

Adolescents' Sleep Behaviors and Perceptions of Sleep

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ABSTRACT

BACKGROUND: Sleep duration affects the health of children and adolescents. Shorter sleep durations have been associated with poorer academic performance, unintentional injuries, and obesity in adolescents. This study extends our understanding of how adolescents perceive and deal with their sleep issues.

METHODS: General education classes were randomly selected from a convenience sample of three high schools in the Midwest. Three hundred eighty-four ninth- to twelfth-grade students (57%) completed a self-administered valid and reliable questionnaire on sleep behaviors and perceptions of sleep.

RESULTS: Most respondents (91.9%) obtained inadequate sleep (≤ 9 hours) on most school nights of the week, with 10% reporting less than 6 hours of sleep each week night. The majority indicated that not getting enough sleep had the following effects on them: being more tired during the day (93.7%), having difficulty paying attention (83.6%), lower grades (60.8%), increase in stress (59.0%), and having difficulty getting along with others (57.7%). Some students reported engaging in harmful behaviors to help them sleep: taking sleeping pills (6.0%), smoking a cigarette to relax (5.7%), and drinking alcohol in the evening (2.9%). Students who received fewer hours of sleep were significantly more likely to report being stressed ($p = .02$) and were more likely to be overweight ($p = .04$).

CONCLUSIONS: Inadequate sleep time may be contributing to adolescent health problems such as increased stress and obesity. Findings indicate a need for sleep hygiene education for adolescents and their parents. A long-term solution to chronic sleep deprivation among high school students could include delaying high school start times, such as was done successfully in the Minneapolis Public School District.

Keywords: child & adolescent health, emotional health, growth & development, sleep.

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Adolescents, parents, and teachers routinely struggle with the negative effects of sleep deprivation experienced by American youth. Most adolescents need slightly more than 9 hours of sleep each night, although this varies slightly among individuals.¹ "Sufficient sleep is the amount necessary to permit optimal daytime functioning."² (p354) The 2 most significant signs that indicate that an adolescent probably had insufficient sleep include changes in mood and decreased motivation, which often result in emotional and behavioral difficulties.² Most adolescents become tired and go to bed at 11 P.M. or later.³ Because most adolescents must rise between 6:00 and 6:30 A.M. to prepare for school, they are getting approximately 7 hours of sleep on school nights.

A variety of factors affect the quantity and quality of adolescents' sleep, including stress,⁴ obstructive sleep apnea,⁵ caffeine consumption,⁶ alcohol consumption,⁷ exercise behaviors,⁸ jobs,⁹ homework, sports, poor time management skills, and school start times.⁵ The most obvious factors affecting the quantity of sleep in youths are when they go to bed and when they arise. A recent study conducted in the Minneapolis Public School System examined the effect of delaying high school start times.¹⁰ Before the delay, high school classes began at 7:15 A.M. and were dismissed at 1:45 P.M. When the delay became effective, the school start time was 8:40 A.M., with a dismissal time of 3:20 P.M., a delay of 1 hour and 25 minutes. Rather than students staying up later, the study found that students obtained an additional hour of sleep each school night.¹⁰ The results of this study showed statistically significant improvement in attendance rates for students in grades 9-11, less sleeping in class, and less student-reported depression.¹¹

Students who are sleepy are not able to work to their fullest potential in school. There are direct connections between rapid eye movement (REM) sleep, sleep occurring later at night, and learning. Adolescents who consistently get less than 8 hours of sleep miss out on the last 2 hours of sleep, which are the most important for storing new information.¹² Three major reviews of sleep loss and academic performance all concluded that sleep deprivation affected school performance through lower grades; decreased alertness and concentration; and an increase in anger, impulsivity, and sadness.¹³⁻¹⁵

Another consequence of inadequate sleep time is greater risk of obesity.¹⁶⁻¹⁹ For example, 1 study of youths aged 10-17 compared 60 overweight youths with matched control youths who were not overweight and found that being overweight was significantly associated with shorter sleep durations.¹⁶ Another study of adolescents aged 11-16 found that shorter sleep duration was significantly associated with obesity. For each hour of lost sleep, the adolescents' odds of developing obesity increased 80%.¹⁷ Two additional studies of ele-

mentary school children found that shorter sleep durations (in preschool and third grade) were significantly associated with being overweight at 3-year follow-up (grades 3-6).^{18,19}

