Published in final edited form as:
Sleep Med. 2011 March ; 12(3): 239–245. doi:10.1016/j.sleep.2010.07.020.

CORRELATES OF ADOLESCENT SLEEP TIME AND VARIABILITY IN SLEEP TIME: THE ROLE OF INDIVIDUAL AND HEALTH RELATED CHARACTERISTICS

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Abstract

Objectives—Adolescents are predisposed to short sleep duration and irregular sleep patterns due to certain host characteristics (e.g., age, pubertal status, gender, ethnicity, socioeconomic class, and neighborhood distress) and health-related variables (e.g., ADHD, asthma, birth weight, and BMI). The aim of the current study was to investigate the relationship between such variables and actigraphic measures of sleep duration and variability.

Method—Cross-sectional study of 247 adolescents (48.5% female, 54.3% ethnic minority, mean age of 13.7 years) involved in a larger community-based cohort study.

Results—Significant univariate predictors of sleep duration included gender, minority ethnicity, neighborhood distress, parent income, and BMI. In multivariate models, gender, minority status, and BMI were significantly associated with sleep duration (all $p<.05$), with girls, non-minority adolescents, and those of a lower BMI obtaining more sleep. Univariate models demonstrated that age, minority ethnicity, neighborhood distress, parent education, parent income, pubertal status, and BMI were significantly related to variability in total sleep time. In the multivariate model, age, minority status, and BMI were significantly related to variability in total sleep time (all $p<.05$), with younger adolescents, non-minority adolescents, and those of a lower BMI obtaining more regular sleep.

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Disclosure
None of the authors have conflicts of interest to disclose.

Conclusions—These data show differences in sleep patterns in population sub-groups of adolescents which may be important in understanding pediatric health risk profiles. Subgroups that may particularly benefit from interventions aimed at improving sleep patterns include boys, overweight, and minority adolescents.

Introduction

Adolescence is characterized by normative biological, psychological, and social changes that impact sleep duration and sleep schedules. In non-clinical samples, adolescents typically obtain less than the 9.2 hours of sleep that is recommended.[1–5] Lack of adequate sleep can lead to chronic patterns of sleep deprivation and attempts at "catch-up sleep," leading to increased variability in sleep patterns. Such poor sleep may lead to negative social, psychological, and public health consequences [6], including suicide and motor vehicle accidents[7], risk taking behaviors[8], increased pain, reports of poor overall health[9,10], and poor functioning at school[11,12] and work. In addition to biological variables (e.g., circadian timing)[13] and genetic factors[14,15], demographic and health-related variables may affect sleep duration and night to night variability. Identifying such associated variables would help to target interventions as well as provide directions for future research.

Factors impacting the variation of sleep duration among adolescent populations have not been well studied, though previous research with younger children underscores the need for further investigation. Minority ethnicity, socioeconomic status, and years of parental education have been shown to be associated with amount of sleep obtained in school age children. Generally, children of minority ethnicity and of lower socioeconomic status obtain less sleep and have more sleep problems than their counterparts. Spilsbury et al.[16] showed that minority boys were more than 4.8 times more likely than non-minority children to have bedtimes of 11 pm or later. Fredriksen et al.[5] found that adolescents who were more economically disadvantaged obtained less sleep. Roberts, Roberts, and Chen[17] found the direction and magnitude of the effect of minority status on symptoms of insomnia depended on the ethnic group, with Chinese-American youths at lower risk and Mexican youths at higher risk for insomnia. African-American children have also been shown to have a higher prevalence of sleep disordered breathing than European Americans[18], which is partly mediated by neighborhood disadvantage[19]. A related finding is that greater education has been associated with better sleep quality and with higher income in adults[20].

Gender has been shown to relate to amount of sleep, frequency of sleep disturbances, and circadian preferences, though the etiology of these effects are unknown. Results of various studies report contradictory findings about whether boys or girls obtain more sleep. For example, one study found that girls obtained less sleep than boys and reported greater sleep disturbances[21]. Another study showed that boys woke up later than girls on weekdays and hypothesized that this was a result of girls having more lengthy morning grooming routines[22]. Alternatively, at least one other study has found that boys obtain less sleep than girls[16]. Finally, one study found that girls reported a longer ideal sleep duration and that there are gender-related circadian preferences for morningness and eveningness in adolescents[23]. It is possible that inconsistencies in the results of existing studies may in fact reflect differences in the measurement of sleep time (e.g., parent report, self-report, sleep diary, actigraphy) or in the age of the participants in the study.

