantly associated with the ADHD status of the children.

Table 5

*MANCOVA Results on ADHD and Selected Demographic Variables*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Wilks’ Lambda Value</th>
<th>F</th>
<th>df</th>
<th>df</th>
<th>$p$</th>
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</thead>
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<td>Intercept</td>
<td>0.58</td>
<td>12.92</td>
<td>6</td>
<td>107</td>
<td>0</td>
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<td>Child Gender</td>
<td>0.97</td>
<td>.62</td>
<td>6</td>
<td>107</td>
<td>0.71</td>
</tr>
<tr>
<td>Child Age</td>
<td>0.92</td>
<td>1.65</td>
<td>6</td>
<td>107</td>
<td>0.14</td>
</tr>
<tr>
<td>Parent Age</td>
<td>0.96</td>
<td>.77</td>
<td>6</td>
<td>107</td>
<td>0.59</td>
</tr>
<tr>
<td>ADHD Status</td>
<td>0.80</td>
<td>4.40</td>
<td>6</td>
<td>107</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table 6 presents the mean and standard deviation of the CSHQ distinguished by ADHD status. The scoring represents the parental report of the observed frequency of the problem using a three-point Likert scale. Parents were asked about their child’s past week or past week of typical sleep and answer with: Usually (3) if something occurs five to seven times a week, Sometimes (2) if it occurs two to four times a week, and Rarely (1) if it occurs none to one time a week. Higher scale scores in the CSHQ indicate more sleep related problems.
### Table 6

**CSHQ Scores by ADHD and Non-ADHD Groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADHD</th>
<th>Non-ADHD</th>
<th>ADHD</th>
<th>Non-ADHD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td><strong>CSHQ Instrument</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime Resistance</td>
<td>1.44</td>
<td>.53</td>
<td>1.21</td>
<td>.36</td>
</tr>
<tr>
<td>Sleep Onset Delay</td>
<td>1.96</td>
<td>.90</td>
<td>1.25</td>
<td>.52</td>
</tr>
<tr>
<td>Sleep Duration</td>
<td>1.56</td>
<td>.62</td>
<td>1.15</td>
<td>.31</td>
</tr>
<tr>
<td>Sleep Disordered Breathing</td>
<td>1.08</td>
<td>.21</td>
<td>1.10</td>
<td>.26</td>
</tr>
<tr>
<td>Daytime Sleepiness</td>
<td>1.49</td>
<td>.53</td>
<td>1.12</td>
<td>.38</td>
</tr>
<tr>
<td>CSHQ Total</td>
<td>1.40</td>
<td>.34</td>
<td>1.17</td>
<td>.18</td>
</tr>
</tbody>
</table>

As evidenced by Table 6, children with ADHD had higher average scores in the CSHQ total score, and all CSHQ scales, except for the sleep disordered breathing subscale. A test of between-subjects effects was conducted to determine how each of the four CSHQ scales for children’s sleep problems of bedtime resistance, sleep onset delay, sleep disordered breathing, and daytime sleepiness were differentiated by the independent variable of ADHD status and the covariates. The test results are presented in Table 7. As can be seen from this table, ADHD status has a statistically significant association with sleep onset delay ($F(1, 112) = 12.92; p < .001$), and daytime sleepiness ($F(1, 112) = 7.26; p = .01$). The results of the MANCOVA found that sleep onset delay and daytime sleepiness were statistically significantly worse in the ADHD group compared to the non-ADHD group.
The Mann-Whitney U test was conducted to determine how the CSHQ total, and sleep duration subscale were differentiated by the independent variable of ADHD status. The test results are presented in Table 8. ADHD status has a statistically significant association with both sleep duration ($Z = -3.72; p < 0.001$) and CSHQ total ($Z = -5.21; p < 0.001$), supporting the hypotheses these variables were significantly worse in the ADHD group compared to the non-ADHD group.

Table 7

*MANCOVA Tests of Between-Subjects Effects for Differences in Children’s Sleeping Problems*

<table>
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<tr>
<th>Source</th>
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<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Gender</td>
<td>Bedtime Resistance</td>
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<td>0.1</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Sleep Onset Delay</td>
<td>0.7</td>
<td>1</td>
<td>0.7</td>
<td>1.37</td>
<td>0.24</td>
</tr>
<tr>
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<td>0</td>
<td>1</td>
<td>0.08</td>
<td>0.08</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>Daytime Sleepiness</td>
<td>0.01</td>
<td>1</td>
<td>0.01</td>
<td>0.07</td>
<td>0.8</td>
</tr>
<tr>
<td>Child Age</td>
<td>Bedtime Resistance</td>
<td>0</td>
<td>1</td>
<td>0.01</td>
<td>0.01</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>Sleep Onset Delay</td>
<td>0</td>
<td>1</td>
<td>0.01</td>
<td>0.01</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Sleep Disordered Breathing</td>
<td>0.08</td>
<td>1</td>
<td>0.08</td>
<td>1.39</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>Daytime Sleepiness</td>
<td>0.31</td>
<td>1</td>
<td>0.31</td>
<td>1.77</td>
<td>0.19</td>
</tr>
<tr>
<td>Parent Age</td>
<td>Bedtime Resistance</td>
<td>0.08</td>
<td>1</td>
<td>0.08</td>
<td>0.4</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>Sleep Onset Delay</td>
<td>0.18</td>
<td>1</td>
<td>0.18</td>
<td>0.36</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>Sleep Disordered Breathing</td>
<td>0.07</td>
<td>1</td>
<td>0.07</td>
<td>1.25</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Daytime Sleepiness</td>
<td>0.11</td>
<td>1</td>
<td>0.11</td>
<td>0.64</td>
<td>0.42</td>
</tr>
<tr>
<td>ADHD</td>
<td>Bedtime Resistance</td>
<td>0.47</td>
<td>1</td>
<td>0.47</td>
<td>2.33</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Sleep Onset Delay</td>
<td>6.59</td>
<td>1</td>
<td>6.59</td>
<td>12.92</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>Sleep Disordered Breathing</td>
<td>0.02</td>
<td>1</td>
<td>0.02</td>
<td>0.33</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>Daytime Sleepiness</td>
<td>1.27</td>
<td>1</td>
<td>1.27</td>
<td>7.26</td>
<td>0.01*</td>
</tr>
</tbody>
</table>
Table 7 (continued)

**MANCOVA Tests of Between-Subjects Effects for Differences in Children’s Sleeping Problems**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Type III</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime Resistance</td>
<td></td>
<td>22.56</td>
<td>112</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Sleep Onset Delay</td>
<td></td>
<td>57.12</td>
<td>112</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Sleep Disordered Breathing</td>
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<td>6.63</td>
<td>112</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
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<td>19.53</td>
<td>112</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime Resistance</td>
<td></td>
<td>227.24</td>
<td>117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Onset Delay</td>
<td></td>
<td>359</td>
<td>117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Disordered Breathing</td>
<td></td>
<td>147.67</td>
<td>117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime Sleepiness</td>
<td></td>
<td>225.05</td>
<td>117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime Resistance</td>
<td></td>
<td>24.19</td>
<td>116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Onset Delay</td>
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<td>72.77</td>
<td>116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Disordered Breathing</td>
<td></td>
<td>6.9</td>
<td>116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime Sleepiness</td>
<td></td>
<td>24.26</td>
<td>116</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8

**Mann-Whitney U Test Statistic for the Association between ADHD Status and the CSHQ Subscales of Sleep**

<table>
<thead>
<tr>
<th></th>
<th>Sleep Duration</th>
<th>CSHQ Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td>789</td>
<td>509</td>
</tr>
<tr>
<td>Z</td>
<td>-3.72</td>
<td>-5.21</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

a. Grouping Variable: ADHD
Based on these results, it is now possible to address the first hypothesis. Hypothesis (1): Parents of children with ADHD will rate their children statistically significantly higher on the CSHQ subscales than parents of children without ADHD. Higher scores are indicative of more sleep related problems.