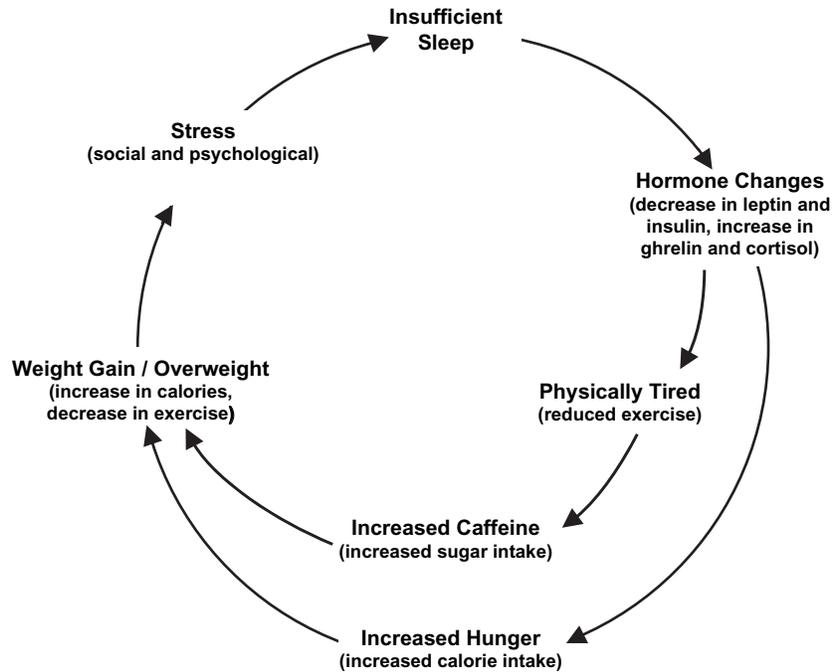
As adolescents age, their bedtimes may be delayed, in part, because of a change in their circadian rhythms that regulate their sleep-wake cycle.²⁰ This shift in the sleep-wake circadian cycle is associated with physical growth changes, cognitive development, and considerable endocrine changes.²⁰

A number of hormonal changes resulting from inadequate sleep time may result in greater calorie intake. For example, the circadian fluctuations of blood leptin levels peak during sleep.²¹ Leptin is a hormone that reduces hunger and is depressed during decreases in sleep time. Sleep time reduction increases the hormone ghrelin, which increases hunger, appetite, and cravings for sweets, starches, and salty snacks.^{22,23} Sleep loss has also been associated with higher cortisol levels and poorer glucose tolerance, resulting in poorer insulin responses to hyperglycemia, a reaction characteristic of individuals in a prediabetic metabolic state who show insulin resistance.^{24,25} In addition, shorter sleep time usually results in less energy, resulting in lower interest in exercise and lower calorie expenditures. The tiredness from shorter sleep times might also lead to greater caffeine consumption in an attempt to increase alertness, but many drinks with high caffeine content are high in sugar and calories. These combined physiological and behavioral changes are likely to result in weight gain, which may combine with other sources of stress and complete the shorter sleep duration-overweight cycle (Figure 1).²¹⁻²⁵

Sleep hygiene is the practice of several behaviors that optimize and promote good sleep and daytime functioning. The components include ensuring regular bedtimes and rise times, limiting napping during the day, avoiding lying in bed waiting to fall asleep, winding down before bed, being relaxed, restricting caffeine and nicotine throughout the day, avoiding alcohol and sleep aids, and providing for a favorable sleeping environment.²⁶ A favorable sleep environment is one free of excessive noise and light, extreme temperatures, pets, and even a bed partner who may be tossing and turning or snoring. Other disruptions to the sleep environment include activities that may take place in bed such as watching television, eating, working on schoolwork,²⁶ or talking on the phone.²⁷

The purpose of this study was to survey adolescents at 3 Midwestern high schools regarding their perceptions of sleep and their sleep behaviors. More specifically, it assessed the prevalence of adolescent sleep deprivation, factors that affect the quantity of sleep, adolescents' perceptions of their sleep, and the effect of sleep deprivation on academic performance and weight status.

