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Implications of Napping Into and Beyond Kindergarten on Sleep, Diet, and the Awakening Cortisol Response

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The University of Southern Mississippi

IMPLICATIONS OF NAPPING INTO AND BEYOND KINDERGARTEN ON SLEEP, DIET, AND THE AWAKENING CORTISOL RESPONSE

by

Alyssa Anne Cairns

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

August 2010
ABSTRACT

IMPLICATIONS OF NAPPING INTO AND BEYOND KINDERGARTEN ON SLEEP, DIET, AND THE AWAKENING CORTISOL RESPONSE

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This study is an examination of sleep distribution, dietary intake, and endocrine function of caregiver-reported Nap and Non-Nap Groups of children before and after they transition to an all-day kindergarten where napping is reduced or eliminated. Measures were assessed the summer prior to kindergarten, within two weeks, and after a month of the transition to kindergarten. The study revealed that the transition to kindergarten was associated with changes in sleep and dietary intake. Endocrine function remained stable as children transitioned to kindergarten. On average, Nap and Non-Nap Groups equally lost total sleep time as they transitioned to kindergarten. However, the Nap Group lost nap sleep, whereas the Non-Nap Group lost nighttime sleep. Children experienced an advance in weekday and weekend sleep periods. The sleep quality data were consistent with the notion that the transition to kindergarten was associated with an increase in sleepiness. On average, children reduced their breakfast intake as they transitioned to kindergarten. Also, changes in sleep were proportional to changes in breakfast consumption.
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by

Alyssa Anne Cairns

A Dissertation
Submitted to the Graduate School of The University of Southern Mississippi in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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INTRODUCTION

The Epidemic of Overweight and Obesity

Adult overweight and obesity, defined as a body mass index (BMI) of ≥ 25 and 30, respectively have been identified as epidemic in the United States, with prevalence estimates doubling in the past twenty years. Adult overweight and obesity is associated with several health problems such as cardiovascular disease, hyperlipidemia, hypertension, and type II diabetes (Pender & Pories, 2005). Overweight and obesity burden the healthcare system and strain economic resources. The total annual cost for overweight and obesity ranges from $70 billion to $100 billion (Wellman & Friedberg, 2002). Moreover, overweight and obesity are the most common health problems for children in our society (National Center for Health Statistics [NCHS], 2003-2004; Strauss & Pollack, 2001).

The National Health and Nutrition Examination Survey (a general population survey conducted by the Center for Disease Control in 2006) suggested that the current prevalence of childhood obesity (defined as ≥ 95th BMI percentile for age) is approximately 17%; triple that of thirty years ago (Ogden et al., 2006). Further, the survey elucidated that current prevalence estimates of obesity for young children (2 to 5 years of age) is approximately 10% (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Childhood obesity is associated with adult-like comorbidities, such as hypertension, type II diabetes, obstructive sleep apnea (OSA), and dyslipidemia (Sorof & Daniels, 2002). One possible reason for the surge in adult obesity is the increased prevalence of childhood obesity.
Research suggests that childhood obesity is a significant risk factor for the development of obesity in adolescence and adulthood (Serdula et al., 1993). For example, a six-year study following Chinese children from age 9 to 15 suggested that overweight children were 2.8 times more likely to become overweight adolescents (≥ 85th gender/age specific BMI percentile) (Wang, Ge, & Popkin, 2000). Likewise, a U.S. study following participants from birth to age 35 revealed the odds ratio (OR) for overweight 5-year-olds (≥ 85th gender/age specific BMI overweight percentile) classified as overweight at 35 (BMI > 26) to be approximately 3 times that of normal weight 5-year-olds (Guo, Roche, Chumlea, Gardner, & Siervogel, 1994).

Weight is determined by a complex interplay of genes, metabolism, behavior, environment, culture, and socioeconomic status (CDC, 2007). According to the Avon Cohort Study (a longitudinal study of 8,234 children from birth to 7 years of age) children born to two obese parents were over 10 times more likely to be obese at age 7 than those born to normal weight individuals (Reilly et al., 2005). There is considerable racial/ethnic variation in overweight and obesity in the United States. According to a meta-analytic review of obesity in the U.S over the past 30 years, prevalence of overweight (≥85th age/gender specific BMI percentile) for non-Hispanic White, non-Hispanic Black, and Mexican American children ages 6 to 19 was 28.2%, 35.4%, and 39.9%, respectively (Wang & Beydoun, 2007). Major lifestyle risk factors for childhood overweight and obesity include sedentary behavior (e.g. T.V. viewing), parental education, and habitual sleep duration. Research suggests that TV viewing ≥3 hours per day is associated with a 1.4-to 2.8-fold increase in BMI (Chaput, Brunet, & Tremblay, 2006; Reilly et al., 2005; Sekine et al., 2002). According to the Quebec en Forme Project
(a cross-sectional study of 422 Canadian children 5 to 10 years of age), children by parents with lower education were 1.7 times more likely to be overweight or obese (Chaput et al., 2006). However, of the factors in the lifestyle domain, short habitual sleep duration may be one of the most important.

Short Sleep is a Risk Factor for Obesity in Children

Both cross-sectional and longitudinal studies have found short habitual sleep duration to be an important lifestyle risk factor for childhood overweight and obesity because (1) it is present over other known risk factors and (2) it is potentially modifiable, unlike many other risk factors (Lumeng et al., 2007; Reilly et al., 2005; Sekine et al., 2002; Snell, Adam, & Duncan, 2007; Taheri, 2006; von Kries, Toschke, Wurmser, Sauerwald, & Koletzko, 2002). In the Toyama birth cohort study of 8,274 six- and seven year-old Japanese children, a dose-response relationship was found between childhood obesity and short sleeping hours. Short sleeping hours (<10 hours) and obesity (≥ BMI of 96.9 and 98.2 for males and females, respectively) (Cole, Bellizzi, Flegal, & Dietz, 2000) were determined by caregiver-reported time in bed and physician-reported height and weight. Holding constant parental obesity and several lifestyle factors, children sleeping between 9 and 10 hours, 8 and 9 hours, and < 8 hours were 1.49, 1.89, and 2.87 times more likely to be obese than children sleeping > 10 hours a night (Sekine et al., 2002).

Notable are the cohort studies providing additional information about important aspects of sleep distribution. In the Quebec en Forme Project of 422 five to ten year-old children, short weekday sleep duration was associated with obesity and overweight status. Short sleep duration (≤11.5 hours) and overweight/obesity (≥85th and ≥95 gender/age specific BMI percentile respectively) was determined by caregiver-reported time in bed
and teacher-assessed height and weight. Holding constant parental obesity and several lifestyle factors, children sleeping between 10.5 to 11.5 and 8 to 10 hours per weekday night were 1.42 and 3.45 times more likely to be overweight or obese (Chaput et al., 2006). Likewise, a cohort study of 6,862 five and six year-old Bavarian children revealed that ≥11.5 relative to ≤10 hours of weekday sleep was associated with a reduced risk of obesity (≥ 97th gender/age specific BMI percentile respectively) by about half. This relationship was present controlling for parental obesity and lifestyle factors (von Kries et al., 2002).

Longitudinal studies provide cause-related information about the role of short sleep duration in the development of overweight and obesity because they more adequately control for confounding variables, most importantly a child’s baseline weight. One study analyzed data from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development where researchers longitudinally examined 785 children in the 3rd and 6th grades (9 to 12 years of age). Total sleep duration (nap and nocturnal sleep) was obtained via caregiver report and overweight status was determined by height/weight measurements taken by research assistants (≥95th gender/age specific percentile). Independent of the child’s weight in the 3rd grade, shorter sleep duration at grade 3 was associated with overweight status at grade 6. For every additional 1 hour of sleep in the 3rd grade, the child was 40% less likely to be overweight in the 6th grade (controlling for gender, racial identity, and several lifestyle factors) (Lumeng et al., 2007). The second longitudinal study was based on the first and seconds waves of the Child Development Supplement of the Panel Survey of Income Dynamics, a representative sample of 2,281 US families with children 3 to 18 years of
age. Sleep duration was obtained via caregiver or self-report and overweight status was determined by height/weight measurements taken by interviewers (≥gender/age specific BMI overweight centile). In comparison to children sleeping 9 to 9.9 hours at time 1, children sleeping 11 hours or more were 17.1% less likely to be overweight at time 2. In other words, every additional hour of sleep time at time 1 was associated with a reduction in BMI at time 2 by .75 (holding constant gender, racial identity and several lifestyle factors) (Snell et al., 2007).

Research suggests there may be developmentally-sensitive periods for weight gain during childhood (Adair, 2008; Dietz, 1997). Body mass typically rises during infancy, declines to its lowest point around 5 to 6 years of age, and rapidly accelerates thereafter (Siervogel, Roche, Guo, Mukherjee, & Chumlea, 1991). According to Dietz (1997), the point at which BMI starts to accelerate during early childhood is termed the “adiposity rebound (AR).” Research suggests that the timing of the AR is a risk factor for development of obesity in adulthood over and above the influence of parental obesity and child’s BMI (Adair, 2008). For example, a retrospective cohort study of 390 U.S. individuals revealed that children with early (<4.8 years) AR were 2.8 times more likely to be obese in adulthood than those with an average AR (between 4.8 and 6.2 years of age) (Whitaker, Pepe, Wright, Seidel, & Dietz, 1998). This period may play a role in the development of future overweight because it corresponds with the time children typically become autonomous enough to make their own food choices (Dietz, 1997; Rolland-Cachera et al., 1987; Whitaker et al., 1998). If lifestyle factors that influence food intake are changed (i.e. sleep loss during this sensitive period), it may lead to an earlier expression of the AR (Whitaker et al., 1998).
Overweight and obesity have proven difficult to treat in adulthood. Behavioral, pharmacological, or surgical modalities are typically utilized (Daniels, 2005). Although these strategies can be effective in the short-term (Anderson, Konz, Frederich, & Wood, 2001), research suggests that individuals typically rebound to their pre-treatment weight within 5 years (Anderson, Vichitbandra, Qian, & Kryscio, 1999; Anderson, Backer, Stockholm, & Quaade, 1984; Brownell & Jeffrey, 1987). For example, a longitudinal study of 114 obese adults on a restricted calorie diet revealed that within three years, participants regained 73.4% of their lost weight. Further, only 25% maintained their post-diet weight after 7 years (Anderson et al., 1999). Therefore, preventative interventions during periods of vulnerability may be the ideal approach to addressing the problem of obesity in our society.