After controlling for child age and gender, and parent age in the MANCOVA, ADHD status had a statistically significant relationship to sleep problems in the areas of sleep onset delay ($F(1, 112) = 12.92; p < .001$) and daytime sleepiness ($F(1, 112) = 7.26; p = .01$). The Mann-Whitney U test was also conducted and ADHD status had a statistically significant relationship to both sleep duration ($Z = -3.72; p < .001$) and CSHQ total ($Z = -5.21; p < .001$). Children with ADHD had significantly more sleep related problems in the areas of sleep onset delay, daytime sleepiness, sleep duration, and the total CSHQ sleep score than children without ADHD.

**Analysis for Research Question Two: Bedtime routine**

A second MANCOVA was conducted to determine potential bedtime routine differences between the two groups on the three BRQ scales, while controlling for differences in child age and gender, and parent age. The test for the homogeneity of covariance of the MANCOVA indicated that the variances of the two groups were significantly different (Box’s $M = 29.59, F(6, 76556.66) = 4.79, p < .001$). However, the ratios of the differences on the three subscales were less than three-to-one indicating that the MANCOVA was robust to violations of the assumption of homogeneity of variances, and therefore, can still be conducted. The variance ratios of the BRQ scales for both groups are summarized in Table 9.
Table 9

Variance Ratio of BRQ Scales between ADHD and non-ADHD Groups

<table>
<thead>
<tr>
<th></th>
<th>ADHD Group</th>
<th>Variance</th>
<th>Ratio</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency</td>
<td>ADHD</td>
<td>0.52</td>
<td>1.41</td>
<td>0.72</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>non-ADHD</td>
<td>0.37</td>
<td></td>
<td>0.61</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.51</td>
<td></td>
<td>0.72</td>
<td>119</td>
</tr>
<tr>
<td>Adaptive Activities</td>
<td>ADHD</td>
<td>0.31</td>
<td>2.69</td>
<td>0.55</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>non-ADHD</td>
<td>0.11</td>
<td></td>
<td>0.34</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.24</td>
<td></td>
<td>0.49</td>
<td>119</td>
</tr>
<tr>
<td>Maladaptive Activities</td>
<td>ADHD</td>
<td>0.58</td>
<td>0.95</td>
<td>0.76</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>non-ADHD</td>
<td>0.62</td>
<td></td>
<td>0.78</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0.60</td>
<td></td>
<td>0.77</td>
<td>119</td>
</tr>
</tbody>
</table>

Table 10 presents the multivariate test involving the independent variable and significant covariates for research question two. The multivariate analysis showed that there were significant overall differences in bedtime routine depending on child age (Wilks’ Lambda = .85, $F(3, 112) = 6.77, p < .001$) and ADHD status (Wilks’ Lambda = .93, $F(3, 112) = 2.91, p = .04$).

Table 10

MANCOVA Results on ADHD and Selected Demographic Variables

<table>
<thead>
<tr>
<th>Effect</th>
<th>Wilks' Lambda Value</th>
<th>Hypothesis</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.28</td>
<td>94.37</td>
<td>3</td>
</tr>
<tr>
<td>Child Gender</td>
<td>0.95</td>
<td>1.86</td>
<td>3</td>
</tr>
<tr>
<td>Child Age</td>
<td>0.85</td>
<td>6.77</td>
<td>3</td>
</tr>
<tr>
<td>Parent Age</td>
<td>0.99</td>
<td>.40</td>
<td>3</td>
</tr>
<tr>
<td>ADHD</td>
<td>0.93</td>
<td>2.91</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 11 presents the mean and standard deviation of three BRQ scales distinguished by ADHD status. These scales measure distinct aspects of bedtime routine including: consistency, adaptive activities, and maladaptive activities. Parents rated how often their child engaged in each aspect of a bedtime routine in the past month using a five point Likert scale: 1-Almost never, 2-Occasionally, 3-Half the time, 4-Often, and 5-Nearly always. Higher scores in the consistency and adaptive activities scales of the BRQ indicate a more positive bedtime routine (i.e., implementing a consistent routine, and using calming activities before bedtime); whereas a higher score for the maladaptive activities scale indicates a less useful bedtime routine (indicating the use of more stimulating activities before bedtime).

Table 11

<table>
<thead>
<tr>
<th>BRQ Scores by ADHD and non-ADHD groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Consistency</td>
</tr>
<tr>
<td>Adaptive Activities</td>
</tr>
<tr>
<td>Maladaptive Activities</td>
</tr>
</tbody>
</table>

As indicated from the mean comparison in Table 11, children with ADHD had a more problematic bedtime routine as measured by lower average scores in the consistency scale and adaptive activities, and higher average scores in maladaptive activities. To determine how each of the three BRQ scales differed by ADHD status, after controlling the impact of the covariates,
The test of between-subjects effects was conducted on each BRQ scale. The test results are presented in Table 12. ADHD status has a statistically significant relationship to the adaptive activities of the children’s bedtime routine \( F(1, 114) = 6.10; p < .02 \). Therefore, the MANCOVA confirmed that the difference in the adaptive activities scale was statistically significantly worse in the ADHD group compared to the non-ADHD group. In contrast, the variables of consistency and maladaptive activities were not significantly different between groups.

There were three other significant results that were not predicted. The confounding impacts of the covariates were controlled. For both ADHD and non-ADHD groups, child gender has a significant relationship to the maladaptive activities of the children’s bedtime routine \( F(1, 114) = 4.79; p = .03 \); with boys having more difficulty than girls. Also, for both groups, child age has a statistically significant relationship with the consistency \( F(1, 114) = 8.67; p < .001 \), and adaptive activities of the children’s bedtime routine \( F(1, 114) = 15.86; p < .001 \), with older children demonstrating less consistency and fewer adaptive activities before bedtime compared to younger children.
Table 12

**MANCOVA Tests of Between-Subjects Effects for Differences in Children’s Bedtime Routine**

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>Consistency</td>
<td>14.04</td>
<td>4</td>
<td>3.51</td>
<td>8.63</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
<td>8.50</td>
<td>4</td>
<td>2.12</td>
<td>12.23</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Maladaptive Activities</td>
<td>3.83</td>
<td>4</td>
<td>0.96</td>
<td>1.63</td>
<td>0.17</td>
</tr>
<tr>
<td>Intercept</td>
<td>Consistency</td>
<td>32.74</td>
<td>1</td>
<td>32.74</td>
<td>80.51</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
<td>33.41</td>
<td>1</td>
<td>33.41</td>
<td>192.43</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
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<td>15.48</td>
<td>26.33</td>
<td>0.001</td>
</tr>
<tr>
<td>Child Gender</td>
<td>Consistency</td>
<td>0.49</td>
<td>1</td>
<td>0.49</td>
<td>1.20</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
<td>0.11</td>
<td>1</td>
<td>0.11</td>
<td>0.62</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
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<td>1</td>
<td>2.82</td>
<td>4.79</td>
<td>0.03*</td>
</tr>
<tr>
<td>Child Age</td>
<td>Consistency</td>
<td>3.53</td>
<td>1</td>
<td>3.53</td>
<td>8.67</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
<td>2.75</td>
<td>1</td>
<td>2.75</td>
<td>15.86</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>Maladaptive Activities</td>
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<td>1</td>
<td>0.64</td>
<td>1.09</td>
<td>0.30</td>
</tr>
<tr>
<td>Parent Age</td>
<td>Consistency</td>
<td>0.01</td>
<td>1</td>
<td>0.01</td>
<td>0.03</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
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<td>1</td>
<td>0.13</td>
<td>0.75</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Maladaptive Activities</td>
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<td>0.37</td>
<td>0.63</td>
<td>0.43</td>
</tr>
<tr>
<td>ADHD</td>
<td>Consistency</td>
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<td>1</td>
<td>1.56</td>
<td>3.84</td>
<td>0.052</td>
</tr>
<tr>
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<td>1.06</td>
<td>1</td>
<td>1.06</td>
<td>6.10</td>
<td>0.02*</td>
</tr>
<tr>
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<td>0.06</td>
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<td>0.75</td>
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</table>
Table 12 (continued)