Previous studies also suggest that health-related variables such as asthma, obesity, and attention deficit hyperactivity disorder (ADHD) may be associated with sleep duration and sleep quality. Children with asthma may experience increased nocturnal awakenings due to poor control of asthma symptoms or because of unrecognized sleep disordered breathing[24]. In studies with both children and adults, body mass index (BMI) has also been associated with complaints of sleep problems, sleepiness, and decreased sleep time[25, 26]. Finally, several studies with children have found a relationship between the presence of ADHD and sleep problems[27–29].

Limitations of previous studies and contribution of current study

Previous research has demonstrated that decreases in sleep quantity, in part related to shifts to later bedtimes, occur with the onset of adolescence, which may be partly attributable to hormonally mediated changes in circadian rhythm[13]. However, there have been relatively few studies of the impact of demographic and health-related variables on sleep time or variability in sleep duration. Moreover, the conclusions that can be drawn from existing studies have been affected by methodological limitations, such as imprecise measurement of sleep duration. Much previous research has primarily relied on single item self-report or parent report of average total sleep time (i.e., “how many hours do you/does your child usually sleep at night”) or bedtimes and wake times, which may not be adequate in terms of validity or reliability. Recent studies have also shown that self-reports of sleep duration and quality may be distorted in certain populations, including anxious adults with higher levels of cognitive and physiological arousal[30] and adolescents with major depressive disorder[31].

The majority of prior studies have not used objective measures of sleep duration such as actigraphy or polysomnography (PSG). The use of actigraphy is a methodological strength, not only because of limitations related to adolescent and parent self-reported sleep time as described above, but also because this technique is less intrusive than PSG and, this may provide representative data over several days obtained in the adolescent’s usual sleeping environment.

Finally, adolescents are an understudied age group, yet adolescence is a time when health habits may begin to shape the emergence of health status in adulthood. Moreover, chronological age may not be the most sensitive variable for defining adolescence, as physiological changes in sleep are thought to relate to physiological changes in puberty[3, 32]. Thus, pubertal status is thought to be a more sensitive marker of physiological changes associated with adolescence, and in the current study Tanner staging was used to determine pubertal status.

Aims and Hypotheses

The primary aim of this study was to determine the relationship between sleep duration and individual subject characteristics (age, Tanner stage, parent education and income, neighborhood distress, gender, ethnicity) and health-related variables that may influence sleep in adolescents (ADHD, asthma, BMI). Based on previous research investigating individual characteristics that relate to sleep duration and variability in sleep duration[5, 16, 20], specific hypotheses were made about such characteristics. It was hypothesized that both environmental and host factors would be associated with sleep patterns. Specifically, we hypothesized that minority ethnicity, less parent education, lower parent income, and the presence of neighborhood distress would correlate with less mean total sleep duration and higher night-to-night variability. Additionally, it was hypothesized that male gender, higher BMI, the presence of asthma, and the presence of ADHD would relate to lower average sleep duration and higher night-to-night variability in sleep duration.

Methods

Participants

The study sample was derived from the Cleveland TeenZzz Study, an ongoing longitudinal cohort study designed to evaluate the role of sleep disturbances on health outcomes.