Sleep and Obesity May be Causally Related

It is possible that short sleep duration and/or other sleep distribution variables may be directly related to overweight and obesity and that alterations in sleep may bring about changes in the probability of or the extent of overweight and obese. That is, research may show that simple caregiver education and guidance interventions may be sufficient to bring about a change in how much children sleep, and thus buffer against adverse metabolic changes and poor diet choices. The findings reviewed in the previous section are consistent with hypotheses that sleep duration may directly contribute to weight gain including three hypotheses focused on reduced level of activity, rapid eye movement (REM) sleep, and endocrine processes. A reduced activity hypothesis holds that when sleep loss occurs, overall activity level and thus energy expenditure, is reduced. Although this hypothesis has not been systematically explored, it is plausible that reduced
activity occurs secondarily to daytime sleepiness (Taheri, 2006). A REM sleep deprivation hypothesis suggests that short sleep periods may result in REM sleep loss and that REM loss leads to increased caloric intake. This hypothesis stems from the proposed connection between REM sleep and motivated behavior (Kleitman, 1963; Vogel, 1975). REM sleep deprivation has been found to produce 34%-100% increases in food intake over baseline levels in both cats and rats (Kushida, Bergmann, & Rechtschaffen, 1989; Vogel, 1975). No studies have directly assessed the effects of long-term REM deprivation on food intake in humans. However, patients with OSA syndrome and severe REM sleep deprivation have been reported to weigh more at the time of diagnosis than OSA patients with comparable respiratory disturbance but without REM deprivation. Moreover, the REM-deprived patients in this study lost more weight during the first year of treatment than patients without REM deprivation and the weight loss was proportional to the amount of REM sleep rebound seen with treatment of the OSAS (Peszka, Harsh, & Hartwig, 1998). The REM sleep deprivation hypothesis is especially relevant to the study of the link between sleep and changes in diet in young children as early school start times (i.e. wake times) may result in curtailing the sleep period at the time when REM sleep is most likely to occur (Carskadon & Dement, 2000).

Endocrine hypotheses suggest that habitual sleep loss results in physiological changes that lead to increased caloric intake and/or changes in metabolism and future weight gain. Although the relationship between sleep loss (i.e. stress) and food intake is complicated, three principle hormones are involved: leptin, ghrelin, and cortisol (see Figure 1). It is well-documented that short-and long-term sleep deprivation changes the ratio of leptin to ghrelin (Copinschi, 2005; Spiegel, Knutson, Leproult, Tasali, & Van
Cauter, 2005; Spiegel, Tasali, Penev, & Van Cauter, 2004; Taheri, Lin, Austin, Young, & Mignot, 2004). Ghrelin is a gut-derived hormone that increases hunger (Spiegel et al., 2004) and food intake (Tolle et al., 2002; Wren et al., 2001), whereas leptin is a hormone secreted by adipocytes (fat cells) and decreases hunger (Spiegel et al., 2004) and food intake (Licinio et al., 2004). Intravenous (IV) administration of ghrelin has been found to increase hunger ratings in fasted individuals by 32% in comparison to controls (Wren et al., 2001). Moreover, IV administration of ghrelin in both fasted humans and sated rats has been found to increase food intake by 28% (Wren et al., 2001) and 140% (Wren et al., 2000), respectively. Individuals born with leptin deficiency (a genetic mutation in the leptin gene) tend to have an elevated appetite and BMI. Leptin replacement therapy has shown to decrease food intake (calories) by 49% over a two-week period (Licinio et al., 2004).

Short- and long-term sleep loss also increases circulating cortisol. For example, in a sample of 33 adult males, participants exposed to partial sleep deprivation (4 hours in bed) and total sleep deprivation had a 37% and 45% higher basal cortisol production (i.e. averaged over the next day) in comparison to those not sleep-deprived (Leproult, Copinschi, Buxton, & Van Cauter, 1997). The relationship between sleep and cortisol has also been observed in children. For example, in a study of 91 healthy Brazilian children ages 45 days to 36 months, shorter sleep duration was associated with elevated morning cortisol values (Silva, Mallozi, & Ferrari, 2007). Studies have shown a relationship between sleep loss, elevated cortisol, and hunger (Epel, Lapidus, McEwen, & Brownell, 2001; Gluck, Geliebter, Hung, & Yahav, 2004); however, this pathway is less understood. In relation to sleep deprivation, cortisol may be most important in the
formation of glucose intolerance, insulin resistance, and subsequent obesity (Copinschi, 2005; Khani & Tayek, 2001).

Metabolically, cortisol functions to elevate blood glucose levels (via gluconeogenesis) and mobilize fatty acids to increase energy available to the organism when stressed (Gunnar, 1989; Guyton & Hall, 1996). If energy is not used, glucose and fatty acids get stored in adipose tissue for future use. This is an adaptive process unless the stressor habitually results in inactivity, where weight gain can follow (Guyton & Hall, 1996). For example, numerous studies of shift work show that habitual short sleep is related to elevated BMI and glucose intolerance secondary to sustained high cortisol levels (Di Lorenzo et al., 2003; Ishizaki et al., 2004). The possible causal link between short sleep and changes in diet establishes the need for further research on the determinants of sleep loss during childhood.

![Endocrine Hypothesis of Sleep Loss and Obesity](image)

*Figure 1. Endocrine Hypothesis of Sleep Loss and Obesity*
Quantification of Sleep

Adult sleep is characterized by two predominant states distinct from wakefulness, REM and non-REM sleep. Non-REM and REM sleep alternate through the night in a cyclical pattern (termed “sleep architecture”) (Carskadon & Dement, 2000). Each sleep state is associated with distinctive levels of arousal, brain activity, and muscle tone. Non-REM sleep is categorized into four distinct stages. The stages represent gradations in depth of sleep and difficulty of arousal, with stage I being the lightest and stage IV (slow wave sleep) being the deepest (Davis, Parker, & Montgomery, 2004). Children sleep more than adults and distribute their sleep differently. Moreover, their sleep architecture is markedly different from adults mostly attributable to the dominance of slow wave sleep over other stages (Carskadon & Dement, 2000).

The gold standard for measuring sleep in children and adults is polysomnography (PSG) because it allows for quantification of stages and states of sleep. Although PSG is considered the gold standard, all night recordings are expensive, time and labor consuming, and do not assess sleep in the natural environment (Sivan, 2005). Activity recording is a newer, more common procedure for discriminating sleep/wake states in children. Activity monitoring can be done with a device called an actigraphy. The actigraphy is a small, computerized movement detector that is worn around the wrist or leg and is a non-intrusive way to measure naturally occurring sleep throughout the day (Acebo et al., 1999). Data can be obtained on total sleep time, sleep onset, wake time, nocturnal arousals and awakenings, latency to sleep reinitiation, sleep efficiency, and timing and duration of naps (Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991).
Sleep/Wake Distribution during Childhood

From infancy to young adulthood, sleep amount, distribution, and architecture is developing and changing (Davis, Parker, & Montgomery, 2004). On average, a newborn infant sleeps 16 to 20 hours each day (Mindell & Owens, 2003). Sleep typically occurs in five to six periods around the 24-hour clock. Sleep architecture in the infant is characterized by periods of wake, active sleep (REM), and quiet sleep (NREM) (Davis et al., 2004). During the next few years, sleep begins to be distributed into a primary nocturnal period and two daytime naps, one in the morning (which disappears around the age of 2 years) and one in the afternoon (Iglowstein, Jenni, Molinari, & Largo, 2003; Weissbluth, 1995). Sleep duration over the 24-hour period declines steadily during childhood to approximately 11 hours by the age of 5 years (Mindell & Owens, 2003). It is generally acknowledged that between the ages of 2 and 5 years, afternoon naps are given up and an adult-like pattern of sleep distribution emerges with a consolidated period of sleep occurring only at night (Sheldon, Spire, & Levy, 1992). However, some research suggests there are racial/ethnic differences in nap tendency (Lavigne et al., 1999) in that Black children tend to give up their naps more gradually than White children and many are still napping into their school years (Crosby, LeBourgeois, & Harsh, 2005). Sleep architecture is not organized into an adult-like pattern until about the age of 5 years (Davis et al., 2004). Understanding of the age-related changes in sleep and wakefulness and the wide individual differences in the rate and extent of these changes is limited. Studies of adults and adolescents have identified the importance of both biological and contextual variables (Sadeh & Anders, 1993).
Biological Mechanisms

The two-process model of sleep/wake regulation proposes that sleep and wake propensity in humans is determined by both a circadian process C and a homeostatic process S (Borbely, 1982). Circadian rhythms refer to the endogenous rhythms that control a myriad of physiological and behavioral functions; characterized by a periodicity (period) of approximately 24 hours. Organized by the suprachiasmatic nucleus (SCN) of the hypothalamus, circadian rhythms collectively regulate sleep/wake cycles, temperature, hormone secretion, and modulate physical activity and eating behaviors. The SCN entrains our circadian rhythms to the 24-hour clock by receiving light inputs from the retina of the eye and transmitting the signals to the rest of the brain and body. The circadian timing system is mostly independent of prior waking and sleep. Process S represents homeostatic sleep pressure and accumulates as the time from waking is lengthened, and dissipates in nocturnal and diurnal sleep (i.e. during a nap) (Borbely & Achermann, 1992). To illustrate the dissipation of process S during a nap, research has shown the level of slow wave activity (a marker of sleep pressure) in the subsequent nocturnal sleep episode to be reduced following a daytime nap (Feinberg et al., 1985; Knowles, Coulter, Wahnon, Reitz, & MacLean, 1990).

Although little is known about maturational effects on the underlying biological mechanisms, Process C and process S presumably interact to influence the timing of children’s sleep and wake periods including naps. Circadian sleep phase refers to where the sleep period is positioned within the 24-hour clock. There are individual differences in the timing of sleep. Some individuals biologically prefer to go to sleep/wake early and function optimally during morning hours, whereas others prefer to go to bed/wake late.
and function best during the evening hours. This biological preference for either the morning or evening is termed chronotype (Roenneberg, Wirz-Justice, & Merrow, 2003). Misalignment of the sleep/wake cycle within the circadian rhythm causes circadian dysfunction. Those that commonly experience circadian dysfunction are individuals that work shift work or travel across time zones (i.e. jet lag) (Lu & Zee, 2006). Circadian dysfunction is associated with a host of negative consequences, including sleep/wake difficulties (Doghramji, 2004), performance decrements (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002), and alterations in metabolic processes (Di Lorenzo et al., 2003).

Sleep onset difficulties occur when sleep is attempted at a time of circadian tendency for wake. For example, research on shift workers has shown that sleeping during a time of circadian tendency for wakefulness is associated with less restorative sleep (Doghramji, 2004). Likewise, reduced alertness and wake-maintenance difficulties occur when wakefulness is attempted at a time of circadian tendency for sleep. For example, individuals with evening chronotypes tend to experience reduced alertness and performance during early morning hours (Giannotti et al., 2002). The most “severe” type of evening chronotype, or Delayed Sleep Phase Syndrome (DSPS), is a circadian rhythm disorder that occurs when the sleep phase is notably delayed relative to conventional sleep/wake times (Baker & Zee, 2000). Individuals with DSPS tend to have shortened sleep periods on weekdays and longer sleep periods on weekends. Shortened weekday sleep periods are mainly attributable to early rise times (because of social obligations) yet still late bedtimes (because of circadian-governed processes) (Roenneberg et al., 2003).

Circadian dysfunction is also associated with alterations in metabolic processes and risk for overweight and obesity. A comparison between 319 healthy shift- and non-
shift working Italian males revealed that shift-work was associated with risk of obesity, elevated BMI ($d = .39$), and reduced glucose tolerance. This relationship was present while controlling for several lifestyle risk factors (Di Lorenzo et al., 2003). Further, a study of 2,824 day and 826 shift workers revealed that shift work was associated with markers for insulin resistance in those younger than 50 years of age (controlling for several lifestyle risk factors). Markers for insulin resistance included high blood pressure, high fasting blood sugar, and high triglycerides (Nagaya, Yoshida, Takahashi, & Kawai, 2002).

