EXAMINATION OF SLEEP DISPARITIES AMONG A RACIALLY/ETHNICALLY DIVERSE SAMPLE OF ADOLESCENTS

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Racial, ethnic and gender disparities have been found among a variety of health variables, but to date no study has comprehensively examined whether similar differences exist between sleep variables such as duration, efficiency and quality, in early adolescence. There is a general consensus among previous literature that adolescence is a time when a decrease in total sleep time and an increase in sleep problems are observed. Previous literature, however, mainly focused on the influence of puberty to explain these changes. The current study examined if differences exist between 1462 Caucasian, Hispanic/Latino, and African American early adolescents (ages 10-14 years) on sleep duration, efficiency and quality. Results showed that adolescent boys reported significantly longer sleep durations, better sleep quality, shorter sleep onset latencies, and later rise times than girls. Results also showed that sixth graders slept longer than seventh and eighth graders, and that seventh graders woke up much earlier than the other two grades. Lastly, results showed that Caucasian students reported longer sleep onset latencies and lower sleep efficiencies than African American students. Trends were observed for boys having greater sleep efficiencies than girls and for Caucasian students sleeping longer than Hispanic students. Based on the differences observed in our sample, introducing sleep education in middle school is discussed.
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CHAPTER 1
INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC, 2011), health disparities are preventable differences that impact socially disadvantaged populations, such as between genders, and race or ethnicity. These differences may also be related to education, such that individuals with higher levels of education are more likely to obtain and understand basic health information. There is evidence that there are racial/ethnic and gender health disparities in depression, anxiety, obesity, hypertension, hypercholesterolemia, and diabetes (Fryar, Hirsch, Eberhardt, Yoon & Wright, 2010; Taylor, Lichstein, Durrence, Reidel & Bush, 2005; Thomas, Temple, Perez, & Rupp, 2011). Research shows that sleep variables may also be related to the significant health problems mentioned above (Bopparaju & Surani, 2010; Gangwisch et al., 2010; Javaheri, Storger-Isser, Rosen, & Redline, 2008; Lytle, Pasch, & Farbakhsh, 2010; Taylor et al., 2005). As these health problems are in some way related to poor sleep, and disparities are evident amongst these health problems in racially/ethnically diverse populations and between genders, it is worth examining whether or not similar disparities exist among various sleep variables between racially/ethnically diverse individuals. Further, all of the above mentioned health problems oftentimes first emerge during adolescence (Golub, 2000); therefore, examining differences among sleep variables between different racial/ethnic groups and genders in healthy adolescents would be beneficial.

Although there appear to be disparities between races/ethnicities and genders on sleep (Durrence & Lichstein, 2006; Hale & Do, 2007; Lauderdale et al., 2006; Mezick et al., 2008; St-Onge et al., 2010), no study has comprehensively examined sleep duration, efficiency and quality between different racial/ethnic groups and genders in healthy, early adolescents. Rather, most sleep research in adolescents has focused on the influence of puberty and has been
performed in high school (e.g., 14-18 years old) students (Laberge et al., 2001). Early adolescence (e.g., 10-14 years old) is an important age range to focus on because this is a time when health habits and behaviors develop that carry over into adulthood (Rivera, Park, & Irwin, 2009), and during which children gain more autonomy from their parents, and therefore, more say in their bedtimes and rise times.

Sleep

Sleep patterns, whether measured by self-report or polysomnography, vary from person to person, from night to night, and across ages. There is a general consensus among previous literature that adolescence is a time when several changes occur in typical sleep patterns. These changes include a decrease in total sleep time as well as potentially longer sleep latencies and lower sleep efficiencies, when compared to younger children (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004). Unfortunately, the use of varying age ranges makes it difficult to generalize results found from one study to the next. Some studies, for example, examined sleep variables in boys and girls aged 5 to 16 years old, while others examined the same variables in 5 to 12 year olds and 13 to 19 year olds. In addition, few studies have compared different ages or grades to see if there is a clear demarcation point in adolescence when sleep problems begin to develop. It should be clear that different variables are affecting sleep in an 11-year-old adolescent, compared to the sleep of a 5 year old or that of an 18 year old.

Iglowstein, Jenni, Molinari & Largo (2003) calculated and described percentile curves for nighttime sleep duration, daytime sleep duration, and total sleep duration (e.g., the sum of nighttime and daytime sleep) from a sample of 493 individuals from the Zurich Longitudinal Studies (see Figure 1). All participants were followed from birth through 16 years of age at set intervals of time (i.e., 1, 3, 6, 9, 18, and 24 months, and every year from 3 to 16 years of age). Nighttime sleep duration and daytime napping were calculated from parent-reported typical
bedtimes, wake times, nap duration, and nap frequency for the three months prior to each visit. As can be seen in Figure 1, the results of this study indicate that total sleep duration (i.e., including daytime naps) averages 14.2 hours a day for infants with a standard deviation (SD) of nearly two hours (Iglowstein et al., 2003). The duration then steadily decreases to 8.1 hours at the age of 16 and becomes much less variable (SD = 0.7). It is possible that the information presented in this study may not be as accurate for adolescents (i.e., older than 10 years old), as they are likely to require less attention at night, and thus their parents may not be aware of their nighttime sleep behaviors (Sadeh, 2008). In addition, the authors did not attempt to determine when significant changes in sleep duration occurred, nor did they report on other variables that define sleep such as efficiency or quality.

