**Adapted from Backgrounder: Later School Start Times**

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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. Sleep is as important to good health as eating well or exercising.

Teens are among those least likely to get enough sleep. They need on average 9 1/4 hours of sleep per night to perform at their best, to be healthy, and for brain development. But instead, older teens average less than 7 hours per school night. Most report feeling tired during the day (Wolfson & Carskadon, 1998).

**Why don’t teens get enough sleep?**

* Poor teen sleep habits.
* Hectic schedules with afterschool activities, jobs, homework and family obligations.
* A clash between early school start times, and biological changes that put most teens on a later sleep-wake clock.

So when it is time to wake up for school, the teen’s body says it is still the middle of the night. He or she has had too little sleep to feel rested and alert.

**The consequences of sleep deprivation during the teen years are very serious.**

1. Education: Teens spend much of each day in school. But they are unable to maximize their learning opportunities. Sleep deprivation impairs their ability to be alert, pay attention, solve problems, cope with stress and retain information.
2. Safety: Teens who do not get enough sleep night after night are at risk for drowsy driving.
3. Emotional and behavioral problems: Teens who don’t get their rest suffer from irritability, depression, poor impulse control and violence.
4. Heath: Sleep-deprived teens have health complaints. They may use tobacco and alcohol.
5. Performance: Teens who aren’t getting enough sleep have poorer cognitive function and decision-making. They have lower overall performance in everything from academics to athletics.

**The Biology of Adolescent Sleep**

Research shows that teens 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).

Changes in sleep patterns and needs during puberty can contribute to excessive sleepiness in adolescents. This sleepiness affects teens’ ability to function during the day.

1. Daytime sleepiness can increase even when teens’ get enough sleep (Carskadon, Vieri, & Acebo, 1993).
2. Most teens experience a sleep-phase delay. This means they tend to fall asleep later at night and wake up later in the morning. 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.
3. It also causes irregular sleep patterns that can hurt the quality of sleep. Teens’ weekend sleep schedule often is much different from the weekday schedule as teens try to catch up on lost sleep (Dahl & Carskadon, 1995).

## Changes in Melatonin

An experiment by Dr. Mary A. Carskadon of Brown University, found that older teens had later circadian rhythm timing. She discovered this by measuring melatonin secretions in saliva samples. This finding shows that melatonin secretion occurs at a later time in adolescents as they mature. That makes it 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).

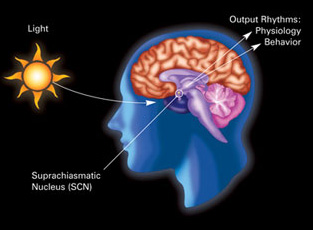
Another important finding from many studies is that the circadian timing system can be reset if light exposure is carefully controlled (Carskadon et al., 1997). In studies where adolescents are paid to keep a specific sleep schedule and wear eyeshades to exclude light during evening hours, they changed their melatonin secretion.

This means that with time, effort, and money, researchers can get adolescents to reset their clocks. This approach may not be realistic for teens who have full and busy lives. Still, the interaction of light exposure and sleep timing is important to keep in mind.

# Circadian Rhythms Fact Sheet

**What are circadian rhythms?**

Circadian rhythms are physical, mental and behavioral changes that follow a roughly 24-hour cycle, responding primarily to light and darkness in an organism's environment. They are found in most living things, including animals, plants and many tiny microbes. The study of circadian rhythms is called chronobiology.

**Are circadian rhythms the same thing as biological clocks?**

No, but they are related. Our biological clocks drive our circadian rhythms.

**What are biological clocks?**

The biological clocks that control circadian rhythms are groupings of interacting molecules in cells throughout the body. A "master clock" in the brain coordinates all the body clocks so that they are in synch.

**How are circadian rhythms related to sleep?**

Circadian rhythms are important in determining human sleep patterns. The body's master clock, the suprachiasmatic nucleus or SCN, controls the production of melatonin, a hormone that makes you sleepy. Since it is located just above the optic nerves, which relay information from the eyes to the brain, the SCN receives information about incoming light. When there is less light—like at night—the SCN tells the brain to make more melatonin so you get drowsy.

## A Widespread and High-Impact Part of Teens' Lives

The fact that teens’ sleep patterns tend to be delayed has 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).

In other words, this problem of being wakeful late at night and unable to get up early in the morning happens to teens all over the world. Scientists believe it’s part of a developmental change. This biological change leads to social and environmental conditions that make it easier for teens to stay awake at night and wake up sleep deprived. The effects are made worse by the demands teens 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 occurs because there is a conflict between teens’ internal biological clocks and the schedules and demands of society.

It makes sense to look at school start times, which set the rhythm of the day for teens.

"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 by Dr. Mary A. Carskadon and colleagues, researchers studied what happened to sleep and circadian rhythms in a group of teens who changed schools. Their middle school started at 8:25. Their new high school began 65 minutes earlier, at 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, the teens came to a sleep lab. They were tested for when their bodies started producing melatonin and for when they were drowsy during the day.

Findings:

1. Students woke up earlier for high school, but only 25 minutes earlier instead of the 65 minutes reflected in the start time change.
2. The time that the teens’ bodies were ready for sleep did not change. It stayed about 10:40 pm.
3. Students got less sleep in high school. On school nights they averaged 6 hours and 50 minutes. This was 17 minutes less than in middle school, which is significant because the students were already sleep-deprived.
4. Nearly half of the 10th high schools showed signs of a condition similar to narcolepsy. They moved immediately into REM sleep before non-REM sleep. This reflected the mismatch between their school day waking times and their circadian rhythms. Half of the students were so tired that they fell asleep within three minutes at 8:30 in the morning.
5. None of the students made a good adjustment to the new schedule. No students slept 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**

**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. 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. During this same time, 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. 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.

**School Start Time Initiatives and Outcomes**

**MASSACHUSETTS (2004)**

Middle school students have also benefited from later start times (Wolfson et al., 2007).

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.

Students whose school started earlier were tardy four times more often.

Students whose school started earlier had significantly worse grades.

Although students at both schools were not getting enough sleep, the bad effects of sleep deprivation were far greater in the earlier starting school.

**School Start Time Initiatives and Outcomes**

**MINNESOTA (1996)**

Early results from schools that have changed their start times are encouraging. For example, Edina and Minneapolis, Minnesota changed their schedules 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*

The Center for Applied Research and Educational Improvement (CAREI) at the University of Minnesota conducted a study on the impact. Three years of data showed:

* Improved attendance
* Increase in continuous enrollment
* Less tardiness
* Students making fewer trips to the school nurse

In suburban districts, students reported:

* Getting an average of about one hour more of sleep per night.
* 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.

Suburban schools reported:

* Students seemed more alert in class.
* Improvements in student behavior.
* Fewer disciplinary referrals to the principal.
* 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 practices and rehearsals were shortened. Students arrived home later. Participation in these activities remained at the same level after the start time change.

Urban schools reported fewer students being involved in extracurricular activities, as well as conflicts with after-school jobs and compromised earnings.

While coaches whose sports involved long practices and traveling long distances for events disliked the change, most coaches and activity leaders supported it 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 problems. Both groups said their children were easier to live with, with fewer confrontations and more actual conversations and connecting time in the morning.