Teen sleep deprivation at epidemic level

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Carolyn Walworth, 17, often reaches a breaking point around 11 p.m., when she collapses in tears. For 10 minutes or so, she just sits at her desk and cries, overwhelmed by unrelenting school demands. She is desperately tired and longs for sleep. But she knows she must move through it, because more assignments in physics, calculus or French await her. She finally crawls into bed around midnight or 12:30 a.m.

The next morning, she fights to stay awake in her first-period U.S. history class, which begins at 8:15. She is unable to focus on what's being taught, and her mind drifts. "You feel tired and exhausted, but you think you just need to get through the day so you can go home and sleep ," said the Palo Alto, California, teen. But that night, she will have to try to catch up on what she missed in class. And the cycle begins again.

"It's an insane system. … The whole essence of learning is lost," she said.

Walworth is among a generation of teens growing up chronically sleep-deprived. According to a 2006 National Sleep Foundation poll, the organization's most recent survey of teen sleep, more than 87 percent of high school students in the United States get far less than the recommended eight to 10 hours, and the amount of time they sleep is decreasing—a serious threat to their health, safety and academic success. Sleep deprivation increases the likelihood teens will suffer myriad negative consequences, including an inability to concentrate, poor grades, drowsy-driving incidents, anxiety, depression, thoughts of suicide and even suicide attempts. It's a problem that knows no economic boundaries.

While studies show that both adults and teens in industrialized nations are becoming more sleep deprived, the problem is most acute among teens, said Nanci Yuan, MD, director of the Stanford Children's Health Sleep Center. In a detailed 2014 report, the American Academy of Pediatrics called the problem of tired teens a public health epidemic.

"I think high school is the real danger spot in terms of sleep deprivation," said William Dement, MD, PhD, founder of the Stanford Sleep Disorders Clinic, the first of its kind in the world. "It's a huge problem. What it means is that nobody performs at the level they could perform," whether it's in school, on the roadways, on the sports field or in terms of physical and emotional health.

Social and cultural factors, as well as the advent of technology, all have collided with the biology of the adolescent to prevent teens from getting enough rest. Since the early 1990s, it's been established that teens have a biologic tendency to go to sleep later—as much as two hours later—than their younger counterparts.

Yet when they enter their high school years, they find themselves at schools that typically start the day at a relatively early hour. So their time for sleep is compressed, and many are jolted out of bed before they are physically or mentally ready. In the process, they not only lose precious hours of rest, but their natural rhythm is disrupted, as they are being robbed of the dream-rich, rapid-eye-movement stage of sleep, some of the deepest, most productive sleep time, said pediatric sleep specialist Rafael Pelayo, MD, with the Stanford Sleep Disorders Clinic.

"When teens wake up earlier, it cuts off their dreams," said Pelayo, a clinical professor of psychiatry and behavioral sciences. "We're not giving them a chance to dream."

Understanding teen sleep

On a sunny June afternoon, Dement maneuvered his golf cart, nicknamed the Sleep and Dreams Shuttle, through the Stanford University campus to Jerry House, a sprawling, Mediterranean-style dormitory where he and his colleagues conducted some of the early, seminal work on sleep, including teen sleep.

Beginning in 1975, the researchers recruited a few dozen local youngsters between the ages of 10 and 12 who were willing to participate in a unique sleep camp. During the day, the young volunteers would play volleyball in the backyard, which faces a now-barren Lake Lagunita, all the while sporting a nest of electrodes on their heads.

At night, they dozed in a dorm while researchers in a nearby room monitored their brain waves on 6-foot electroencephalogram machines, old-fashioned polygraphs that spit out wave patterns of their sleep.

One of Dement's colleagues at the time was Mary Carskadon, PhD, then a graduate student at Stanford. They studied the youngsters over the course of several summers, observing their sleep habits as they entered puberty and beyond.

Dement and Carskadon had expected to find that as the participants grew older, they would need less sleep. But to their surprise, their sleep needs remained the same—roughly nine hours a night—through their teen years. "We thought, 'Oh, wow, this is interesting,'" said Carskadon, now a professor of psychiatry and human behavior at Brown University and a nationally recognized expert on teen sleep.

