NEED FOR SLEEP: CAUSES AND CONSEQUENCES OF INSUFFICIENT SLEEP IN ADOLESCENTS. CAN DELAYING SCHOOL START TIMES HELP?

At a Glance

Delaying school start times may help in alleviating some of the negative effects of the lack of sleep among adolescents. There appears to be a consensus among various researchers that later school start times are associated with an increase in total sleep time in adolescents, although some researchers find that such an effect might be fleeting. In addition, later school start times are associated with better behavioral health, decreased tardiness, and a decreased rate of vehicle crashes for school-aged drivers. Findings on the effects of delayed school start times on student academic performance appear to be inconsistent.

The issue of student sleep needs has been the topic of conversation among educational researchers and policymakers for many years. This Research Capsule aims to review and summarize the findings of research devoted to this issue.

Sleeping Needs of K-12 Students vs. the Amount of Sleep They are Getting

The American Academy of Sleep Medicine has recommended that children aged 6-12 years should regularly sleep 9-12 hours and teenagers aged 13-18 years should sleep 8-10 hours per 24 hours (Paruthi, et al., 2016). The American Academy of Pediatrics has issued a Statement of Endorsement supporting these guidelines (American Academy of Pediatrics, 2018).

However, according to the Centers for Disease Control and Prevention (CDC), in 2017, only 25.4% of students in grades 9 through 12 had a sufficient amount of sleep (Centers for Disease Control and Prevention, 2018). Here, sufficient sleep was defined as 8 or more hours of sleep on an average school night.

As seen in Figure 1, this marks a steady decline from 30.9% reported in 2009 nationally. In comparison, the state of Florida reported even a smaller proportion of students (21.1%) getting sufficient sleep on school nights.

Figure 1. Students Getting Sufficient Sleep on School Nights Grades 9-12
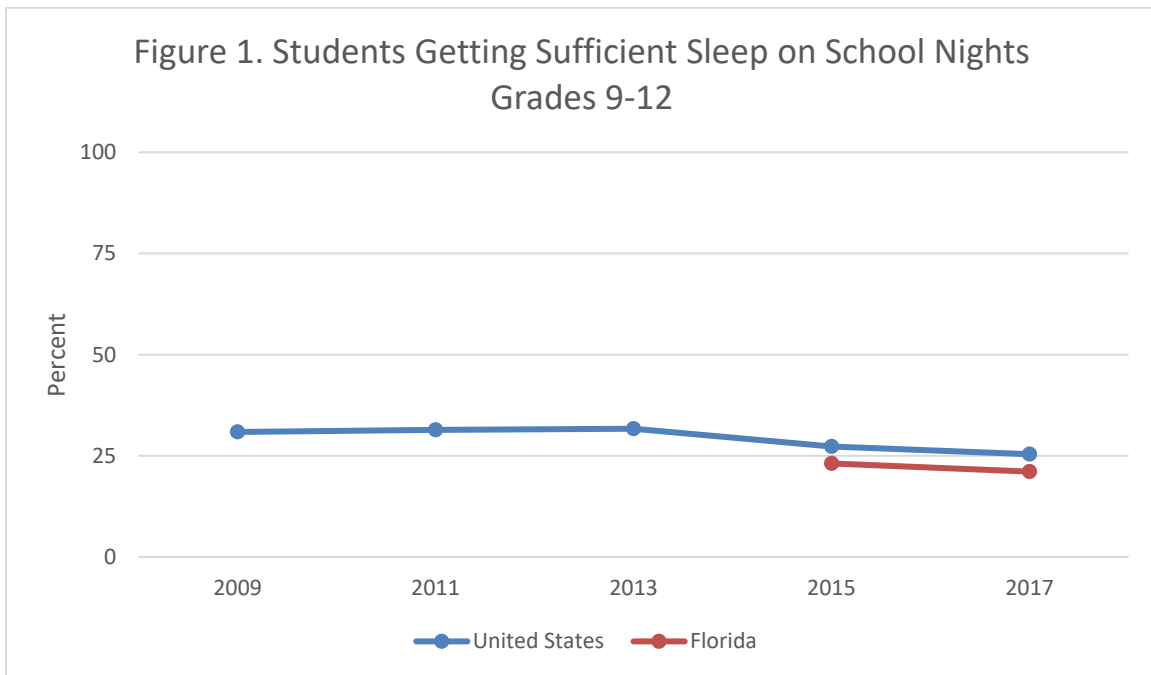
Data Source: Office of Disease Prevention and Health Promotion
https://www.healthypeople.gov/2020/data/Chart/5260?category=1&by=Total&fips=-1