Results of a recent meta-analysis on quantitative sleep patterns in healthy individuals indicate that both total sleep time and sleep efficiency decrease with age, while time spent awake in bed was found to increase with age (Ohayon et al., 2004). Interestingly, there was little change in sleep efficiency or time awake in bed from childhood to adolescence. A potential problem with this meta-analysis was that it compared studies that utilized in-laboratory polysomnography (PSG) with at-home ambulatory monitoring systems to capture nighttime sleep patterns. This is troublesome as sleep in the laboratory is not always similar to sleep in the home for various reasons. Additionally, though the authors examined changes in sleep patterns across the lifespan, they grouped several ages into single categories (e.g., children = 5 to 12 year olds; adolescents = 13 to 18 year olds; young adults = 18 to 40 year olds), which does not allow for the examination of changes that may occur between each age (e.g., from 10 to 11 years of age, or 11 to 12 years, etc.). Further, they did not report on differences or changes in sleep patterns that may occur between genders or races/ethnicities.
Gender. Several studies suggest that the sleep parameters of adult women are all around better than the sleep parameters of men. For instance, women self-report longer total sleep time than men (Hale & Do, 2007; St-Onge et al, 2010; Unruh et al., 2008). The results of these self-report studies are consistent with studies that utilized objective polysomnography recordings and state that women have a better sleep efficiency and spend less time awake in bed compared to men (Goel, Kim, & Lao, 2005; Jean-Louis, Kripke, Ancoli-Israel, Klauber & Sepulveda, 2000; Lauderdale et al., 2006; Unruh et al., 2008).

Gender differences among children in sleep research are more mixed and difficult to interpret because, as previously stated, studies often span multiple age ranges (i.e., childhood, early and late adolescence) or use varying modalities for data collection (e.g., parent report, single item self-report, PSG, actigraphy). For instance, a CDC report indicated that high school girls were more likely than boys to sleep less than 8 hours on an average school night (71.8% vs. 66.7% respectively; CDC, 2009). This study only included one single-time-point retrospective estimate on sleep, which gauged the amount of hours of sleep the high school students received on a single school night. Conversely, in a study of 2669 Turkish schoolchildren (mean age 8.2 ± 2.4 years; 51% girls), girls were found to have a tendency to sleep longer than boys (Arman et al., 2010). In this study, parents completed a questionnaire on typical school day bedtimes, risetimes, and sleep onset latency for the most recent week of sleep. Still, other studies indicate that no differences exist between early adolescent (i.e., age 11-14 years) or high school (i.e., age 14-18 years) boys and girls on total sleep time (Lee, McEnany, & Weekes, 1999; Wolfson & Carskadon, 1998; Yang, Kim, Patel & Lee, 2005).

Regardless of the number of hours of sleep that boys and girls receive a night, total sleep time does not present a complete image of what an individual’s sleep looks like. This is where sleep efficiency and variables of sleep continuity come into play. Literature indicates that
females have higher sleep efficiencies than males (Jean-Louis et al., 2000; Sadeh, Dahl, Shahar, & Rosenblat-Stein, 2009), which suggests that females may have less interrupted sleep than males. However, similar to total sleep time, the literature on sleep continuity (e.g., time awake in bed) in adolescents also appears quite mixed. For example, girls from Korean middle schools and high schools were found to report significantly longer time awake in bed than boys (Yang et al., 2005), while no difference was found between girls and boys in San Francisco middle schools (Lee et al., 1999).

Race/Ethnicity. Several studies on adult populations show that African American adults report shorter total sleep times, lower sleep efficiency, and poorer sleep quality than Caucasian adults (Beatty et al., 2011; Durrence & Lichstein, 2006; Lauderdale et al, 2006; Mezick et al, 2008; St-Onge et al, 2010). However, very little research has been done to compare sleep between ethnicities in children and adolescents. One study found that among 2- to 8-year-old children in southern Mississippi, African American children slept less at night and napped significantly more during the day than Caucasian children based on caretaker reports (Crosby, LeBourgeois, & Harsh, 2005). Despite these identified differences in sleep patterns, Crosby et al. noted that there was little difference in the overall total sleep duration (i.e., nocturnal sleep plus daytime naps) between the two racial/ethnic groups. Unfortunately, it is difficult to extrapolate these results to adolescent populations.

To date, no studies have comprehensively compared African Americans, Caucasians, and Hispanics on sleep duration, efficiency, and quality. One study of adults identified that non-Hispanic Blacks, non-Hispanic “others”, and non-Mexican Hispanics had higher odds of reporting short sleep durations compared to Whites, with non-Hispanic Blacks having the highest odds (Hale & Do, 2007). Another study reported that both African-Americans and Latinos had increased odds for poor sleep compared to Caucasians (Patel, Grandner, Xie, Branas, &
Gooneratne, 2010). Unfortunately, because both studies were performing secondary analyses of existing datasets, neither could report nighttime sleep durations or other sleep continuity variables, because the parent study only asked one or two questions about sleep (i.e., “total hours usually slept during a 24-hour day, including naps” and “In general, how would you rate the quality of your sleep in the past week on a scale from 1 to 5, with 1 being restless and 5 being restful,” respectively).