Figure 1. Reduced Sleep Duration–Overweight Cycle



METHODS

Subjects

A convenience sample of 3 high schools in the Midwest were approached regarding participating in this study. The first school that participated in the study was a large middle-class public school with 2,183 students. The second and third schools were rural public schools with 500 and 544 students, respectively. All 3 schools had start times of 7:30 A.M. A power analysis was conducted based on a population size of 3227 for the 3 high schools. The number of responses would need to be 345 students to generalize the results to the total population of the 3 high schools with a sampling error of no more than $\pm 5\%$ at the 95% confidence level.²⁸

Instrument Development

The instrument was a 4-page, 37-item, closed-format questionnaire that was developed from a comprehensive literature review of childhood, adolescent, and adult sleep behaviors and the effect of health behaviors on sleep. Face validity was established by reviewing the published literature for relevant key concepts associated with sleep behaviors and attitudes. Content validity of the survey instrument was determined by forwarding it to a panel of experts in survey research and sleep behaviors ($n = 6$) for review of content. Several minor wording changes were made to the instrument, along with the deletion of 1 question because of redundancy. Stability reliability

was assessed by giving the instrument to a class of adolescents ($N = 25$) similar to those who participated in the study. The questionnaire was given to the students, and 1 week later it was given again to the same students to establish stability reliability. The mean Pearson correlation coefficient for the scale items had a stability reliability of $r = .69$. Items that were “check all that apply” had an average agreement of 88%.

Procedure

Following approval of the study proposal by the University of Toledo Human Subjects Committee, permission was sought from parents to survey a sample of 678 adolescents. Classroom selection for study participation was based on being a general education class that every student had an opportunity to take. One week before the students took the survey, teachers received a packet with a letter explaining the purpose of the survey, process of administration, and copies of the permission slips and surveys. One week before survey administration, students were given a permission slip for parents or guardians to sign and return. A signed permission slip by a parent or guardian and an assent form completed by the student allowed the student to participate in the study.

Data Analysis

Descriptive and analytical data analyses were performed using SPSS 10.0 (SPSS, Inc, Chicago, IL) on the data collected from the Adolescent Sleep Behaviors

Questionnaire. A series of t-tests were calculated to determine whether socioeconomic status (free or reduced-price lunch) and living in a single-parent vs a 2-parent household had an effect on the amount of sleep time received. A Pearson correlation coefficient was calculated for the amount of sleep time adolescents received and their self-reported academic grades. Additionally, analysis of variance (ANOVA) tests were calculated between the amount of sleep and the levels of stress being experienced by students. ANOVA was also used to test for the amount of sleep according to whether an adolescent had a healthy weight (<85th percentile for age and sex) or was overweight (\geq 85th percentile for age and sex) as determined according to body mass index (BMI). Statistically significant ANOVA findings were followed by appropriate post hoc t-tests. Level of significance was established a priori at $p < .05$.

RESULTS

Demographic and Background Characteristics of Participants

Six hundred seventy-eight students were given the opportunity to complete the survey. The number of surveys in which consent and assent were obtained was 384. The response rate of 57% (384/678) was greater than what was needed to generalize the results to the school populations. The majority of the participants were female (54.8%) and white (85.1%) (characteristic of the schools surveyed), and a plurality were in the ninth grade (46.2%). Approximately half (50.9%) of the participants lived with both parents; 20.6% lived only with their mother. Slightly more than 80% had a bedroom to themselves, and 17% shared a bedroom with at least 1 other person. Of those who shared a bedroom, most (63.1%) indicated it did not affect their sleep (Table 1).

Adolescents' Perceptions of Sleep Hygiene

The majority of participants indicated that not getting enough sleep had the following effects on them: being more tired during the day (93.7%), having difficulty paying attention (83.6%), lower grades (60.8%), increase in stress (59.0%), and having difficulty getting along with others (57.7%). The majority (73.3%) of participants believed that high school students should get between 8 and 9 hours of sleep each night. The adolescents were asked when they thought that school should start each day. This was with the understanding that, if school started later, it would end later in the day. A plurality (31.6%) of respondents indicated that school should start at 8:00 A.M., and almost one-fourth (24.5%) wanted school to start earlier than 8:00 A.M. Other school start times desired by the students were 8:30 A.M. (16.7%), 9:00 A.M. (17.5%), and 9:30 A.M. (9.4%).