A National Sleep Foundation's Sleep in America Poll (2006) found that 59% of 6th through 8th graders and 87% of high school students in the United States were getting less than the recommended 8.5 to 9.5 hours of sleep on school nights. The study authors found that the average amount of school night sleep obtained by grade 6-8 students was slightly over 8 hours. The average amount of school night sleep for high school students decreased as they progressed through high school years from 7.6 hours for grade 9 students to 6.9 hours for seniors. Approximately 28% of students reported falling asleep in school at least once a week, and more than 1 in 5 reported falling asleep doing homework at least once a week as well.

Interestingly, the same study found that for these same students, 71% of parents or guardians believed that their adolescent was obtaining sufficient sleep (80% for grade 6-8 students and 64% for grade 9-12 students). This indicates a lack of awareness among adults regarding the extent of adolescent sleep deficit.

Galland and colleagues (2018) performed a systematic review and meta-analysis of studies that used actigraphy (a non-invasive method of monitoring human rest/activity cycles) to establish observed values for pediatric nighttime sleep across several age groups. They included 82 studies performed in 17 different countries in their meta-analysis. (Of those, 32 studies were performed in the US and 10 in Canada.) The results for total sleep time indicated an inverse relationship with age: estimates for nighttime sleep duration were 8.98 hours in 6–8 years old, 8.85 hours in 9–11 years old, 8.05 hours in 12–14 years old, and 7.40 hours in the 15–18 years age group. Clearly, these estimates are below those recommended by the American Academy of Sleep.

Main Factors Related to Insufficient Sleep Time in Adolescents

Researchers have identified various factors contributing to insufficient sleep in adolescents. The most commonly referenced factors are discussed below.

Biological Changes related to the onset of Puberty

As children experience the onset of puberty, their circadian rhythm changes resulting in the preference for delayed sleep patterns. Another biological process related to insufficient sleep in adolescents is a developmentally based slowing of the "sleep drive". That is, the pressure to sleep as one stays awake longer builds at a slower rate in post-puberty adolescents than in pre-puberty adolescents (Owens, Adolescent Sleep Working Group, & Committee on Adolescence, 2014).

Use of Electronic Devices

According to the Sleep in America Poll (National Sleep Foundation, 2006), almost all adolescents had at least one electronic device in their bedrooms. Twenge and colleagues (Twenge, Krizan, & Hisler, 2017) found that three activities contributed substantially to the rise in the percentage of adolescents who reported sleeping less than 7 hours on most nights from approximately 37% in 2009 to about 43% in 2015. These activities were electronic device use, social media use, and Internet news consumption.

Caffeine Consumption

A technical report issued by the American Academy of Pediatrics (Owens, Adolescent Sleep Working Group, & Committee on Adolescence, 2014) discussed the linkage between caffeine consumption sleep problems in adolescents. High school students who reported a moderate or high intake of caffeine were almost 2 times more likely to have difficulty sleeping and to have morning sleepiness than those with low caffeine intake. Interestingly, high school students who consumed the most caffeine also reported the highest level of multitasking involving electronic devices.