*Contextual Variables*

Biological mechanisms operate in the context of environmental variables (i.e. family, medical status, physical environment, and psychosocial functioning) (Lebourgeois, 2003). These contextual variables are mediated or moderated by caregiver/child sleep-related behavior (i.e. sleep hygiene). Contextual variables importantly influence the distribution, amount, and quality of sleep. Contextual factors that lead to sleep and circadian-related problems in adulthood and adolescence are well-known. In adults, lifestyle/occupational factors (i.e. shift work) lead to insufficient and poorly timed sleep. During adolescence, an interaction between changes in the biological regulation of the sleep-wake cycle and psychosocial demands is thought to perpetuate sleep loss and circadian dysfunction (Colten & Altevogt, 2006). Little is known of the contextual factors that lead to insufficient or poorly timed sleep during childhood but it is likely that biologically- and/or behaviorally-shaped preferences for timing of sleep/wake periods are at times incompatible with sleep/wake schedules dictated by family or school schedules. A specific concern of the research proposed here is that a napping pattern
shaped prior to school years may be incompatible with the demands on wakefulness associated with attendance of an all-day kindergarten that does not allow napping. Specifically, this incompatibility may have adverse consequences affecting the long-term health and well-being of the child. As of 2005, a survey of pre-kindergarten and kindergarten napping policies in the U.S. revealed that only 28% of all 50 states had policies regarding naptime (Daniel & Lewin, 2005). Because the majority of states have no policy on napping, and there may be a trend to eliminate nap opportunities from children in kindergartens and even preschools (Trejos, 2004), there is a need for systematic research on the consequences of nap restriction from children that are still napping.

Napping in Childhood

We do not have a complete understanding of why some children continue to nap and others do not. There may be a number of processes involved; however those in the biological, family/cultural, and psychosocial realm may have the broadest influence. It is possible that napping children simply require more sleep and are unable to meet their total sleep need in one nocturnal sleep period and/or circadian processes that strengthen the tendency for wakefulness may be immature. Also, the caregiver’s home environment or culture may influence napping because of a strong preference for (i.e. siesta cultures) or against napping. Last, persistent napping may reflect lower adaptability to new sleep/wake routines.

The popular belief is that children in the U.S. stop napping by the time they reach school age; however recent findings reveal that a significant proportion of children continue to nap into and beyond kindergarten (Crosby et al., 2005; Lavigne et al., 1999).
In a large community sample of 2 to 12 year-old children, 72% of five-year-old Black children and 45% of five-year-old White children were reported by parents to nap (Crosby et al., 2005). Thus, we know that racial/cultural variables influence whether napping occurs among school-age children. However, little is known about the relationship between nocturnal sleep and diurnal sleep and what would happen if we restricted diurnal sleep.

Analyses from our laboratory of 3 to 12 year-old children indicated that napping relative to non-napping is associated with shorter weekday nocturnal time in bed (20 minutes; $\eta^2 = .07$). This finding was associated with later bedtimes (18 minutes; $\eta^2 = .02$) but not later rise times. It was also associated with circadian-related difficulties, like greater difficulties getting to sleep at night ($\eta^2 = .02$) and greater difficulty awakening in the morning ($\eta^2 = .07$). These problems would be expected if weekday sleep periods were scheduled such that sleep onset was attempted at a time of circadian tendency for wake and waking was attempted at a time of circadian tendency for sleep. Napping was also associated with a delayed sleep period on the weekend. On weekends, napping children had both later bedtimes (30 minutes; $\eta^2 = .07$) and later rise times (40 minutes; $\eta^2 = .03$) (Cairns, Lebourgeois, & Harsh, 2007). Likewise, a comparison between 441 Japanese kindergarten and nursery school children of the same age revealed that long, obligatory napping in nursery school children was associated with shorter weekday sleep through delayed bedtimes (~30 minutes) but still early rise times (Fukuda & Sakashita, 2002). In a follow-up study of 981 elementary school children, researchers found that “ex-nursery school” children (who are accustomed to taking a long nap) compared to “ex-kindergarten school” children (who are not given a nap) had a 30 minute delay in bedtime
(per caregiver-reported sleep time) notable for up to five years. Further, ex-nursery
school children were more likely to complain of circadian-related sleep difficulties like
returning to wakefulness in the morning (Fukuda & Asaoka, 2004).

These data call for further investigation of the link between napping and nocturnal
sleep. Nap weaning for example, may result in increased weekday nocturnal time in bed
or changes in the circadian sleep phase. To date, there have been no systematic studies of
the relationship between nap removal and nocturnal sleep during childhood. Given this, a
primary objective is to better understand the relationship between diurnal sleep and
nocturnal sleep in young children during the transition to all day school, when napping is
typically reduced or eliminated.

It is anticipated based on research in Japan (Fukuda & Sakashita, 2002) and
analyses of our data (Cairns et al., June 2007) that during the transition to kindergarten
weekday sleep time will be reduced for the napping children because of earlier rise times
and continuing preference for later bedtimes. It is anticipated that napping children will
compensate for weekday sleep loss with longer sleep on weekend nights.

Napping and the Awakening Cortisol Response

A second objective is to determine if a history of napping results in a more
physiologically stressful or demanding school experience. The present study addresses
this objective by comparing the weekday awakening cortisol response (ACR) in napping
and non-napping children as they transition from preschool to kindergarten. Cortisol
production follows a circadian rhythm where values are highest approximately 30
minutes after waking (the ACR), followed by a sharp decline over the next couple of
hours, and a more gradual decline into evening (Watamura, Donzella, Kertes, & Gunnar,
The ACR has two components reflecting a circadian-governed secretory rhythm and a response stimulated by the waking process (Wilhelm, Born, Kudielka, Schlotz, & Wust, 2007). According to Clow et al. (2004), the increase in cortisol in the first 30 minutes after awakening may represent the cumulative effect of as many as three cortisol secretory episodes; typically a 50-100% increase in cortisol production (Kirschbaum & Hellhammer, 1989). Methods for quantifying how much cortisol is produced during an ACR vary; however two indices are typically used: area under the curve (AUC) with respect to ground (g) and area under the curve with respect to increase (i). The AUC with respect to increase $AUC_i$ is an index of the magnitude of the waking response (i.e. amplitude), whereas the $AUC_g$ takes into consideration the individual’s baseline cortisol rhythm (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003).

The ACR is a stable indicator of hypothalamic pituitary adrenal axis (HPA) regulation within any given individual; however the amplitude varies in relation to factors such as environmental stress (Clow, Thorn, Evans, & Hucklebridge, 2004; Fries, Dettenborn, & Kirschbaum, 2009). For example, a study of 196 British adults revealed that the ACR was higher for weekdays than weekends ($d = .55$) and that weekday ACR values correlated with ratings of job stress (Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004). Further, a sample of 65 teachers showed that individuals with high burnout scores had a smaller ACR compared to those with normal burnout scores ($f^2 = .27$) (Pruessner, Hellhammer, & Kirschbaum, 1999).

The transition to kindergarten naturally activates basal cortisol (average cortisol production during the day; $d = .31$) (Boyce et al., 1995); however, the ACR is much less explored in young children. To date, there is only one published study that investigated
sleep and the ACR in young children. In this study of 67 kindergarten-aged children, those classified as “poor sleepers” (via caregiver-reported sleep impairment or not) showed an elevated ACR in comparison to their “good sleeping” peers (AUC d = 1.08; mean ACR d = 1.23) (Hatzinger et al., 2007). Based on research by Boyce et al. (1995), it is expected that most children will experience an increase in the ACR during the transition to kindergarten. However, based on research by Fukuda and Sakashita (2002) and Hatzinger et al. (2007), it is expected that napping children will experience a particularly difficult transition because of sleep loss and/or circadian-related dysfunction and thus exhibit an elevated ACR in comparison to their non-napping peers.

Napping and Dietary Intake

As introduced earlier, it is well-documented that inadequate sleep is associated with elevated cortisol production, hunger, food intake, and subsequent risk for obesity in adults. However, very little data is available for this relationship in children. The relationship between sleep and breakfast consumption is a main focus in the current study because research has shown it to be associated with better dietary choices and healthy weight management (Dubois, Girard, Potvin Kent, Farmer, & Tatone-Tokuda, 2009; Ortega et al., 1998; Wyatt et al., 2002). For example, according to Ortega et al. (1998) overweight and obese children (≥ 75th gender/age BMI percentile) in comparison to normal weight children had less amount of energy supplied by breakfast, a poorer energy profile during breakfast, and were more likely to omit breakfast all together. As napping children are expected to experience sleep loss as they transition from preschool to kindergarten, it is possible that they will also be likely to reduce breakfast intake and increase overall caloric intake.
There are several reasons why the relationship between sleep, the ACR, and dietary intake in children has not already been researched. Sampling the ACR is difficult because of many methodological issues created by lack of time adherence, poor participant compliance, light and food consumption prior to morning sample, etc. (Clow et al., 2004). These methodological concerns are especially robust in children because of the necessity of third-party compliance. Also, dietary assessment in young children unable to accurately self-report is inherently difficult (Serdula, Alexander, Scanlon, & Bowman, 2001) because measurement strategies typically require caregiver recall of foods eaten by the child. This issue is often coupled with the difficulty in accurately assessing foods eaten away from home. However, a combined protocol of parent-reported food diaries and meal-observer appraisal can be a sound method for assessment of young children’s dietary intake (Bollella et al., 1999).

Statement of Purpose

This study is an examination of sleep, endocrine function (cortisol), and dietary intake in 5-year-old Nap and Non-Nap Groups (as identified by caregivers) prior to and during the attendance of an all-day kindergarten where the opportunity for napping is reduced or eliminated. Kindergarten assessments were made at a time point within two weeks of the start of kindergarten (“KA”) and after one month of kindergarten (“KB”). The research has the following specific aims:

Specific Aim 1. A major aim of the research is to document the effects of kindergarten attendance on diurnal sleep time (i.e. nap time) by children taking naps. The following hypothesis is based on restricted nap opportunities in the kindergarten environment.
Hypothesis 1: Diurnal sleep will be reduced for the Nap group as they transition from preschool to kindergarten (Pre-K vs. KA and Pre-K vs. KB).

Specific Aim 2. The second aim is to examine the timing of weekday and weekend nocturnal sleep periods of Nap and Non-Nap Groups during the transition to kindergarten. Earlier findings of later weekday and weekend bedtimes by children taking naps (Cairns, Lebourgeois, & Harsh, 2007; Fukuda & Sakashita, 2002) support the following two hypotheses

Hypothesis 2a: Pre-K weekday nocturnal bedtimes will be later in the Nap Group relative to the Non-Nap Group.

Hypothesis 2b: Pre-K weekend nocturnal bedtimes will be later in the Nap Group relative to the Non-Nap group.

Kindergarten start times establish an early morning schedule for all children regardless of napping status. For at least some, and likely most children, this will require an earlier weekday rise time than their Pre-K schedule.