**MANCOVA Tests of Between-Subjects Effects for Difference in Children’s Bedtime Routine**

<table>
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<th>Source</th>
<th>Dependent Variable</th>
<th>Type III Sum of Squares</th>
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<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
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<td>114</td>
<td>0.41</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
<td>19.79</td>
<td>114</td>
<td>0.17</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Maladaptive Activities</td>
<td>67.01</td>
<td>114</td>
<td>0.59</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
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<td>119</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
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<td>119</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maladaptive Activities</td>
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<td>119</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
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<td>60.39</td>
<td>118</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adaptive Activities</td>
<td>28.29</td>
<td>118</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maladaptive Activities</td>
<td>70.83</td>
<td>118</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on these results, it is now possible to address the second hypothesis.

Hypothesis (2.): Children with ADHD will score worse in their bedtime routine scores compared to children without ADHD. Lower scores are indicative of a more problematic bedtime routine for the consistency and adaptive activities scale of the BRQ, while higher scores for maladaptive activities would indicate a more problematic bedtime routine.

The results of the MANCOVA showed that the ADHD group had a significantly worse bedtime routine in the area of adaptive activities. The score for adaptive activities was statistically significantly lower in the ADHD group ($F(1, 114) = 6.10; p = .02$) indicating that ADHD children used fewer positive bedtime routines compared to children without ADHD. The confounding impacts of the covariates were controlled in the MANCOVA results. Therefore, despite demographic differences, it can be said that children with ADHD engaged in fewer
adaptive activities before bedtime. Children with ADHD also had lower average scores in the consistency scale of their bedtime routines at a level that approached but did not reach statistical significance, with \( p = .052 \).

Table 13 outlines the relationship between child age, gender and BRQ scores. A Pearson’s correlation test was conducted to determine the correlation between these findings. Child gender was significantly associated with the level of maladaptive activities at bedtime \( (p = .02, r = -.21) \), with boys faring worse than girls. In addition, there was a significant correlation between child age and the consistency and adaptive bedtime routines. Older children were more likely to have less consistency \( (p < .001, r = -.43) \) and use fewer adaptive activities \( (p < .001, r = -.50) \) compared to younger children.

<table>
<thead>
<tr>
<th>Table 13</th>
<th>Correlations between Child’s Age, Gender and BRQ Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adaptive</td>
</tr>
<tr>
<td></td>
<td>Consistency</td>
</tr>
<tr>
<td>Child Gender</td>
<td>Pearson Correlation</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>121</td>
</tr>
<tr>
<td>Child Age</td>
<td>Pearson Correlation</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
</tr>
<tr>
<td>N</td>
<td>122</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.05 level (2-tailed).
Analysis for Research Question Three: Bedtime and amount of sleep

A third MANCOVA was conducted to determine differences in bedtime and the amount of sleep, by ADHD status, controlling for the impact of child age and gender, and parent age. The test assumption of homogeneity of covariance for the MANCOVA was conducted. The results showed that the assumption of homogeneity of covariance was not violated since the p-value (Box’s M = 5.82, F(3, 495964.35) = 1.90, p = .13) was greater than the level of significance of 0.05. The assumption of homogeneity of covariance was satisfied.

Table 14 presents the results of multivariate analysis for child age, ADHD status, and hours of sleep indicating a significant overall difference, with younger children in both groups sleeping more hours than older children (Wilks’ Lambda = 0.79, F(2, 103) = 13.67, p < .001).

Table 14

<table>
<thead>
<tr>
<th>Effect</th>
<th>Wilks' Lambda</th>
<th>F</th>
<th>df</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.12</td>
<td>391.85</td>
<td>2</td>
<td>103</td>
<td>0.001</td>
</tr>
<tr>
<td>Child Gender</td>
<td>0.98</td>
<td>1.29</td>
<td>2</td>
<td>103</td>
<td>0.28</td>
</tr>
<tr>
<td>Child Age</td>
<td>0.79</td>
<td>13.67</td>
<td>2</td>
<td>103</td>
<td>0.001*</td>
</tr>
<tr>
<td>Parent Age</td>
<td>0.97</td>
<td>1.63</td>
<td>2</td>
<td>103</td>
<td>0.20</td>
</tr>
<tr>
<td>ADHD</td>
<td>0.95</td>
<td>2.56</td>
<td>2</td>
<td>103</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Table 15 presents statistics of the study variables of bedtime and amount of sleep measured at the interval level. The table summarizes the total data and also compares the ADHD
and non-ADHD groups. These variables compare bedtime and amount of sleep between both groups. On the study questionnaire, parent participants were asked to write in the child’s bedtime, and also the child’s usual amount of sleep each day in hours and minutes.

Table 15

**Bedtime and Amount of Sleep by ADHD status**

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADHD</th>
<th></th>
<th></th>
<th>non-ADHD</th>
<th></th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>0</td>
<td>5</td>
<td>Min</td>
<td>0</td>
<td>6.5</td>
<td>Min</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>10.5</td>
<td>11</td>
<td>Max</td>
<td>10</td>
<td>12</td>
<td>Max</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>8.88</td>
<td>9.16</td>
<td>Mean</td>
<td>8.37</td>
<td>10.24</td>
<td>Mean</td>
<td>8.57</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>0.63</td>
<td>1.07</td>
<td>Std. Deviation</td>
<td>0.53</td>
<td>0.91</td>
<td>Std. Deviation</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>48</td>
<td>45</td>
<td>N</td>
<td>71</td>
<td>68</td>
<td>N</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>10.5</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>8.57</td>
<td>9.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>0.62</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>119</td>
<td>113</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The average bedtime for all children (N=119) was 8:34 pm, with averages of 8:52 pm for the ADHD group, and 8:22 pm for the non-ADHD group. The average amount of sleep for all children (N=113) was 9 hours and 48 minutes, with averages of 9 hours and 9 minutes in the ADHD group, and 10 hours and 14 minutes in the non-ADHD group. The ADHD group on average had a later bedtime and slept fewer hours than the non-ADHD group. To determine how both the bedtime and amount of sleep differed in the independent variable of ADHD status and in the covariates, a test of between-subjects effects was conducted. The test results are presented in Table 16. Child age is statistically significantly correlated with earlier bedtimes ($F(1, 104) = 15.86; p < .001$) and greater amount of sleep ($F(1, 104) = 19.43; p < .001$); ADHD status was statistically significantly correlated to the amount of sleep ($F(1, 104) = 4.78; p = .031$). Thus, according to the MANCOVA, children with ADHD got statistically significantly less sleep than children without ADHD.

Table 16

*MANCOVA Tests of Between-Subjects Effects for Differences in Children’s Bedtime and Amount of Sleep*

| Source            | Dependent Variable | Type III Sum of
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Squares</td>
</tr>
<tr>
<td>Corrected Model</td>
<td>Bedtime</td>
<td>13.69</td>
</tr>
<tr>
<td></td>
<td>Amount Of Sleep</td>
<td>57.76</td>
</tr>
<tr>
<td>Intercept</td>
<td>Bedtime</td>
<td>67.68</td>
</tr>
<tr>
<td></td>
<td>Amount Of Sleep</td>
<td>211.35</td>
</tr>
<tr>
<td>Child Gender</td>
<td>Bedtime</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Amount Of Sleep</td>
<td>1.01</td>
</tr>
<tr>
<td>Child Age</td>
<td>Bedtime</td>
<td>4.37</td>
</tr>
<tr>
<td></td>
<td>Amount Of Sleep</td>
<td>12.65</td>
</tr>
</tbody>
</table>
Based on these results, it is now possible to address the third hypothesis.