School Start Times

According to a report from the CDC (Wheaton, Ferro, & Croft, 2015), the average starting time across US public schools was 7:59 a.m. for high schools and 8:04 a.m. for middle schools. Only about 19% of public middle schools and about 14% of high schools started school at 8:30 a.m. or later, the school start time recommended by the American Academy of Sleep Medicine (Watson, et al., 2017). The same report from the CDC stated that the average starting time for public middle, high, and combined school in Florida was 8:17 a.m. Early school times combined with biological factors affecting adolescents' circadian rhythm and their sleep drive contribute to the problem of insufficient sleep n adolescents.

Consequences of Insufficient Sleep in Adolescents

Many studies have shown an association between decreased sleep duration and negative physical and mental health, safety, and academic performance outcomes. More specifically, shorter sleep time during school nights have been shown to be associated with

- Depressive symptoms and daytime sleepiness (Owens, Adolescent Sleep Working Group, & Committee on Adolescence, 2014; Beebe, 2011),
- Difficulties with attention, impulse control, and behavior regulation,
- Increased crash risk in teen drivers,
- Engaging in risky behaviors,
- Increased risk of obesity (Beebe, 2011),
- Less positive attitudes toward life,
- Lower school grades (Perkinsoon-Gloor, Lemola, & Grob, 2013)

In its policy statement, the American Academy of Pediatrics (AAP) pointed to a variety of factors related to the insufficient sleep in adolescents but stated that the early school start times (those before 8:30 a.m.) were the key *modifiable* contributor to the lack of sleep in adolescents. Consequently, the AAP issued a policy statement urging middle and high schools to modify start times to no earlier than 8:30 a.m. to aid students in getting optimal levels of sleep (8.5-9.5 hours) and to improve their overall health, safety, academic performance, and quality of life (2014). The American Academy of Sleep Medicine also issued a position statement asserting that middle and high school start times should be 8:30 a.m. or later to support an opportunity for adolescents to obtain sufficient sleep on school nights, optimal alertness in the classroom, reduced tardiness and school absences, adolescent mental health and well-being, and driving safety (Watson, et al., 2017).

Research on the Effects of School Start Times

Many recent research studies have shown that delaying school start times for middle and high school students is accompanied by positive outcomes including more school night total sleep, less daytime sleepiness, decreased tardiness rates, improved academic performance, and better performance on computerized attention tasks.

Wolfson and colleagues (2007) examined sleep-wake patterns of young adolescents attending two public middle schools with early (7:15 a.m.) versus late (8:37 a.m.) start times. Students (N = 205) were assessed at 2 time periods. The researchers found that students who attended a late-starting school reported waking up over 1 hour later on school mornings and obtaining 50 more minutes of sleep each night, less sleepiness, and a smaller tardiness rate than students attending an early-starting school. All students reported similar school-night bedtimes, sleep hygiene practices, and weekend sleep schedules.

Wahlstrom and colleagues (2014) examined whether a delay in school start times would

impact the students' overall health, academic performance, and safety. They examined the data on over 9,000 students at eight public high schools in Minnesota, Colorado, and Wyoming before and after the change to later school start times. Of these schools, four schools changed their starting time by 30 minutes, two – by 60 minutes, and one – by 80 minutes.

The researchers found that most schools with later start times saw a significant decrease in student tardiness. In addition, schools that had greater delays in school start times also tended to see the greatest decreases in tardiness and absences. They also found that two of the five districts/schools saw a significant increase in their composite scores and one saw a significant increase in mathematics scores on national standardized achievement tests. On the other hand, the researchers also found a significant decrease in writing scores in one school district and in mathematics scores in one school. In addition, most of the comparisons of standardized test scores between the pre- and post-school start time change to a later time were not statistically significant. In terms of student safety, researchers found that of the four communities for which they had car crash data before and after the change to later start times for high schools, the rate of car crashes involving high school age drivers in two communities dropped by 65-70%, in one community – by 6%. However, one community experienced a 9% increase in such a rate. Researchers speculated that because this community contains many highway routes between the suburbs and the city of Minneapolis, those crashes may involve teen drivers who attend other nearby schools with earlier start times.