Moreover, the researchers made a number of other key observations that would plant the seed for what is now accepted dogma in the sleep field. For one, they noticed that when older adolescents were restricted to just five hours of sleep a night, they would become progressively sleepier during the course of the week. The loss was cumulative, accounting for

what is now commonly known as sleep debt.

"The concept of sleep debt had yet to be developed," said Dement, the Lowell W. and Josephine Q. Berry Professor in the Department of Psychiatry and Behavioral Sciences. It's since become the basis for his ongoing campaign against drowsy driving among adults and teens. "That's why you have these terrible accidents on the road," he said. "People carry a large sleep debt, which they don't understand and cannot evaluate."

The researchers also noticed that as the kids got older, they were naturally inclined to go to bed later. By the early 1990s, Carskadon established what has become a widely recognized phenomenon—that teens experience a so-called sleep-phase delay. Their circadian rhythm—their internal biological clock—shifts to a later time, making it more difficult for them to fall asleep before 11 p.m.

Teens are also biologically disposed to a later sleep time because of a shift in the system that governs the natural sleep-wake cycle. Among older teens, the push to fall asleep builds more slowly during the day, signaling them to be more alert in the evening.

"It's as if the brain is giving them permission, or making it easier, to stay awake longer," Carskadon said. "So you add that to the phase delay, and it's hard to fight against it."

Pressures not to sleep

After an evening with four or five hours of homework, Walworth turns to her cellphone for relief. She texts or talks to friends and surfs the Web. "It's nice to stay up and talk to your friends or watch a funny YouTube video," she said. "There are plenty of online distractions."

While teens are biologically programmed to stay up late, many social and cultural forces further limit their time for sleep. For one, the pressure on teens to succeed is intense, and they must compete with a growing number of peers for college slots that have largely remained constant. In high-achieving communities like Palo Alto, that translates into students who are overwhelmed by additional homework for Advanced Placement classes, outside activities such as sports or social service projects, and in some cases, part-time jobs, as well as peer, parental and community pressures to excel.

At the same time, today's teens are maturing in an era of ubiquitous electronic media, and they are fervent participants. Some 92 percent of U.S. teens have smartphones, and 24 percent report being online "constantly," according to a 2015 report by the Pew Research Center. Teens have access to multiple electronic devices they use simultaneously, often at night. Some 72 percent bring cellphones into their bedrooms and use them when they are trying to go to sleep, and 28 percent leave their phones on while sleeping, only to be awakened at night by texts, calls or emails, according to a 2011 National Sleep Foundation poll on electronic use. In addition, some 64 percent use electronic music devices, 60 percent use laptops and 23 percent play video games in the hour before they went to sleep, the poll found. More than half reported texting in the hour before they went to sleep, and these media fans were less likely to report getting a good night's sleep and feeling refreshed in the morning. They were also more likely to drive when drowsy, the poll found.

The problem of sleep-phase delay is exacerbated when teens are exposed late at night to lit screens, which send a message via the retina to the portion of the brain that controls the body's circadian clock. The message: It's not nighttime yet.

Yuan, a clinical associate professor of pediatrics, said she routinely sees young patients in her clinic who fall asleep at night with cellphones in

hand.

"With academic demands and extracurricular activities, the kids are going nonstop until they fall asleep exhausted at night. There is not an emphasis on the importance of sleep, as there is with nutrition and exercise," she said. "They say they are tired, but they don't realize they are actually sleep-deprived. And if you ask kids to remove an activity, they would rather not. They would rather give up sleep than an activity."

The role of parents

Adolescents are also entering a period in which they are striving for autonomy and want to make their own decisions, including when to go to sleep. But studies suggest adolescents do better in terms of mood and fatigue levels if parents set the bedtime—and choose a time that is realistic for the child's needs. According to a 2010 study published in the journal *Sleep*, children are more likely to be depressed and to entertain thoughts of suicide if a parent sets a late bedtime of midnight or beyond.

In families where parents set the time for sleep, the teens' happier, better-rested state "may be a sign of an organized family life, not simply a matter of bedtime," Carskadon said. "On the other hand, the growing child and growing teens still benefit from someone who will help set the structure for their lives. And they aren't good at making good decisions."

According to the 2011 sleep poll, by the time U.S. students reach their senior year in high school, they are sleeping an average of 6.9 hours a night, down from an average of 8.4 hours in the sixth grade. The poll included teens from across the country from diverse ethnic backgrounds.