Table 1. Demographics and Background Characteristics of Participants

Item	N (%)
Sex	
Female	210 (54.8)
Male	172 (44.9)
Age	
14	44 (11.5)
15	136 (35.5)
16	89 (23.2)
17	74 (19.3)
\geq 18	39 (10.3)
Race or ethnicity	
Caucasian	326 (85.1)
African American	30 (7.8)
Other	44 (11.5)
Grade level	
9th	177 (46.2)
10th	75 (19.6)
11th	77 (20.1)
12th	48 (12.5)
Who do you live with?	
Both parents	195 (50.9)
Mother	79 (20.6)
Mother and stepfather	63 (16.4)
Father and stepmother	23 (6.0)
Grandparent	20 (5.2)
Father	14 (3.7)
Other	12 (3.1)
Do you qualify for free or reduced-price lunch?	
No	266 (69.5)
Yes	70 (18.3)
Not sure	44 (11.5)
Do you have an after-school job?	
No	262 (68.4)
Yes	115 (30.0)
Do you sleep in the same room as someone else?	
No	311 (81.2)
Yes	65 (17.0)
If Yes, do they interfere with your sleep?	
No	41 (63.1)
Yes	23 (35.4)
Grades	
Almost all As	78 (20.4)
As and Bs	102 (26.6)
Almost all Bs	27 (7.0)
Bs and Cs	80 (20.9)
Almost all Cs	26 (6.8)
Cs and Ds	37 (9.7)
Almost all Ds	8 (2.1)
Ds and Fs	13 (3.4)
Almost all Fs	5 (1.3)
Have you ever been told by a doctor or nurse that you have attention deficit hyperactivity disorder?	
No	308 (80.4)
Yes	53 (13.8)
Not sure	22 (5.7)

N = 384.

Note: May not add to 100% because of nonresponse.

In relation to participating in behaviors that could affect sleep, such as exercise behaviors and caffeine consumption, the majority of participants (82.0%) believed that getting exercise on most days of the

week would help them sleep better, yet only 68.4% reported engaging in daily exercise. Many of them also believed reducing or eliminating caffeine from their diet would help them sleep better (67.4%), although 51.7% reported drinking caffeinated soda daily, and 20.6% reported drinking energy drinks daily. Nearly 70% believed they could make up for lost sleep by taking naps during the day, and 38.6% reported taking naps daily.

Sleep Hygiene Practices of Adolescents

The adolescents selected from a list of potential strategies they used to get to sleep or stay asleep (Table 2). The most commonly used methods were watching TV (46.2%), making the bedroom very dark (45.2%), having a comfortable temperature in the bedroom (37.1%), and going to bed and waking up at a regular time (30.3%). More-harmful behaviors engaged in by a minority of students to help them sleep were taking sleeping pills (6.0%), smoking a cigarette to relax (5.7%), and drinking alcohol in the evening (2.9%). In addition, the adolescents were asked to identify from a list of items that prevented them from getting enough sleep (Table 3). The most common barriers to good sleep were too much homework (46.5%), too much stress (42.0%), watching TV (39.4%), and too much hanging out with friends (30.3%). It should be noted that 11.0% of students used TVs to get to sleep and also thought it to be a barrier to good sleep.

Students were asked to indicate specifically what time they went to bed and what time they woke up. Few students (5.0%) indicated that they obtained 9 or more hours of sleep on school nights. Many more students obtained the recommended 9 or more hours of sleep on Friday nights (59.0%) and Saturday nights

(44.4%). On Sunday nights, the responses were similar to school nights, with few participants (6.3%) getting 9 hours or more of sleep (Table 4).

There were no statistically significant differences in sleep duration according to socioeconomic status or whether the students lived in a single- or 2-parent home. The correlation between sleep duration of adolescents and their self-reported grades was also found to not be statistically significant.

A statistically significant difference ($F = 4.05$, $df = 2$, $p = .02$) was found between the amount of sleep and the levels of stress experienced by students. Post hoc t-tests indicated a significant difference in the number of hours slept on Friday and Saturday nights according to perceived levels of stress of the adolescents. Those experiencing low levels of stress obtained on average 9.7 (SD = 1.8) hours of sleep, those with average levels of stress obtained 9.4 (SD = 1.8) hours of sleep on Friday nights, and those who indicated higher levels of stress obtained only 7.5 (SD = 3.0) hours of sleep on Friday nights. On Saturday nights, those with lower levels of stress obtained 8.9 (SD = 2.1) hours of sleep, those with average levels of stress obtained 8.8 (SD = 1.8) hours of sleep, and those who indicated higher levels of stress obtained 7.5 (SD = 2.1) hours of sleep.