Hypothesis (3a.): Children with ADHD will have a later bedtime than children without ADHD as measured on the CSHQ.

Hypothesis (3b.): Children with ADHD will get fewer hours of sleep than children without ADHD as measured on the CSHQ.

The MANCOVA test did not indicate a significant association between ADHD status and bedtimes, but there was a significant relationship \( (F(1, 104) = 4.78; p = .031) \) between ADHD status and hours of sleep, controlling for child age and gender and parent age. The data, presented in Table 16, indicates that the mean amount of sleep of the ADHD group \( (M = 9.16) \) was significantly lower than in the non-ADHD group \( (M = 10.23) \). Children with ADHD slept an average of one hour and five minutes less than those without ADHD.
Analysis for Research Question Four: Significant relationships for ADHD group

The final question addressed the significant relationships found in the three hypotheses. The MANCOVA and Mann-Whitney U test determined that six out of the 11 dependent variables were significantly associated with ADHD status: sleep onset delay, daytime sleepiness, sleep duration, CSHQ total, adaptive activities of the children’s bedtime routine, and amount of sleep time. The relationship among these six dependent variables within the group of ADHD children was examined to determine whether these variables were interrelated suggesting possible clusters of sleep-related problems. Table 17 presents the Pearson’s correlation coefficients among these variables.

As a summary for the significant variables, higher scores in the CSHQ subscales (sleep onset delay, sleep duration, daytime sleepiness and CSHQ total) indicate greater sleep problems, whereas higher scores in the adaptive activities of the BRQ indicate a more positive bedtime routine. Table 17 lists the ten statistically significant correlations for the six significant variables in the ADHD group. Amount of sleep negatively correlated with sleep onset delay, sleep duration, and CSHQ total, and positively correlated with adaptive activities. Sleep onset delay positively correlated with sleep duration, and with CSHQ total. Sleep duration positively correlated with daytime sleepiness and CSHQ total, and negatively correlated with adaptive activities. Daytime sleepiness positively correlated with CSHQ total. These results suggested that children in the ADHD group with more sleep-related problems tended to get less sleep, and children in the ADHD group with more adaptive activities in their bedtime routine tended to get more sleep. The correlation results showed that in the ADHD group, children’s sleep problems, bedtime routine, and amount of sleep were interrelated.
Table 17
Correlation Coefficients among Outcome Variables of Interest

<table>
<thead>
<tr>
<th>Amount Of Sleep</th>
<th>Sleep Onset Delay</th>
<th>Sleep Duration</th>
<th>Daytime Sleepiness</th>
<th>CSHQ Total</th>
<th>Adaptive Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Of Sleep</td>
<td>Pearson Correlation</td>
<td>- .42*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Onset Delay</td>
<td>Pearson Correlation</td>
<td>- .62*</td>
<td>.50*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sleep Duration</td>
<td>Pearson Correlation</td>
<td>-.15</td>
<td>.19</td>
<td>.36*</td>
<td>1</td>
</tr>
<tr>
<td>Daytime Sleepiness</td>
<td>Pearson Correlation</td>
<td>-.32*</td>
<td>.49*</td>
<td>.56*</td>
<td>.66*</td>
</tr>
<tr>
<td>CSHQ Total</td>
<td>Pearson Correlation</td>
<td>.36*</td>
<td>-.18</td>
<td>-.36*</td>
<td>-.18</td>
</tr>
</tbody>
</table>

Sig. (2-tailed) N 49 54 54 54 54 54

Correlation

Sig. (2-tailed) N 49 54 54 54 54 54

Adaptive Activities

Sig. (2-tailed) N 49 54 54 54 54 54
Summary

As predicted in the hypotheses, children with ADHD had greater sleep problems than children without ADHD. There was a statistically significant difference between the ADHD and non-ADHD groups in six out of 11 sleep variables, even after controlling for the covariates.

Children in the ADHD group had significantly more sleep problems in the areas of sleep onset delay, daytime sleepiness, sleep duration, and the CSHQ total score compared to children in the non-ADHD group.

The ADHD group also had a poorer bedtime routine in the area of adaptive activities compared to the non-ADHD group. In addition, for both groups, consistency and adaptive activities became worse as the children’s age increased, and the bedtime behavior problem of maladaptive activities was less problematic in female children.

As expected, children with ADHD had less sleep than those without ADHD, though for all children in both categories, the amount of sleep tended to decrease with age.

Finally, the relationship between the statistically significant variables within the ADHD group showed that children in the ADHD group with more sleep problems tended to get less sleep. Children who used more adaptive activities as part of their bedtime routine tended to get more sleep. These results showed that for children in the ADHD group, their sleep problems, bedtime routine, and amount of sleep were interrelated.
Discussion

The objective of this research study was to investigate whether children with ADHD differ in regard to sleep problems, bedtime routine, and number of sleep hours compared to children without ADHD. And, if there were statistically significant differences, to further understand the relationship between the significant variables.

In general, the results supported the hypotheses that children in the ADHD group were rated as having significantly more sleep difficulties, and that the significant variables were interrelated. In review, sleep onset delay, daytime sleepiness, sleep duration, the CSHQ total score, adaptive activities, and amount of sleep were all statistically significantly worse in the ADHD group compared to the non-ADHD group, even after controlling for the covariates. Children with ADHD who had more sleep problems tended to get less sleep, and had more daytime sleepiness. Children who used more adaptive activities as part of their bedtime routine tended to get more sleep.

There were no significant differences in bedtime resistance, sleep disordered breathing, consistency or maladaptive activities, and bedtime hour between the two groups.

For both ADHD and non-ADHD groups in this study, consistency and adaptive activities were more problematic for older children, and the bedtime behavior problem of maladaptive activities was less problematic in female children. Children with ADHD slept a reported average of one hour and five minutes less than children without ADHD.

The results of this study support the concept that for many children with ADHD, the disorder is linked to sleep problems. While the direction of causality is not clear, it is certainly
plausible that less overall sleep may account in part for the difficulty these children have, especially in focusing in a consistent, sustained manner.

Similar to the current study’s results, previous researchers have identified significant sleep problems which corresponds with daytime sleepiness in children with ADHD (van der Heidjen et al., 2005). However, there have also been data that have not supported these findings. One explanation for the conflicting results is that lack of sleep for some children may manifest in hyperactivity, rather than with typical sleepy behavior (Carskadon, 1980; Carskadon & Dement, 1987, Chervin et al., 2002). Whether these children exhibit sleepiness, hyperactivity, or inattention, a sleep deficit apparently doesn’t bode well for sustained attention, learning and self-control.

The relationship between children with ADHD and daytime sleepiness is multifactorial. Insufficient amount of sleep is one explanation for daytime sleepiness (Gruber et al., 2000). This is typically due to a short sleep duration, interrupted sleep, or other physiological factors that would be measured in a sleep study. Yet, other studies report that children with ADHD still have daytime sleepiness, even when they receive similar amounts of sleep as controls. This may be due to dysregulation of arousal or disorder of vigilance, and some ADHD children may have hypo, not hyperarousal, and therefore behave hyperactively in order to combat their daytime sleepiness. Also, instability of sleep patterns may be present and attribute to a problem of arousal for some children with ADHD. This may explain why many ADHD children respond well to psychostimulants, as it may help with their daytime sleepiness (Golan et al., 2004). Therefore, although nocturnal sleep may be similar, children with ADHD may still be sleepier during the day compared to non-ADHD children.
The Relationship of Sleep to ADHD Among Elementary School Aged Children

This study found significant correlations between sleep duration and daytime sleepiness, but not between daytime sleepiness and sleep onset delay. This emphasizes the complexity of the sleep process and the difficulty in pinpointing how abnormalities in sleep duration/quality manifest as behavioral abnormalities, as with ADHD.