Perhaps the best study of health disparities in adolescent sleep patterns utilized polysomnography in a small ($N=96$) group of racially diverse teens (mean ages ranging from $14.8 \pm 1.5$ to $15.3 \pm 1.5$). This study found that African American adolescents had lower sleep efficiencies than Asian American, Mexican American and non-Hispanic White adolescents. Further, African American boys had lower sleep efficiencies than African American girls (Rao, Hammern, & Poland, 2009). The relatively small sample size (i.e., 18 Asian American, 19 Mexican American, 13 African American, 46 non-Hispanic White) in this study makes generalization of results difficult. It is curious that they found results with such a small sample of people, as those small of numbers could easily have resulted in spurious results. One also has to worry if there was a selection bias (i.e., were the African American and Hispanic children representative) given the willingness to come into a sleep study, and if there were any cultural reactions to sleeping in a sleep lab. Finally, as previously mentioned, sleep reported in overnight sleep studies is difficult to characterize as a “normal” night’s sleep.

Summary

In sum, little research on sleep duration, efficiency and quality exists between young adolescent boys and girls of different races/ethnicities. This is particularly important because this age range is a developmentally advantageous time to intervene on sleep behaviors, as sleep education can reach all children at school, regardless of race/ethnicity or socioeconomic status,
and sleep is a health behavior over which adolescents have more autonomy as they grow older. The ability to identify adolescents that are at higher risk for sleep difficulties and to intervene early can perhaps prevent or delay the onset of subsequent more serious consequences (e.g., lower academic achievement, depression, anxiety, obesity, diabetes, cardiovascular disease). Additionally, sleep in general might be easier to intervene on during adolescence, because a number of effective behavioral interventions for sleep problems have been developed and target this age range (Moseley & Gradisar, 2009). Introducing interventions in the school system may also reduce health disparities stemming from the lack of education about healthy sleep behaviors, as all children regardless of race/ethnicity, gender or socioeconomic status have equal opportunity to receive information on better sleeping habits.

Perhaps the primary limitation of previous research is that it failed to account for other characteristics of sleep continuity, such as sleep efficiency (i.e., ratio of sleep duration to time spent in bed) and sleep quality, both of which are important because they take into account several factors of sleep (e.g., time awake in bed trying to sleep and feelings of fatigue/restfulness upon morning awakening; Pilcher, Ginter, & Sadowsky, 1997) that are not accounted for by total sleep time alone. Another major limitation is that many of the studies (Arman et al., 2010; Crosby et al., 2005; Iglowstein et al., 2003; Laberge et al., 2001) used parent-report questionnaires, which may become less accurate as children age and require less oversight by parents. Finally, no previous study has comprehensively examined sleep differences between both gender and race/ethnicity across different ages in an adolescent sample.
CHAPTER 2
CURRENT STUDY

The aim of the current study was to examine and describe the relationship between race/ethnicity, gender, and grade on sleep duration, efficiency and quality in a sample of early adolescents (i.e., 10 to 14 year olds) attending middle school. Participants were Black/African-American, Hispanic/Latino, and White/Caucasian early adolescents ages 11-14. Sleep variables included self-reported total sleep duration, sleep efficiency and sleep quality over seven days on the Pittsburg Sleep Quality Index (PSQI). Based on previous research (Arman et al., 2010; Iglowstein et al., 2003; Jean-louis et al., 2000; Rao et al., 2009; Sadeh et al., 2009; Yang et al., 2005;) we expected to find total sleep duration to decrease as students progress through middle school, girls to report longer sleep durations, greater sleep efficiency and better sleep quality than boys, and for Caucasian students to sleep better than Hispanic and African American students, with no differences between Hispanic and African American students. There is not sufficient research to predict interactions at this point.
CHAPTER 3

METHODS

Participants

This study examined a large ($N = 1556$) racially/ethnically diverse sample of female (50.8%) and male (49.2%) middle school students (mean age = 12.34) from six different middle schools in a north Texas school district. Race/ethnicity characteristics of this sample include 64.5% Caucasian, 24.4% Hispanic/Latino, and 11.1% African American early adolescents.

Measures

Information on the students’ race/ethnicity, gender, grade level, and age, was provided by the school district. Information on subjective sleep duration, sleep quality, and variables to calculate sleep efficiency (e.g., sleep onset latency, bedtimes and risetimes), was obtained by student self-report on the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

Sleep variables. The PSQI is a 19-item self-rated questionnaire assessing the domains of subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Fifteen multiple-choice items and 4 write-in items yield scores from 0 (no difficulty) to 3 (severe difficulty) on these seven domains, which summed together produce a global score ranging from 0 – 21. A score greater than 5 is indicative of poor sleep. In the present study, all 4 write-in items were used and 11 of the 15 multiple-choice items were used. Four items were excluded that assessed the use of sleep medications, daytime dysfunction (e.g., trouble staying awake while driving), and bed partner/roommate reports of nighttime sleep behaviors, because they did not appear to apply to adolescents. The instructions to the PSQI were modified to ask students to reflect on their usual
sleep habits during the past seven days rather than during the past month, to match the time reference of other questionnaires in the parent study (see appendix).

