

Sleep crisis: The science of slumber

Go to bed. On time. Tonight. Or else

by Luiza Ch. Savage on Monday, June 17, 2013



Florian Jaenicke/Redux

The sleep doctors are coming and they want you to go to bed. On time. Tonight. Every night. Or else.

They want doctors to add a single question to routine checks of vital signs like body temperature, pulse, blood pressure and rate of breathing. The question is: How did you sleep?

If you're like most people, probably not well, or at least not enough.

Coffee-fuelled North Americans, with our smartphones at our bedsides, are sleeping, on average, nearly two hours less than we were 40 years ago, when most people slept 8½ hours or more. More and more people are being diagnosed with sleep apnea, a disorder in which breathing is disrupted during sleep. And insomnia, which affects about 10 per cent of the population, is no longer considered merely a symptom of other medical or psychiatric problems but has been classified as a full-fledged disorder in its own right.

The scientific evidence is mounting that getting less than the recommended seven to nine hours of nightly sleep is having wide-ranging impacts on our bodies, our minds and, especially, on the health of our children, who need even more sleep: 10 to 11 hours per night.

In March, the [U.S. Centers for Disease Control and Prevention declared](#) that “insufficient sleep is a public health epidemic.” It released a survey showing that more than 35 per cent of U.S. adults reported getting less than seven hours of sleep a night; 38 per cent reported unintentionally falling asleep at least once during the day in the preceding month.

Armed with proliferating studies, the sleep scientists are turning their attention from the laboratory to advocacy, asking lawmakers for more research funding, and urging the general public to start thinking about sleep loss the way we think about smoking: as a serious hazard to our health.

The evidence is chilling. When researchers at the University of Chicago took seven lean and healthy volunteers and restricted their sleep to only 4½ hours per night, they found a result that went far beyond mere grogginess. Their very cells had been transformed. It was as if the bodies of the otherwise healthy specimens had been swapped with that of someone else: someone heavy and sick.

The six men and one woman, average age 24, took an intravenous test to measure how their bodies responded to glucose, and researchers biopsied samples of fat cells from their abdomens to test how the cells responded to insulin. Compared to results from the same tests carried out when the volunteers were well-rested, their bodies’ insulin response had decreased by an average of 16 per cent and insulin sensitivity of their fat cells decreased by 30 per cent—levels comparable to the differences between lean and obese people, and those with diabetes compared to those without. While the link between sleep, obesity and diabetes has become a burgeoning area of research, this was the first time someone had shown how sleep changes human metabolism at a molecular level. Even our fat cells, the researchers concluded, need sleep.

“Some people claim they can tolerate the cognitive effects of routine sleep deprivation,” said Eve Van Cauter, professor of medicine and director of the [Sleep Metabolism and Health Center](#) at the University of Chicago, a lead researcher on the study published in the *Annals of Internal Medicine* last fall. “In this small but thorough study, however, we found that seven out of seven subjects had a significant change in insulin sensitivity. They are not tolerating the metabolic consequences.”

This month, 5,500 sleep scientists and clinicians gathered for the 27th annual meeting of the Associated Professional Sleep Societies in Baltimore. They gave Van Cauter an award for “distinguished scientist of the year” for her work showing the links between sleep and metabolism.

They also presented and discussed hundreds of studies probing the links between sleep loss and increased risk of all kinds of physical, emotional and intellectual impairments: from depression and suicidal thoughts to increased pain sensitivity and inflammation; from memory failures to a weakened ability to judge subtle social cues, such as the sexual receptiveness of a potential mate. On the frontlines of sleep science there is no area of human function that isn’t affected by this far-reaching—yet largely preventable—health affliction of our times.

At the Baltimore conference, called **Sleep 2013**, more than 1,300 papers were presented from all over the world. Individually, they looked at issues from sleep in space flight (it turns out that like the rest of us, astronauts on the International Space Station don't sleep as much as NASA says they should) to how chronic partial sleep deprivation affects a key enzyme in the brains of adolescent rats. Collectively, the findings have startling implications for our health. The research is increasingly showing that a powerful intervention for many modern ailments may indeed be simply getting more sleep. "If you sleep restrict humans, there are two major consequences," said Dr. Allan Pack, director of the **Center for Sleep and Circadian Neurobiology** at the Perelman School of Medicine at the University of Pennsylvania. "Behavioural consequences—you feel sleepy—and metabolic changes at the cellular level."

Pack and his colleagues recently deprived lab mice of three, six and nine hours of sleep per day. They found that a biological function called "protein folding," a fundamental part of cell growth and repair, was derailed in mice who missed their sleep.

"When you are sleep-deprived, you're not making the proteins properly—the proteins that are the building blocks of cells," he explained. "At the most basic level, when you are missing your sleep, your cells are very stressed. They're not making the things they need to make."

