IN SEARCH OF THE SWEET SPOT

AN EXCELLENT SET OF LUNGS

"We were so worried. We had to keep checking that you were still breathing!" My parents love to recount how my arrival robbed them of sleep for almost an entire year. Their new baby had an excellent set of lungs, but seemed incapable of sleeping for more than two hours at a time. After months of short naps punctuated with crying, I finally slept for several hours. Rather than relief, they were beset with worry. What had brought about this drastic change? Would I ever wake again? Should they be on their way to the emergency room? Their extended sleep loss probably interfered with their ability to decipher this new, positive development. As many new parents will attest, those first few months with a newborn can wreak havoc on sleep patterns.

We become acutely aware of the impact of sleep in its absence. Who hasn't complained about tiredness, irritability or hunger after a less-than-adequate night's rest? While it is recommended that adults get between 7 and 9 hours' sleep, the likelihood that you fall within this range varies depending on the country you inhabit. In the United States, for example, the average sleep time falls at the lower

end of the spectrum, with 35% of adults not getting the recommended minimum of 7 hours of sleep. In Sweden, adults do somewhat better, with only a small proportion (5%) of their population sleeping less than 6 hours.

These cross-country differences are reported even before adults join the workforce. A survey of almost 17,500 university students from 24 countries also reported very different average sleep times. Students in countries such as Thailand, Japan, Taiwan and Korea clustered around the 6.5-hour mark, while students in Spain and Romania reported getting about 8 hours.

Aside from differences across countries, about one fifth of university students get less than 7 hours' sleep per night. General population figures estimate that at least one third of adults report some sleep difficulty or other. Many of us are not getting enough sleep.

A large body of scientific studies now shows that too little sleep over time is linked to negative health consequences. These range from an increased risk of cardiovascular disease and stroke to diabetes and obesity, and early death. Even short-term sleep deprivation can have harmful effects, particularly reducing our capacity to pay attention.

Serious drops in attention, a hallmark of disrupted sleep, can be lethal. For driving performance, sleep deprivation can have effects equivalent to blood alcohol levels considered to be hazardous. Adults deprived of sleep for 17–19 hours in a lab experiment, and then tested on a driving simulator, performed at least as poorly as adults

with a blood alcohol level of 0.05%, the legal limit in many countries. Thousands of car crashes every year can be traced back to a drowsy driver.

While many of us are aware of the consequences of too little sleep, there is growing evidence that we can also get too *much* sleep. Our best understanding is that there is a 'sweet spot' for what appears to be healthy sleep. Somewhere between 'not too little' and 'not too much' seems to be best for brain health and general functioning.

This sweet spot idea also applies to other areas of life, such as body weight, where 'too light' and 'too heavy' both entail health risks. In many cases, oversleeping is a side effect or an indicator of another health issue, like depression or a viral infection. What we do understand is that good-quality sleep, and a reasonable amount of it, is fundamental to well-being.

WHY DO WE SLEEP?

Across a life span of 80 years, we sleep for roughly 232,960 hours, or around 10,000 full days. We often consider sleep as wasted time. Yet our clear biological drive to sleep, and its occurrence across species, suggests that sleep provides benefits that outweigh its costs. And it is costly, depriving us of time we could otherwise spend interacting with others, foraging, learning. It renders us vulnerable to threats from the environment, unaware of our surroundings. Given the sacrifices we make to sleep, as the American sleep scientist Allan Rechtschaffen eloquently noted: "If sleep does not serve an absolutely vital function,

then it is the biggest mistake the evolutionary process has ever made."

For years, scientists have tried to answer the question of why we sleep. Another American scientist Dr J Allan Hobson once joked that "The only known function of sleep is to cure sleepiness". Consider how we spend our time: two thirds awake, and one third asleep. We accomplish more than one function while awake, from eating and drinking to working or socialising. It seems reasonable to expect that we also accomplish more than one function while asleep. Indeed, many sleep functions have now been identified, ranging from restoring important peripheral tissues like skin and muscles, to clearing waste products in the brain built up over the day, to supporting memory and emotion processing. While it may not be the most satisfying of answers, it seems that sleep may serve *many* crucial functions.

One method for obtaining scientific evidence of sleep functions involves examining people when they are deprived of sleep, either deliberately or circumstantially. By observing the effects of going without sleep, we can get a sense of the purposes it serves, much like the process of removing parts of a bicycle and checking what still works.

There are numerous extreme cases of people voluntarily staying awake for unfathomable periods. Back in 1964, a seventeen-year-old student, Randy Gardner, undertook a project that would have lifelong consequences. Randy had moved to San Diego and decided he would need to pull out all the stops to win a science fair

in the big city. With the help of two friends, he concocted a plan to attempt to break the world record for time awake. After 11 days, waves of severe nausea and memory loss, Randy got into the record books.

