

Please note: links are provided at the bottom to other informational articles including an online video of PBS' Frontline program addressing sleep and student learning.

Backgrounder: Later School Start Times

Adolescents today face a widespread chronic health problem: sleep deprivation. Although society often views sleep as a luxury that ambitious or active people cannot afford, research shows that getting enough sleep is a biological necessity, as important to good health as eating well or exercising. Teens are among those least likely to get enough sleep; while they need on average 9 1/4 hours of sleep per night for optimal performance, health and brain development, teens average fewer than 7 hours per school night by the end of high school, and most report feeling tired during the day (Wolfson & Carskadon, 1998). The roots of the problem include poor teen sleep habits that do not allow for enough hours of quality sleep; hectic schedules with afterschool activities and jobs, homework hours and family obligations; and a clash between societal demands, such as early school start times, and biological changes that put most teens on a later sleep-wake clock. As a result, when it is time to wake up for school, the adolescent's body says it is still the middle of the night, and he or she has had too little sleep to feel rested and alert.

The consequences of sleep deprivation during the teenage years are particularly serious. Teens spend a great portion of each day in school; however, they are unable to maximize the learning opportunities afforded by the education system, since sleep deprivation impairs their ability to be alert, pay attention, solve problems, cope with stress and retain information. Young people who do not get enough sleep night after night carry a significant risk for fall asleep automobile crashes; emotional and behavioral problems such as irritability, depression, poor impulse control and violence; health complaints; tobacco and alcohol use; impaired cognitive function and decision-making; and lower overall performance in everything from academics to athletics.

The Biology of Adolescent Sleep

Research shows that adolescents require at least as much sleep as they did as children, generally 8 1/2 to 9 1/4 hours each night (Carskadon et al., 1980). Key changes in sleep patterns and needs during puberty can contribute to excessive sleepiness in adolescents, which can impair daytime functioning. First, daytime sleepiness can increase during adolescence, even when teens' schedules allow for optimal amounts of sleep (Carskadon, Vieri, & Acebo, 1993). Second, most adolescents undergo a sleep phase delay, which means a tendency toward later times for both falling asleep and waking up. Research shows the typical adolescent's natural time to fall asleep may be 11 pm or later; because of this change in their internal clocks, teens may feel wide awake at bedtime, even when they are exhausted (Wolfson & Carskadon, 1998). This leads to sleep deprivation in many teens who must wake up early for school, and thus do not get the 8 1/2 - 9 1/4 hours of sleep that they need. It also causes irregular sleep patterns that can hurt the quality of sleep, since the weekend sleep schedule often ends up being much different from the weekday schedule as teens try to catch up on lost sleep (Dahl & Carskadon, 1995).

Adolescents in Study Show Changing Sleep Patterns

Since the 1970s, there has been a growing awareness of the changes in sleep patterns as children transition to adolescence. In a study at a summer sleep camp at Stanford during the 1970s, boys and girls who enrolled at 10-12 years of age were monitored every year for 5-6 years. While researchers had thought older children would need less sleep during the 10 hour nocturnal window they were given, from 10 pm to 8 am, they found that regardless of age, the children all slept about 9 1/4 of the 10 hours. As they progressed through adolescence, participants continued to get the same amount of sleep, but they no longer woke spontaneously before the end of the sleep window at 8 am (Carskadon et al., 1979). In addition, when the Multiple Sleep Latency Test (MSLT)—given at designated periods throughout the day to determine the speed of falling asleep, to measure

sleepiness—was given to the adolescents, they showed more alertness at 8 pm than earlier in the day, and even greater alertness at 10 pm. Also, at midpuberty, adolescents became sleepier in the middle of the day. According to the tests, more mature adolescents showed signs of reduced alertness during the day even though they slept an equivalent amount at night (Carskadon et al., 1980).

Changes in Melatonin

Another experiment, conducted by Dr. Mary A. Carskadon of Brown University, found that more mature adolescents had later circadian rhythm timing, based on melatonin secretions in saliva samples. This finding shows that melatonin secretion occurs at a later time in adolescents as they mature; thus, it is difficult for them to go to sleep earlier at night. The melatonin secretion also turns off later in the morning, which makes it harder to wake up early (Carskadon et al., 1998).

Another important finding from many studies is that the circadian timing system can be reset if light exposure is carefully controlled (Carskadon et al., 1997). In studies where adolescents are paid to keep a specific sleep schedule and wear eyeshades to exclude light during evening hours, measurements of melatonin secretion show that the rhythm had moved significantly toward a designated time. This means that with time, effort, and money, researchers can get adolescents to reset their clocks. This approach, however, is not necessarily realistic for teens who have full and busy lives. Nevertheless, the interaction of light exposure and sleep timing is important to keep in mind.