This area of research is relatively new. "Ten years ago, we had the first early studies that really provided very strong signals of the relationship between sleep and health. Not just number of hours, but quality of sleep," said Dr. Phyllis Zee, professor of neurology and director of the sleep disorders center at Northwestern University's Feinberg School of Medicine. "It's such a fundamental process to your body, your brain, all your tissues."

In the conference rooms of the cavernous Baltimore Convention Center, researchers presented an array of studies that left few areas of life untouched. One study, led by researchers from the University of Hull in the U.K., tested the abilities of young men to drive safely in a vehicle simulator. They found that not only did they drive with less control over the course of the night, but in the wee hours of the morning, they were particularly dangerous drivers. "In the early hours of the day, brake-reaction time was significantly slower and collisions with other vehicles, roadside objects and pedestrians more frequent," the researchers found.

Another study found that professional baseball players who report feeling sleepy during the day have shorter careers in the major leagues. Researchers gave 80 randomly selected major league players a questionnaire called the "Epworth sleepiness scale," on which they ranked their levels of sleepiness. Their answers translated into a score from zero to 24, which increased with their levels of sleepiness. The result was that 75 per cent of players with a score of five were still in the league three seasons later, compared with only 39 per cent of players with a score of 10, and only 14 per cent of players with a score of 15. "We were shocked by how linear the relationship was," the study's principal investigator, Dr. W. Christopher Winter, medical director of the Martha Jefferson Hospital's sleep medicine center in Charlottesville, Va., said. "It is a great reminder that sleepiness impairs performance."

Another study of 30 Major League Baseball teams showed that over the course of a season, a player's so-called "strike-zone judgment"—frequency of swinging at pitches outside the strike zone—got worse. Rather than improving with experience, researchers believe it deteriorated with fatigue from frequent travel and few breaks, and reasoned that teams enacting "fatigue-mitigating strategies" could gain "a larger competitive advantage."

Sleep loss can impair judgment, as well. Past studies have shown that sleep loss impairs the frontal lobe of the brain and has negative effects on decision-making such as sensitivity to risk-taking, moral reasoning and inhibitions. A new experiment with 60 college students in Arkansas showed that following just one night of total sleep deprivation, men's perception of women's sexual intent and interest increased significantly. "Our findings here are similar to those from studies using alcohol, which similarly inhibits the frontal lobe," said study co-author Jennifer Peszka, an associate professor of psychology at Hendrix College in Conway, Ark., leading researchers to conclude that sleep deprivation could contribute to sexual harassment and even unplanned pregnancies.

The link between sleep and depression has long been observed, though researchers are still trying to untangle the connections. A study from the Durham VA Medical Center in North Carolina of more than 1,600 military veterans from Iraq and Afghanistan found that those who had sleep disturbances were at a higher risk of having suicidal thoughts. It concluded that clinicians should be screening for sleep disturbances as a risk factor for suicide—especially in patients who already have a diagnosis of depression.

One area of research drawing the most attention these days is the emerging evidence of a link between sleep loss and obesity. More than 70 epidemiological studies indicate this relationship in both children and adults, according to Fred Turek, director of the [Center for Sleep and Circadian Biology](#) at Northwestern University,

"We predict that an increase in sleep duration from seven or eight hours to 10 could lower the prevalence of adolescent obesity by four per cent," Turek said in a presentation to the sleep conference.

Short sleepers—those who slept less than six hours per night—had 89 per cent increased odds of being obese, and 28 per cent increased odds of being diabetic. The difference between having a sleep debt and being fully rested is equivalent to consuming 1,000 calories less over three days, he said.

Lab studies show that sleep deprivation affects the hormones that control appetite. As sleep decreases, the hormone that makes you feel full—leptin—goes down. Meanwhile, the levels of the hormone ghrelin—which tells your body to eat more—goes up.

Turek notes that while newly approved weight-loss drugs promise to aid in the loss of two to four kilograms per year, along with diet and exercise, comparable results could be achieved if people simply slept more. He insisted that sleep should be used alongside diet and exercise to combat

America's rapid weight gain. "In the war on body-weight regulation, we need to use all our weapons," he said.

And the studies suggest it's not just how much sleep you get that matters, but also when you get it, the scientists say.

"We have found that people who eat late and sleep late and [are exposed to] light late in the evening are more likely to be obese. And it's not just that staying up late gives you more time to ingest food," said Northwestern University's Phyllis Zee. "Eating late at night changes your appetite. If you are up at 1 or 2 a.m., you're hungry. But are you craving a salad? No, you are craving a pizza."