One of the more interesting results was the lack of correlation between children with ADHD and sleep disordered breathing. There have been other studies which similarly found no relationship, whereas several others did find an association. One possible reason for the lack of a relationship between these two variables in the current study and some other studies is that the measures were not sufficiently sensitive to detect a sleep disorder. Sleep disordered breathing is typically diagnosed by an objective sleep study (i.e. a polysomnogram), whereas this study utilized a questionnaire. It is also possible that the sample in this study did not include children with sleep disordered breathing, but another explanation is that the children in the study were never formally evaluated for sleep disordered breathing and, therefore, its presence was underappreciated. Finally, there may be another reason: a sleep deficit itself is associated with inattentive and hyperactive behavior. For example, other studies have documented correlations between children with sleep disordered breathing and hyperactive, inattentive behavior, and other problems including aggression, poor social capabilities and communication, and less proficient adaptive skills (Perfect, Archbold, Goodwin, Levine-Donnerstein, & Quan, 2013).

Since these are the symptoms of ADHD, it is often unclear which diagnosis best describes these behaviors. For example, Kravitz (2004) found that children with sleep apnea are more likely to have ADHD. Guilleminault et al. (1992) found that by treating sleep apnea, ADHD symptoms dissipated. Similarly, Chervin et al. (2006) found 50% of children who were diagnosed with ADHD did not meet the ADHD criteria one year after removing their adenoids and tonsils. These
findings make a compelling argument that ADHD may, in many cases, be a consequence of a sleep disorder (Golan et al., 2004).

In this study, there was also a lack of association between ADHD and bedtime resistance. This was an unexpected finding, since a relationship between the two has often been documented in the literature (Ivanenko et al., 2005). Typically significant bedtime resistance is associated with side effects from stimulants (Bartholomew & Owens, 2006), as children taking stimulant mediation in the afternoon may not feel tired at bedtime. Alternatively, children with ADHD may simply have difficulty settling down at night for sleep (Wilens et al., 1994; Hart, 2001). Comorbidity, such as anxiety or ODD also may be associated with bedtime resistance (Bartholomew & Owens, 2006; Corkum et al., 2001). Perhaps this study did not find a relationship bedtime resistance and ADHD because all children, to some degree resist going to sleep at night.

In addition to sleep disorders and bedtime resistance, this study also evaluated the influence of bedtime routine, or lack thereof, on sleep. The components of bedtime routine were divided into adaptive activities, maladaptive activities, and consistency. The ADHD group used fewer positive adaptive activities as part of a bedtime routine, but there was no difference in maladaptive activities and consistency. This is significant because the ADHD group used less of these calming behaviors and rituals before bed, and slept less than the non-ADHD group. However, it was surprising that there were no significant differences in consistency or maladaptive activities between groups. Consistency is highly recommended as part of a bedtime routine, and maladaptive behaviors, such as television watching before bedtime appear to deter sleep (National Sleep Foundation; Garrison, Liekweg & Christakis, 2011).
There are many plausible explanations for these findings. Perhaps one or more of the maladaptive activities in this study should not be considered maladaptive (e.g. having a snack or drink). Another could be the unit of measurement per question. The questionnaire asked about activities in the hour before bed. Perhaps more data are needed to determine what amount of time should constitute a bedtime routine, or activities before bedtime. For example, there may or may not be a difference between children who watch television in the hour before going to bed, and children who watch immediately before bed. Further research should study these activities, time frames, and their relationship with dim light melatonin onset (DLMO), which helps a person feel sleepy. Bright lights such as television and computer use before bedtime could therefore delay DLMO. Lastly, another explanation is that it may be that the presence of adaptive behaviors are much more important than the absence of maladaptive behaviors. This study suggests the possibility that it may be more important to add adaptive activities than it is to eliminate maladaptive ones.

The variable of consistency was not related to ADHD, but, because it approached significance, perhaps a larger sample size in this study would have resulted in statistically significant finding. Similar to this study, in the psychometric evaluation of the BRQ instrument, (Henderson & Jordan, 2009), the relationship between consistency and child behavior was not found. It appears as though there are sparse data to support the widespread recommendations advocating the use of consistency. More studies in the future should analyze the integral aspects of bedtime routines similar to those of the BRQ.

For both ADHD and non-ADHD groups in this study, consistency and adaptive activities were less frequent among older children. This may be due to decreased parental involvement in bedtime routines as children get older, or to environmental factors that impact older children at
night (i.e. homework, after school activities) that cause them to have less time for adaptive activities, and/or a less consistent schedule. Gender differences were noted, as maladaptive activities were less common in female children. As with this study, a gender gap was noted in the psychometric evaluation of the BRQ instrument, (Henderson & Jordan, 2009). This finding is not too surprising, in that boys typically engage in behaviors such as roughhousing more often than girls.

The National Sleep Foundation recommends 10-11 hours of sleep for 5-12 year olds. The non-ADHD group slept for an average of 10 hours and 14 minutes, which fell within the recommended amount, whereas the ADHD group slept for an average of 9 hours and 9 minutes, lower than recommended. Other studies have also found significant differences in amount of sleep between the ADHD group and controls, typically with less sleep for ADHD children (Owens et al., 2000; Gruber et al., 2008), though this has not always been the case (Owens, 2009; Bhargava & Sethi, 2005). Golan et al. (2004) found the ADHD group had shorter sleep latency, and a longer total sleep time.

Bedtime hour did not differ between groups, and perhaps there is no consensus given how wake times differ across families, cultures, and parts of the countries, whereas school start times vary across school districts, and furthermore, differ by country (Mindell et al., 2010; Tynjala et al., 1993). Certain countries have earlier school start times than others, and as a result children often sleep less. These early start times cause children to sleep less, which leads to daytime sleepiness, and difficulty with attention and concentration (Epstein et al., 1998).

Therefore, instead of a suggested bedtime for all children of a particular age, perhaps bedtime needs to be adjusted in response to wake times for school, so that children get the appropriate amount of sleep for their age. Although this seems obvious, it is challenging, given
the studies that demonstrate that children sleep less when school times are earlier. Furthermore, there is evidence to suggest that even if children get similar sleep, the earlier wake time itself for school is connected to daytime sleepiness (Epstein et al., 1998). Therefore, school districts might want to consider adjusting school start times, as studies show that when children sleep even an hour more, they are less sleepy, and perform better (Epstein et al., 1998; Sadeh et al., 2003; Lufi, Tzischinsky, & Hadar, 2011).

It was also determined in this study that in both groups, older children got significantly less sleep than younger children. This is consistent with recommended sleep times for younger and older aged children (National Sleep Foundation).

Finally, the correlational analysis for children with ADHD showed that sleep problems, bedtime routine, and number of hours of sleep were interrelated. Children with ADHD who had more sleep problems tended to get less sleep, and had more daytime sleepiness. Children who used more adaptive activities as part of their bedtime routine tended to get more sleep. This has significant implications because it demonstrates that there are clusters of sleep problems that are related to ADHD. Understanding this cluster is important because it provides an ecological view of understanding the issues related to sleep and ADHD to further assess and provide appropriate interventions.

