

BETTER SLEEP THROUGH SCIENCE

Basic research is starting to produce viable advice in the quest for a good night's sleep.

By Lynne Peeples

From TikTok videos touting mouth tape and weighted blankets, to magazines ranking insomnia-curbng pillows, sleep advice is everywhere. And it's no wonder. People all over the world complain of insomnia and not getting enough sleep, driving a market for sleep aids worth more than US\$100 billion annually.

But scientists warn that online hacks and pricey tools aren't always effective. And failed attempts to remedy the situation could have negative effects, says Andrew McHill, a circadian scientist at Oregon Health & Science University in Portland. "It could discourage people from finding help, and things could get worse," he says.

Instead, researchers point to the lessons coming from circadian science, which over the past five decades has exposed a network of biological clocks throughout the body. This timekeeping machinery ensures that physiological systems are primed to do the right things at the right times – such as defend against pathogens, digest food and sleep. But circadian clocks don't cycle precisely on their own. To stay in sync and function optimally, they need regular calibration from sunlight, daily routines and other cues.

Modern life doesn't often cooperate. People spend much of their time indoors. They eat late into the night. They shift sleep schedules between workdays and weekends, effectively jet-lagging themselves. The toll is steep. In the short term, circadian disruption and insufficient sleep can reduce cognition, mood and reaction time. In the long term, they can increase risks of infections, diabetes, depression, dementia, cancer, heart disease and premature death.

For better sleep and overall health, McHill and other scientists emphasize three basics: contrasting light and dark, consolidating mealtimes and keeping sleep times consistent.

"Simply taking a walk outside during the day and reducing our light exposure in the evening could have great effect," says McHill.

Seek contrasts

Light provides the most powerful signal to the circadian system. Blue wavelengths are especially potent. That is not a coincidence. Humans evolved outdoors, under the sky. And the midday sky is rich in blue light. Still, common advice about avoiding blue light at night captures only part of the story.

In the 1990s and 2000s, a string of discoveries proved the existence of light-sensitive cells in the eye that are not directly involved in seeing¹.

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Rather, these cells synchronize body clocks. They detect both intensity and wavelength, with input from rods and cones, and relay those data to a circadian pacemaker in the brain.

The circadian system requires bright light to operate properly. "But we're pretty bad at determining how much light we're getting," says Jamie Zeitzer, a sleep and circadian scientist at Stanford University in California. Typical home lighting of 100–250 lux might feel like a lot to the eye. But the blue-rich daylight that the circadian system is primed to detect shines orders of magnitude brighter – upwards of 10,000 lux even on an overcast day.



Timing matters, too. Bright blue light during the daytime synchronizes circadian rhythms and supports the nightly surge of melatonin – the hormone signal that tells the body it's time to sleep. It can also directly boost alertness and cognitive performance. The same illumination at night, from artificial lights and glowing screens, confuses the circadian system.

Blue light is the strongest disruptor, but enough photons of any colour at night can shift rhythms, suppress melatonin levels and hinder sleep. Exposure in the middle of the night, such as with a flip of a toilet light switch,



ILLUSTRATION: MIRIAM MARTINCIC

is most disruptive, says Zeitzer. The circadian system's sensitivity peaks near the midpoint of sleep, when it least expects light. Studies show that even dim light, such as a hallway bulb, can raise overnight heart rate and impair sleep².

Ultimately, scientists say, what matters most is contrast: bright days and dark nights. In fact, light during the day can buffer against the potential harms of light at night, says Mariana Figueiro, director of the Light and Health Research Center at the Icahn School of Medicine at Mount Sinai in New York City. Mounting research links greater daytime light exposure with stronger circadian rhythms and higher

sleep quality. One study of college students found that their total hours of light exposure during the day better predicted their bedtimes and wake times than did light exposure after dusk³. "The more light you get during the day, the better you'll sleep at night," says Figueiro.

Too little daylight and too much night light could even shorten life expectancy. A UK study of nearly 90,000 people found that the 20% with the poorest light-exposure patterns were predicted to die around five years earlier than were the 20% with the healthiest habits, even after accounting for factors such as income and physical activity⁴.

Andrew Phillips, a sleep health scientist at Flinders University in Adelaide, Australia, and an author of the study, pins the explanation on circadian rhythms: "They regulate every aspect of your physiology."

Unfortunately, achieving this daily contrast is difficult in the modern world. Indoor lighting leans on green wavelengths that serve vision but not circadian signalling. Energy-usage codes limit how bright those fixtures shine. Daylight entering through windows gets quickly diluted. And energy-efficient window glass and blue-light-blocking spectacle-lens coatings further reduce how

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many circadian-stimulating photons reach the eyes. Ageing compounds the problem; people's lenses become more yellow over time and filter out more blue light.

Circadian science's prescription: spend more time outdoors, sit near windows and use daylight-mimicking light-emitting-diode lamps during the day. In the evening, lower the brightness of lamps and power down screens – or use apps that dim or shift screens to a warmer spectrum. And consider a low-intensity amber night light for the toilet.