It was not easy. According to a scientist overseeing the experiment, each time Randy closed his eyes during the 11-day period, he immediately fell asleep. His friends had a hard fought battle to keep him awake, particularly during the night. Remarkably, at the end of his ordeal, he slept for just 14 hours and soon reported returning to what felt like 'normal'.

However, reflecting in a 2017 interview, Randy described being haunted by his teenage stunt, blaming it for his "unbearable" insomnia later in life. The *Guinness Book of World Records* has since removed the category of going without sleep because of the health risks involved.

Among the others who have attempted lengthy periods without sleep was Peter Tripp, the American radio DJ. He managed an 8-day stint in a glass booth in Times Square, New York City, in 1959. After about 105 hours, Tripp began to lose touch with reality, experiencing severe hallucinations. The psychiatrist overseeing Tripp noted "He was a sick man". After the stunt, Tripp's life took a series of downturns: he lost his job, was involved in serious financial scandals, and his wife divorced him.

However, as striking as these cases are, they are not our primary means to understand sleep deprivation and its consequences. Anyone willing to undertake such an extended ordeal may not represent 'the average person',

and the data obtained does not tell us much about everyday sleep processes.

Instead, a lot of what we know about sleep comes from tightly controlled lab-based studies where volunteers are kept awake for shorter periods. Typically these studies restrict sleep for 24 to 48 hours, or ask people to sleep a bit less than they otherwise would. Even these short periods of disruption can have measurable, typically negative effects on the body, behaviour and brain.

Take our immune system, where even brief sleep deprivation can have an impact, for instance on how adults respond to a vaccine. For vaccines to work the body needs to produce specific proteins, antibodies, in response to the invading bacteria or virus. When people are partially deprived of sleep, perhaps having their sleep time halved for a few nights, then vaccinated, their bodies produce less of these critical antibodies. Ultimately, this can impact a vaccine's effectiveness.

A similar detrimental pattern is observed outside of the lab. People who get less than 6 hours of sleep per night are less likely to have an adequate antibody response, for instance to a hepatitis B vaccine, than longer sleepers. On the flip side, if you get more than 7 hours of sleep you tend to be more resistant to catching a cold when exposed to the virus in the lab. Sleep duration is not the only important variable here, either. Poor sleep efficiency – spending time in bed but not sleeping – may also lowers resistance to the common cold virus.

Think back on your last poor night's sleep. How

was your mood the next day? Your ability to cope under pressure? This, too, seems to be intricately tied to how you sleep. Numerous lab experiments have restricted people's opportunity to sleep, checking that volunteers are still awake by monitoring their brain activity, or asking them to fill in questionnaires at frequent intervals. After ensuring a sleep-restricted night, researchers are then free to probe emotional responses using standard psychological tests.

One elegant example of such a study took a group of teenagers and tinkered with their sleep opportunity over three weeks. For five nights, the teens were allowed to sleep their regular, and age-appropriate, 10 hours. For another five nights, they were only allowed 6.5 hours. With just a few hours less over five nights, the teenagers themselves noted feeling more tense, angry, confused and frustrated.

The sleep deprivation effects were also clear to the teenagers' parents, who noted greater irritability and poorer emotion regulation in their children. What makes these findings especially important is that the teenagers were restricting their sleep over a short period, and not by a huge quantity. It seems that even partial, never mind total, sleep deprivation can affect mood regulation.

Similar negative patterns have also been found in adults. When studying healthy adults, researchers are allowed to ramp up the conditions of sleep deprivation compared to what is ethically acceptable for teenage volunteers. One American study from 2005 allowed adults to sleep for only 4 hours, half the normal, recommended

nightly amount, over a longer period of 12 days. As the experiment rolled on, the adults on the 4-hour sleep regimen became progressively less optimistic about the future and less social. They also reported more bodily discomfort, such as pain and an upset stomach, peaking at day 6, at about the halfway point of the study.

Some good news, however: After a single 12-hour recovery period in bed, participants reported feeling back to their initial baseline levels, including for self-reported optimism and pain. Although this return to baseline coincided with the experiment ending – which may indicate participants' relief that their ordeal was over – the scientists suggested that quick recovery from sleep deprivation may indeed be possible.

FOOD AS A CONSOLATION PRIZE

If you tend to reach for sugary, high-fat foods like a Danish pastry or pizza after a sleepless night, you are not alone. People who habitually sleep less than 6 hours a night are more likely to end up with an unhealthy body mass index. One reason is that we seem to compensate for sleep loss by increasing our calorie intake.

Nestled within the sprawling Ivy League campus of the University of Pennsylvania in Philadelphia is a laboratory dedicated to studying sleep as rigorously as possible. The lab is custom-built so that the lighting can be precisely controlled, along with the ambient temperature and noise levels. It is stocked with a range of physiological monitoring equipment, along with more mundane items