Indeed, a study from the University of Pennsylvania found that on days when test subjects delayed their bedtime from 10 p.m. to 4 a.m., they increased their food intake by an average of 650 calories.

Not everyone is persuaded by the links between sleep loss and weight gain. James Horne, professor and former director of the sleep research centre at the University of Loughborough in the U.K., and former editor of the *Journal of Sleep Research*, debated Turek at the conference. "Exercise and diet are much more important than sleep," said Horne. "There is a lot of fear-mongering going on about not getting enough sleep."

For starters, he said, much of the research is based on laboratory experiments where subjects are allowed very short sleep times. "Habitual four-hour sleepers are extremely rare—only five to eight per cent of the population," he said. And while he concedes that people are getting less sleep than in the past, he's not ready to accept that it is driving obesity. Above all, he fears that patients will start popping sleeping pills in an effort to lose weight.

"I would say that if that patient had a half hour to spend, they should spend it on brisk exercise—not sleeping," he said.

But one group that even Horne said needs more sleep is children. Inadequate sleep in children has been linked to hyperactivity and even incorrect diagnoses of attention deficit disorder. Sleep loss affects their hormones and their moods.

"Our children are a population that are sleep deprived. They have lots of stuff to do. They get up early for swim meets and extra-curriculars," said Zee.

Teenagers and young adults are a population at particular risk of insufficient sleep, as their biological clock shifts to later bedtimes and later wake-up times—effects that can be exacerbated by late-night computer use. "They tend to stay up, they get bright light on their screens, and before you know it, they can't fall asleep until one or two in the morning," said Zee.

The effects are far-reaching. A Penn State study presented at the conference found that suicidal thoughts and attempts are independently associated with decreased total sleep time in adolescents

and young adults. “Decreased sleep may weaken certain neurobehavioural mechanisms—increasing impulsivity and impaired regulation,” wrote the authors.

Effects of sleep loss affect very young children too, as any parent of a cranky toddler who skipped a nap can certainly attest.

One study, from Temple University, examined saliva samples from three-year-olds who napped, and compared them to those who missed their nap, and found that their hormones were affected, with decreased cortisol levels.

Zee’s advice to parents is to prioritize sleep for their kids. “Even if their children are doing well academically, there may be a longer-term impact on their health and metabolism,” she said. Researchers are even looking for new ways to help parents cope with bedtimes.

One study of low-income mothers of infants in Philadelphia found that waking babies were just one obstacle to their sleep loss. The mothers were staying up late to do household tasks, but also lacked a regular, organized evening routine. Sharon Herring, of the Temple University school of medicine, suggested that perhaps along with vouchers for baby formula and milk, social workers could help the moms with interventions such as a daily text message to tell the women when to start putting their children to bed.

Indeed, the socio-economic context of sleep is another area researchers are beginning to explore. Michael Grandner at the University of Pennsylvania mapped out a county-by-county map of sleep deprivation across the U.S., using geographic data on responses to a 2009 questionnaire that asked people about how many days in the previous week they did not get enough sleep. The greatest concentration of insufficient sleep was a “hotspot” cluster of counties in Appalachia—at the intersection of Kentucky, Tennessee, West Virginia and Virginia. In his colour-coded map, they are a bright zone of red, an area of the country also marked by poverty and low education.

Sleep has implications for pain management, too. Kristian Nilsen, a researcher with the [National Institute of Occupational Health of Norway](#), presented results of an experiment with 22 subjects who were restricted to only half their normal sleep for two days, and were then prodded in the trapezius muscle in the back with a device that measured pressure. The experiment confirmed that sleep restriction made them more sensitive to pain. “Things that are painful, become more painful,” explains Nilsen, who hopes further research will help workplaces plan work schedules that will minimize the chronic pain of ordinary shift workers.

There is an interesting undercurrent to the explosion of research in this field; even as science is getting increasingly more precise in cataloguing the tentacle reach of sleep into myriad aspects of health, researchers recognize that for the population at large, things are getting worse, not better.

“As we realize more about the importance of sleep, we see that people are sleeping less. We are moving in the wrong direction,” said Pack. Over the last 20 years, sleep duration has been declining.

The gap between what we know is required and what we actually do in practice is getting wider. Yet when it comes to solutions, for most people they are not complicated or expensive. For starters: have a regular bedtime, at the right time.

The best sleep is aligned with the body's natural sleep cycles, known as circadian rhythms, which make us sleepy at night and alert in the morning: "If you are getting your sleep at the wrong circadian time, it's decreased quality. The misalignment of your internal clock and your work shift is a risk factor for poor health outcomes," said Zee. The sleep-wake cycle can be stimulated by natural light. "Light is the most powerful time-giver for your brain. It makes you more happy, more alert, and signals the biological clock and trains it."