Cleveland TeenZzz Study participants represent a sample of adolescents, studied at ages 13 to 16 years, who initially participated in the Cleveland Children's Sleep and Health Study (CCSHS). The CCSHS is an urban community-based cohort of 907 children assembled as a stratified random sample of full-term and preterm children born at one of three Midwestern hospitals between 1988 and 1993, designed to over-represent African-American and former preterm children, as described previously[18]. Recruitment for the TeenZzz Study was designed to enroll at least 250 CCSHS participants, representing all snorers and children with SDB at the time of the CCSHS examination, and a stratified (gender, race, term) random sample of the remaining cohort. This sampling frame identified 389 potentially eligible children. Of those 389, 75.1% (292) agreed to participate, 14.9% refused, 10.0% could not be located, and <1% were ineligible due to illness (e.g., kidney failure, oral surgery, and mental illness). There were no differences on key demographic variables between those who decided to participate and those who did not. Of the families who refused to participate, the most common reasons were passive refusal (e.g., agreed to participate but did not respond to calls) (17.2%), too busy (19.0%), did not like blood work, needles, or hospitals (13.8%), or miscellaneous reasons (50.0%). Of the 292 who agreed to participate, adolescents with clinically significant levels of obstructive sleep apnea (obstructive apnea hypopnea index≥5, n=23) were excluded as previous studies have shown that actigraphy may systematically underestimate sleep time in those with sleep apnea[33, 34]. Adolescents whose actigraphy did not include at least two weekdays and one weekend day were also excluded (n=18), as one of the primary outcomes was night-to-night variability. Additionally, those with a severe medical illness (e.g., cerebral palsy; n=4) were also excluded. This brought the total sample to 247 (see Table 1 for characteristics of the sample).

Procedures

The Institutional Review Board approved this study, and written informed consent was obtained from all parents/guardians and adolescents. The larger study, the TeenZzz study, utilized an extensive protocol at the 13–16 year time point that included home visits, in-home overnight cardio-respiratory studies (polysomnography) and actigraphy and questionnaires about sleep, general health, behavior, and emotional functioning. After informed consent was obtained, a research assistant visited the participant's home and provided instructions on actigraphy. The parent and child were taught how to use the actigraph and how to complete the sleep diary. The actigraph was either returned to the investigators at a scheduled visit at the research facility or by courier. Parents and children were also asked to fill out information about their child's/their own sleeping patterns, medical history, and behavior.

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Within two weeks of the home visit, the child was examined in the General Clinical Research Center, when overnight full attended PSG was performed, as well as a history and physical examination (including Tanner staging), and measurement of height and weight.

Predictors

Individual characteristics: Information regarding the demographic variables was collected from a parent questionnaire that included information about the adolescent's age, gender, ethnicity, parent income, and parent education. Tanner staging was characterized using published criteria and a physician-examination[35, 36]. Neighborhood distress[37] was calculated as in previous studies with this cohort[19, 37], wherein the US census tract of each participant's address at the time of enrollment into the study was determined. Characteristics of each tract (% poverty, % female headed households, % high school dropouts, % males disengaged from workforce) were utilized to determine neighborhood distress. A

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neighborhood was considered distressed if any three characteristics were > 1 standard deviation about the mean for all US census tracts.

Health-related variables: The presence of ADHD, asthma, and prematurity were determined via parent questionnaire. Both ADHD and asthma were identified if these conditions were reported to have been diagnosed by a physician and the conditions were reported to be still present or the adolescent was currently on medication to treat ADHD or asthma. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2) based on direct measurements.

Outcomes

Sleep Duration and Coefficient of Variation (CV): Wrist actigraphy (Octagonal Sleep Watch 2.01; Ambulatory Monitoring, Inc., Ardsley, NY), used for 3 to 7 consecutive days, provided data for calculation of mean total sleep time (MTST) as well as variability in sleep duration across the week and weekend. An actigraph is a watch-like device worn on the wrist from bedtime to wake time that uses a piezoelectric sensor that generates a signal based on movement. Actigraphy data were analyzed with ACT-Millennium software using the time-above-threshold analysis mode. Total sleep time was calculated as the weighted average of weekday and weekend sleep times. The sleep duration variable was the sum of the average weekday sleep duration multiplied by 5, and the average weekend sleep duration multiplied by two were divided by 7. The ICC for mean sleep time vs. weighted mean sleep time was 0.996.

The coefficient of variation of total sleep time (CV) was used to represent variability in sleep and wake times from night to night. CV was calculated as the standard deviation of total sleep duration divided by the mean sleep duration, expressed as a percentage. For total sleep time, studies with healthy adults have found rates of agreement with polysomnography (PSG), the "gold standard" of sleep measurement, to be 78–90%[34]. A study by Johnson et al. from the TeenZzz cohort[33] showed intraclass correlation coefficients (ICCs) between actigraphy and PSG for total sleep time in adolescents to be 0.64 for those without sleep disordered breathing. ICCs were calculated on a subset of the current sample that also completed one night of both actigraphy and PSG in the sleep lab (N=115). The ICC for girls (N=59) was 0.68 and the ICC for boys (N=56) was 0.56.