Similarly, Danner and Phillips (2008) studied approximately 10,000 students in 6th through 12th grades attending public schools in Kentucky that delayed start times by 1 hour, from 7:30 a.m. to 8:30 a.m. for high schools and from 8:00 a.m. to 9:00 a.m. for middle schools. In the publication, the authors reported their findings for only high school students. The researchers found that the self-reported amount of sleep increased across all four high school grades. These increases averaged from 12 minutes in grade 9 to 30 minutes in grade 12. Furthermore, the percentage of students who reported at least 8 hours of sleep increased from 37% to 50%. In this same study, the researchers investigated motor vehicle crash rates for students aged 17 and 18. They found that the average crash rate in the 2 years after the change in school start times decreased by 16.5% vs. the rate 2 years before the change in the study county. By comparison, the state experienced an increase of 7.8% during the same time period.

Sabia, Wang, and Cesur (2016) used data from the National Longitudinal Study of Adolescent Health (about 14,000 participants) which examined the relationship between sleep duration and academic performance. They found that longer sleep was associated with higher classroom concentration and increased education attainment, measured as high school and college graduation rates. They also determined that the number of hours of sleep that maximized the estimated probability of high school graduation was 8.5 hours per night.

Morgenhaler and colleagues (2016) performed a literature review and meta-analysis of studies that offered a direct comparison of sleep time, academic or physical performance,

behavioral health measures, or motor vehicular accidents in high school students. Using their selection criteria, the authors included 18 studies in their review and eight studies in the meta-analysis. The results demonstrated that later school start times, particularly when compared with start times more than 60 min earlier, were associated with longer weekday sleep durations, lower weekday-weekend sleep duration differences, reduced vehicular accident rates, and reduced subjective daytime sleepiness. However, the effects on academic achievement were "less established". The authors stated, "although delaying school start times appears to be associated with an increase in total sleep duration on school nights, this does not appear to translate into improved performance as reflected in grades or standardized test scores."

Minges & Redeker (2016) conducted a systematic review of experimental research that used quantitative methods to access the impact of the delayed school start time on adolescents. Using their selection criteria, the authors identified six studies for inclusion in their review. All these studies had a delayed school start time ranging from 25 to 60 minutes. Compared with pre-intervention, all studies reported a significant change in sleep duration ranging from 25 minutes to 77 minutes. Three of the studies used a control group of students. These studies found a significant difference in sleep duration favoring the delayed school start times group. This finding was further confirmed in one study that used actigraphy to objectively measure sleep. That study reported a net increase for intervention vs. control condition (65 min. vs. -11 min.) Two of the reviewed studies reported a significant decrease in depression scale, and one study reported a significant decrease in caffeine consumption. Two studies reported a significant decrease in tardiness and a significant decrease in the number of students who reported being too tired to complete schoolwork.

Wheaton, Chapman, & Croft (2016) conducted a review of the literature (based on 38 reports) examining the association between school start times, sleep, and other outcomes in adolescent students. The majority of the reviewed studies reported longer sleep duration in later starting schools primarily due to delaying the rise times. One study reported that bedtimes were delayed by 10 minutes on average for each 30 minutes delay in school start times. Students in schools with later starting times were less likely to report sleepiness or falling asleep in class. The authors reported conflicting results from studies that examined the effect of delayed school times on academic outcomes. One cross-sectional study included in this literature review reported higher self-reported grades for students in later starting schools. On the other hand, a study by Hinrichs (2011) included in this review reported no association between school start times and students' ACT scores controlling for various covariates.

A study by Carrell, Maghaklan & West (2011) took advantage of randomized assignment of students to courses and teachers, standardized grading procedures, and policy changes on school start times in the United States Air Force Academy (USAFA) over the three-year period. The authors found that when students were randomly assigned to a first-period course starting at 8 a.m., they performed significantly worse in all their courses taken on that day compared to students who were not assigned to a first-period class. In addition, the authors found that this negative effect of earlier school starting time

diminished the later the school day began. The authors acknowledged that they used university-level data and not the high school data. However, they expressed the belief that their findings might be applicable to high school students by stating, "we consider only freshmen students in their first semester at USAFA. Like high school seniors, first semester college freshman are still adolescents and have the same biological sleep patterns and preferences as those in their earlier teens."