For the purpose of the current study, Items 1 (“At what time have you usually gone to bed at night?”), 2 (“How long (in minutes) has it usually taken you to fall asleep each night?”), 3 (“When have you usually gotten up in the morning?”), and 4 (“How many hours of actual sleep did you get at night?”) were used to determine differences in bedtime, sleep onset latency, rise time, and total sleep duration respectively. Component scores were also calculated for those components that had completed items (e.g., subjective sleep quality, habitual sleep efficiency, sleep disturbances) and a total score, which gave a global assessment of sleep quality, but is not comparable to previous studies due to the exclusion of the four inappropriate items.

Procedures

This study was part of a larger investigation examining a variety of psychosocial and physical constructs, and was approved by the university Human Subjects Research Institutional Review Board (IRB), the school district administrative offices, and the principals at each of the six middle schools in the Denton Independent School District. Parental consent and child assent was obtained before participation in the study. Students took approximately 30 minutes to complete questionnaires during their physical education class, in which they all participated in annual fitness testing. Upon completion of the questionnaires, students at each school were entered into a lottery drawing for cash prizes (Petrie, Greenleaf, & Martin, 2010). All data collection took place during the regular school year (2010-2011).

Data Analysis

Prior to running analyses, the data was examined for missing data and outliers, and cleaned through imputation if missing data was >5%, and transformation if there were extensive outliers. Following this, frequencies were run for the categorical variables of race/ethnicity,
gender, and grade. Descriptive statistics were run for the continuous variables of age, sleep
duration, sleep efficiency and sleep quality to examine whether the data met basic assumptions
of normality by examining skewness and kurtosis, and probability plots.

Next, a three-way multivariate analysis of variance (MANOVA) was performed with
race/ethnicity, gender and grade as the grouping variables and sleep duration, efficiency and
quality as the dependent variables. This helps control for inter-correlation between the variables
while decreasing experiment-wise error. If significant interactions were not found on the
MANOVA, significant main effects were reported and followed with analyses of variance
(ANOVAs) of those significant variables (i.e., race/ethnicity, gender, and grade) for each
dependent variable (i.e., total sleep duration, sleep efficiency, and sleep quality). If significant
interactions were found on the MANOVA, a series of ANOVAs were performed to compare
differences between groups for each dependent variable (i.e., total sleep duration, sleep
efficiency, and sleep quality). Significant ANOVA interactions were followed by simple effects
tests to identify where significant interactions existed.

As the literature on other variables of sleep continuity (e.g., sleep onset latency, bedtime
and rise time) is very limited, exploratory analyses were performed in the form of a three-way
MANOVA with race/ethnicity, gender and grade as the grouping variables and variables of sleep
continuity as the dependent variables. Similar to the primary analyses, if significant interactions
were not found on the MANOVA, significant main effects were reported and followed with
ANOVAs of those significant variables (i.e., race/ethnicity, gender, and grade) for each
dependent variable (e.g., sleep onset latency, bedtime and rise time). If significant interactions
were found on the MANOVA, a series of ANOVAs were performed to compare differences
between groups for each dependent variable (i.e., sleep onset latency, bedtime and rise time).
Significant ANOVA interactions were followed by simple effects tests to identify where significant interactions exist.
CHAPTER 4

RESULTS

Missing Data and Outliers

Prior to running analyses, data was examined for missing data and outliers. Thirty-eight participants were excluded for missing age, race/ethnicity, or grade information, 13 participants were excluded for being outside of the 11- to 14-year-old age range, and 59 participants were excluded based on race/ethnicity criteria, because cell sizes would have been inadequate to power comparisons (i.e., 52 Asian, 6 American Indian/Alaskan Native, 1 Filipino). Although differences between ethnicities with 52 participants would have been able to be compared, there would not have been enough power to examine interactions due to inadequate cell sizes (i.e., 10 male and 15 female sixth graders, 9 male and 8 female seventh graders, and 5 male and 5 female eighth graders).

Additionally, 47 participants were excluded for missing more than one of the four core sleep variables (i.e., bedtime, rise times, sleep onset latency, and total sleep time), because this precluded the ability to impute missing data. For the 52 cases that were missing only one of the four core sleep variables, the missing data was imputed by using the three available sleep variables to calculate the most likely missing variable. Bedtime was calculated for 13 cases by subtracting the sum of reported sleep onset latency and hours of actual sleep from the reported rise time. Rise time was calculated for 4 cases by adding the sum of reported sleep onset latency and hours of actual sleep to the reported bedtime. Sleep onset latency was calculated for 22 cases by first calculating time in bed from reported bedtime and rise time, and then subtracting reported hours of actual sleep. Finally, total sleep time was calculated for 13 cases by subtracting reported sleep onset latency from calculated time in bed. Following imputation of calculated
variables, 5 more cases were excluded from the dataset for impossible data (i.e., negative calculated sleep onset latency, reported rise time being earlier than bedtime).

The final sample included 1462 middle school girls (51.5%) and boys (48.5%), with an average age of 12.32 ($SD = .96$) years. Race/ethnicity characteristics of the final sample include 65.6% Caucasian, 23.9% Hispanic/Latino, and 10.5% African American students. Additionally, 41.9% of the final sample were sixth graders, 33.0% were seventh graders, and 25.1% were eighth graders.