Hypothesis 3: Weekday rise time will be advanced once kindergarten starts (Pre-K vs. KA and Pre-K vs. KB).

It is anticipated that caregivers will establish earlier weekday bedtimes in response to the earlier rise times associated with kindergarten attendance. Although little data were found on this issue, the following hypothesis will be tested.

Hypothesis 4: Weekday nocturnal bedtimes will be advanced once kindergarten starts (Pre-K vs. KA and Pre-K vs. KB).

Specific Aim 3. The third aim was to examine if the transition to kindergarten is a more stressful or physiologically demanding experience for the Nap Group relative to the Non-
Nap Group. The following hypothesis is based on research that kindergarten activates basal cortisol (Boyce et al., 1995) and that ACR varies in relation to factors such as environmental stress (Clow et al., 2004).

**Hypothesis 6a:** On average, children will experience an elevation in the ACR as they transition to kindergarten (Pre-K vs. KA).

**Hypothesis 6b:** The Nap-Group relative to the Non-Nap Group will experience a greater elevation in the ACR as they transition to kindergarten.

Specific Aim 4. The final aim is to explore how sleep and diet co-vary as children transition to kindergarten. Because this is the first study to address the relationship between sleep and diet in children, hypotheses are limited. However, the following questions are based on the adult literature that suggests sleep loss causes an upregulation of the hunger and satiety hormones that control appetite and food intake (Van Cauter et al., 2007).

**Question 1:** Will the amount and distribution of dietary intake (i.e. calories) change in the Nap and Non-Nap groups differently across the transition to kindergarten? Specific concern remains with breakfast calories as it has been implicated as a factor in healthy weight management.
CHAPTER II

METHODOLOGY

Participants

Caregivers of 5-year-old children were recruited from various sites in the general community (e.g. daycares, community events, churches, etc.) and informed about the study through multiple strategies (flyers, face-to-face interactions, media advertisement) aimed at recruiting a heterogeneous group of children. Children were excluded from the study prior to enrollment if they were already attending kindergarten or too young to enroll in kindergarten. A total of 38 children were enrolled into the study. Data collection occurred at two separate occasions: the summer of 2008 (cohort 1; n = 11) and the summer of 2009 (cohort 2; n= 23). No cohort-related differences were found with regard to any demographic or outcome variables.

Data from a total of 34 children (44% female, 32% Black) were included in the present analyses. Four children were excluded from the analyses because they did not complete all waves of data collection. The summer prior to kindergarten, each caregiver was asked “do you consider your child to be a napping child?” The answer to this question (“yes, “no, or “do not know”) was the foundation for the Nap and Non-Nap comparison groups throughout the study. Table 1 presents the characteristics of the total sample and the caregiver-reported Nap (38%) and Non-Nap Groups (56%) in the study. Caregiver-reported Nap data were not available for 2 of the 34 children because they were unaware or unsure of their child’s napping habits. Caregiver-reported napping (yes or no) was statistically equal for Black and White children as well as males and females.
Children in the Nap Group were more likely going to a structured daycare where there was a structured nap opportunity (p = .05).

Table 1

*Sample Characteristics for Study Groups*

<table>
<thead>
<tr>
<th></th>
<th>Total Sample (n = 34)</th>
<th>Nap Group (n = 19)</th>
<th>No-Nap Group (n = 13)</th>
<th>Statistical Comparisons&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race (% Black)</td>
<td>32.0%</td>
<td>54.5%</td>
<td>36.4%</td>
<td>n.s.</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>56.0%</td>
<td>57.9%</td>
<td>31.6%</td>
<td>n.s.</td>
</tr>
<tr>
<td>Daycare (% yes)</td>
<td>41.2%</td>
<td>78.6%</td>
<td>21.4%</td>
<td>(\chi^2 = 3.8, \ p = .051; \eta^2 = .12)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chi Square analysis

**Materials**

*Caregiver Telephone Screen (Appendix A)*

This basic questionnaire obtained information regarding child’s medication use, medical conditions, and current sleep behaviors (bedtime, wake time, and any napping).

**Actigraphy**

The actigraph was also used to cross-validate caregiver-reported wake times for the days of salivary cortisol data. The actigraph is a watch-size activity monitor that allows for the continuous recording of sleep-wake states. Validation studies in infants aged 12 to 48 months show an overall sleep/wake agreement rate of 85.3% (sleep and wake agreement 87.7% and 76.9%, respectively) when compared to PSG (Sadeh et al., 1991). Model AW64 Actigraphs are accelerometers with a sensitivity of less than .01g, and a sampling rate of 32 Hz (Respironics, 1999). This device collects data at a chosen epoch length (.25 min, .5 min, 1 min, 2 min, 10 min, or 15 min). After downloading the actigraphy data, sleep periods were scored using Actiware Software- v5.0 (Respironics, 2005) using specific movement amplitude criteria. If movement amplitude was above a
given threshold, the epoch was scored as wake. Parameters of interest included sleep onset, sleep offset, and sleep duration.

*Sleep-Wake Diary (Appendix B)*

Data from the diary were used to cross-validate actigraph sleep/wake parameters. Caregivers were asked to document on this daily diary their child’s bedtime, wake time, naps, and any periods the activity monitor is not worn. Validation studies show a correlation between .49 (for sleep onset latency) to .99 (for bedtime, rise time, and total sleep time) when compared to actigraphy sleep parameters (Gaina, Sekine, Chen, Hamanishi, & Kagamimori, 2004).

*Children’s Sleep-Wake Scale (CSWS; Appendix C)*

The purpose of the CSWS was to assess changes in sleep quality between Nap and Non-Nap Groups prior to and during the transition to kindergarten. This 26-item parent-report scale assesses behavioral sleep quality in 2- to 8-year-old children. Children's sleep is measured along five dimensions, including going to bed, falling asleep, maintaining sleep, reinitiating sleep, and returning to wakefulness. In total, five subscale scores and a total scale score can be obtained. The development and psychometric properties of the CSWS are detailed in a manuscript in preparation (Lebourgeois & Harsh, 2003).

*Awakening Cortisol Response*

The ACR was used to assess changes in HPA regulation between Nap and Non-Nap Groups prior to and during the transition to kindergarten. The ACR was assessed by a series of three salivary samples taken at 15 minute intervals starting at rise time (Clow et al., 2004). Caregiver(s) were informed of the importance of having their child abstain
from brushing teeth, eating/drinking, vigorous exercise, and being exposed to direct sunlight until last sample is taken. Cortisol can be sampled via blood or saliva where it is bound or unbound to proteins, respectively. Validation studies suggest very good correlation between the methods, from .67 to .89 (Calixto, Martinez, Jorge, Moreira, & Martinelli, 2002; Umeda et al., 1981). In pediatric research, the salivary route is desired over plasma sampling because it is non-invasive and unlikely to cause distress. Unlike adults, there is no gold standard for sampling salivary cortisol in children. In adults, a small synthetic oral sponge (salivette) is used in lieu of cotton because the natural fibers in cotton have been shown to retain a small amount of endogenous cortisol (Harmon, Hibel, Rumyantseva, & Granger, 2007). However, salivettes are too small for use in young children, and can present a choking hazard. Given this, saliva was collected using a 6-inch braided cotton rope that allowed the caregiver to hold one end while the child chewed the other. The laboratory that performed the salivary cortisol assay corrected for any natural cortisol retained during the assay.

Food Diary (Appendix D)

The food diary was used to assess changes in breakfast and daily caloric intake for Nap and Non-Nap Groups of children prior to and during the transition to kindergarten. The food diary probes for portion sizes, method of preparation, and amount of food left over using the visual estimation method. This method quantifies food and beverage consumption/ leftovers by using household measures, such as cups, ounces, apples, eggs, and soft drinks (Lee, 2007). There are benefits and disadvantages to every method of dietary assessment; however 24-hour recall and food diaries are the most commonly used in pediatric diet research. Validation studies assessing the visual estimation method in
children are limited, however research suggests that food diaries and 24-hour recalls in young children are similar when compared to doubly labeled water (a test of energy expenditure) both underestimating total energy by about 3% (Serdula et al., 2001).

*Visual Plate Waste (Appendix E)*

Plate waste is method of dietary assessment that records waste of prepared foods under standardized conditions. This method was used in combination with food diaries on days the child was at school to give a complete 24-hour dietary profile. Trained research assistants visually assessed standardized meal consumption during the breakfast and lunch period at summer daycare and kindergarten on a 5-point likert scale: 0 (ate all), 1 (1/4 remaining), 2 (1/2 remaining), 3 (3/4 remaining), 1 (ate nothing) (Carr, 1981). In the case that the child brought a bagged lunch (instead of eating in the café), a plate waste was still performed, but specific questions about portion size and method of preparation was addressed at the end of the 7-day follow-up. Although weighed plate waste methods are more accurate than visual estimation, researchers found visual plate waste in young children to be highly correlated (93%) (Comstock, St. Pierre, & Mackiernan, 1981). All dietary data were entered into the ESCHA food processor SQL version 10.0.

**Procedure**

Potential caregivers were contacted by the researcher, given an explanation of the study, and screened to assure their child did not meet any of the exclusion criteria. Each caregiver was asked “do you consider your child to be a napping child?” upon telephone screen. Families that met the criteria for the study were assigned their first of three training sessions. The study consisted of three longitudinal waves of data collection; the summer prior to kindergarten (Pre-K), within two weeks of the transition to kindergarten
(KA), and after a month of transition time to kindergarten (KB). Each wave of data collection required the caregiver to make two separate visits to The USM Children’s Sleep Research Center. The first visit at each wave was to serve as training session, whereas the second visit was to serve as a review of collected data. Each training session lasted approximately 30 minutes and approximately 4 parent-child dyads were scheduled for a given session.

During Pre-K’s training session, caregivers read and signed an Institutional Review Board approved consent form (Appendix F). Once informed consent was received from the parent, verbal assent was received from the child. A trained research assistant entertained the children while caregivers completed the CSWS. The remainder of the session (~30 minutes) consisted of an in-depth instruction of how to complete a 7-day sleep diary, wear and care for the actigraph, sample saliva, and record diet. The training session followed a validated training method that combines verbal instruction, modeling, and rehearsal (Mueller et al., 2003). Children were shown how to wear the actigraph on their wrist. Caregivers were notified that the child must wear the actigraph on their non-dominant wrist for 7 consecutive days at each sampling period, except when bathing or involved in contact or water sports. Caregivers were told of the importance of pressing the event marker at bedtime, morning wake time, any naps, and during sample times of the ACR.

Because cortisol is a stress-reactive hormone, it was imperative the children were not frightened by the saliva sampling procedure. Given this, children were instructed to practice chewing on the cotton roll to ensure the sampling process was not novel or threatening. Caregivers were shown a video on how to capture and store the ACR using a
timer and sampling every 15 minutes from wake time with emphasis on having child refrain from eating, drinking, and brushing teeth until completed. Cotton rolls and storage tubes were individually packaged in sample-specific plastic storage bags. Participants were sent home with a timer to ensure accurate time intervals between saliva samples.

Participants were shown a video demonstration by Dr. Jamie Zoellner on how to accurately complete a 3-day food diary using household measuring devices. Caregivers were supplied a set of measuring cups and visual probes to assist in estimating portion size at home. At the conclusion of the training session, participants were scheduled for a time to return and review study materials.