There was a statistically significant difference in the amount of sleep adolescents reported receiving on school nights according to BMI ($F = 4.14$, $df = 1$, $p = 0.04$). Those who were a healthy weight reported receiving 7.34 (SD = 1.20) hours of sleep, whereas those who were overweight reported receiving 7.03 (SD = 1.23) hours of sleep. For weekend nights, there was no statistically significant difference between hours slept for healthy-weight students and overweight students.

Table 2. Strategies Adolescents Use to Get to Sleep or Stay Asleep

Item	N (%)
What do you do to help yourself get to sleep or stay asleep?	
Watch TV	177 (46.2)
Make my bedroom very dark	173 (45.2)
Have a comfortable temperature in my bedroom	142 (37.1)
Go to bed and get up at a regular time	116 (30.3)
Nothing	90 (23.5)
Other	77 (20.1)
Try not to eat or drink caffeine later in the day	52 (13.6)
Try to read something just before bedtime	47 (12.3)
Exercise before bedtime so I can relax	44 (11.5)
Take sleeping pills	23 (6.0)
Smoke a cigarette to relax	22 (5.7)
Drink alcohol in the evening	11 (2.9)
Drink a glass of warm milk	8 (2.1)
Wear a sleep mask	7 (1.8)
Use breathing strips for my nose	7 (1.8)
Use ear plugs	7 (1.8)

N = 384.

Note: Respondents were instructed to select all that apply.

Table 3. Things That Keep Adolescents From Getting Enough Sleep

Item	N (%)
What are things that keep you from getting enough sleep?	
Too much homework	178 (46.5)
Too much stress in my life	161 (42.0)
Watching TV	151 (39.4)
Too much hanging out with friends	116 (30.3)
Temperature of bedroom is too warm or too cold	111 (29.0)
Too much noise	94 (24.5)
After school sports	93 (24.3)
Chores at home	89 (23.2)
Part-time job	79 (20.6)
Bad dreams	69 (18.1)
Other [written] included video games and Internet use	63 (16.4)
Helping take care of brothers and sisters	57 (14.9)
Bedroom too light	50 (13.1)
Exercise	40 (10.4)
Eating breakfast	15 (3.9)

N = 384.

Note: Respondents were instructed to select all that apply.

Table 4. Number of Hours Slept Each Night

	School Night	Friday Night	Saturday Night	Sunday Night
Hours	n (%)			
< 5	7 (1.8)	3 (0.8)	8 (2.1)	15 (3.9)
5.0–5.9	31 (8.1)	2 (0.5)	11 (2.9)	30 (7.8)
6.0–6.9	75 (19.6)	18 (4.7)	29 (7.6)	82 (21.4)
7.0–7.9	143 (37.3)	32 (8.4)	47 (12.3)	115 (30.0)
8.0–8.9	96 (25.1)	48 (12.5)	59 (15.4)	89 (23.2)
≥9	19 (5.0)	226 (59.0)	170 (44.4)	24 (6.3)

N = 384.

Note: May not add to 100% because of nonresponse.

DISCUSSION

One of the most significant factors affecting adequate sleep time and quality of sleep is a consistent sleep and wake schedule. Previous studies have determined that people who go to bed and rise at the same time each day, including the weekend, have higher quality of sleep and are less likely to report sleep deprivation.²⁹

In this study, the vast majority of adolescents obtained fewer than 9 hours of sleep on school nights. The duration of sleep on the weekend was better. This may represent an attempt to make up for lost sleep during the school week. Although participants reported more sleep on the weekend nights, their bedtimes and rise times were dramatically different from on school nights. As mentioned earlier, dramatic changes in the sleep cycle and an inadequate number of hours of sleep can have detrimental effects on adolescents. It can take several days or longer for one's sleep schedule to become regulated again. During this time, the adolescent may suffer from extreme tiredness, mood swings, feelings of jet lag, lack of motivation, and difficulty concentrating,¹³⁻¹⁵ all symptoms that teachers see in some students on Monday morning.

