

COVER STORY

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Sleep deprivation may be undermining teen health

Lack of sufficient sleep--a rampant problem among teens--appears to put adolescents at risk for cognitive and emotional difficulties, poor school performance, accidents and psychopathology, research suggests.

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October 2001, Vol 32, No. 9

Print version: page 42

On any given school day, teen-agers across the nation stumble out of bed and prepare for the day. For most, the alarm clock buzzes by 6:30 a.m., a scant seven hours after they went to bed. Many students board the school bus before 7 a.m. and are in class by 7:30.

In adults, such meager sleep allowances are known to affect day-to-day functioning in myriad ways. In adolescents, who are biologically driven to sleep longer and later than adults do, the effects of insufficient sleep are likely to be even more dramatic--so much so that some sleep experts contend that the nation's early high-school start times, increasingly common, are tantamount to abuse.

"Almost all teen-agers, as they reach puberty, become walking zombies because they are getting far too little sleep," comments Cornell University psychologist James B. Maas, PhD, one of the nation's leading sleep experts.

There can be little question that sleep deprivation has negative effects on adolescents. According to the National Highway Traffic Safety Administration, for example, drowsiness and fatigue cause more than 100,000 traffic accidents each year--and young drivers are at the wheel in more than half of these crashes.

Insufficient sleep has also been shown to cause difficulties in school, including disciplinary problems, sleepiness in class and poor concentration.

"What good does it do to try to educate teen-agers so early in the morning?" asks Maas. "You can be giving the most stimulating, interesting lectures to sleep-deprived kids early in the morning or right after lunch, when they're at their sleepiest, and the overwhelming drive to sleep replaces any chance of alertness, cognition, memory or understanding."

Recent research has also revealed an association between sleep deprivation and poorer grades. In a 1998 survey of more than 3,000 high-school students, for example, psychologists Amy R. Wolfson, PhD, of the College of the Holy Cross, and Mary A. Carskadon, PhD, of Brown University Medical School, found that students who reported that they were getting C's, D's and F's in school obtained about 25 minutes less sleep and went to bed about 40 minutes later than students who reported they were getting A's and B's.

In August, researchers at the University of Minnesota reported the results of a study of more than 7,000 high-school students whose school district had switched in 1997 from a 7:15 a.m. start time to an 8:40 a.m. start time. Compared with students whose schools maintained earlier start times, students with later starts reported getting more sleep on school nights, being less sleepy during the day, getting slightly higher grades and experiencing fewer depressive feelings and behaviors.

Also troubling are findings that adolescent sleep difficulties are often associated with psychopathologies such as depression and attention deficit hyperactivity disorder (ADHD).

This research, combined with studies showing widespread sleep deprivation among teens, has propelled efforts to educate children and adults about the importance of a good night's sleep and to persuade schools to push back high-school starting times.

"There is substantial evidence that the lack of sleep can cause accidents, imperil students' grades and lead to or exacerbate emotional problems," says U.S. Rep. Zoe Lofgren (D-Calif.), who has introduced a bill that would provide federal grants to help school districts defray the cost of pushing back school starting times. Adjusting school schedules, Lofgren says, "could do more to improve education and reduce teen accidents and crime than many more expensive initiatives."

The research has also spurred further investigations into why teens need extra sleep, the effects of sleep deprivation on cognition, emotion regulation and psychopathology, and the long-term consequences of chronic sleep deprivation.

Dogma reversed

For decades, experts believed that people require less sleep as they move from infancy through adulthood.

It's easy to see why this belief persisted: Adolescents sleep less than they did as children, declining from an average of 10 hours a night during middle childhood to fewer than 7.5 hours by age 16. According to Wolfson and Carskadon's 1998 study, 26 percent of high school students routinely sleep less than 6.5 hours on school nights, and only 15 percent sleep 8.5 hours or more. The same study indicated that to make up for lost sleep, most teens snooze an extra couple of hours on weekend mornings—a habit that can lead to poorer-quality sleep.

But to researchers' surprise, in the past two decades studies have shown that teen-agers require considerably more sleep to perform optimally than do younger children or adults. Starting around the beginning of puberty and continuing into their early 20s, Carskadon and colleagues have shown, adolescents need about 9.2 hours of sleep each night, compared with the 7.5 to 8 hours that adults need.

In addition to needing more sleep, adolescents experience a "phase shift" during puberty, falling asleep later at night than do younger children. Researchers long assumed that this shift was driven by psychosocial factors such as social activities, academic pressures, evening jobs and television and Internet use. In the past several years, however, sleep experts have learned that biology also plays a starring role in adolescents' changing sleep patterns, says Carskadon.

Indeed, Carskadon's research is greatly responsible for that new understanding. In a pair of groundbreaking studies published in 1993 and 1997, she and colleagues found that more physically mature girls preferred activities later in the day than did less mature girls, and that in more physically mature teens, melatonin production tapered off later than it did in less mature teens. Those findings, Carskadon says, suggest that the brain's circadian timing system—controlled mainly by melatonin—switches on later at night as pubertal development progresses.