At the review appointment, the caregiver returned all materials to The USM Sleep Research Lab. At this time, the researcher downloaded and printed actiwatch data. The print-out was compared to the caregiver sleep diary to cross-validate bedtimes, rise times, naps, and timing of the ACR. Any discrepancies were addressed during this time. Each day of the food diary was checked for completeness and clarity. Any omissions or ambiguities were addressed at this time. All caregivers were rewarded a gift certificate ($5 to $10 value) to a local restaurant. Caregivers were notified that a researcher would contact them via telephone to schedule them for the second wave of data collection (KA). The above scenario was repeated two additional times (two weeks post-kindergarten and one-month post-kindergarten).

All actigraph sleep periods were scored individually and defined as usable if (a) the child was not sick or taking any medications, (b) the caregiver did not report any atypical events (e.g. a long car trip), (c) the actigraph was attached to the child during the entire scoring period, and (d) the actigraphic data corresponded with the caregiver’s sleep
diary. Only five children (4.9%) had fewer than the five days of useable actigraphy recording suggested for reliable measure of children’s sleep (Acebo et al., 1999). A “nap” was considered a sleep period of any length separate from the night time sleep period and had to correspond to the caregiver-reported sleep diary. In many cases, the teacher reported the child’s nap times on the diary for naps at school. Not included in the current analyses were naps that occurred in a vehicle or stroller (etc.). These naps were recorded by the caregiver sleep diary, but could not be scored using the Actiware software due to the interference of external motion.

Dietary data for breakfast, lunch, dinner, and snacks for two weekdays and one weekend day at each time point were entered into the ESHA food processor SQL. Breakfast was operationally defined as the first meal (i.e. food or drink consumed) of the day. Diet data were defined as unusable if the child was sick (n = 2) or he or she diverged from their typical home/school routine (e.g. stayed home when they should have gone to school; n = 1). At the completion of entry, all dietary data were exported from the food processor SQL into the Statistical Package for Social Sciences (SPSS) for analyses.

Salivary cortisol data were sent to The University of Trier, Germany’s Psychobiology Laboratory for chemical assay. Cortisol levels were determined by employing a competitive solid phase time-resolved fluorescence immunoassay with fluromeric end point detection. All assays were done in duplicate, and all intra-and inter-assay coefficients of variation were between 4.0% and 6.7%, and 7.1% and 9.0%, respectively. Cortisol samples were excluded if (a) the child was sick or injured (n = 2), (b) any cortisol value was $\geq 75$ nmol/l as this indicates possible contamination (n = 1)
(Kunz-Ebrecht et al., 2004), and (c) if caregiver did not adhere to sampling procedure (n = 1).

Analyses

All analyses were performed with the aid of SPSS version 17.0. Prior to analyses, all paper-and-pencil diaries and questionnaires were double-entered and checked for validity. Exploratory data analyses consisted of an exploration of univariate and bivariate distributional characteristics. Descriptive statistics were computed for every variable to view shape and identify extreme scores. Outliers (i.e. scores ≥ 3 standard deviations from the mean) were identified and replaced with the next closest score. This strategy was implemented for actigraphy data (1.8% outliers), dietary data (3.4% outliers), and cortisol data (4.4% outliers). After outlying data were transformed, missing values were replaced using the mean of the appropriate wave (Pre-K, KA, or KB). This method was implemented for actigraphy data (2.5% missing), dietary data (3.8% missing), the second cohort of CSWS (3.5% missing), and the individual saliva samples (7.2% missing). Missing values for cortisol AUC_r and AUC_i were replaced by applying the AUC formulae on replaced individual saliva values. One participant’s AUC data were estimated using the mean of the third wave (KB) as they did not complete any individual samples.

This study included data analyses with multiple statistical tests. The significance level for all comparisons was set at α = .05. Planned comparison procedures (using a repeated measures ANOVA with two levels of repeated factors) were conducted that were consistent with the stated hypotheses. As the current study was exploratory in nature, marginal effects (p< .10) were presented and described.
Sleep Variables

A McNemar’s test for related proportions was used to test changes in nap frequency as children transitioned to kindergarten. A 2 (Nap) x 2 (Day) x 3 (Time) mixed model ANOVA was used to assess Nap Group differences in sleep timing, duration, and quality as children transitioned from preschool to kindergarten. Although this original mixed model was used to identify interaction effects associated with weekday/weekend, the finding that weekends were inherently more variable than weekdays suggested separate analyses for weekdays and weekends for interaction effects. Significant main effects of time were followed-up with Fisher’s LSD post-hoc test. Significant interaction effects between time and nap group were followed-up with a test of simple effects.

Cortisol Variables

A 2 (Nap) x 3 (saliva sample) mixed model ANOVA was first used to explore the distribution (i.e. shape) of the ACR across time in napping and non-napping children. Formulae for cortisol area under the curve with respect to ground (AUC_g) and increase (AUC_i) were computed per the protocol established by Pruessner et al. (2003). To determine whether Nap and Non-Nap Groups of children had differences in the ACR upon transitioning to kindergarten, a 2 (Nap) x 3 (Time) mixed model ANOVA was used to assess differences in ACR amplitude (using AUC_g and AUC_i methods) between napping groups across time.

Diet Variables

A 2 (Nap) x 3 (Time) mixed model ANOVA was first used to examine Nap Group differences in breakfast, lunch, dinner, and total (i.e. daily) kilocalorie (kcals) intake over time. A cross-lagged structural equation technique was used to develop a
model of how sleep and diet co-vary as children transition to kindergarten. This technique consists of cross-correlations between variables of interest across time. Our model included two sets of autoregressive paths and one set of cross-lagged paths (Figure 2). Residual correlations at the first and second kindergarten assessments were of principle interest as they reflect the unique relationship between sleep and diet.

*Figure 2. Cross-lag Panel Analysis Model of Changes in Sleep and Diet*
CHAPTER III

RESULTS

Sleep Duration, Timing, and Quality

Napping (Table 2)

Nineteen Nap (56%) and 13 Non-Nap (38%) children were identified upon caregiver query (i.e. “do you consider your child a napping child?”) at Pre-K. Actigraphic comparison of each child’s sleep record at Pre-K revealed that four of the children in the Non-Nap Group (~31%) took naps. Moving these four children to the Nap group was considered. However, it was decided that these children would remain in the Non-Nap Group because a) they were not taking regular, scheduled naps in a preschool or daycare setting (as none were attending summer care), b) they had infrequent weekday naps (~1.5 days per week) compared to “napping children” (~3 days per week), and c) it is reasonable to assume that the majority of 5-year-olds nap at least occasionally.

The hypothesis that children in the Non-Nap Group would reduce nap sleep as they transitioned from preschool to kindergarten was supported. Nap tendency decreased as children transitioned to kindergarten. Compared to Pre-K, only seven children (~39% of original) were taking naps per actigraphy at the first kindergarten assessment (p<.001). At the second kindergarten assessment, 10 children (~56% of original) were taking naps (p<.05). Nap tendency did not change between the first and second kindergarten assessments. It was also noteworthy that five (38%) of the children in the Non-Nap Group started to nap at the first kindergarten assessment (p = .18). Weekday nap duration also decreased as children transitioned to kindergarten. Compared to Pre-K, average nap duration was decreased by ~51 minutes at the first kindergarten assessment, $F (1, 33) = $
33.6, p<.01, η² = .87 and ~47 minutes at the second kindergarten assessment, F (1, 33) = 21.7, p<.01, η² = .73. Nap duration did not change from the first to second kindergarten assessments.
Table 2

*Changes in Nap Sleep* as Children Transition from Pre-K to Kindergarten

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>PRE-K</th>
<th></th>
<th></th>
<th>K A</th>
<th></th>
<th></th>
<th>K B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Days (SD)</td>
<td>Duration (SD)</td>
<td>n</td>
<td>Days</td>
<td>Duration</td>
<td>n</td>
<td>Days</td>
<td>Duration</td>
</tr>
<tr>
<td><strong>WEEKDAYS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nap Group</td>
<td>18/19</td>
<td>3 (1.5)</td>
<td>84.9 (18.0)</td>
<td>7/19</td>
<td>3.5 (1.5)</td>
<td>34.3 (16.7)</td>
<td>10/19</td>
<td>2.5 (1.6)</td>
<td>39.7 (16.2)</td>
</tr>
<tr>
<td>Non-Nap Group</td>
<td>4/13</td>
<td>1.5 (.3)</td>
<td>78.8 (43.8)</td>
<td>9/13</td>
<td>2.3 (1.3)</td>
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<td>4/13</td>
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<td><strong>WEEKENDS</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nap Group</td>
<td>9/19</td>
<td>1.3 (.5)</td>
<td>68.2 (38.7)</td>
<td>9/19</td>
<td>1.4 (.5)</td>
<td>100.0 (41.9)</td>
<td>6/19</td>
<td>1.3 (.5)</td>
<td>94.0 (17.7)</td>
</tr>
<tr>
<td>Non-Nap Group</td>
<td>3/13</td>
<td>1.2 (.8)</td>
<td>110.0 (23.5)</td>
<td>5/13</td>
<td>1.6 (.5)</td>
<td>65.3 (44.8)</td>
<td>4/13</td>
<td>1.3 (.5)</td>
<td>60.8 (23.8)</td>
</tr>
</tbody>
</table>

*a:* As measured by actigraphy  
*b:* number of children actually napping by actigraph verification
Sleep Duration

A 2 (Nap) X 2 (Day) X 3 (Time) mixed model ANOVA revealed a significant interaction between time and day of the week in total sleep duration (nap and nocturnal sleep), F (1.9, 55.9) = 5.7, p<.01, η² = .16; Figure 3. On average, children lost ~38 minutes of weekday total sleep duration at the first kindergarten assessment (p<.01) and stabilized thereafter. Weekend total sleep duration remained stable throughout the transition to kindergarten.

Figure 3. Changes in Total Sleep Duration (Nap and Nocturnal Sleep) for the Nap and Non-Nap Group as They Transitioned to Kindergarten. t: refers to a main effect of time.

Due to increased error on weekends compared to weekdays for nocturnal sleep, separate weekday/weekend ANOVAs were used to examine changes in nocturnal sleep duration. A 2 (Nap) X 3 (Time) mixed model ANOVA for weekday revealed a significant interaction of time by nap group, F (2.0, 58.8) = 4.5, p<.01, η² = .15; Figure 4 where weekday nocturnal sleep duration was reduced for the Non-Nap Group as they transitioned to kindergarten. On average, the Non-Nap Group lost ~30 minutes of weekday nocturnal sleep duration at the first kindergarten assessment (p<.05) and
stabilized thereafter. Weekend nocturnal sleep duration remained stable throughout the transition to kindergarten.

Figure 4. Changes in Nocturnal Sleep for the Nap and Non-Nap Group as They Transitioned to Kindergarten. t x n: refers to a nap by time interaction; bracket shows significant simple effects; p-value illustrates significant comparison between Nap and Non-Nap Group at the first kindergarten assessment.