This study contributes to the literature in valuable theoretical and practical ways. Previous studies have usually focused on one area of sleep by studying the relationship between ADHD and sleep disorders (i.e., sleep apnea, restless leg syndrome) or behavioral sleep interventions. This study adds to the literature by incorporating how sleep disorders, bedtime routine and overall amount of sleep relate to ADHD. This study helps advance theory behind why sleep and ADHD are related, and although ADHD is highly genetic, the sleep problems
highlighted in this study provide another opportunity to understand ADHD, and its course of treatment.

Ultimately, sleep and ADHD requires a multidisciplinary approach in both assessment and treatment. There are many factors that cause a child to sleep less, and they need to be discovered and effectively addressed. In a practical sense, this information may help inform parents of ADHD children of the active role they can play in helping their children get more sleep. This entails education about potential sleep problems associated with ADHD, getting screened for medical sleep problems by a sleep clinician, and/or focusing more on implementing a positive bedtime routine.

Limitations of the Current Study

Parents were the sole participants in this study. Although parents may be accurate reporters of their children’s sleep habits, difficulties with retrospective reporting exist. Van der Heidjen et al. (2005) concludes that sleep onset results differ depending on whether parents assess their child’s sleep problems retrospectively or documenting each night as it occurs. For example, the directions on the questionnaires request information on children’s sleep during the past week or month, but it is possible that parents may instead describe the most difficult, the most recent, or alternatively, the most ideal night they have had. Matricciani (2013) reviewed the literature regarding the specific wording assessing sleep duration in subjective questionnaires, and how the wording of the question impacts the answer. This variable may be difficult to answer because it would require a parent to know exactly when their children fall asleep each night, which is not likely to be the case.

Although parents are knowledgeable reporters regarding their children’s sleep, they may not know every nuance of their children’s sleep-related behavior (i.e. specific sleep onset and
night wakings). Studies such as Meltzer et al. (2013), and Owens et al., (2000), have validated child self-report sleep questionnaires, confirming children are reliable reporters of their own sleep. For children ages seven and up (Owens et al., 2000), or eight and up (Meltzer et al., 2013) child self-report questionnaires provide additional valuable information to complete subjective reports. This current study focused on children ages 5-10, therefore some children were not old enough to fill out a self-report. As a result, this approach was not pursued, since it was felt that the data should be collected in a consistent manner for all the participants.

The questionnaires used were for parents of elementary school aged children. However, the psychometric evaluation of the BRQ (Henderson & Jordan, 2009) used parents of children aged 2-8, whereas this current study was for children aged 5-10. This may have influenced the finding that, for both groups, consistency and adaptive activities were less common among older children. It is possible that parents intervene more in the lives of younger children, or there are younger siblings that also require bedtime attention, which may help explain why consistency and adaptive activities decrease as children get older. It may also be likely that older children have more after school responsibilities such as homework and activities, which take time away from a consistent and positive bedtime routine. Moreover, it is possible that the specific adaptive activities used in the questionnaire are not as relevant for older children.

The instrument used in this study involved four paper and pencil questionnaires. An objective measure (e.g., polysomnogram, actigraphy) in addition to the parent reported subjective measures might have yielded additional useful information. There were limitations of data collection in that every question was not filled in completely on every questionnaire, and it is difficult to ascertain why this occurred. Interviewing the participants might have enhanced compliance; and although still confidential, it would no longer be anonymous, which would
introduce a different kind of bias, as many parents might not feel comfortable answering honestly.

Although the intent was to study the relationship between ADHD and sleep, the ADHD sample included children with ADHD only, and children with ADHD and other disorders. Comorbidity occurs among most children with ADHD (Bartholomew & Owens, 2006). It is also important to be cognizant that these comorbid disorders can influence sleep problems as well. For example, both anxiety and ODD are associated with sleep problems, and could have affected sleep onset delay, and sleep duration as well. Future research should consider these factors.

Other limiting factors were age and gender, because the two groups were dissimilar in those variables. A comparison group that more accurately matched age groups and gender would have been preferable. This study attempted to control these confounding factors, but it is possible that there might be factors associated with gender and age that this study did not control.

The majority of data reported from both groups were from married participants, and this high percentage is not representative of the general population (CDC, 2010; Pew, 2011). If more single parents were represented, there would be a lower adult-to-child ratio, which may be challenging for parents when they put their children to sleep, which in turn could affect bedtime routines.

Another limitation was that the ADHD group included all three subtypes, inattentive, hyperactive and combined, and there are data to suggest that each subtype may be associated with different sleep disorders (Chervin et al., 2002; Lecendreux et al., 2000). Having more participants represent each age group, and a greater sample size for each subtype of ADHD might give more specific information regarding sleep problems associated with different age groups and with different types of ADHD. Furthermore, the ADHD group comprised both
medicated and unmedicated children. Other studies have used only unmedicated children with ADHD, and the results of these studies may not generalize to medicated children. It would therefore be helpful in the future to have a larger study, which could generate even more data to stratify risk based on the various subgroups within ADHD.

Regarding generalization of data, the majority of participants were Caucasian, and the results may not generalize as well to other ethnic groups.

**Summary and Recommendations**

The diagnosis of ADHD is increasing, with an estimated prevalence of 11% in school-aged children (Schwartz & Cohen, NYT, 2013). Research on this topic that so greatly impacts children, families, schools, and society is more crucial than ever.

Insufficient sleep is often associated with symptoms similar to those of ADHD; therefore, sleep lends itself to another way of theoretically understanding this disorder. Studies regarding children’s sleep and ADHD have typically focused on a specific area of sleep by investigating either medical sleep problems (i.e., sleep apnea, restless leg syndrome) or behavioral sleep problems. The current study cast a wider net by studying multiple categories simultaneously, including medical and behavioral sleep problems, as well as the parent reported duration of sleep, and evaluating how these facets are interrelated.

The results identified six statistically significant variables out of eleven studied: sleep onset delay, sleep duration, daytime sleepiness, CSHQ total sleep score, adaptive activities, and amount of sleep. Furthermore, these variables are interrelated. Children with ADHD who had more sleep problems tended to get less sleep, and had more daytime sleepiness; children who used more adaptive activities as part of their bedtime routine tended to get more sleep.
In recent years, more studies have evaluated the relationship between ADHD and sleep problems (Cortese et al., 2009). The literature review reveals both consistent and conflicting results which highlight the factors that could be due in part to the difficulty in comparing studies (Owens, 2009) because of varying methodology, ADHD subtypes, comorbidity, medication issues, and type of sleep disorder. This study supports previous research findings, that children with ADHD have sleep problems, but adds to the literature by evaluating the interaction of medical and behavioral sleep issues in a more comprehensive manner. The relationship between sleep problems and ADHD has found support in numerous studies (Barkley, 1998; Silver, 2001; Sung et al., 2008; Weissbluth, 2005), to such an extent that it should be recommended that children with ADHD be screened for sleep problems (Mindell & Owens, 2003). Similarly, anyone with sleep problems should pay closer attention to the possibility that he/she has ADHD symptoms (Chervin et al., 2002). It is both enticing and quite plausible to find that treating sleep problems may decrease ADHD symptoms (Dahl & Puig-Antich, 1990; Owens, 2009; Walters et al., 2008).

If ADHD can be seen as both a daytime and nighttime disorder, then interventions regarding sleep would be incorporated with other ADHD best practices to form a comprehensive treatment plan. Such an approach would include education of parents about the importance of sleep, treatment of medical sleep problems, and improvement of bedtime routine. To understand that children with ADHD typically sleep less than those without ADHD is a fundamental starting point. With this in mind, focus can shift toward appropriate interventions which include both medical interventions and alterations in the bedtime routine.
Future Research

Future studies should further integrate research on sleep disorders, bedtime routine, and amount of sleep in children with ADHD and help to devise strategies for improving each of these facets. Researchers should include a multidisciplinary collaboration between clinicians specializing in ADHD, and clinicians specializing in sleep to ensure a more comprehensive theoretical understanding, and to positively affect best practices regarding ADHD and sleep.