Data analysis

Descriptive statistics are presented for all variables including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Linear regression models were used to test for relationships between the demographic, health-related, and sleep variables. Since sleep duration may vary during vacation periods, vacation status, defined as "yes" if the date of the actigraphy was over the summer or winter break of the public schools, was included as a covariate in all regression models. In order to test for the effects of individual characteristics on total sleep time or sleep variability, regression analyses were first conducted using age, pubertal status, gender, minority status, parent income, parental education, and neighborhood distress as predictors while controlling for school vacation status. These regression models were extended adding the health-related variables (ADHD, asthma, birth weigh status, and BMI) to the final model developed based on individual characteristics. Variables were retained in the regression model if they were related to the outcome at $p < 0.10$. To correct for the right skewness of the CV, the natural logarithm transformation was used to achieve a distribution that approximated normality. Results of the regression models are presented as adjusted least squares means and slopes and 95% confidence intervals (CIs).

Results

Descriptive Statistics

The final sample was comprised of 247 adolescents with a mean age of 13.7 years (range 13–16) and nearly equal numbers of boys and girls (Table 1). Most of the sample (74%) had reached at least Tanner stage 4. Adolescents of minority ethnicity (54.3%) were primarily African American (93%). In this sample, 91.3% of caregivers reported obtaining at least a high-school diploma or GED, 37.1% reported an income below $30,000 per year and 28.9% had resided in a neighborhood classified as distressed. With regard to health conditions, 22.7% were reported with a diagnosis of asthma, 6.5% with ADHD, 57.9% were born prematurely (i.e., gestational age < 37 weeks by neonatal record), and 41% had a BMI at or above the 86^{th} percentile. On average, total sleep duration determined by actigraphy in this group was 471.2 minutes (7.85 hours) and the average coefficient of variation was 16.4%.

Total sleep time

Demographic variables—Unadjusted means for the demographic variables demonstrated significant differences in sleep duration by gender with girls sleeping more than boys [480.45 (53.77) vs. 462.52 (58.60)]; p<.01), by ethnicity with those of non-minority ethnicity sleeping more than those of minority ethnicity (483.33 (51.81) vs. 461.03 (59.16); p<.05), and by neighborhood distress with those living in non-distressed neighborhoods sleeping more than those living in distressed neighborhoods (476.61 (57.70) vs. 457.36 (52.45); p<.05). Spearman correlations showed that sleep duration was significantly associated with parent income (r=−.19, p<.005) and BMI (r=−.25, p<.001). In the multivariate models, neighborhood distress and parent income were no longer significant. The final linear regression model for total sleep time included gender and minority ethnicity and controlled for the effect of school vacation. Consistent with initial hypotheses, adjusted analyses showed that gender was significantly associated with total sleep duration (p<.05), with girls sleeping approximately 22.14 minutes (95% CI: 21.97, 22.31) more than boys (484.51 +/−4.99 vs. 462.37 +/− 4.90). Minority ethnicity was also a significant predictor of total sleep duration (p<.05) with those of non-minority ethnicity sleeping 19.91 minutes (95% CI: 19.46, 20.36) more than those of minority ethnicity (483.64 +/−5.12 vs. 463.73 +/− 4.89).

Health-Related variables—A second regression model included the demographic factors above and also added health-related variables including asthma, ADHD, preterm birth, and BMI while again controlling for vacation status. Both preterm status and asthma were retained in the model, though they did not reach significance of p<.05 in order to adjust for the study design (over-recruitment of preterm children) and for a clinically plausible risk factor (asthma). Gender and minority ethnicity were significantly associated with total sleep time with girls estimated to sleep on average 20.92 minutes (95% CI: 20.72, 21.12) more than boys (482.15 +/− 4.9 vs. 461.23 +/−4.85) and non-minority adolescents estimated to sleep on average 19.72 minutes (95% CI: 18.77, 20.67) more than minority adolescents (482.27 +/− 5.1 vs. 462.55 +/− 4.71). BMI also was significantly associated with total sleep time with those of a higher BMI obtaining less sleep. The model predicted that sleep duration was on average 10.91 minutes (95% CI: −17.24, −4.5) with every increase in BMI of 5 kg/m^2.