Sleep Timing

The hypothesis that children would experience an advance in weekday rise times as they transitioned to kindergarten was supported. Compared to Pre-K, children advanced their weekday rise times by ~78 minutes at the first kindergarten assessment, F (1, 33) = 74.0, p<.001, η² = .69; Figure 5 and ~70 minutes at the second kindergarten assessment, F (1, 33) = 41.8, p<.001, η² = .56. A noteworthy finding was that children delayed their weekday rise time by ~9 minutes from the first to second kindergarten assessment, F (1, 33) = 14.0, p<.01, η² = .30.

A 2 (Nap) x 2 (Day) x 3 (Time) mixed model ANOVA revealed an interaction between day and time in that the advance in rise time was greater for weekdays than weekends (F 1.8, 56.7 = 14.0, p<.001, η² = .32). On average, children advanced their weekend rise times by ~26 minutes at the first kindergarten assessment (p<.05) and remained stable thereafter.
The hypothesis that, at Pre-K, the Nap Group would have a later weekday bedtime compared to the Non-Nap Group was supported. On average, the Nap Group went to bed ~50 minutes later on weekdays, $F(1, 30) = 5.0, p<.05, \eta^2 = .14$; Figure 6. The hypothesis that the Nap Group would have a later weekend bedtime at Pre-K compared to the Non-Nap Group was not supported. The hypothesis that weekday nocturnal bedtimes would advance as children transitioned to kindergarten was supported. Compared to Pre-K, children advanced their weekday bedtimes by ~63 minutes at the first kindergarten assessment, $F(1, 33) = 75.5, p<.001, \eta^2 = .70$ and ~66 minutes at the second $F(1, 33) = 41.8, p<.001, \eta^2 = .56$; Figure 6.

A 2 (Nap) x 2 (Day) x 3 (Time) mixed model ANOVA revealed an interaction between nap, day, and time, $F(1.9, 56.0) = 4.6, p<.05, \eta^2 = .13$. That is, bedtimes on weekdays advanced more precipitously for the Nap Group relative to the Non-Nap Group ($p<.05$; Figure 6). Children in the Nap-Group advanced their weekday bedtimes by ~74 minutes at the first kindergarten assessment, $F(1, 18) = 69.1, p<.001, \eta^2 = .79$, whereas the Non-Nap Group advanced their weekday bedtimes by ~51 minutes, $F(1, 12) = 15.9,$

**Figure 5.** Changes in Rise Time for Nap and Non-Nap Groups as They Transitioned to Kindergarten. $t$: refers to a main effect of time; $p$-value illustrates significant comparison for Nap vs. Non-Nap Group at the second kindergarten assessment.
p<.01, $\eta^2 = .57$. Despite the 71 minute advance in weekday bedtime for Nap-Group, they still marginally had a later weekday bedtime relative to the Non-Nap Group, $F (1, 30) = 4.0, p=.06, \eta^2 = .18$. Weekday bedtime did not change from the first to second kindergarten assessment. Weekend bedtimes also showed an advance as children transitioned to kindergarten, $F (1.8, 54.2) = 6.5, p<.01, \eta^2 = .18$, and marginally differed across Nap Group ($p = .06$). The Nap-Group advanced their weekend bedtime by ~49 minutes at the first kindergarten assessment ($p<.01$), whereas the Non-Nap Group did not show an advance until the second kindergarten assessment (~41 minutes; $p<.05$).

![Figure 6](image.png)

**Figure 6.** Changes in Bedtime in the Nap and Non-Nap Group as They Transitioned to Kindergarten. t x n: refers to a nap by time interaction; brackets show significant simple effects; p-value for weekday bedtime illustrates a marginal comparison at the first kindergarten assessment between the Nap and Non-Nap Group; p-value for weekend bedtime illustrates significant comparison between Nap and Non-Nap Group at the second kindergarten assessment.

**Sleep Quality**

A 2 (Nap) x 2 (Day) x 3 (Time) mixed model ANOVA on all subscales of the CSWS revealed that, on average, children were reported to have an easier time going to bed ($p<.05$), falling asleep ($p<.05$), but more difficulty awakening in the morning ($p<.05$) as they transitioned to kindergarten (Figure 7). There were no differences in maintaining or returning to sleep. No differences in sleep quality were found with regard
to nap group. Moreover, on average, there was a decrease in actigraphically-assessed weekday nocturnal sleep fragmentation as children transitioned to kindergarten (p<.05) which did not differ across napping groups.
Figure 7. Sleep Quality in Nap and Non-Nap Groups as Children Transition from Preschool to Kindergarten. 

$t$: refers to a main effect of time.
The Awakening Cortisol Response

The hypothesis that, on average, the ACR would be elevated as children transition to kindergarten, but more elevated in the Nap Group was not supported. A 2 (Nap) x 3 (Time) mixed model ANOVA suggested that the amplitude of the ACR did not change across time (Figure 8). However, the data did suggest that the Non-Nap Group, on average, had a higher cortisol response (i.e. using the AUCi) relative to the Nap Group (9.5 versus 5.8 nmol/l; F (1, 29) = 5.6, p<.05, η² = .15).

The ACR was evident in 88% of the time in our sample of children. On average, cortisol production increased by 62.0% and 63.9% 15 and 30 minutes post rise-time, respectively, F (1.3, 36.4) = 41.7, p<.001, η² = .59. At Pre-K, five children (15.6%) showed a flat or decreasing cortisol production post-rise time (hereafter termed “non-responsive”). Three children (9.4%) at the first and four children (12.5%) at the second kindergarten assessments were non-responsive. Five children in total (15.6%) showed a pattern of non-responsiveness (defined as being non-responsive across ≥ 2 waves). These participants were not excluded from the analyses due to sample size limitations.
**Figure 8.** The Awakening Cortisol Response in Nap and Non-Nap Groups as They Transition from Preschool to Kindergarten. Top three graphs illustrate distributional characteristics of the ACR across time. Bottom graph shows Nap Group differences in the amplitude of the ACR. n: refers to a main effect of Nap Group.
Dietary Intake

A 2 (Nap) x 3 (Time) mixed model ANOVA suggested that, on average, daily calories consumed remained constant as children transitioned from preschool to kindergarten and did not vary across nap group. There were, however, meal-specific changes as children transitioned to kindergarten (Figure 9). For example, on average, calories consumed at breakfast on weekdays decreased as children transitioned to kindergarten (p<.01). This effect did not vary across nap group. Compared to Pre-K, breakfast was reduced by ~100 calories (31%) at the first kindergarten assessment. Breakfast calories did not change between the first and second kindergarten assessment.

Calories consumed at lunch also changed as children transitioned to kindergarten and varied across nap group (p<.05). The Nap Group increased their lunch intake by ~95 calories or 24% (p<.05) at the first kindergarten assessment, whereas the non-napping group remained stable across time. Lunch intake stabilized for the Nap Group by the second kindergarten assessment. Calories consumed at dinner and at snacks did not change as children transitioned to kindergarten and did not vary across napping groups.
Figure 9. Dietary Intake in Nap and Non-Nap Groups as Children Transition from Preschool to Kindergarten. 
	t: refers to a main effect of time; t x n: refers to an interaction of nap group and time; bracket shows significant simple effects.
Sleep Duration and Dietary Intake

Results from the cross-lagged panel analysis suggested that change in total sleep duration (nap and nocturnal sleep) from Pre-K to the first kindergarten assessment was proportional to change in breakfast calories (Figure 10; $\beta = .26$, $p = .06$). That is, children that lost the most sleep during the transition to kindergarten were more likely to decrease breakfast intake at the start of kindergarten.

*Figure 10. Cross-lagged Panel Analyses for Weekday Total Sleep Duration (Nap and Nocturnal Sleep) and Breakfast Calories. Bolded $\beta$-weights regard primary analyses involving sleep and breakfast intake; $^a$: marginal significance ($p = .06$).*
CHAPTER IV
DISCUSSION

Summary

This study revealed that the transition to kindergarten was associated with changes in sleep and dietary intake in caregiver-reported Nap and Non-Nap Groups of children. Endocrine function remained stable. On average, Nap and Non-Nap Groups lost an equal amount of total sleep time, however, children in the Nap Group lost diurnal sleep (reduced napping), whereas children in the Non-Nap Group lost nocturnal sleep. An advance was seen in the weekday and weekend sleep period. Weekday rise times were dramatically advanced for both groups. Children in the Nap Group advanced their weekday bedtimes more rapidly than children in the Non-Nap Group. The sleep quality data were consistent with the notion that the transition to kindergarten was associated with an increase in sleepiness. On average, children reduced their breakfast intake as they transitioned to kindergarten. Changes in breakfast consumption were proportional to changes in sleep.

Changes in Sleep as Children Transition to Kindergarten

Nocturnal Sleep Timing

A major objective of the current study was to understand the impact of kindergarten on children’s rise times. It was hypothesized that children would experience an advance in rise times as they transitioned to kindergarten. Our data suggested that the transition to kindergarten was associated with dramatically earlier rise times, presumably because of the earlier kindergarten start times. On average, children were waking up at 6:14 a.m. at the first kindergarten assessment compared to 7:30 a.m. at Pre-K. No
differences were found with regard to Nap Group at any of the time points. One can surmise that the earlier weekday rise times were due to kindergarten attendance as this has been previously reported with young adolescents. For example, Wolfson, Spaulding, Dandrow, and Baroni (2007) reported that children had earlier rise times (and less sleep time) if they were attending a school with an early, compared to a later start time. A rise time of 6:14 a.m., on average, is not surprising given the high demand of the morning schedule in kindergarten. For example, the kindergartens in this program started homeroom at approximately 8 a.m., but many children had to get up “extra early” because they rode a bus to school. Bus commutes, especially in rural communities such as those in Mississippi can exceed 30 minutes. Further, many of the children in this study participated in the school’s breakfast program. Depending on the school, breakfast was served between 7:10 and 7:30 a.m. Interestingly, from the first to the second kindergarten assessment, children delayed their rise times by approximately 10 minutes (6:22 a.m. vs. 6:14 a.m.). This delay may be attributable to children and caregivers becoming more efficient at their new morning kindergarten routine. On the other hand, it could also be attributable to children “sleeping in” as a result of sleepiness.

Another aim of the current study was to explore if bedtimes would adequately advance as to compensate for the early rise times in kindergarten and prevent nocturnal sleep loss. Our hypothesis that weekday bedtimes would advance as children transitioned to kindergarten was supported, but only for children in the Nap Group. On average, children were going to bed at 9:03 p.m. at the first kindergarten assessment compared to 10:08 p.m. at Pre-K. Caregivers likely advanced bedtimes because of the earlier rise times required by the kindergarten schedule. Also possible, is that children found it easier
to go to bed and fall asleep earlier in the evening because of the earlier rise times (Borbely & Achermann, 2000). The greater bedtime advance in the Nap Group relative to the Non-Nap Group (71 min. vs. 51 min.) may be attributable to caregivers attempting to minimize any additional sleep loss as they already lost nap time. However, it is also possible that, because they lost nap time, the children in the Nap Group were sleepier and able to go to bed and fall asleep at an earlier time (Borbely & Achermann, 2000). Notably, despite the greater advance in bedtime by the Nap Group, bedtimes remained numerically later than those in the Non-Nap Group (30 minutes; p = .09) at the first kindergarten assessment. This difference disappeared by the second kindergarten assessment, where both groups were going to bed at approximately the same time (9 p.m.) These data suggest that it took into the first month of kindergarten for the children in the Nap Group to adjust to their new kindergarten bedtimes.