American teens aren't the worst off when it comes to sleep, however; South Korean adolescents have that distinction, sleeping on average 4.9 hours a night, according to a 2012 study in Sleep by South Korean

researchers. These Asian teens routinely begin school between 7 and 8:30 a.m., and most sign up for additional evening classes that may keep them up as late as midnight. South Korean adolescents also have relatively high suicide rates (10.7 per 100,000 a year), and the researchers speculate that chronic sleep deprivation is a contributor to this disturbing phenomenon.

By contrast, Australian teens are among those who do particularly well when it comes to sleep time, averaging about nine hours a night, possibly because schools there usually start later.

Regardless of where they live, most teens follow a pattern of sleeping less during the week and sleeping in on the weekends to compensate. But many accumulate such a backlog of sleep debt that they don't sufficiently recover on the weekend and still wake up fatigued when Monday comes around.

Moreover, the shifting sleep patterns on the weekend—late nights with friends, followed by late mornings in bed—are out of sync with their weekday rhythm. Carskadon refers to this as "social jet lag."

"Every day we teach our internal circadian timing system what time it is—is it day or night?—and if that message is substantially different every day, then the clock isn't able to set things appropriately in motion," she said. "In the last few years, we have learned there is a master clock in the brain, but there are other clocks in other organs, like liver or kidneys or lungs, so the master clock is the coxswain, trying to get everybody to work together to improve efficiency and health. So if the coxswain is changing the pace, all the crew become disorganized and don't function well."

This disrupted rhythm, as well as the shortage of sleep, can have far-reaching effects on adolescent health and well-being, she said.

"It certainly plays into learning and memory. It plays into appetite and metabolism and weight gain. It plays into mood and emotion, which are already heightened at that age. It also plays into risk behaviors—taking risks while driving, taking risks with substances, taking risks maybe with sexual activity. So the more we look outside, the more we're learning about the core role that sleep plays," Carskadon said.

Many studies show students who sleep less suffer academically, as chronic sleep loss impairs the ability to remember, concentrate, think abstractly and solve problems. In one of many studies on sleep and academic performance, Carskadon and her colleagues surveyed 3,000 high school students and found that those with higher grades reported sleeping more, going to bed earlier on school nights and sleeping in less on weekends than students who had lower grades.

Sleep is believed to reinforce learning and memory, with studies showing that people perform better on mental tasks when they are well-rested. "We hypothesize that when teens sleep, the brain is going through processes of consolidation—learning of experiences or making memories," Yuan said. "It's like your brain is filtering itself—consolidating the important things and filtering out those unimportant things." When the brain is deprived of that opportunity, cognitive function suffers, along with the capacity to learn.

"It impacts academic performance. It's harder to take tests and answer questions if you are sleep-deprived," she said.

That's why cramming, at the expense of sleep, is counterproductive, said Pelayo, who advises students: Don't lose sleep to study, or you'll lose out in the end.

The panic attack

Chloe Mauvais, 16, hit her breaking point at the end of a very challenging sophomore year when she reached "the depths of frustration and anxiety." After months of late nights spent studying to keep up with academic demands, she suffered a panic attack one evening at home.

"I sat in the living room in our house on the ground, crying and having horrible breathing problems," said the senior at Menlo-Atherton High School. "It was so scary. I think it was from the accumulated stress, the fear over my grades, the lack of sleep and the crushing sense of responsibility. High school is a very hard place to be."

Where she once had good sleep habits, she had drifted into an unhealthy pattern of staying up late, sometimes until 3 a.m., researching and writing papers for her AP European history class and prepping for tests.

"I have difficulty remembering events of that year, and I think it's because I didn't get enough sleep," she said. "The lack of sleep rendered me emotionally useless. I couldn't address the stress because I had no coherent thoughts. I couldn't step back and have perspective. … You could probably talk to any teen and find they reach their breaking point. You've pushed yourself so much and not slept enough and you just lose it."

The experience was a kind of wake-up call, as she recognized the need to return to a more balanced life and a better sleep pattern, she said. But for some teens, this toxic mix of sleep deprivation, stress and anxiety, together with other external pressures, can tip their thinking toward dire solutions.

Research has shown that sleep problems among adolescents are a major risk factor for suicidal thoughts and death by suicide, which ranks as the third-leading cause of fatalities among 15- to 24-year-olds. And this link between sleep and suicidal thoughts remains strong, independent of

whether the teen is depressed or has drug and alcohol issues, according to some studies.