**Three-Way-MANOVA**

A 2 (Gender) x 3 (Grade) x 3 (Race/Ethnicity) between-subjects multivariate analysis of variance (MANOVA) was performed with the dependent variables of sleep duration, sleep efficiency and sleep quality. Box’s test of equality of covariance matrices was significant ($p < .001$), suggesting there was not homogeneity of the variance-covariance matrices of the dependent variables. This heterogeneity was likely related to outlier data produced by participants who reported longer or shorter sleep durations, or who yielded lower sleep efficiencies, as this may have produced distributions of varying levels of kurtosis across the independent variables. Pillai’s trace was used to test significance, as it is robust to violations of the homogeneity of the variance-covariance assumption (Tabachnick & Fidell, 2007).

Multivariate tests were significant for the main effects of gender (Pillai’s trace = .02, $F(3, 1344) = 9.34, p < .001$, partial $\eta^2 = .020$), grade (Pillai’s trace = .03, $F(6, 2690) = 7.09, p < .001$, partial $\eta^2 = .016$), and race/ethnicity (Pillai’s trace = .02, $F(6, 2690) = 5.20, p < .001$, partial $\eta^2 = .012$), but the interactions were not. Follow-up univariate analysis of variance (ANOVA) tests and Tukey HSD pairwise comparisons were used to investigate differences among the individual dependent variables. Levene’s test of equality of error variances was violated for total sleep time
and sleep efficiency, therefore a more conservative alpha level of .025 was used to determine significance among these variables (Tabachnick & Fidell, 2007).

Follow-up univariate tests revealed that boys reported significantly longer sleep durations and better sleep quality than girls (ps < .01), with a trend for sleep efficiency (see Table 1 for descriptive statistics and pairwise comparisons).

Follow-up univariate tests revealed significant differences between grades on sleep duration (p < .001), but not on sleep quality or efficiency. Pairwise comparisons demonstrated sleep duration was significantly different between sixth graders and both seventh and eighth graders, but not between seventh and eighth graders (see Table 2 for descriptive statistics and pairwise comparisons).

Follow-up univariate tests revealed significant differences between race/ethnicity on sleep efficiency (p < .025) and a trend towards significance for sleep duration. No differences were observed between race/ethnicity on sleep quality. Pairwise comparisons revealed African American students reported significantly higher sleep efficiencies than Caucasian students (p < .025), but no differences were observed between Hispanic and Caucasian or African American students. Additionally, a trend towards significance was observed on sleep duration, such that Caucasian students reported longer sleep durations than Hispanic students, while no differences were observed on sleep duration between African American and Caucasian or Hispanic students (see Table 3 for descriptive statistics and pairwise comparisons).

Exploratory Analyses

A 2 (Gender) x 3 (Grade) x 3 (Race/Ethnicity) between-subjects multivariate analysis of variance (MANOVA) was performed with the dependent variables of sleep onset latency, bedtime, and rise time. Box’s test of equality of covariance matrices was significant (p < .001), suggesting there was not homogeneity of the variance-covariance matrices, so Pillai’s trace was
used to evaluate multivariate significance. Multivariate tests were significant for the main effects of gender (Pillai’s trace = .01, $F(3, 1442) = 5.57, p = .001$, partial $\eta^2 = .011$), grade (Pillai’s trace = .01, $F(6, 2886) = 2.60, p = .016$, partial $\eta^2 = .005$) and race/ethnicity (Pillai’s trace = .01, $F(6, 2886) = 2.68, p = .013$, partial $\eta^2 = .006$). Additionally, a significant interaction effect was observed for grade-by-race/ethnicity (Pillai’s trace = .02, $F(12, 4332) = 1.90, p = .030$, partial $\eta^2 = .005$); however, because Levene’s test of equality of error variances was violated for all variables (i.e. bedtime, rise time and sleep onset latency) in follow-up analyses, an alpha level of .025 was used to determine significance among these variables, and subsequently reduced the significant grade-by-race/ethnicity interaction on rise time to a trend. Further, as this interaction for rise time was no longer significant, main effects for rise time among grade and race/ethnicity were interpreted.

Follow-up ANOVAs and Tukey HSD pairwise comparisons were used to investigate differences among the individual dependent variables. Follow-up univariate tests revealed that boys reported significantly shorter sleep onset latencies, and later rise times compared to girls. No differences were observed for bedtime between genders (see Table 1). Follow-up univariate tests also revealed that seventh graders wake up significantly earlier than sixth or eighth graders, but no differences were observed between the rise times of sixth or eighth graders. No differences were observed for grade on sleep onset latency or bedtime (see Table 2).

With respect to race/ethnicity, a main effect was only observed for sleep onset latency, such that Caucasian students reported significantly longer sleep onset latencies than African American students ($p < .01$), but not Hispanic students (see Table 3), and no differences were observed between African American and Hispanic students on this variable. No differences were observed between race/ethnicity on bedtime, or rise time; however, a trend towards significance was observed for a grade-by-race/ethnicity interaction on rise time. After collapsing across
genders, rise time appeared to vary between races/ethnicities across the three grades. Specifically, African American and Caucasian students woke up much earlier in seventh grade than in sixth or eighth grade. In addition, the rise time of Hispanic students steadily increased from sixth to eighth grade (see Figure 2).
CHAPTER 5
DISCUSSION

The aim of the current study was to comprehensively examine and describe the relationship between gender, grade, and race/ethnicity on a variety of sleep variables in a sample of early adolescents. Surprisingly, adolescent boys in the sample reported significantly better sleep than girls (i.e., longer sleep durations, better sleep quality, shorter sleep onset latencies, later rise times, and a trend towards greater sleep efficiencies). Results also showed that sixth graders slept longer than seventh and eighth graders, and that seventh graders woke up much earlier than the other two grades. Additionally, results showed that Caucasian students slept significantly worse (i.e., longer sleep onset latencies and lower sleep efficiencies) than African American students, but had a trend to sleep longer than Hispanic students.