A Widespread and High-Impact Part of Teens' Lives

Findings of the tendency for adolescent sleep patterns to be delayed have been reported not only in North America, but also in South America, Asia, Australia and Europe (Andrade & Menna Barreto, 2002; Carskadon & Acebo, 1997; Ishihara, Honma & Miyake, 1990; Bearpark & Michie, 1987; Strauch & Meier, 1988; LeBourgeois et al., 2005; Thorleifsdottir et al., 2002). The diversity of such research supports the view that intrinsic developmental changes play a role in delayed sleep patterns in adolescents. This biological shift sets the stage for other social and environmental conditions that make it easier for these adolescents to stay awake at night and wake up sleepdeprived. The effects of changing sleep patterns are compounded by the demands older students face in academics, extracurricular activities, social opportunities, after-school jobs, and other obligations.

"Sleep isn't a priority for teenagers, and it typically isn't made one by parents or schools."

--Jodi Mindell, PhD, Director of Graduate Program in Psychology, St. Joseph's University and Children's Hospital of Philadelphia

The School Start Time Issue

Adolescent sleep deprivation is largely driven by a conflict between teens' internal biological clocks and the schedules and demands of society. Therefore, it makes sense to look at school start times, which set the rhythm of the day for students, parents, teachers and members of the community at large.

"Given that the primary focus of education is to maximize human potential, then a new task before us is to ensure that the conditions in which learning takes place address the very biology of our learners."

Mary A. Carskadon, PhD, Director of E.P. Bradley Hospital Research Laboratory and professor in Department of Psychiatry and Human Behavior at Brown University School of Medicine

Research on School Start Times and Biology

In a project spearheaded by Dr. Mary A. Carskadon and colleagues, researchers investigated what would happen to sleep and circadian rhythms in a group of young people for whom the transition from junior high to senior high required a change in school starting time from 8:25 am to 7:20 am (Carskadon et al., 1998).

The 25 students completed the study at two time points, in the spring of 9th grade and autumn of 10th grade. The students kept their usual schedules, wore small activity monitors on their wrists, and kept diaries of

activities and sleep schedules for two consecutive weeks. At the end, participants came to Carskadon's sleep lab for assessment of the onset phase of melatonin secretion, an overnight sleep study, and daytime testing with MSLT. The in-lab sleep schedule was fixed to each student's average school night schedule, based on data from the wrist monitors.

Carskadon and colleagues found that in the 10th grade:

On a typical school morning, the students woke up earlier for high school, but only 25 minutes earlier instead of the 65 minutes reflected in the start time change.

Sleep onset times did not change, and averaged about 10:40 pm in both 9th and 10th grade.

The average amount of sleep on school nights fell from 7 hours 9 minutes to 6 hours 50 minutes, which is significant because the students were already accumulating a sleep deficit.

Nearly one-half of the 10th graders showed a reversed sleep pattern on the morning MSLT. This pattern is similar to the sleep disorder narcolepsy, moving immediately into REM sleep before non-REM sleep. The 12 students who showed this pattern did not have narcolepsy, but they did have a mismatch between their school day waking times and their circadian rhythms. Indeed, at 8:30 in the morning, they fell asleep within three minutes.

None of the students made an optimal adjustment to the new schedule; none was sleeping even 8 1/4 hours on school nights.

"Even without the pressure of biological changes, if we combine an early school starting time--say 7:30 am, which, with a modest commute, makes 6:15 am a viable rising time--with our knowledge that optimal sleep need is 9 1/4 hours, we are asking that 16-year olds go to bed at 9 pm. Rare is a teenager that will keep such a schedule. School work, sports practices, clubs, volunteer work, and paid employment take precedence. When biological changes are factored in, the ability even to have merely 'adequate' sleep is lost," Carskadon explains.

School Start Time Initiatives and Outcomes

MINNESOTA (1996)

Early results from schools that have changed their start times are encouraging. For example, successful high school start time changes were made in Edina and Minneapolis, Minnesota after the Minnesota Medical Association issued a 1993 resolution, Sleep Deprivation in Adolescents, based on the research that puberty resets teens' internal biological clocks. The schedule was changed from:

A 7:15 am-1:45 pm day to an 8:40 am-3:20 pm day in Minneapolis

A 7:25 am-2:10 pm day to an 8:30 am-3:10 pm day in Edina

RESULTS

The Center for Applied Research and Educational Improvement (CAREI) at the University of Minnesota conducted a study on the impact of changing school start times on academic performance, behavior and safety in urban and suburban schools (Wahlstrom, 2002). Results from three years of data from both Edina and Minneapolis showed:

Improved attendance

Increase in continuous enrollment

Less tardiness

Students making fewer trips to the school nurse

In suburban districts, students reported:

Gaining an average of about one hour of sleep per night, since their bed times stayed the same even after the start time change.

Eating breakfast more frequently

Being able to complete more of their homework during school hours, because they were more alert and efficient during the day.

Grades showed a slight improvement, although the change was not statistically significant. Researchers noted that it was difficult to assess changes in grades due to differences in school schedules, course names, grading policies, student transience, and the subjective nature of grading by teachers.

Suburban teachers and principals reported:

Students seemed more alert in class.