"Sleep, especially deep sleep, is like a balm for the brain," said Shashank Joshi, MD, associate professor of psychiatry and behavioral sciences at Stanford. "The better your sleep, the more clearly you can think while awake, and it may enable you to seek help when a problem arises. You have your faculties with you. You may think, 'I have 16 things to do, but I know where to start.' Sleep deprivation can make it hard to remember what you need to do for your busy teen life. It takes away the support, the infrastructure."

Sleep is believed to help regulate emotions, and its deprivation is an underlying component of many mood disorders, such as anxiety, depression and bipolar disorder. For students who are prone to these disorders, better sleep can help serve as a buffer and help prevent a downhill slide, Joshi said.

Rebecca Bernert, PhD, who directs the Suicide Prevention Research Lab at Stanford, said sleep may affect the way in which teens process emotions. Her work with civilians and military veterans indicates that lack of sleep can make people more receptive to negative emotional information, which they might shrug off if they were fully rested, she said.

"Based on prior research, we have theorized that sleep disturbances may result in difficulty regulating emotional information, and this may lower the threshold for suicidal behaviors among at-risk individuals," said Bernert, an instructor of psychiatry and behavioral sciences. Now she's studying whether a brief nondrug treatment for insomnia reduces depression and risk for suicide.

Sleep deprivation also has been shown to lower inhibitions among both

adults and teens. In the teen brain, the frontal lobe, which helps restrain impulsivity, isn't fully developed, so teens are naturally prone to impulsive behavior. "When you throw into the mix sleep deprivation, which can also be disinhibiting, mood problems and the normal impulsivity of adolescence, then you have a potentially dangerous situation," Joshi said.

Some schools shift

Given the health risks associated with sleep problems, school districts around the country have been looking at one issue over which they have some control: when school starts in the morning. The trend was set by the town of Edina, Minnesota, a well-to-do suburb of Minneapolis, which conducted a landmark experiment in student sleep in the late 1990s. It shifted the high school's start time from 7:20 a.m. to 8:30 a.m. and then asked University of Minnesota researchers to look at the impact of the change. The researchers found some surprising results: Students reported feeling less depressed and less sleepy during the day and more empowered to succeed. There was no comparable improvement in student well-being in surrounding school districts where start times remained the same.

With these findings in hand, the entire Minneapolis Public School District shifted start times for 57,000 students at all of its schools in 1997 and found similarly positive results. Attendance rates rose, and students reported getting an hour's more sleep each school night—or a total of five more hours of sleep a week—countering skeptics who argued that the students would respond by just going to bed later.

Other studies have reinforced the link between later start times and positive health benefits. One 2010 study at an independent high school in Rhode Island found that after delaying the start time by just 30 minutes, students slept more and showed significant improvements in alertness

and mood. And a 2014 study in two counties in Virginia found that teens were much less likely to be involved in car crashes in a county where start times were later, compared with a county with an earlier start time.

Bolstered by the evidence, the American Academy of Pediatrics in 2014 issued a strong policy statement encouraging middle and high school districts across the country to start school no earlier than 8:30 a.m. to help preserve the health of the nation's youth. Some districts have heeded the call, though the decisions have been hugely contentious, as many consider school schedules sacrosanct and cite practical issues, such as bus schedules, as obstacles.

In Fairfax County, Virginia, it took a decade of debate before the school board voted in 2014 to push back the opening school bell for its 57,000 students. And in Palo Alto, where a recent cluster of suicides has caused much communitywide soul-searching, the district superintendent issued a decision in the spring, over the strenuous objections of some teachers, students and administrators, to eliminate "zero period" for academic classes—an optional period that begins at 7:20 a.m. and is generally offered for advanced studies.

Certainly, changing school start times is only part of the solution, experts say. More widespread education about sleep and more resources for students are needed. Parents and teachers need to trim back their expectations and minimize pressures that interfere with teen sleep. And there needs to be a cultural shift, including a move to discourage late-night use of electronic devices, to help youngsters gain much-needed rest.

"At some point, we are going to have to confront this as a society," Carskadon said. "For the health and well-being of the nation, we should all be taking better care of our sleep, and we certainly should be taking better care of the sleep of our youth."