With respect to gender differences, based on previous research, it was hypothesized that girls would report longer sleep durations, greater sleep efficiency and better sleep quality than boys; however, the results of the current study yielded the opposite of what was expected. For instance, Arman and colleagues (2010) reported that girls slept on average approximately 10 minutes more than boys, whereas girls in our study slept on average approximately 18 minutes less than boys. This discrepancy, however, may in part be due to the difference in method of data collection (i.e., parent-report vs. self-report) and age between the samples (i.e., 8.2 vs. 12.3). Further, it is possible that a puberty-related phase delay may have played a role in these differences, as girls enter puberty earlier (10 or 11 years old) than boys (12 years old; American Medical Association, 2001). Similar to Lee et al. (1999), we found that girls wake up earlier than boys; however, unlike the early adolescent boys and girls in their study, we also observed differences in sleep onset latency, such that boys reported shorter sleep onset latencies than girls. It is possible that the adolescent girls in our sample took longer to fall asleep because of late
night socializing (i.e., instant messaging or bedtime texting) with friends. Though we did not gather information on this nighttime behavior, research does show significant phone use after lights out (Van den Bulck, 2007), and that females are more likely to use text messaging (Faulkner & Culwin, 2005), instant messaging and social networking sites than males (Pujazon-Zazik & Park, 2010). Similar to sleep onset latency, though not statistically significant, Lee and colleagues (1999) found that girls reported more awake time after sleep onset than boys, which, with longer sleep onset latency, suggests that girls would have lower sleep efficiencies (a variable that Lee et al. did not assess). The findings of our study did in fact show a trend towards girls having lower sleep efficiencies than boys, which is in line with girls having longer sleep onset latencies as well. Once again, the lower sleep efficiency reported by girls, may be attributed to bedtime texting or messaging behavior, as this activity would keep them awake while in bed. Lastly, it is to be expected that if boys had shorter sleep onset latency and slept longer than girls, that they would also report better sleep quality, as research shows a moderate association between sleep efficiency and sleep quality (Palermo, Fonareva, & Janosy, 2008).

As hypothesized, sleep duration was found to decrease as students progressed through middle school. This may possibly be due to age-related changes that were found to impact sleep duration, such as increased nighttime awakenings (Arman et al., 2010) and delayed bedtime (Taylor et al., 2005; Wolfson and Carskadon, 1998; Yang et al., 2005). In our study, however, differences in bedtime were not observed between grades. Rather, our results revealed differences in rise time, such that seventh graders woke up much earlier than sixth or eighth graders. These results are somewhat in line with other studies that state rise times get earlier as grade level increases (Yang et al., 2005; Wolfson & Carskadon, 1998); however, in our study, eighth graders reported later rise times than seventh graders. This discrepancy is most likely due to the Denton Independent School District middle school athletic practice schedule, as seventh
grade sports teams across the district meet for practice between 7:00 and 7:15 in the morning and through first period, while eighth grade sports teams meet for practice during the last period (2:45PM) and/or after school (R. Reeves, personal communication, March 27, 2012). It is surprising that our results did not yield differences in bedtime as grade levels increased, as previous literature reports otherwise. In particular, Yang and colleagues (2005) found that entertainment (i.e., internet and television use) and academic demands affected the sleep/wake patterns of 1,457 Korean 5th- to 12th-grade students, such that students reported later bedtimes as grade levels increased. It is likely that these differences were not observed in our sample, because our participants were restricted to a smaller grade range (i.e., 6th to 8th grade compared to 5th to 12th grade), which argues for more research studies on age-restricted samples of adolescents in the future, as individuals across the adolescent age range (i.e., 10 through 24 years) are not the same.

With respect to racial/ethnic differences, it was hypothesized that Caucasian students would have better sleep than Hispanic and African American students, with no differences found between the sleep characteristics of Hispanic and African American students. Surprisingly, African American students presented with shorter sleep onset latencies and higher sleep efficiencies than Caucasian students, indicating that they spend less time awake in bed. Further, a trend was observed suggesting that Caucasian students have longer sleep durations than Hispanic students, but not African American students. These results are incongruent with previous literature that demonstrated that African Americans take longer to fall asleep, have shorter sleep durations, and have poorer sleep efficiency than Caucasians (Durrence & Lichstein, 2006; Mezick et al., 2008, Rao et al., 2009). It is possible that parent-set bedtimes may be responsible for the discrepancies seen in our results. Specifically, research on infant and toddler sleep shows that African American parents are less likely to enforce regular bedtimes compared to Caucasian
parents (Lozoff, Askew, & Wolf, 1996). Though our sample was comprised of early adolescents and reason for going to bed was not measured in our study, it is possible that Caucasian parents set strict bedtimes for their children, while African American parents did not. It is also possible that because these adolescents were so young, their parents may have had similar sleep expectations for them as for even younger children (i.e., early bedtimes). If so, Caucasian students would have gone to bed at a time when they may not have been tired. It is difficult to fall asleep when not tired, so parents enforcing a regular bedtime is likely to result in a child lying in bed awake for a longer period of time before falling asleep, thus resulting in a longer sleep onset latency, as seen in Caucasian students. Lastly, our results indicating that there were no differences on sleep quality between races/ethnicities did not support our hypothesis; however, this is not surprising given that the literature on sleep quality between race/ethnicity is inconsistent (Durrence & Lichstein, 2006). As expected, no differences were observed between Hispanic and African American students on the variables of sleep duration, efficiency or quality.

