

# Sleep well

**I**T IS no secret that sleeping is one of the most important things you can do for your health. Mountains of research over the past decade demonstrate, time and again, that good sleep is essential to everything from our cognitive function to heart health, mood and more. So far, so straightforward.

For many of us, however, getting a good night is easier said than done. Much of the advice out there is probably familiar by now, if a little too generic: sleep for 8 hours, avoid bright light and anything stressful before bed, and so on.

In reality, life is messier. For a start, we don't all need the same amount of sleep. We have different lifestyles, including work and travel, which might see us needing to adjust our sleep schedules on a regular basis. What's more, getting good sleep is about more than just clocking up time spent in bed – but we also aren't great judges of the quality we get, a consequence of being unconscious when we are doing the thing we are trying to assess. All of this means that following prescriptive messages about sleeping more can feel frustrating.

The good news, as we explore over nine pages here, is that research is revealing the benefits of a more holistic approach to sleep. Our efforts to get better shut eye shouldn't be confined to the bedroom: what we do during the rest of the day – what and when we eat, our gut health, our hormones – all make an important difference. What we need, in fact, is a 24-hour perspective on sleep.

None of this changes how crucial our unconscious hours are, but it does give us fresh opportunities to improve them well before we lay down our heads.

## HOW MUCH SLEEP IS THE RIGHT AMOUNT FOR YOU?

WOULD we feel better if we slept a bit more? Possibly – but it isn't guaranteed. While we know the amount of sleep the average person needs, there is a lot of variation. To get a better idea about how many hours you require – and how and when to get it – let's start with the basics.

According to the US National Sleep Foundation, a typical adult needs between 7 and 9 hours per night, although we begin life needing a lot more – newborns sleep 14 to 17 hours, and this gradually decreases through childhood. Teenagers need about 9 hours a night and people over 65 tend to need around 7 to 8 hours. Sex can also be a factor. "There are some studies that show women, on average, need about 20 minutes more than men do," says Veena Kumari at Brunel University of London. And there is evidence that humans, just like many animals, tend to sleep a little longer during winter, too.

Of course, there are exceptions. A rare genetic trait called familial natural short sleep sees individuals habitually going to bed late and waking up early, thriving on just 4 to 6 hours. "We don't know how prevalent this is," says Liza Ashbrook at the University of California San Francisco, who has identified a number of gene variants involved in the trait, but "it's a minority".

Most of us aren't that lucky, although the occasional disturbed or shortened night doesn't matter too much. "We are able to get through a night with no sleep and more or less function the next day, and then catch up with

it," says Malcolm von Schantz at Northumbria University in Newcastle upon Tyne, UK.

However, regularly going without sleep is bad news. Epidemiological studies of sleep duration show that people who regularly get 7 to 9 hours have the lowest risk of dying over the next decade or so, while people who sleep less or more than that have a higher risk of mortality; the longer-term health consequences of sleep deprivation include a higher risk of type 2 diabetes and cardiovascular problems. Studies also suggest that for most people, sleeping less or more than this negatively impacts cognitive health. "There are also consequences for how we process emotions," says Kumari.

But working out how much sleep you personally require is tricky – there is no equivalent of a diagnostic blood test. One useful – if socially challenging – method to determine how much you need is to take a "sleep vacation": over a two-week period, go to bed at the same time every night, but don't set an alarm. What time you naturally wake up can help you figure out your natural rhythms and sleep need. You can also use a sleep tracker or keep a diary, ideally over several weeks, to get a sense of your patterns of sleeping and waking. Noting whether you feel drowsy during the day and when can be useful in determining your personal rhythms.

This will help you figure out your "chronotype", or what times of day you prefer to sleep or be active. "We have a spectrum, from people who are natural







morning larks and people who are natural night owls," says von Schantz.

Adapting to your chronotype can help keep your sleeping schedule consistent, although researchers acknowledge that this can be a challenge. "The problem with being an evening type is that we live in a society which is designed by larks," says von Schantz. Early risers typically get enough sleep by going to bed early, but night owls can struggle.

A lot of research has shown that night owls tend to have worse mental health. However, a 37-year follow-up study of Finnish adults found that this chronotype on its own didn't translate into higher mortality risk. Meanwhile, a 2024 study, yet to be peer-reviewed, found that an evening chronotype in itself isn't a risk factor for psychiatric conditions because all the risk could be explained by night owls getting less sleep. Evidence also shows that night owls perform better on cognitive tests than morning larks, provided they regularly slept 7 to 9 hours.