Because the majority of adolescents reported getting fewer than the recommended hours of sleep, and their sleep schedules were inconsistent, it was expected to be reflected in their self-reported grades, but no significant relationship was found. These findings are in conflict with previous research¹³⁻¹⁵ that found through student self-report that those who obtained more sleep had higher grades. Differences in the 2 samples such as socioeconomic status and age may explain this difference, or it may be because so few students obtained the recommended number of hours (9) of sleep that the study may have had inadequate power to detect a statistically significant difference.

The majority of adolescents participating in this study indicated that high school students should get between 8 and 10 hours of sleep each night. These participants also perceived that lack of sleep would have a variety of negative consequences for them. This seems to indicate that knowledge regarding

appropriate hours of sleep and knowledge of likely consequences of sleep deprivation are insufficient to motivate adolescents to get adequate sleep. Thus, educational programs for high school students regarding sleep need to do more than just increase knowledge on the importance of adequate sleep time and how to obtain it.

Some strategies the participants indicated using to help them get to sleep or stay asleep may have had an adverse effect on them, causing stimulation rather than relaxation. For example, nearly half reported watching TV to help them get to sleep. Another strategy used by the adolescents was exercising before bed. This, too, can cause stimulation and should be avoided several hours before bedtime. Thus, these students might benefit from more information regarding sleep hygiene.

The 4 most common items that students indicated kept them from getting the sleep they needed were too much homework, too much stress, watching TV, and too much hanging out with friends. Having too much homework is difficult to assess in this study because the study did not assess how many hours each night respondents spent on homework. For some students, any homework may have been too much. Stress is also difficult to assess. Most participants did not indicate high levels of stress, although almost 1 in 4 respondents felt that, at some point during the 30 days before the survey, their difficulties were piling up so high that they could not overcome them. Watching TV and hanging out with friends are activities that tend to be stimulating and can have a negative effect on sleep quality if done during the hours before going to bed.

Finally, the results of this study should be considered in light of the potential limitations. First, the data were based on self-report. The extent of underreporting or overreporting is unknown. Second, the survey was administered only to students who were present in school on the day the survey was administered, accompanied by a signed permission slip from a parent and a signed assent form from the student. This, along with the convenience sampling, may have limited the external validity of the results. Finally, the survey was conducted using a monothematic questionnaire on sleep. This concentration of questions on sleep may have caused some students to think about the topic in a unique way. If so, this too could have affected the internal validity of the results.

CONCLUSIONS

Adolescents benefit from having consistent sleep times that are adequate in quantity. Having regular bed times and rising times that remain consistent through the weekend significantly affects this. Adolescents may not realize that they cannot make up for

lost sleep during the week by sleeping more on the weekends or by napping. Although parents may be involved with the sleep schedules of young children, it is likely that they become less involved as their children get into high school. Therefore, it might benefit adolescents if parents remain involved in their children's sleep schedule through high school and if parents are well informed about factors that interfere with the sleep of their children. Adolescents also need to be educated regarding the importance of adequate sleep, the components of good sleep hygiene, and strategies such as time management to facilitate healthy sleep behaviors. Although education may be necessary to improve sleep hygiene of students, it is probably not sufficient. A long-term solution to chronic sleep deprivation in adolescents that others conducting research on adolescent sleep behaviors support^{30,31} may mean that high school start times should be no earlier than 8:30 A.M. The change in high school start times will need to occur at the state level so that school sports and social events can be coordinated among schools.³²