Limitations

There were several limitations in this study. As participants were from one independent school district in North Texas, it is possible that the results do not generalize to early adolescents in other regions of the country, or to other racial/ethnic groups or cultures. That said, this provided for a level of control for both school start times as well as extracurricular activities, as these were standardized across schools by the Denton Independent School District.

Another limitation of the current study was the use of the PSQI to measure sleep continuity in adolescents. The PSQI is a widely and internationally used instrument that maintains high reliability and validity in adult populations (Smyth, 2012), but it is difficult to determine whether the same would hold true for early adolescents. Additionally, the current study did not include four items that assessed the use of sleep medications, daytime dysfunction
(e.g., trouble staying awake while driving), and bed partner/roommate reports of nighttime sleep behaviors in the survey, however, these items are likely of little relevance to young adolescents. Regardless of these limitations, it is the best available sleep quality index, and gathers more detail on sleep parameters than other self-report or parent-report measures currently available for younger populations.

Implications and Future Directions

The results of this study show that differences do exist in the basic sleep patterns of early adolescents of different genders, grades, and races/ethnicities. It is important that these results be replicated in other samples, but in general they argue for a more detailed analysis of adolescent sleep across the age ranges before sweeping comments about adolescents as a whole, versus particular ages, can be made. Further, several factors that have not been examined in this study may be responsible for the differences observed. For example, the timing of sports practice clearly influenced the rise time of seventh graders. Future research should expand on this further, and examine how the sleep patterns of students who participate in sports and/or other extracurricular activities differ from students that do not partake in these activities. Similarly, future research should examine whether or not early adolescents have parent-set bedtimes, and also query adolescents about their pre-bedtime routine. Specifically, it would be beneficial to examine how nighttime socializing behavior (i.e., text messaging, instant messaging, surfing on social networking sites) differs among genders and how it subsequently impacts bedtime, sleep onset latency, and even time awake after sleep onset. Further, as four of the 19-items on the PSQI were not included in our adolescent questionnaire because they did not appear to apply to adolescents, research should focus on developing and validating a similar sleep quality index for early adolescents (i.e., 10 to 14 year olds) that does incorporate questions on sleep medications,
daytime dysfunction, co-sleeping practices, and bed partner/roommate reports of nighttime sleep behaviors.

Though the differences found in our study were not always in the direction expected, it is important to note that all students, regardless of gender, grade, or race/ethnicity, slept less than the 9.25 hours recommended for adolescents to maintain optimal daytime alertness (Carskadon et al., 1980). This is also important as shorter sleep has been found to be related to higher BMI, diabetes, hypercholesterolemia, and increased odds for pre-hypertension (Gangwish et al., 2007; Gangwisch et al., 2010; Mezick et al., 2010). Intervening early and promoting good sleep hygiene in middle school may improve sleep, and can perhaps prevent or delay the onset of subsequent more serious consequences (e.g., lower academic achievement, depression, anxiety, obesity, diabetes, cardiovascular disease).
Table 1

*Means, Standard Deviations, and Results of Univariate Tests for Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male Mean (SD)</th>
<th>Female Mean (SD)</th>
<th>F</th>
<th>p</th>
<th>Partial eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Duration (hours)</td>
<td>8.50 (.07)</td>
<td>8.20 (.06)</td>
<td>10.020</td>
<td>.002</td>
<td>.007</td>
</tr>
<tr>
<td>Sleep Efficiency (%)</td>
<td>96.03 (.29)</td>
<td>95.19 (.26)</td>
<td>4.790</td>
<td>.029</td>
<td>.004</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>3.30 (.04)</td>
<td>3.04 (.03)</td>
<td>24.280</td>
<td>.000</td>
<td>.018</td>
</tr>
<tr>
<td>Bedtime (hour)</td>
<td>21.47 (.15)</td>
<td>21.66 (.14)</td>
<td>.977</td>
<td>.323</td>
<td>.001</td>
</tr>
<tr>
<td>Rise Time (hour)</td>
<td>6.86 (.04)</td>
<td>6.67 (.04)</td>
<td>10.204</td>
<td>.001</td>
<td>.007</td>
</tr>
<tr>
<td>Sleep Onset Latency (minutes)</td>
<td>19.60 (1.25)</td>
<td>23.72 (1.17)</td>
<td>5.808</td>
<td>.016</td>
<td>.004</td>
</tr>
</tbody>
</table>
Table 2