It is of interest that the phase of weekend sleep periods also advanced, although to a smaller degree than the weekday sleep period. The trend (p=.06) that children in the Nap Group advanced their weekend bedtimes more rapidly (at the first rather than the second kindergarten assessment) than those in the Non-Nap Group is not surprising given that they advanced their weekday bedtimes more rapidly. There are several potential explanations for this effect. The weekend advance may be indicative of an advance in the circadian timing system, increased homeostatic pressure for sleep, and/or parental influence. The circadian hypothesis is favored here based on the assumption that caregivers may be unlikely to wake their child early on the weekends. However, further research is needed.
Sleep Duration

Typically, 5-year-old children sleep between 10 to 12 hours over the 24-hour period (Mindell & Owens, 2003). Children in this study were, on average, at the lower end of this range prior to kindergarten with approximately 9.9 hours per day. Once kindergarten started however, children were consistently under sleeping. On average, children in both Nap and Non-Nap Groups lost approximately 40 minutes of total sleep at both the first and the second kindergarten assessment (~9.3 hours per day). Interestingly, the data suggested that the Nap Group lost diurnal (nap) sleep, whereas the Non-Nap Group lost nocturnal sleep. Consistent with a loss of total sleep duration was the sleep quality data that suggested that children experienced increased sleepiness as they transitioned to kindergarten. For example, children were described as having an easier time going to bed, falling asleep, but a harder time waking in the morning. Also, the actigraphy data suggested that children had fewer awakenings throughout the night. All effect sizes were in the large range ($\eta^2$ between .14 and .19). Together, these data suggest that children maximized their sleep opportunity when they transitioned to kindergarten, presumably as a result of lost sleep.

A major objective of the current study was to investigate the impact of kindergarten attendance on nap behavior. It was hypothesized that napping would be sharply reduced as children started kindergarten. The findings suggested that the transition to kindergarten was associated with a reduction in both nap tendency and duration. This reduction is reasonably attributable to a loss of nap opportunity in the kindergarten environment. That is, six of the 19 children (32%) in the Nap Group were no longer offered a nap opportunity in kindergarten. Where nap opportunities were
available, the time allotted was shorter relative to the preschool and daycare setting. On average, the kindergartens in this research program allotted between 20 to 45 minutes of “rest time” per day. Rest time is used in lieu of nap time because those that did not want to nap were instead allowed to engage in quiet activities. This duration of rest time was in contrast to the ~60 to 90 minutes that was commonly allotted for napping in preschools and other daycare centers. Thus, average nap duration was reduced by ~51 minutes at the first kindergarten assessment (from 85 minutes to 34 minutes) and did not change to the second kindergarten assessment.

Noteworthy was that five children in the Non-CNap Group started to nap as they transitioned to kindergarten. Review of the sleep diaries revealed that all five of these children were newly presented a structured, daily nap routine in the kindergarten environment. Thus, it is possible that these children started to nap simply because the opportunity was presented. This has been reported in the literature. A study of three to five year-old children attending childcare suggested that children generally sleep during a nap if given the opportunity to do so (Ward, Gay, Anders, Alkon, & Lee, 2007). However, it is also possible these children started napping in reaction nocturnal sleep loss.

An unexpected finding was that the Non-Nap Group lost approximately 30 minutes of nocturnal sleep at the first kindergarten assessment (from 9.9 hours to 9.4 hours) while the Nap Group remained stable at approximately 9 hours of sleep. It seems that children in the Non-Nap Group were less successful at adequately advancing their bedtime as they transitioned to kindergarten in order to avoid sleep loss. In order for children in each group to maintain the same nocturnal sleep time across the transition,
they would have had to advance their bedtimes by approximately 80 minutes (equal to the 
advance in rise times). Children in the Non-Nap Group were less successful in advancing 
their bedtimes by this amount of time perhaps because they had earlier bedtimes than the 
Nap Group at Pre-K (9:38 vs. 10:28 p.m.). In other words, because children in the Non-
Nap Group had earlier bedtimes at Pre-K, they would have needed a bedtime of 
approximately 8:15 p.m. to prevent nocturnal sleep loss. Possibly, the social obligations 
of modern society (dinner, bathing, homework, etc.) make it difficult for 5-year-old 
children to be in bed by 8:15 p.m.

Sleep and Dietary Intake

It is well-established that sleep loss during childhood is associated with a host of 
cognitive, performance, emotional, and metabolic problems (e.g. obesity). In this study, 
we focused on dietary intake as a metric of future obesity risk. Results from this study 
suggested that children, on average, reduced their breakfast intake by ~30% at the first 
kindergarten assessment. This decrease was calorically equivalent to a piece of bread 
(~100 calories). Breakfast intake remained at this lower level at the second kindergarten 
assessment. There are several explanations for the decrease in breakfast calories. The 
breakfast and lunch programs within the school systems in Mississippi follow the dietary 
guidelines established by the USDA to ensure adequate consumption of all food groups. 
It is possible that children may eat more balanced and less-calorically-dense foods in the 
kindergarten environment simply because that is what is provided. Another explanation 
for the decrease in breakfast consumption is that children had inadequate time to eat 
breakfast in the morning. This could be for many reasons including the high demand of 
the morning schedule (e.g. bathing, dressing, bus schedule, etc.).
Despite all of these reasonable explanations for the decrease in breakfast intake; however, our analyses suggested that change in sleep duration played a unique and important role in the reduction of breakfast consumption as children transitioned to kindergarten. That is, children that lost the most total sleep across the transition to kindergarten also decreased breakfast intake. This suggests that children that lost sleep were not biologically prepared to consume breakfast. Research has consistently shown that inadequate breakfast consumption is associated with a poor dietary profile (e.g. consumption of fast food) and an elevated risk for obesity (Niemeier, Raynor, Lloyd-Richardson, Rogers, & Wing, 2006; Ortega et al., 1998).

Although the direct connection between endocrine function and dietary intake has not been systematically studied in humans, it is possible that increased risk for obesity as a result of breakfast reduction/omission may be secondary to the dysregulation of the hunger and satiety hormones leptin and ghrelin (Leidy & Racki, 2010). In other words, if the first meal of the day is inadequate, one may be likely to overeat (especially foods high in carbohydrates) later in the day (Dubois, Girard, Potvin Kent, Farmer, & Tatone-Tokuda, 2009). In fact, our data suggested that children in the Nap Group increased their lunch intake by ~24% (95 calories) at the first kindergarten assessment. Although this issue needs to be further explored, it is possible that children in the Nap Group increased lunch intake as a coping mechanism for sleepiness as this was the time of day they were accustomed to napping.

The Awakening Cortisol Response

We hypothesized that children would have an increased ACR as they transitioned to kindergarten based on the finding that kindergarten activates basal cortisol (Boyce et
al., 1995) and that the amplitude of the ACR is sensitive to environmental stress (Clow, Thorn, Evans, & Hucklebridge, 2004). However, our data suggested that the ACR remained stable as children transitioned to kindergarten. Although this may be an accurate null finding, it may also be due to low power and the many methodological factors associated with capturing the ACR (Clow et al., 2004). According to Clow et al. (2004), issues known to impact the ACR include habitual rise time (i.e. chronotype), morning light exposure, gender, assay system, and participant compliance. One explanation for the null finding across time is that children had less light exposure when they transitioned to kindergarten as a result of earlier rise times. As research has suggested that light enhances the ACR (Thorn, Hucklebridge, Esgate, Evans, & Clow, 2004), less morning light exposure at the first kindergarten assessment relative to Pre-K could have attenuated the effects of the kindergarten transition.

Of all potential confounding factors, participant adherence/compliance may play the greatest role in the amplitude of the ACR. This is especially the case when collecting the ACR in the domestic setting (Kudielka, Broderick, & Kirschbaum, 2003). Poor participant compliance can occur when saliva samples are delayed, and typically yields a flatter ACR (Clow et al., 2004). Accurate timing of the first saliva sample is of the utmost importance as it is the reference point for the post-rise time curve calculations. Accurate timing of the wake sample is even more challenging when the participant is a child because caregivers may not know exactly when the child wakes up.

An unanticipated finding was that children in the Non-Nap Group had, on average, a higher ACR than their Nap Group peers (d = .46). As this was the first study to investigate napping-related trends in the ACR, several explanations are possible. It may
be that caregivers of Non-Nap children are more able to accurately capture the first saliva sample (which typically yields a higher ACR) because their children have more regular sleep/wake habits. Another explanation is that Non-Nap children have greater demands of the waking period, and thus need more endocrine activity, because they do not have a mid-day respite.

Limitations and Future Directions

Several limitations in the current study should be noted. First, as the principle investigator was the primary individual recording and entering data, one can not rule out the possibility of implicit bias. Second, the actigraphy data suggested that four of the children in the Non-Nap Group were actually still napping in some capacity. Although these children had relatively infrequent (perhaps unplanned) naps in comparison to their “Napping” peers, it is possible that this level of napping influenced their sleep distribution. It is not surprising that caretakers either were not aware of or did not classify their child as a “napping child” if they took relatively infrequent naps. First, it is safe to assume that the vast majority of children in this age group nap at least once in a while (depending on need or opportunity). Also, as the vast majority of pediatric napping literature suggests, we relied on the caregiver’s judgment of whether their child was a “napper” or not. The criteria used by the caregiver to categorize their child are unknown. Last, research has suggested that caregivers may not always be aware of how much or when their child is sleeping (Sadeh, 2008). Caregivers are most likely to be aware of their child’s sleep patterns when they are with the child. So, for example, if the child is napping while in the care of another adult (grandparent, babysitter) it is reasonable that the parent may not be aware of the child’s napping habits unless he or she specifically
queries or is told. This limitation begs for more objective measures of sleep (like actigraphy) in children.

Another limitation has to do with measures. Although actigraphy is a more objective method of estimating sleep in children than caregiver-report, it is an imperfect measure. The basic assumption of actigraphy is that if the child is not moving he or she most likely asleep. Although this may characterize many children, it may not work for all. This is especially the case for naps, where it is possible that a child may be very still but not actually asleep. Likewise, assessment of the awakening cortisol response (ACR) in the domestic setting comes with its own set of challenges. The ACR can be subject to a host of confounding factors that are difficult to navigate around unless assessed in a controlled environment. As few studies have assessed the ACR under controlled conditions, future studies should address this issue (especially with children). Last, to the best of our knowledge, this was the first study to explore the relationship between sleep and dietary intake in children. As we found relationships using some methods of dietary assessment (plate waste) but not others (food diary), this suggests that future studies may want to refine current measures used for children.

Another limitation has to do with our small sample size. Overall, inadequate power may have prevented detection of meaningful relationships. For example, as little information was available on the ACR in young children at the time of this proposal, power calculations were performed using adult standards. It may be the case that children do not exhibit the same magnitude of response to stressors as adults. Future studies should examine this function under controlled conditions. Dietary research typically requires large sample sizes because of the many sources of variance associated with it.
Because we found meal-specific effects only, this suggests that future studies may require larger sample size to detect overall daily calorie change in children.