As part of the process to help improve the quality of research in this area, the term “bedtime” should be defined more specifically in order to clearly differentiate between the two concepts of getting into bed and falling asleep. This would improve consistency of data collection both within a particular study but also when it comes to comparing data from different studies.

An exciting area of interest involves more objective assessment of sleep quality and, in particular, evaluating for sleep disorders, by expanding the use of sleep studies both in the lab and at home. Future studies should explore why certain children with ADHD have shorter sleep duration, whereas other children with ADHD have shorter sleep latency and longer sleep duration. As noted above, increasing the sample size of studies would permit analyses of the relationship between sleep and the different types of ADHD.

The next wave of research should study both nighttime and daytime interventions to understand and combat daytime sleepiness in children with ADHD. To achieve this, research efforts should expand to include teacher reports to assess daytime somnolence, alertness, behavior, and academic performance. School psychologists are positioned to coordinate efforts with teachers, students and parents to educate, assess, and form a comprehensive treatment plan.
The bedtime routine depends so heavily on parents; therefore, future research should also incorporate analyses of parent sleep habits. Other familial and socioeconomic factors (number of children, availability of tools such as books, beds, and pajamas) should also be considered in more detail.

Finally, evaluating the impact of medications/supplements, such as melatonin, on the sleep process in children with ADHD may offer useful insights into the pathophysiology of this disorder and, at the same time, have some potential as a therapeutic tool.
The Relationship of Sleep to ADHD Among Elementary School Aged Children

References


American Academy of Sleep Medicine, 2007 http://www.aasmnet.org


Hinshaw, S. P. (2002). Preadolescent girls with attention-deficit/hyperactivity disorder: I. Background characteristics, comorbidity, cognitive and social functioning, and parenting


Sleep Hygiene, Medical College of Wisconsin, http://www.mcw.edu/sleepmed/SleepHygiene.htm


The Relationship of Sleep to ADHD Among Elementary School Aged Children


The Relationship of Sleep to ADHD Among Elementary School Aged Children


http://www.pewsocialtrends.org/2011/12/14/barely-half-of-u-s-adults-are-married-a-record-low


Sangal R, Owens J, & Sangal J. (2005). Patients with attention-deficit/ hyperactivity disorder without observed apneic episodes in sleep or daytime sleepiness have normal sleep on polysomnography. Sleep, 28(9): 1143-1148.

The Relationship of Sleep to ADHD Among Elementary School Aged Children


This survey is about sleep habits of children. Keep in mind, there are no right or wrong answers. Thank you for your participation.

Date__________________

1. What grade is your child in? K 1 2 3 4 5
2. Is your child male or female? Male Female
3. What is your child’s age? __________
4. How many children do you have? __________
5. What number child is he or she? __________
6. Ages of all of your children? ____________________
7. What is your relationship to child? mother father other (please fill in) __________
8. What is your marital status? Single Married Divorced Widow/Widower __________________
9. Are you the primary caregiver? Yes No __________________
10. Does your child live with you full time or part time? ______________
11. Would you consider your child to be Caucasian, African American, Asian American, Latino-American, or some other racial or ethnic background? ______________
12. Would you consider yourself to be Caucasian, African American, Asian-American, Latino-American, or some other racial or ethnic background? ______________
13. What is your age? __________
14. What level of education did you complete?
   1.) 0-8th grade       2.) 9th-12th grade       3.) 1-2 years college       4.) 4 years of college
   5.) post-graduate degree
15. What is your occupation? ______________
16. What is your zip code? __________________

17. Has your child ever been diagnosed with the following: (Please circle all that apply.)

<table>
<thead>
<tr>
<th>Sleep Apnea</th>
<th>Restless Legs Syndrome</th>
<th>Nightmares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep terrors</td>
<td>Sleep Walking</td>
<td>Narcolepsy</td>
</tr>
<tr>
<td>Insomnia</td>
<td>Snoring</td>
<td>ADHD- combined type</td>
</tr>
<tr>
<td>Depression</td>
<td>Anxiety</td>
<td>ADHD- hyperactive-impulsive type</td>
</tr>
<tr>
<td>Speech Delay</td>
<td>Asthma</td>
<td>ADHD- inattentive type</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Learning Disability</td>
<td>Behavioral Problems</td>
</tr>
<tr>
<td>Fine Motor Skills Delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. Name and type (i.e. psychologist, neurologist, pediatrician etc…) of professional(s) that provided the diagnosis/diagnoses that you circled above:

Diagnosis: ___________________________ Type of Professional: ______________

Diagnosis: ___________________________ Type of Professional: ______________

Diagnosis: ___________________________ Type of Professional: ______________

19. Has your child ever received Speech Therapy, Occupational Therapy or Physical Therapy? (Please circle.) If yes, why and age of the child at the time?

__________________________________  ________________________________  ________

20. Has your child ever had his tonsils and/or adenoids removed? Yes  No

Why? ________________________________________________________________

21. Has your child ever been given any prescription or over-the-counter medications to help him/her sleep? Yes  No  If yes, please list ____________________________

22. Does he/she currently take this? Yes  No

23. Is your child taking any medication? Yes  No

24. Please list medication and dosage:

________________________________________________________________________

25. For what reason does your child take this medication:

________________________________________________________________________

26. What time(s) does your child take the medication? __________________________
December 16, 2008

Ms. Robyn Cohen
49 Oakwood Drive
Dresher, PA 19025

Dear Ms. Cohen:

This correspondence is in response to your request to use questions (whole or in part) from the National Sleep Foundation’s 2004 Sleep in America poll to collect data for your doctoral dissertation. The National Sleep Foundation grants your request with the following stipulations:

- The questions and data will not be used for commercial reproduction, but rather for the purpose of scientific research and aggregate statistical reporting.
- Any publications or presentations based on NSF data will cite and reference NSF as the source. The format for citation is “National Sleep Foundation. 2004 Sleep in America poll. Washington, DC: National Sleep Foundation; 2004.”
- NSF will have the opportunity to review any articles, books, presentations or other materials that use NSF data prior to publication, and to correct any inaccurate information.

Thank you for your interest in the National Sleep Foundation.

Sincerely,

Darrel Drobnich
Chief Program Officer

National Sleep Foundation

Wake America to the Importance of Sleep

1522 K Street, NW • Suite 500 • Washington, DC 20005 • (202) 347-3471 • Fax (202) 347-3472
The Relationship of Sleep to ADHD Among Elementary School Aged Children

**ADHD RATING SCALE-IV: HOME VERSION**

<table>
<thead>
<tr>
<th>Item</th>
<th>Never or rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>16.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>17.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>18.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

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Child’s Sleep Habits
(Preschool and School-Aged)
(Abbreviated Version)

The following statements are about your child’s sleep habits and possible difficulties with sleep. Think about the past week in your child’s life when answering the questions. If last week was unusual for a specific reason (such as your child had an ear infection and did not sleep well or the TV set was broken), choose the most recent typical week. Answer USUALLY if something occurs 5 or more times in a week; answer SOMETIMES if it occurs 2-4 times in a week; answer RARELY if something occurs never or 1 time during a week. Also, please indicate whether or not the sleep habit is a problem by circling “Yes,” “No,” or “Not applicable (N/A).”