Scientists note that the precise prescription is personal. Even people of the same age can vary considerably in how they respond to the same light, possibly because of characteristics such as sex or eye colour. And when light comes from screens, the content can matter as much as the light itself. "If you're on an iPad at 11 at night, then the light exposure might have some effect," says Zeitzer. "But if you are doing something relaxing, that might outweigh the effect."

Consolidate calories

Calorie intake is also intricately linked with circadian rhythms and sleep. The human liver at 10 a.m. and the human liver at 10 p.m. are very different organs. The same can be said for other parts of the body that process food. Hunger hormones, digestive enzymes and glucose-regulating insulin have rhythms, too.

Humans are simply not equipped to deal with food at all hours, says Emily Manoogian, a circadian scientist at the Salk Institute for Biological Studies in San Diego, California. Late morning to early afternoon is when the body is usually most prepared for incoming calories. Eating late in the evening disrupts clocks and leaves key steps of digestion incomplete. It can also disrupt the gut microbiome, which could contribute to insomnia⁵. What's more, late meals send blood to the gut and raise core body temperature, countering the natural night-time dip that promotes sleep. And they elevate glucose levels and uncouple liver and kidney clocks from the core clock in the brain, raising the chance of midnight toilet trips.

Manoogian and others suggest reviving the old adage: eat like a king in the morning, a prince at noon and a peasant at dinner. That last meal, they say, should fall at least three hours before bedtime, ideally with no subsequent snacks or caloric drinks.

Food quality matters, too. Diets high in sugar and saturated fat lighten and fragment sleep. Caffeine lingers for hours. And alcohol is deceptively disruptive: "You might fall asleep, but the quality of your sleep will be quite poor," says Manoogian. On the flip side, eating some plant-based foods during the day could improve sleep. Research shows that walnuts boost melatonin levels and sleep quality⁶. Marie-Pierre St Onge, a nutrition, sleep and circadian scientist at Columbia University in

New York City, co-authored a study that links greater daytime intake of fruits and vegetables with less-fragmented sleep⁷.

If a bedtime snack is unavoidable, St Onge recommends something light and easy to digest, such as yogurt or granola. Another option, if you can find it: cow's milk that has been collected at night contains more melatonin and lower levels of the stress hormone cortisol than does milk collected during the day. Research confirms that similar fluctuations occur in human breast milk⁸, suggesting that new parents might want to label pumped bottles with 'a.m.' and 'p.m.' to help their babies – and themselves – to sleep soundly.

Consistent sleep times

Sleeping at the right time can be just as – if not more – important than getting lots of sleep. "You're getting more bang for your buck," says Phillips.

The circadian system regulates sleep in tandem with the sleep homeostat, a separate system that influences drowsiness through a molecule called adenosine. Adenosine



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builds up in the bloodstream while a person is awake and is broken down during sleep. But it alone isn't enough to initiate and maintain quality sleep. At 8 a.m. after an all-nighter, for example, circadian signals would be promoting wakefulness by raising body temperature and alertness – countering high adenosine levels.

Aligning the homeostat with circadian signals means going to bed and waking up at consistent times in tune with a person's biology. This optimal sleep window will differ for an early bird versus a night owl. So, inevitably, strict work and school schedules will conflict with some people's internal clocks. Perhaps the most glaring mismatch is that teenagers' rhythms naturally shift later even as school bells ring earlier.

Research estimates that at least 80% of workers and students rely on alarm clocks – evidence that most are living in discord with their biology⁹. Accumulated sleep deprivation over days of waking with an alarm causes many people to compensate by sleeping in on non-working days. Springing forward to daylight-saving time and falling back to standard time adds further whiplash.

The risks of malalignment and inconsistency go beyond poor rest. Phillips and his

colleagues found that an unstable day-to-day sleep schedule alone predicted mortality better than did total sleep hours¹⁰. Another study he co-authored showed that people with heart failure who had irregular sleep patterns had twice the risk of another medical event (such as hospitalization or death) compared with regular sleepers¹¹. "We need to reframe how we think about sleep," says Phillips. "It's not just about hitting a daily quota."

Combine and compromise

Focusing on any one factor can help the others to fall into place, says Phillips. A regular eating schedule can anchor sleep timing, which in turn can make it easier to get morning light and avoid light at night.

Still, adhering perfectly to the rules is not necessary to reap the benefits. People should adjust what they can, when they can, scientists say. Shift workers, for example, face barriers to all three. But compromise can get them closer. Eating meals during the day, even while working nights, could lower many of the risks associated with shift work, such as mood disorders and blood-sugar problems¹². And people can use other behavioural cues, such as exercise. A hard morning workout promotes night-time sleep, says St Onge.

Life also calls for flexibility. Manoogian allows herself the occasional late dinner with friends. And people with a large sleep debt can benefit from an extra hour or two of catch-up sleep on non-working days¹³.

Although sleep gadgets might not cure sleeplessness, some tools could guide healthier habits. Wearable trackers and light sensors might prompt users with personalized feedback. Cory McLean, an engineer at Google in Cambridge, Massachusetts, and co-author of a paper on using large language models for personal health¹⁴, imagines digital devices giving a nudge: "If it sees you tend to go to bed at a reasonable hour on weekdays, but then you're much more variable on weekends, it could suggest that as an area for improvement."

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