Improvements in student behavior, with a calmer atmosphere in the hallways and cafeteria.

Fewer disciplinary referrals to the principal.

Suburban counselors reported:

Fewer students seeking help for stress relief due to academic pressures.

Fewer students coming to them with peer relationship problems and difficulties with parents.

Urban teachers, on the other hand, did not see any general improvement in student behavior.

In suburban schools, after-school athletic and other activity practices and rehearsals were shortened, with students arriving home later; however, actual participation in extracurricular activities and after-school jobs remained at the same level after the start time change. Urban schools, on the other hand, reported fewer students being involved in extracurricular activities, as well as conflicts with after-school jobs and compromised earnings. While some coaches whose sports involved long practices and traveling long distances for events disliked the change, most coaches and activity leaders supported the change because they felt students were less tired and more mentally alert at the end of the day.

Most suburban parents supported the change; urban parents had mixed reactions because of work schedules and transportation limitations. Both groups said their children were easier to live with, with fewer confrontations and more actual conversations and connecting time in the morning.

MASSACHUSETTS (2004)

Middle school students, many of whom are entering puberty and experiencing changes to their sleep patterns, have also benefited from later start times (Baroni et al., 2004). In a study comparing 7th and 8th graders at two different schools—one starting at 7:15 am, the other starting at 8:37 am—the students who started school earlier reported inadequate sleep and struggling to stay awake in school more often than the students who started later. While there was no difference in weekend sleep patterns between the students at the two schools, the students who started school later reported sleeping an hour longer on school nights than those with early start times. This difference was due to later rise times; there was no difference in bed times. Academic benefits were also apparent, as students whose school started earlier were tardy four times more often, and 8th grade transcripts showed significantly worse grades. These results occurred in the fall following the start time change, and these findings were replicated in the spring. Although students at both schools were not getting enough sleep, the negative effects of sleep deprivation were far more pronounced in the earlier starting school.

KENTUCKY (1998): PREVENTING DROWSY DRIVING CRASHES

Other school districts have focused on improved safety as a successful outcome of later start times. In fall 1998, a school district in Fayette County, Kentucky moved its start time from 7:30 am to 8:30 am, and students averaged up to 50 minutes more sleep per night. Comparisons in the collision rates of Fayette County teens revealed that the crash rate for 16-18 year olds dropped following the change, even while crash rates for 17-18 year olds actually rose in the rest of the state.

This finding is especially important considering data from the National Highway Traffic Safety Administration, which estimates that up to 100,000 police-reported crashes annually are related to drowsiness, and that among drivers age 15-24, more than 1,500 fatalities each year are associated with such crashes. In a North Carolina state study, 55% of fall asleep crashes involved drivers 25 years old or younger.

Thus, unstable wakefulness and lapses in attention are not just detrimental to performance, like students missing an important piece of information from a teacher—they can also be dangerous, such as a sleepy driver missing a stop sign and causing a fatal accident.

Collaborating in the Best Interests of Students

Many schools across the country are working to synchronize school clocks with students' body clocks, so that teens are in school during their most alert hours and can achieve their full academic potential. Working to bring school start times in line with teens' sleep needs presents a number of challenges and opportunities. Individual communities can vary greatly in their priorities and values; factors to consider include bell schedules of elementary and middle schools; transportation; athletic programs and extracurricular activities; use of schools for community activities; student employment; and safety issues for younger students who either may be waiting for a bus in the dark or need supervision of older siblings after school. There are also safety issues for older students, since violent activities, sex, recreational use of alcohol or drugs, and criminal and other risky behaviors frequently occur between 2 and 4 pm, according to data from the Federal Bureau of Investigation. It is also important that any consideration of a school start time change takes into account the impact on families, including transportation, dependence on teens' income, chores and other family responsibilities, and teens' mood and behavior at home.

Changing a school's start time involves a wide array of people--parents, teachers, students, principals, school boards, superintendents, counselors and healthcare professionals, among others. The impact is felt at a community level, but it is also felt individually, and the individuals who are affected need to have their views heard and acknowledged so that discussions can move forward in search of common ground.

Obviously, moving bell times is one major step in a larger picture of ensuring that adolescents get the sleep they need. It will not put more hours in the day, so it is important for teens to know about their sleep needs and have the skills to make a conscious effort to get a good night's sleep. Many teens assume they are expected to function with a lack of sleep, but sleep is not optional; it is biologically necessary. If sleep is incorporated into educational efforts, teens will be armed with information that will enable them to use a later school start time to their advantage.

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Other Resources for Information/Research Regarding Adolescents, Sleep and Learning:

Hold down CTRL + Click to view these links:

PBS VIDEO: <http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/view/>

<http://www.pbs.org/wgbh/pages/frontline/shows/teenbrain/from/sleep.html>

<http://www.sleepfoundation.org/>

<http://www.cbsnews.com/stories/2006/03/28/earlyshow/living/parenting/main1444540.shtml>

<http://archives.cnn.com/2000/HEALTH/children/09/28/sleepy.teens.01/>