If you are a night owl but are forced to get up early due to the constraints of daily life, there are ways to try to shift your body clock to a more lark-like schedule. To do this, expose yourself to bright light around 7 am, which will advance your circadian rhythms and help you get to sleep earlier (see "What's the best way to beat jet lag?", page 38). As you approach bedtime, avoid bright light as it will delay your body clock. Von Schantz adds that for some people, taking supplemental melatonin, the hormone involved in signalling sleep, can be used to help shift the clock, if timed correctly.

Work on some of these strategies and, regardless of whether you are a lark or an owl, you might greet your alarm with less of a groan – in fact, you might not need one at all. **Michael Marshall**

## WHAT DOES GOOD

### QUALITY SLEEP LOOK LIKE?

HOW did you sleep last night? Your response might depend on how long you were in bed, how much of that time you spent tossing and turning or whether you feel rested. But it might also depend on whether you exercised today, what your wearable device says, or when you are being asked.

"Everyone has their own definition of sleep quality – and that is the problem," says sleep researcher Nicole Tang at the University of Warwick, UK.

Though sleep quality and what defines it is a puzzle scientists are still figuring out, we do know that a good night's rest involves a series of sleep cycles, the distinct succession of phases of brain activity we experience during sleep (see diagram, below right). And for most of us, each stage of those cycles is necessary to wake up feeling refreshed. The average person experiences four to five complete cycles during a night and disrupting these can come with health consequences, both in the short and long term.

"Poor sleep quality is associated with many adverse physical health outcomes,"

says Jean-Philippe Chaput at the University of Ottawa, Canada. Similar to what you can expect from not sleeping enough (see "How much sleep is the right amount for you?", page 32), these include a higher risk of cardiovascular disease, stroke, hypertension, type 2 diabetes and weight gain.

Although there is no definitive consensus on what defines sleep quality, researchers and doctors frequently analyse sleep with an electroencephalogram (EEG), which tracks brain activity during sleep cycles, or using actigraphy, where body movement is monitored throughout the night as a measure of wakefulness. Such measurements show that the factors with the greatest impact on what scientists would broadly call sleep quality include how long it takes to doze off, how often you wake up and sleep efficiency – the percentage of time in bed that is actually spent in slumber. "Usually, the case is that not just one parameter predicts sleep quality – it's a bunch of different parameters added up together," says Tang.

But how those parameters stack up doesn't always tally with subjective experience. For example, a 2023 study of 100 people grouped them by sleep quality using EEG measurements, finding that poor sleepers spent less time in the deeper phase of non-rapid eye movement (NREM) sleep compared with better sleepers. However,

## WHAT THE EXPERTS DO TO GET THE BEST SLEEP

**Sleep researchers dedicate their careers to understanding how and why we sleep – so what do they do to get a better night's rest?**

**It might be reassuring to know that even the experts aren't always able to practise what they preach. "I think you'll find a lot of sleep researchers are not very good at sleeping," says Malcolm von Schantz at Northumbria University in Newcastle upon Tyne, UK. But one thing many of them agree on is that consistency is crucial. Here's what else they had to say:**

### MAKE A PLAN

"It is about prioritisation and planning. So I try not to have meetings before 10 o'clock, for example, because I am more of an evening type: I quite like to go to bed late and wake up late. So I'm thinking ahead in terms of what's best for me with my sleep timing, my circadian timing, how can I try and arrange my schedule to support that?"

**Steven Lockley, Timeshifter**

### CONTROL YOUR LIGHTING

"We dim our lights in our house pretty much when the sun sets, and then, in the mornings, turn the lights on inside as much as possible and certainly open up the window shades to get the sunlight in the house as soon as the sun is coming up. I think those are really





## SLEEP IN NUMBERS

# 3

The number of days it took for otherwise healthy people to become pre-diabetic during a sleep-restriction study

SOURCE: DOI: 10.1016/j.cub.2015.10.011

self-reported measures of sleep quality didn't match the EEG-based ones. A 2024 analysis of EEG data from more than 250 people over seven nights found that subjective sleep ratings were only moderately related to objective metrics, with sleep efficiency the most important variable in determining whether participants reported better-quality sleep.