Although these analyses included a weighted average of weekdays and weekends, in order to further investigate differences in sleep duration between weekdays and weekends analyses were repeated on weekday and weekend sleep durations separately. Additionally, the ICC for weekend vs. weekday sleep was found to be 0.43. Regressions for the weighted average of total sleep time were similar to regressions for the weekend total sleep time, in that both were significantly related to gender, minority status, and BMI. Vacation status was significant in the weighted average model but not in the weekend only model and preterm status was significant in the weekend only model but not the weighted average model. Preterm status was kept in the weighted average model as a means of adjusting for the study design.

Variability in total sleep time

Analyses were repeated using the coefficient of variation (CV), a measure of night-tonight variability in sleep time, as the dependent variable. A similar model building strategy was used as in total sleep time.

Demographic variables—Univariate analyses showed that those of non-minority ethnicity had significantly less night-to-night variability compared with those of minority ethnicity [14.55 (7.34) vs. 17.92 (9.21); $p<.05$], and those living in non-distressed neighborhoods had less night-to-night variability than those living in distressed neighborhoods [15.56 (7.81) vs. 18.48 (10.00); $p<.05$].

Spearman correlations demonstrated that night-to night variation in total sleep time was also significantly associated with age ($r=.15$, $p<.05$), neighborhood distress ($r=.17$, $p<.01$), parent education ($r=-.13$, $p<.05$), parent income ($r=-.23$, $p<.001$), pubertal status ($r=.14$, $p<.05$), and BMI ($r=.25$, $p<.001$). The final linear regression model for CV included age and minority ethnicity. Consistent with our hypotheses, both age ($\beta=.12 \pm .04$) and minority ethnicity ($\beta=.24 \pm .06$) were significantly associated with variation in total sleep time, with older adolescents having less regular sleep than younger adolescents, and minorities having less regular sleep than non-minorities. When these factors were included in the multivariate model, neighborhood distress, parent education, parent income, and pubertal status were no longer significant.

Health-related variables—A second regression model included the demographic factors (age and minority ethnicity) and also added health-related variables including asthma, ADHD, preterm birth, and BMI. With the addition of these variables, age ($\beta=.10 \pm .04$), minority status ($\beta=.21 \pm .06$), and BMI ($\beta=.02 \pm .01$) were significantly associated with variability in total sleep time (CV) with older adolescents, minority adolescents, and those of a higher BMI having had less consistent sleep patterns than their counterparts. Age was associated with CV such that for each year increase the adjusted mean level of CV increased 11% (95% CI: 2%, 20%). For a 5 kg/m^2 increase in BMI the mean level of CV increased by 10% (95% CI: 4%, 17%). Though asthma and preterm birth met our criteria of $p<.10$ for retention in the model, neither were statistically significant at $p<.05$.

Discussion

It is likely that certain host characteristics and medical conditions predispose adolescents to obtain less total sleep time and less regular sleep. The current study was designed to investigate the relationship between such variables on total sleep time and variability in total sleep time. Findings regarding which adolescents obtain the least sleep and have the most variability in sleep time were generally consistent with *a priori* hypotheses as well as with previous literature investigating such characteristics in children[5, 16, 20].

When considering a host of individual and demographic data, including an assessment of neighborhood distress, sleep duration was significantly associated with gender, minority ethnicity, and BMI. Adjusted means (see Table 3) demonstrate that these differences are clinically significant with boys and those of minority ethnicity sleeping approximately 20 minutes less per night than girls or non-minorities. This cumulative difference is almost two hours per week, which is a large sleep debt not likely to be restored and which has been implicated in contributing to other negative psychosocial and academic outcomes[6, 11, 12]. Similarly age, minority ethnicity, and BMI related to variability in total sleep time even after considering the influence of health variables on these associations.

Both asthma and preterm status were marginally significantly associated with the sleep outcomes, and in fact the direction of the relationship between preterm status and night-to-night variability was unexpected, with adolescents born preterm having less variability in sleep patterns. Including these variables in the final regression analysis, however, improved precision of the estimates for minority ethnicity and BMI. Although prior work has suggested that asthma and ADHD are associated with poor sleep, the lack of significant associations with the sleep outcomes may be because the sample was recruited from a community source, without significant disease, and studied at times when they were in stable health.