Changes in adolescents' circadian timing system, combined with external pressures such as the need to awaken early in the morning for school, produce a potentially destructive pattern of early-morning sleepiness in teen-agers, Carskadon argues. In a laboratory study of 40 high-school students published in the journal *Sleep* (Vol. 21, No. 8) in 1998, she, Wolfson and colleagues examined the effect of changing school starting times from 8:25 a.m. to 7:20 a.m.

Their results were disturbing: Almost half of the students who began school at 7:20 were "pathologically sleepy" at 8:30, falling directly into REM sleep in an average of only 3.4 minutes—a pattern similar to what is seen in patients with narcolepsy.

Those findings, says Carskadon, persuaded her that "these early school start times are just abusive. These kids may be up and at school at 8:30, but I'm convinced their brains are back on the pillow at home."

Elusive questions

The evidence of adolescents' increased need for sleep and that many--if not most--teen-agers are chronically sleep deprived has raised further questions. Particularly elusive, says Carskadon, has been the question of why adolescents' circadian clocks shift to a later phase around the beginning of puberty.

One possibility, she believes, is that the brain's sensitivity to light changes during adolescence. At the annual meeting of the Associated Professional Sleep Societies in June, she and colleagues presented research showing that in the evening, exposure to even very dim lighting delayed melatonin secretion for participants who were in middle or late puberty, but not for prepubertal participants.

Carskadon is also interested in how teen-age alcohol use might affect the brain's sleep system. Following up on studies in adults that have established a link between drinking problems and changes in sleep patterns, for example, she and her colleagues plan to examine whether during early development, young people with a family history of problem drinking might have abnormalities in the brain mechanisms that govern sleep.

Just as important as the question of why sleep patterns change during adolescence is the issue of how sleep deprivation influences adolescents' emotion regulation and behavior. Many researchers have noted that sleep-deprived teen-agers appear to be especially vulnerable to psychopathologies such as depression and ADHD, and to have difficulty controlling their emotions and impulses.

Although it's difficult to untangle cause and effect, it's likely that sleep deprivation and problems controlling impulses and emotions exacerbate one another, leading to a "negative spiral" of fatigue and sleepiness, labile emotions, poor decision-making and risky behavior, says Ronald E. Dahl, MD, a professor of psychiatry and pediatrics at the University of Pittsburgh.

Despite the evidence that insufficient sleep affects young people's thinking, emotional balance and behavior, the long-term effects of chronic sleep deprivation on learning, emotion, social relationships and health remain uncertain.

"There's a real need for longitudinal studies to follow through later childhood and adulthood," says psychologist Avi Sadeh, PhD, a sleep researcher at Tel Aviv University. Although research has amply demonstrated that sleep problems affect young people's cognitive skills, behavior and temperament in the short term, he says, "It's not at all clear to what extent these effects are long-lasting."

Researchers push for school changes, public outreach

With such a wealth of evidence about the prevalence of adolescent sleep deprivation and the risks it poses, many sleep researchers have become involved in efforts to persuade school districts to push back high-school starting times so that teens can get their needed rest.

Some schools argue that adjusting school schedules is too expensive and complicated. But others have responded positively to sleep experts' pleas. The Connecticut legislature is considering a bill that would prohibit public schools from starting before 8:30 a.m., and Massachusetts lawmakers are also weighing the issue. And Lofgren's "Zzzzz's to A's" bill, first introduced in the U.S. House of Representatives in 1998, would provide federal grants of up to \$25,000 to school districts to help cover the administrative costs of adjusting school start times.

These efforts are a move in the right direction, says Wolfson. But, she says, changing school start times isn't the entire answer. "I think we have to be educating children, parents and teachers about the importance of sleep, just as we educate them about exercise, nutrition and drug and alcohol use."






Toward that end, several public-education efforts are now under way:

its consequences and the "golden rules" for healthy sleep. The film is scheduled for distribution through parent-teacher associations and school principals this fall. In August, Maas also published a children's book, "Remmy and the Brain Train," which discusses why the brain requires a good night's sleep.

Next year, the National Center for Sleep Disorders Research at the National Institutes of Health plans to release a supplemental sleep curriculum for 10th-grade biology classes, addressing the biology of sleep, the consequences of insufficient sleep and the major sleep disorders. In a related effort, the center is coordinating a sleep-education campaign aimed at 7- to 11-year-olds.

Wolfson and colleague Christine A. Marco, PhD, a psychologist at Worcester State College, are pilot-testing an eight-week sleep curriculum for middle-school students. As part of the curriculum, students keep sleep diaries, play creative games and participate in role-playing about sleep, and set goals—for example, for the amount of sleep they want to get or for regulating their caffeine intake. Preliminary results indicate that the curriculum helps students improve their sleep habits.

"Changing school start times is one critical measure we can take to protect young people's sleep," says Wolfson. "And then, if we can only understand what's going on with sleep in these sixth-, seventh- and eighth-graders, we can intervene to change their sleep behavior before it gets out of hand."

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