REFERENCES

1. Wolfson AR, Carskadon MA. Sleep schedules and daytime functioning in adolescents. *Soc Res Child Dev.* 1998;69:875-887.
2. Dahl RE. The consequences of insufficient sleep for adolescents: links between sleep and emotional regulation. *Phi Delta Kappan.* 1999;80:354-359.
3. O'Brien EM, Mindell JA. Sleep and risk-taking behavior in adolescents. *Behav Sleep Med.* 2005;3(3):113-133.
4. Bernert RA, Merrill KA, Braithwaite SR, Van Orden, KA, Joiner TE. Family life stress and insomnia symptoms in a prospective evaluation of young adults. *J Fam Psychol.* 2007;21:58-66.
5. Spilsbury JC, Storfer-Isser A, Kirchner HL, Nelson L, Rosen CL, Drotar D, et al. Neighborhood disadvantage as a risk factor for pediatric obstructive sleep apnea. *J Pediatr.* 2006;149:342-347.
6. Orbeta RL, Overpeck MD, Ramcharan D, Kogan MD, Ledsky R. High caffeine intake in adolescents: associations with difficulty sleeping and feeling tired in the morning. *J Adolesc Health.* 2006;38:451-453.
7. Vitiello MV. Sleep, alcohol and alcohol abuse. *Addict Biol.* 1997;2:151-158.
8. Taylor S. The influence of exercise on sleep quality. *Int Sport Med J.* 2001;2(3):1-10.
9. Carskadon MA. Patterns of sleep and sleepiness in adolescents. *Pediatrician.* 1990;17:5-12.
10. Wahlstrom KL, Davison ML, Choi J, Ross JN. Minneapolis Public Schools Start Time Study executive summary. August 2001. Available at: <http://cehd.umn.edu/carei/Reports/docs/SST-2001ES.pdf>. Accessed January 17, 2008.
11. Wahlstrom K. Changing times: findings from the first longitudinal study of later high school start times. *NASSP Bulletin.* 2002;86:3-21.
12. Smith C, Lapp L. Increases in the number of REMS and REM density in humans following an intensive learning period. *Sleep.* 1991;14:325-330.
13. Taras H, Potts-Datema W. Sleep and student performance at school. *J Sch Health.* 2005;75:248-254.
14. Curcio G, Ferrara M, DeGennaro L. Sleep loss, learning capacity and academic performance. *Sleep Med Rev.* 2006;10:323-337.
15. Wolfson AR, Carskadon MA. Understanding adolescents' sleep patterns and school performance: a critical appraisal. *Sleep Med Rev.* 2003;7:491-506.
16. Beebe DW, Lewin D, Zeller M, et al. Sleep in overweight adolescents: shorter sleep, poorer sleep quality, sleepiness, and sleep-disordered breathing. *J Pediatr Psychol.* 2006;104:1-11.
17. Gupta NK, Mueller WH, Chan W, Meininger JC. Is obesity associated with poor sleep quality in adolescents? *Am J Hum Biol.* 2002;14:762-768.
18. Agras WS, Hammer LD, McNicholas F, Kramer HC. Risk factors for childhood overweight: a prospective study from birth to 9.5 years. *J Pediatr.* 2004;145:20-25.
19. Lumeng JC, Somashekar D, Appugliese D, Kaciroti N, Corwyn RF, Bradley RH. Shorter sleep duration is associated with increased risk for being overweight at ages 9-12 years. *Pediatrics.* 2007;120:1020-1029.
20. Carskadon MA, Wolfson AR, Aceboc TO, Seifer R. Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. *Sleep.* 1998;21:871-881.
21. Kalra SP, Bagnasco M, Otukonyong EE, Bube MG, Kalra PS. Rhythmic, reciprocal ghrelin and leptin signaling: new insight in the development of obesity. *Regul Pept.* 2003;111:1-11.
22. Spiegel K, Tasali E, Penev P, Van Canter E. Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med.* 2004;141:845-850.
23. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med.* 2004;1:e62.
24. Van Helder T, Symons JD, Radomski MW. Effects of sleep deprivation and exercise on glucose tolerance. *Aviat Space Environ Med.* 2003;4:487-492.
25. Spiegel K, Leproult R, Van Canter E. Impact of sleep debt on metabolic and endocrine function. *Lancet.* 1999;354:1435-1439.
26. Carskadon, MA. (Ed.). *The Encyclopedia of Sleep and Dreaming.* New York: Macmillan; 1993.
27. Van den Bulck J. Adolescent use of mobile phones for calling and for sending text messages after lights out: results from a prospective cohort study with a one-year follow-up. *Sleep.* 2007;30:1220-1223.
28. Price J, Dake J, Murnan J, Dimmig J, Akpanudo S. Power analysis in survey research: importance and use for health educators. *Am J Health Educ.* 2005;36:202-207.
29. Dahl RE, Lewin DS. Pathways to adolescent health: sleep regulation and behavior. *J Adolesc Health.* 2002;31:175-184.
30. Epstein R, Chillag N, Lavie P. Starting times of school: effects on daytime functioning of fifth-grade children in Israel. *Sleep.* 1998;21:250-256.
31. Wolfson AR, Carskadon MA. Early school times affect sleep and daytime functioning in adolescents. *Sleep Res.* 1996;25:117.
32. Hansen M, Janssen I, Schiff A, Zee PC, Dubocovich ML. The impact of school daily schedule on adolescent sleep. *Pediatrics.* 2005;115:1555-1561.