These findings highlight the importance of body weight, gender, and minority ethnicity as important variables when investigating sleep-related constructs. The association with shorter and more variable sleep duration is consistent with a large body of research that indicates that short sleep alters appetite regulatory hormones, which may cause a predisposition to weight gain and thus an increased BMI[26, 38].

The relationship between gender and sleep duration is difficult to interpret in the context of the larger body of adolescent sleep literature, as findings differ by study. When this same cohort had been studied at an earlier age (8 to 11 years) we previously observed delayed sleep times in boys compared to girls[16]. It may be that the gender differences found in the current study were the continuation of a developmental trajectory. More research is needed to identify factors that influence this difference throughout development. It may also be that adolescent boys consume more caffeinated beverages than girls, as was found in a large national poll[39]. Finally, it is possible that these differences relate to technology use, though such differences have not been previously identified.

The association with minority ethnicity is likely complex and may partly relate to cultural or socioeconomic factors that require further study. A unique feature of this study was the consideration of a measure of neighborhood distress, which prior work has shown to be associated with pediatric sleep apnea[19]. Increased neighborhood distress was associated with reduced sleep duration and increased variability in sleep duration; however, this association was attenuated after adjusting for minority ethnicity (correlated with neighborhood distress: $r=.22$; $p<.001$). Given that the influence of ethnicity on sleep duration may reflect biological and environmental factors, future research is needed to address specific factors of the home and neighborhood environment that may be targets for interventions aimed at improving sleep, such as home density, number of people sharing sleeping space, environmental noise, parental shift work schedules, or family and peer attitudes towards sleep.

Limitations

The methodological limitations of the current study affect the interpretation of results and at the same time provide avenues that inform future research. First the cross-sectional study design limited the degree to which the direction of the relationships could be established. ADHD and asthma were identified by parent-report of physician diagnosis, which may have led to misclassification. In addition, both conditions may have been relatively mild compared to conditions in clinic samples, reducing the ability to detect associations with sleep. The narrow range of Tanner stages was also a limitation. It is likely that the limited variability in this sample (71% of the sample were Tanner 4–5) may have precluded an effect of pubertal status from being detected. Additionally, while adolescents with an apnea hypopnea index > 5 were excluded from the analyses, we did not assess potential confounding by primary snoring or milder levels of sleep apnea.

Clinical Implications

Empirical evidence, including findings from this study, continues to demonstrate the relationship between demographic and health-related variables and sleep. Interventions to improve sleep need to be developed and tested, especially with adolescents. Groups in whom such interventions may be initially targeted include boys, those with a higher BMI and those of minority status.

Research Implications

Longitudinal studies with large samples are needed in order to investigate the causal relationship of demographic and health variables to sleep time. Although it is likely that bidirectional relationships exist between some factors, repeated assessments are needed to determine causality more precisely. Additional characterization of risk factors that may specifically elucidate the bases for gender and race/ethnicity associations would help develop new targets for interventions. It is important to note that although we considered a wide range of variables, the predictors of the sleep variables in this study accounted for only a small portion of the variance found in adolescent sleep duration (18%) and variability in sleep time (17%) after adjusting for significant covariates. Additional factors that impact adolescent sleep (both environmental and relevant traits that measure cognitive and physiological arousal processes) need to be better understood. Finally, further studies that investigate the relationship between gender, minority status, BMI, and sleep variables are needed. Results from this study underscore the importance of understanding the mechanisms by which gender, minority status and BMI affect sleep.

Acknowledgments

Supported by HL07567, HL60957, K23 HL04426, RO1 NR02707, and M01 RR00080

The authors would like to thank Dr. James Spilsbury for his contribution of the neighborhood distress index.