Edwards (2012) used the data on all middle school students in Wake County, North Carolina from 1999 to 2006 to examine how start times affect the performance of students in grades 6–8 on standardized tests. The author took advantage of considerable variation in school start times across schools as well as variation in start time within schools over time. Using the variation in start times across schools the author found that a one-hour delay in start times was associated with increased standardized test scores in both reading and mathematics by three percentile points. Using only the variation in school start times within the same schools over time in an effort to exclude the influences of other school characteristics on student achievement, the author found two percentile points improvement in mathematics and 1.5 percentile points improvement in reading.

Bastian & Fuller (2018) used statewide student-level data from North Carolina to estimate the effects of school start times for all high school students and for traditionally disadvantaged students. The researchers found that later start times were associated with reduced suspensions and higher course grades, especially for disadvantaged students. On the other hand, achievement results were mixed, with positive and negative associations between start times and high school students' test scores.

A longitudinal study (Thacher & Onyper, 2016) conducted in one high school in upstate New York used survey data collected over the course of one year (the baseline data collected in May 2012 with follow-up data collected in November 2012 and May 2013) as well as school records on tardiness, attendance, disciplinary violations, and academic performance for two years before and two years after the school delayed its start time by 45 minutes. The results indicated that at the first follow-up the average sleep duration increased by 20 minutes primarily due to the later rise times from the baseline. However, at the second follow-up, students delayed bedtimes and returned total sleep time to baseline levels. In addition, the results indicated that the rate of tardiness decreased significantly from the baseline year to the year immediately following the school start time delay. Surprisingly, the absenteeism rate increased over the same period. The number of disciplinary violations in the two years following the school start time delay was significantly reduced in most categories compared with the two-year period following the change. As to the academic performance, the authors did not find any "…compelling evidence to indicate that the change in school start times resulted in a positive shift in standardized assessment scores."

Appleman, Stavitsky Gilbert & Au (2015) examined the effects of districtwide start school time change from 8:20 a.m. to 7:45 a.m. on sleep patterns of grades 3-5 students. They found that third graders reported longer total sleep time (by 24 minutes compared to the pre-change school year), while fourth and fifth graders reported slightly shorter total sleep

times (by 4 and 9 minutes respectively). The authors concluded, "school start time change did not decrease total amount of sleep."

A recent study (Keller, et al., 2015) examined data on public elementary schools in Kentucky (718 schools) to determine the potential implications of early school start times for standardized test scores of elementary school students. The researchers found an association between early school start times and poorer academic performance for schools with smaller proportions of students eligible for the free/reduced-price lunch (more affluent schools).

Summary

According to the American Academy of Sleep Medicine children aged 6-12 years should regularly sleep 9-12 hours and teenagers aged 13-18 years should sleep 8-10 hours per 24 hours. Recent research studies show that only a small percentage of school-aged children get the recommended amounts of sleep. The lack of sleep is especially apparent among school-aged adolescents (middle and high school students).

The major factors contributing to the lack of sleep are biological (changes in circadian rhythms, and sleep drive), use of electronic devices, caffeine consumption, and early school start times. Reported negative consequences of inadequate sleep in adolescents include depressive symptoms and daytime sleepiness; difficulties with attention, impulse control and behavior regulation; increased rates of tardiness; increased crash risk in teen drivers; less positive attitudes toward life; and lower school grades.

Delaying school start time may help in alleviating some of these negative effects. There appears to be a consensus among various researchers that later school start times are associated with an increase in total sleep time in adolescents, although some researchers find that such an effect might be fleeting. In addition, later school start times are found to be associated with better behavioral health (such as depression and irritability), decreased tardiness, and a decreased rate of vehicle crashes for school-aged drivers. Findings on the effects of delayed school start times on student academic performance appear to be inconsistent.

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