But light at the wrong time can disrupt the body's natural cycles. "You want to avoid bright lights late at night. That's what teenagers are doing. We have this light pollution in the evening before bedtime from iPhones, iPads and electronics. We want to avoid that. If you get too much light at night, it signals your clock to delay. That means you can't fall asleep and you can't wake."

One study led by Ph.D. student Ivy Cheung of Northwestern University found that day-shift workers who had windows in their workplace slept an average of 47 minutes more per night than workers whose offices were walled off from daylight.

In fact, one the best things you can do to help you fall asleep at night is to take a walk in the sunlight in the morning, said Dr. Rebecca Robillard, a sleep researcher at the University of Sydney in Australia. "It sounds paradoxical, but our biological clock that regulates the sleep-wake cycle sits on top of a nerve that links the eye and the brain. It is what sends the signal to the body to secrete melatonin, the sleep-promoting hormone. By getting the light in the morning we set the clock," she said. "The amount of light we get from outdoors, even on a cloudy day, is much more powerful than anything we get indoors."

Daily physical activity can also help the body fall asleep at night—as long as it's not too late in the evening. "You don't have to do anything complex, high-level activity—just walking steps versus taking the elevator can help get a better night's sleep," said Robillard.

Even though it may seem to relax you, scientists recommend skipping the alcoholic nightcap before bed because it reduces the quality of sleep. A study from the University of Melbourne found that pre-sleep consumption of alcohol also reduces "the beneficial changes in the autonomic nervous system" that occur during sleep, and these changes persist through the night, even after alcohol has been eliminated from the body.

Alongside the new science, family medicine is increasingly taking up this message of good "sleep hygiene" and researchers are urging more awareness of sleep among physicians. Many would like to see doctors routinely screening for sleep issues at checkups by asking a few simple questions to flag behaviour such as insufficient sleep duration and physiological problems such as sleep apnea: "Are

you snoring? Loud habitual snoring, night after night? Is your spouse or bed partner telling you that you stop breathing? Do you not feel refreshed even if you sleep for a long period?”

Help is at hand, and it's not always a pill. At the sleep conference, a separate exhibit hall showed more than 100 products and services on display, booths filled with products to help with sleep, from special pillows and devices to the latest drugs and treatments.

Sleep apnea, a disorder in which nighttime breathing is interrupted or obstructed, can be treated by sleeping with a device that pumps air pressure through a mask worn over the nose and mouth, or an oral device, similar to a mouth guard, fitted by a dentist, that realigns the jaw slightly to keep airways open. Insomnia can be treated with behavioural therapy—steps to help the body and mind shut down before sleep. “The new data shows insomnia is physiological. It's a state of mental and physiological hyper-arousal,” said Zee. “Their blood pressure, heart rate is higher, stress hormone levels are higher. When you look at their brains using imaging, their brain's metabolic activity is higher than people without insomnia—they are never quite turned off.”

Insomnia can run in families, and that points to the next frontier in sleep research: genetics. “How well you sleep, whether you get the amount of deep sleep, can be genetically influenced. This is an area we need a lot more research in,” said Zee.

The latest research shows that humans inherit their response to sleep deprivation and whether they are more or less sensitive to its effects. Despite the recommendation of seven to nine hours of sleep for most adults, some need more and others can get by with less and not feel sleepy during the day.

Pack did a study with healthy identical and non-identical twins showing that identical twins, who share all their genetic material, had much more similar sleep-loss responses than did the fraternal twins. Then his team identified a specific pair of genes that seemed to determine who was sleepy and who wasn't. “The twin with the mutation slept for two hours less a night and was more resistant to the effects of sleep deprivation,” said Pack.

His findings were interesting in light of an intriguing German study published in the journal *Science* last fall. It looked at birds called sandpipers that fly to the Arctic to mate. By monitoring their sleep habits, researchers found that some male sandpipers were able to stay awake 95 per cent of the time during their three-week mating trip, and that their ability to function without sleep was an advantage: the males that slept less had more time to copulate with females, and sired more offspring.

Perhaps one day, human genetics could be adjusted to make us more like the sandpipers. “If you understand what these genetic pathways were, maybe you could manipulate them and maybe wouldn't have to sleep as long,” muses Pack.

Until then, the sleep doctors will keep preaching their gospel. Straight from the Baltimore conference, Zee travelled to Capitol Hill to meet with U.S. lawmakers to advocate for sustained

public funding for sleep research in light of budget cuts, making an impassioned case for the necessity of this health research.

“Everybody has to prioritize in times of austerity. But it’s an area ripe for health interventions,” Zee said. “If you improve sleep, sleep is like water: all health boats will rise.”

<http://www2.macleans.ca/2013/06/17/the-sleep-crisis/>