Means, Standard Deviations, and Results of Univariate Tests for Grade

<table>
<thead>
<tr>
<th>Variable</th>
<th>6th Grade&lt;sup&gt;a&lt;/sup&gt;</th>
<th>7th Grade&lt;sup&gt;b&lt;/sup&gt;</th>
<th>8th Grade&lt;sup&gt;c&lt;/sup&gt;</th>
<th>F</th>
<th>p</th>
<th>Partial eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Duration (hours)</td>
<td>8.72 (.07)</td>
<td>8.27 (.08)</td>
<td>8.06 (.10)</td>
<td>18.460&lt;sup&gt;ab,ac&lt;/sup&gt;</td>
<td>.000</td>
<td>.027</td>
</tr>
<tr>
<td>Sleep Efficiency (%)</td>
<td>96.15 (.28)</td>
<td>95.19 (.32)</td>
<td>95.48 (.40)</td>
<td>2.802</td>
<td>.061</td>
<td>.004</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>3.25 (.04)</td>
<td>3.12 (.04)</td>
<td>3.14 (.05)</td>
<td>3.031</td>
<td>.049</td>
<td>.004</td>
</tr>
<tr>
<td>Bedtime (hour)</td>
<td>21.39 (.14)</td>
<td>21.59 (.17)</td>
<td>21.71 (.20)</td>
<td>.924</td>
<td>.397</td>
<td>.001</td>
</tr>
<tr>
<td>Rise Time (hour)</td>
<td>6.80 (.04)</td>
<td>6.64 (.05)</td>
<td>6.86 (.06)</td>
<td>4.968&lt;sup&gt;ab,be&lt;/sup&gt;</td>
<td>.007</td>
<td>.007</td>
</tr>
<tr>
<td>Sleep Onset Latency (minutes)</td>
<td>20.16 (1.24)</td>
<td>23.89 (1.41)</td>
<td>20.94 (1.75)</td>
<td>2.053</td>
<td>.129</td>
<td>.003</td>
</tr>
</tbody>
</table>

<sup>Note.</sup> Letter pairs indicate significantly different groups.
### Table 3

**Means, Standard Deviations, and Results of Univariate Tests for Race/Ethnicity**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hispanic&lt;sup&gt;a&lt;/sup&gt;</th>
<th>African American&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Caucasian&lt;sup&gt;c&lt;/sup&gt;</th>
<th>F</th>
<th>P</th>
<th>Partial eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Duration (hours)</td>
<td>8.26 (.07)</td>
<td>8.31 (.12)</td>
<td>8.47 (.04)</td>
<td>3.628</td>
<td>.027</td>
<td>.005</td>
</tr>
<tr>
<td>Sleep Efficiency (%)</td>
<td>95.49 (.29)</td>
<td>96.31 (.47)</td>
<td>95.02 (.17)</td>
<td>3.847&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>.022</td>
<td>.006</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>3.16 (.04)</td>
<td>3.17 (.06)</td>
<td>3.18 (.02)</td>
<td>.129</td>
<td>.879</td>
<td>.000</td>
</tr>
<tr>
<td>Bedtime (hour)</td>
<td>21.58 (.15)</td>
<td>21.63 (.24)</td>
<td>21.48 (.09)</td>
<td>.271</td>
<td>.763</td>
<td>.000</td>
</tr>
<tr>
<td>Rise Time (hour)</td>
<td>6.79 (.04)</td>
<td>6.73 (.07)</td>
<td>6.78 (.03)</td>
<td>.332</td>
<td>.718</td>
<td>.000</td>
</tr>
<tr>
<td>Sleep Onset Latency (minutes)</td>
<td>21.84 (1.31)</td>
<td>17.78 (2.06)</td>
<td>25.37 (.78)</td>
<td>7.383&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>.001</td>
<td>.010</td>
</tr>
</tbody>
</table>

*Note.* Letter pairs indicate significantly different groups.
Figure 1. Percentiles for total sleep duration per 24 hours from infancy to adolescence (adapted from Iglowstein et al., 2003).
Figure 2. Grade-by-race/ethnicity interaction for rise time.
APPENDIX

PITTSBURGH SLEEP QUALITY INDEX
Part C. The following questions relate to your usual sleep habits during the *past 7 days only*.

Your answers should indicate the most accurate reply for the majority of days and nights in the *past 7 days*.

<table>
<thead>
<tr>
<th>Question</th>
<th>AM/PM</th>
<th>MINUTES</th>
<th>AM/PM</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. At what time have you usually gone to bed at night?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. How long (in minutes) has it usually taken you to fall asleep each night?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. When have you usually gotten up in the morning?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. How many hours of actual sleep did you get at night?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. During the *past 7 days*, how often have you had trouble sleeping because you...

<table>
<thead>
<tr>
<th>Reason</th>
<th>Not during the past 7 days</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cannot get to sleep within 30 minutes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Wake up in the middle of the night or early morning</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c. Have to get up to use the bathroom</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d. Cannot breathe comfortably</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>e. Cough or snore loudly</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>f. Feel too cold</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>g. Feel too hot</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>h. Had bad dreams</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>i. Have pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>j. Other reason(s),</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>k. Please describe other reasons:___________</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

6. During the *past 7 days*...

<table>
<thead>
<tr>
<th>How would you rate your sleep quality overall?</th>
<th>Very good</th>
<th>Fairly good</th>
<th>Fairly bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
REFERENCES