### Bedtime

Write in child’s bedtime: ___________________

<table>
<thead>
<tr>
<th></th>
<th>3 Usually (5-7)</th>
<th>2 Sometimes (2-4)</th>
<th>1 Rarely (0-1)</th>
<th>Problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Child goes to bed at the same time at night (R)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>2) Child fails asleep within 20 minutes after going to bed (R)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>3) Child fails asleep alone in own bed (R)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>4) Child falls asleep in parent’s or sibling’s bed</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>5) Child needs parent in the room to fall asleep</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>6) Child struggles at bedtime (cries, refuses to stay in bed, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>7) Child is afraid of sleeping in the dark</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>8) Child is afraid of sleep alone</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
</tbody>
</table>

### Sleep Behavior

Child’s usual amount of sleep each day: __________ hours and __________ minutes (combining nighttime sleep and naps)

<table>
<thead>
<tr>
<th></th>
<th>3 Usually (5-7)</th>
<th>2 Sometimes (2-4)</th>
<th>1 Rarely (0-1)</th>
<th>Problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>9) Child sleeps too little</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>10) Child sleeps the right amount (R)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>11) Child sleeps about the same amount each day (R)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>12) Child wets the bed at night</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>13) Child talks during sleep</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>14) Child is restless and moves a lot during sleep</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>15) Child sleepwalks during the night</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>16) Child moves to someone else’s bed during the night (parent, brother, sister, etc.)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>17) Child grinds teeth during sleep (your dentist may have told you this)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>18) Child snores loudly</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>Yes No N/A</td>
</tr>
</tbody>
</table>

---

CSHQ Abbreviated
### Sleep Behavior (continued)

<table>
<thead>
<tr>
<th></th>
<th>3 Usually (5-7)</th>
<th>2 Sometimes (2-4)</th>
<th>1 Rarely (0-1)</th>
<th>Problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Child seems to stop breathing during sleep</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>20</td>
<td>Child snorts and/or gasps during sleep</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>21</td>
<td>Child has trouble sleeping away from home (visiting relatives, vacation)</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>22</td>
<td>Child awakens during night screaming, sweating, and inconsolable</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>23</td>
<td>Child awakens alarmed by a frightening dream</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

### Waking During the Night

<table>
<thead>
<tr>
<th></th>
<th>3 Usually (5-7)</th>
<th>2 Sometimes (2-4)</th>
<th>1 Rarely (0-1)</th>
<th>Problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Child awakes once during the night</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>25</td>
<td>Child awakes more than once during the night</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Write the number of minutes a night waking usually lasts: ____________

### Morning Waking/Daytime Sleepiness

Write in the time of day child usually wakes in the morning: ____________

<table>
<thead>
<tr>
<th></th>
<th>3 Usually (5-7)</th>
<th>2 Sometimes (2-4)</th>
<th>1 Rarely (0-1)</th>
<th>Problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Child wakes up by him/herself (R)</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>27</td>
<td>Child wakes up in negative mood</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>28</td>
<td>Adults or siblings wake up child</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>29</td>
<td>Child has difficulty getting out of bed in the morning</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>30</td>
<td>Child takes a long time to become alert in the morning</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>31</td>
<td>Child seems tired</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Child has appeared very sleepy or fallen asleep during the following (check all that apply):

<table>
<thead>
<tr>
<th></th>
<th>1 Not Sleepy</th>
<th>2 Very Sleepy</th>
<th>3 Falls Asleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>Watching TV</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>33</td>
<td>Riding in car</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
## BEDTIME ROUTINES QUESTIONNAIRE

Bedtime routines are a set sequence of events that occur regularly in the same order and with the same caretaker before a child goes to bed. For each item below, please rate how often your child engages in each aspect of a bedtime routine or the intensity of your child's reaction by circling a rating of your child's behavior in the past month. Further instructions are provided for each set of questions.

### During weeknights (Sunday through Thursday nights only) for the past month, how often did your child...

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Possible Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) perform the same activities</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>2) perform activities in the same order</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>3) sleep in the same place</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>4) go to bed at the same time</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>5) get put to bed by the same person</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
</tbody>
</table>

### During weekends (Friday and Saturday nights) for the past month, how often did your child...

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Possible Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>6) perform the same activities</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>7) perform events in the same order</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>8) sleep in the same place</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>9) go to bed at the same time</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
<tr>
<td>10) get put to bed by the same person</td>
<td>1 = Almost never, 2 = Occasionally, 3 = Half the time, 4 = Often, 5 = Nearly always</td>
</tr>
</tbody>
</table>

### How upset does your child get if he or she does NOT...

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Possible Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>11) perform the same activities</td>
<td>1 = Not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely</td>
</tr>
<tr>
<td>12) perform activities in the same order</td>
<td>1 = Not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely</td>
</tr>
<tr>
<td>13) sleep in the same place</td>
<td>1 = Not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely</td>
</tr>
<tr>
<td>14) go to bed at the same time</td>
<td>1 = Not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely</td>
</tr>
<tr>
<td>15) get put to bed by the same person</td>
<td>1 = Not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely</td>
</tr>
<tr>
<td>Question</td>
<td>How often does it occur?</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>16) ...read/listen to a story?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>17) ...play with games or toys?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>18) ...have active play (such as roughhouse or run around)?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>19) ...watch TV?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>20) ...play video games?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>21) ...listen to music?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>22) ...have a snack or drink?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>23) ...take a shower/bath?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>24) ...brush teeth?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>25) ...use the toilet?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>26) ...hug/kiss caregiver?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>27) ...say goodnight to family members?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>28) ...get tucked in?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>29) ...put on pajamas?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>30) ...say prayers?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>31) ...cuddle with caregiver?</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

In the past month, in the hour before going to bed, how often did your child...
unsigned informed consent

Northeastern University, Department of Counseling & Applied Psychology
Deborah Greenwald, Ph.D.
Robyn Cohen, M.S.
Sleep in ADHD and non ADHD Elementary School Aged Children

Request to Participate in Research
We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. By completing and handing this research study in, you will be giving your consent. The purpose of this research is to better understand the sleep habits of ADHD and non ADHD elementary school aged children.

You must be at least 18 years old to be in this research project. If you decide to take part in this study, you will be asked to fill out a questionnaire which involves filling out 4 short questionnaires. This study uses a sample of parents who have a child in K-5th grade. In order to meet the criteria to participate, your child needs to reside with you. You have to be the primary caregiver or share childcare equally.

Where will this take place and how much of my time will it take?
You will be given the questionnaire to fill out now. It will take approximately 15-20 minutes to complete. After you fill it out, you will return it to me enclosed in a sealed envelope I will provide.

Will there be any risk or discomfort to me?
There is no foreseeable risk or discomfort by participating in this study.

Will I benefit by being in this research?
There will be no direct benefit to you for taking part in the study. However, the information learned from this study may increase our understanding of children’s sleep habits. In addition, after this research is complete, this researcher will share the results with the director/group leader who will be asked to share the results with you. In addition, you can contact me directly for the results at rcohen65@comcast.net.

Your part in this study will be handled in a confidential way. We are not asking for your name on any form. Your responses will not be known. All information will be deidentified and coded for research purposes. Any reports or publications based on this research will use only group data and will not identify you, your child or any individual as being of this project.

The decision to participate in this research project is up to you. Your participation in this research is completely voluntary. Whether you participate or not, it will have no bearing on your participation in this group. You do not have to participate if you do not want to. Even if you begin the study, you may quit at any time.
You will not be paid for your participation in this study.

If you have any questions about this study, you can contact Deborah Greenwald, Ph.D. at Northeastern University at 617-373-3276. You can also contact this researcher, Robyn Cohen at 267-977-4599 or by email at recohen65@comcast.net. I will send the results of this study to your group leader who will be asked to share them with you. In addition, you may contact me directly for the results.

Who can I contact about my rights as a participant?
If you have any questions about your rights as a participant, you may contact Nan C. Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University Boston, MA 02115 tel. 617-373-7570, email: hsrp@neu.edu You may call anonymously if you wish.

Thank you.

Robyn Cohen