Another limitation to this project was that it was correlational in nature, and hence interpretations of cause cannot be formed. For example, it is not clear if changes in sleep (e.g. bedtimes getting earlier) and diet occurred as a result of the stress of kindergarten or some other variable that co-varied with the transition (e.g. parental stress).

The results of this study suggest that further research on the underlying mechanisms of sleep and hormonal regulation in childhood is needed. Future studies should address the long-term consequences of sleep and dietary changes of children as they transition to kindergarten. Specifically, information is needed on the developmental patterns of breakfast as children progress throughout childhood. Because 30% of the sample decreased their breakfast intake, and the importance of breakfast been consistently established, it is imperative to know if children maintain this status throughout their youth.
APPENDIX A

CAREGIVER TELEPHONE SCREEN

Caretaker Name: ____________________________  Child Name: _____________________________

Telephone/Email:______________________________________________________________________

Address: _____________________________________________________________________________

1.  Child’s DOB: _________ and Age __________

2.  What is your child’s gender? [ ] M [ ] F

3.  What is your child’s race? [ ] B [ ] W

4.  What kindergarten will your child attend? ______________________________

5.  What is the start date? ____________________________

6.  How many days per week does your child nap? ______________________________


8.  If yes, when will they terminate? ______________________________

9.  Do they serve breakfast and lunch at the daycare?

10. Do they serve snacks?

11. Do you anticipate your child will participate in the breakfast program at Kindergarten?

    [ ] Y [ ] N [ ] DK

12. Do you “know” when your child wakes up? ______________________________

13. Does your child have any medical conditions? [ ] Y [ ] DK [ ] NO

14. Does your child take any medications?
    a. Allergy meds
    b. Asthma meds
    c. Anti-inflammatory

15. Does your child have any indication they may have a sleep disorder? [ ] Y [ ] N [ ] DK

16. Caretaker Night Scheduled: ______________________________
APPENDIX B

SLEEP DIARY

ID #: ______________________
Start Date: ____________________

Weekly Sleep Diary

Instructions: Please answer the top part of each page after your child wakes up in the morning. Answer the bottom part of each night after your child goes to bed at night.

BUTTON PRESSES:

- LIGHTS OUT
  - Time child expected to start falling asleep
- WAKE TIME
- NAP START/END
- WATCH OFF/ON
- NEW COTTON ROLL IN MOUTH
<table>
<thead>
<tr>
<th>Day of Week (circle):</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID: ___________________</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date:__________________</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ANSWER 1 – 6 JUST AFTER YOUR CHILD WAKES UP**

1. *Number of times child awakened during the night:* 0 1 2 3 ___

2. *Did child awaken before you today?* ___ Yes ___ No ___ Not Sure

3. *Time child finally woke up today:* _______________

4. *Child was awakened by:* ___ Just woke up ___ Parent/other person ___ Alarm___

5. *Time child finally got out of bed today:* _______________

**STOP! … Finish The Rest Of The Questions Later!!!**

**ANSWER 7-15 AFTER CHILD FALLS ASLEEP AT NIGHT**

6. *Did any of these happen today?* ___ Child sick ___ School/day care cancelled ___ Holiday/Vacation ___ Missed School


8. *Any different medication today?* ___ Yes / No (Circle one) Type? _______________


10. *Tonight, child got into bed at (time):* _______________

11. *Lights out/child tried to fall asleep at (time):* _______________

12. *Length of time (minutes) for child to fall asleep after turning the lights out:* ____ minutes

13. Please tell me one exciting thing that happened today (Ex: child played with his new friend Eric).

____________________________________________________________________________
____________________________________________________________________________

**STOP!!! End Of Diary For Today!!!**
# Children's Sleep Wake Scale

The University of Southern Mississippi • Sleep Research Laboratory

## Questions 1 – 5 only concern your child **Going to Bed**.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Never</th>
<th>Once in a While</th>
<th>Sometimes</th>
<th>Quite Often</th>
<th>Frequently, if not always</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>When it’s time to go to bed, your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. …makes repeated requests (for example: asks for another drink, hug, story)</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>2. …wants to stay up and do other things (for example: read, play, or watch TV)</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>

## Questions 6 – 10 only concern your child **Falling Asleep**.

When it’s time to go to sleep (lights-out), your child...

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Never</th>
<th>Once in a While</th>
<th>Sometimes</th>
<th>Quite Often</th>
<th>Frequently, if not always</th>
<th>Always</th>
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<tbody>
<tr>
<td>Your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. …is ready to go to bed at bedtime</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>4. …complains about going to bed</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>5. …“puts off” or delays going to bed</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Never</th>
<th>Once in a While</th>
<th>Sometimes</th>
<th>Quite Often</th>
<th>Frequently, if not always</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. …is quiet and calm</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>7. …has trouble settling down</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Never</th>
<th>Once in a While</th>
<th>Sometimes</th>
<th>Quite Often</th>
<th>Frequently, if not always</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. …has trouble going to sleep</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>9. …needs help getting to sleep</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>10. …falls asleep quickly after “lights-out”</td>
<td>N</td>
<td>O</td>
<td>S</td>
<td>Q</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>
### Questions 11 – 16 only concern your child Arousing and Awakening during the night.

<table>
<thead>
<tr>
<th>Question</th>
<th>Always</th>
<th>Frequently, if not always</th>
<th>Quite Often</th>
<th>Sometimes</th>
<th>Once in Awhile</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the night, your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. tosses and turns in the bed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. is very restless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. moans, groans, or talks in sleep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. arouses, but does not fully awaken</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. awakens more than once</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. sleeps soundly through the night</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questions 17 – 21 only concern your child Returning to Sleep after waking during the night.

<table>
<thead>
<tr>
<th>Question</th>
<th>Always</th>
<th>Frequently, if not always</th>
<th>Quite Often</th>
<th>Sometimes</th>
<th>Once in Awhile</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>After arousing or awakening, your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. comes out of the bedroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. awakens other family members</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. calls out for the caretaker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. goes into someone else’s bed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. rolls over and goes back to sleep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questions 22 – 26 only concern your child Waking in the Morning.

<table>
<thead>
<tr>
<th>Question</th>
<th>Always</th>
<th>Frequently, if not always</th>
<th>Quite Often</th>
<th>Sometimes</th>
<th>Once in Awhile</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the morning, your child wakes up...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. without any help</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. and is ready to get up for the day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. rested and alert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your child...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. is slow-to-start in the morning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. is difficult to get out of the bed in the morning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

FOOD DIARY

3 Day Food Diary

Instructions:
1. Please do not change your child’s normal diet during this time.
2. List foods right after they are eaten.
3. You do not have to list foods eaten that were provided by the school (foods served in the School Breakfast or Lunch Program).
4. Record one food item per line.
5. Indicate how the food was prepared.
   - If cooked, how was it cooked? (Ex: Grilled, fried, baked, etc.)
   - Was the item frozen, fresh, or canned?
6. Include the brand name when possible.
7. List drinks and toppings such as margarine, salt, gravy, sugar, chocolate syrup, jam/jelly, ketchup, etc.
8. Report the amount eaten, not served.
   - Report amounts eaten in cups, ounces, tablespoons, and teaspoons and count items, such as “3 chicken nuggets.”
   *Example: 8 fluid ounces of milk instead of 1 glass of milk*
9. The following guide is an easy way of estimating amounts eaten:

Handful = 1-2 oz.
Example:
1 oz. nuts = 1 handful or 2 oz. pretzels = 2 handfuls

Fist = 1 cup
Example: Two servings of pasta or oatmeal

Palm = 3 oz.
Example: A cooked serving of meat.

Thumb = 1 oz.
Example: Piece of cheese
<table>
<thead>
<tr>
<th>Time</th>
<th>Food Provided By:</th>
<th>Food Item &amp; Method of Preparation</th>
<th>Amount Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00am</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00am</td>
<td>H</td>
<td>Nutrigrain Bar- Strawberry</td>
<td>1 bar</td>
</tr>
<tr>
<td>12:00pm</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00pm</td>
<td>O</td>
<td>Banana</td>
<td>1 small</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Milk</td>
<td>½ pint (1 cup)</td>
</tr>
<tr>
<td>6:00pm</td>
<td>H</td>
<td>Iron Kids Bread</td>
<td>2 slices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oscar Mayer Turkey breast</td>
<td>2 oz.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kraft 2% American cheese</td>
<td>1 slice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heinz Mustard</td>
<td>2 tsp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Campbell’s Chicken and Stars Soup</td>
<td>1 cup</td>
</tr>
</tbody>
</table>
WEEKDAY 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Food Provided By:</th>
<th>Food Item &amp; Method of Preparation</th>
<th>Amount Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H: Home</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S: School (no record)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>O: Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Name __________________________________________

Date ____________________________
APPENDIX E

VISUAL PLATE WASTE

Date:___________________ Observer:_____________________________

☐ School Breakfast   OR   ☐ Brought Food from Home

☐ Female   OR   ☐ Male

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Start how much</th>
<th>At end, how much left?</th>
<th>Amount Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:

☐ School Lunch   OR   ☐ Brought Food from Home

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Start how much</th>
<th>At end, how much left?</th>
<th>Amount Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:
APPENDIX F

HUMAN SUBJECTS APPROVAL

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the “Adverse Effect Report Form”.
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 28032801
PROJECT TITLE: Napping Into and Beyond Kindergarten: Implications for Sleep, Cortisol, and Diet
PROPOSED PROJECT DATES: 04/01/08 to 12/01/08
PROJECT TYPE: Dissertation or Thesis
PRINCIPAL INVESTIGATORS: Alyssa Cairns
COLLEGE/DIVISION: College of Education & Psychology
DEPARTMENT: Psychology
FUNDING AGENCY: N/A
HSPRC COMMITTEE ACTION: Expedited Review Approval
PERIOD OF APPROVAL: 03/28/08 to 03/27/09

Lawrence A. Hosman, Ph.D.
HSPRC Chair

4/2/09 Date
THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
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PROTOCOL NUMBER: R28032801
PROJECT TITLE: Napping Into and Beyond Kindergarten: Implications for Sleep, Cortisol, and Diet
PROPOSED PROJECT DATES: 04/01/2009 to 12/01/2010
PROJECT TYPE: Previously Approved Project
PRINCIPAL INVESTIGATORS: Alyssa Anne Cairns
COLLEGE/DIVISION: College of Education & Psychology
DEPARTMENT: Psychology
FUNDING AGENCY: National Institute of Child Health and Development
Grant # F31 HD057765
HSPRC COMMITTEE ACTION: Expedited Review Approval
PERIOD OF APPROVAL: 02/23/2010 to 02/22/2011

[Signature]
Lawrence A. Hosman, Ph.D.
HSPRC Chair

[Signature]
2-24-10
Date
REFERENCES


Peszka, J., Harsh, J., & Hartwig, G. (1998). Obesity and obstructive sleep apnea- is REM suppression related to weight gain?


Taheri, S. (2006). The link between short sleep duration and obesity: We should recommend more sleep to prevent obesity. *Archives of Disease in Childhood, 91*(11), 881-884.