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Table 1

Sample characteristics, N=247

	Mean (SD)
Age (years)	13.673 (0.751) (Range: 12.94–16.67)
BMI (kg/m^2)	22.84 (5.518) (Range: 14.47–46.20)
BMI %tile	68.214 (27.829) (Range: 4.47–46.20)
	Number (%)
Female	120 (48.6%)
Non-minority Ethnicity	113 (45.7%)
History of Preterm Birth	104 term (42.1) 143 preterm (57.9)
History of Asthma	191 no (77.3) 56 yes (22.7)
ADHD	229 non-ADHD (93.5) 16 ADHD (6.5)
[1]**Study Period**	161 non-vacation (69.4) 71 vacation (28.7)
[2]**Tanner Stage (n;%)**	
Stage 1	9 (3.8%)
Stage 2	25 (10.6%)
Stage 3	27 (11.5%)
[2]**Tanner Stage (n;%)**	
Stage 4	20 (8.5%)
Stage 5	154 (65.5%)
Neighborhood Distress (n;%)	
Yes	69 (27.9%)
No	178 (72.1%)
Parent Education (n;%)	
Some HS	21 (8.7%)
HS diploma/GED	50 (20.7%)
Some college/voc	86 (35.7%)
College	60 (24.9%)
Grad/professional	24 (10.0%)
[3]**Parent Income (n;%)**	
< 5,000	23 (9.8%)
5000–9,999	19 (8.1%)
10–19,000	23 (9.8%)
20–29,999	22 (9.4%)
30–39,999	25 (10.6%)

	Mean (SD)
40–49,999	20 (8.5%)
Over 50,000	103 (43.8%)

[1] N= 232

[2] N= 235

[3] N= 235

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Table 2

Unadjusted Means for Sleep Variables

	Total Sleep Duration Mean ± SD	**Coefficient of Variation (CV) Mean ± SD**
Gender		
Female	**480.451 (53.77)	16.833 (8.41)
Male	**462.521 (58.60)	15.953 (8.70)
Ethnicity		
Minority	*461.032 (59.16)	*17.924 (9.21)
Non-minority	*483.329 (51.81)	*14.550 (7.34)
Tanner Stage		
Stage 1	470.788 (36.90)	11.396 (5.45)
Stage 2	490.552 (69.95)	14.927 (6.93)
Stage 3	468.069 (58.46)	16.968 (10.55)
Stage 4	473.448 (34.09)	13.810 (7.64)
Stage 5	468.712 (57.28)	17.222 (8.69)
Neighborhood Distress		
Yes	*457.36 (52.45)	*18.48 (10.00)
No	*476.61 (57.79)	*15.56 (7.81)
Parent education		
Some HS	454.204 (50.52)	17.520 (5.70)
HS diploma/GED	460.301 (64.72)	18.960 (9.64)
Some college/voc	485.110 (50.26)	15.123 (6.71)
College	467.163 (56.53)	15.577 (9.15)
Grad/professional	460.248 (56.77)	15.867 (7.66)
Parent Income		
< 5,000	441.937 (59.46)	20.609 (14.36)
5000–9,999	463.080 (73.99)	17.772 (7.15)
10–19,000	470.164 (51.30)	17.608 (6.82)
20–29,999	465.811 (51.47)	19.569 (8.84)
30–39,999	471.504 (59.13)	16.899 (9.94)
40–49,999	470.286 (69.87)	14.802 (8.56)
50–59,999	477.609 (49.88)	14.667 (6.60)
Over 60,000	487.537 (51.81)	14.154 (6.82)
ADHD		
Yes	473.896 (70.50)	16.062 (8.67)
No	470.419 (55.80)	16.392 (8.58)
Asthma		
Yes	468.265 (58.45)	15.042 (7.36)
No	472.103 (56.57)	16.773 (8.86)

	Total Sleep Duration Mean ± SD	Coefficient of Variation (CV) Mean ± SD
Premature		
Yes	467.540 (53.16)	15.758 (8.64)
No	473.918 (59.52)	17.263 (8.41)

*p<.05

**p<.01

Table 3

Adjusted Means for Sleep Duration and CV

	Total Sleep Time Mean ± SE	**95% CI**
***Girls**	484.513 (4.992)	474.676–494.350
***Boys**	462.372 (4.904)	452.708–472.036
***Minority**	463.730 (4.893)	454.087–473.372
***Nonminority**	483.640 (5.119)	473.551–493.729
	Coefficient of Variation (CV) Mean ± SE	**95% CI**
****Minority**	17.906 (.710)	16.507–19.304
****Nonminority**	14.621 (.783)	13.080–16.163
***Full term**	17.170 (.811)	15.572–18.768
***Preterm**	15.875 (.688)	14.521–17.230
Asthma	14.905 (1.123)	12.693–17.117
No asthma	16.851 (.592)	15.684–18.018

*p<.05

**p<.005