What that means is that your EEG or actigraphy measurement can reflect what looks like a stellar night's rest, and yet you would still rate your sleep quality as poor, and vice versa. Exactly why that can be the case isn't entirely clear, but other research backs up the idea that what happens in bed isn't the only way we determine the quality of the sleep we have had. In a 2022 study, Tang and her colleagues found that participants' perception of how they slept was influenced by factors experienced the following day, such as their current mood or their level of physical activity. "What you do during the day could affect your evaluation of the sleep the night before," says Tang.

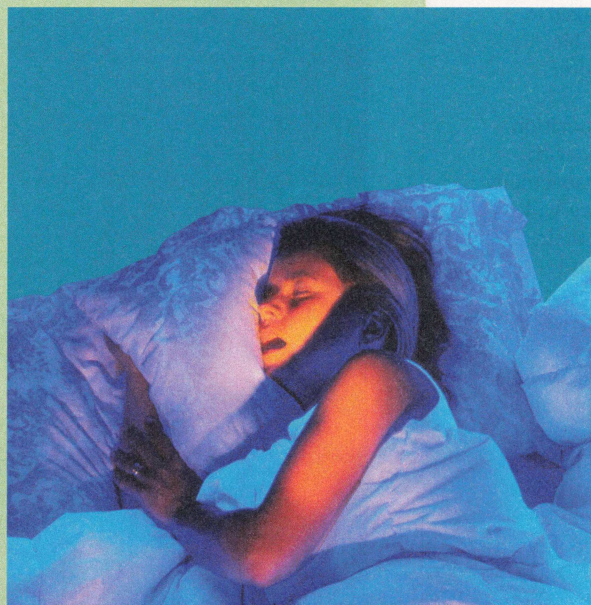
This frustrating situation led a panel of sleep experts who reviewed the evidence for physiological markers of the "elusive, amorphous, and multi-dimensional construct of sleep quality" to conclude that "ultimately, the determination of 'quality sleep' remains largely subjective and inconsistently quantifiable by current measures".

That sleep quality is so difficult to assess objectively should give us pause when considering data from wearables that provide a sleep quality score. Many of these are based on measurements, such as heart rate or movement that can accurately determine whether you are asleep, but the makers of these gadgets typically don't explain how these factors are weighted to determine the final output. Some experts caution against giving too much importance to these scores, as they can be unreliable and increase anxiety around sleep.

Even if we can't always accurately assess our sleep quality, there are things we can do to attempt to get a better night's sleep – for example, not drinking. Alcohol may help you nod off and increase the amount of deep NREM sleep in the first half of the night, but it triggers wakefulness in the second half and impairs rapid eye movement sleep. Maintaining a regular sleep schedule and good sleep hygiene habits will also help (see "What the experts do to get the best sleep", page 34).

Of course, some sleep fragmentation is unavoidable – tending to a crying baby, nighttime visits to the toilet – and circumstances change over your lifetime. So avoid fretting about one night's interrupted sleep: precisely because sleep quality is so subjective, if you start feeling anxious about it, you may wake up thinking your night went even worse than it did.

**Sophie Bushwick**

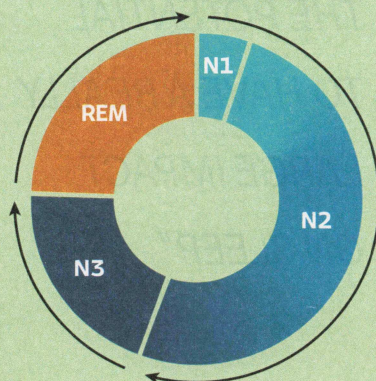


Objective measures of sleep quality don't always match subjective assessments

STEVEN PLETZER/GETTY IMAGES

### Your sleep cycle

Lasting 90 to 120 minutes, a cycle starts with three stages of **non-rapid eye movement (NREM) sleep** - N1, N2, and N3, each descending into deeper sleep – and ends with a phase of vivid dreaming during **rapid eye movement (REM) sleep**.



### HOW DOES THE MICROBIOME INFLUENCE OUR SLEEP?

THERE are many things we can blame for a bad night's sleep – screen time, stress, too much booze. Now there is another culprit: the microbes in our gut.

We have long known that our microbiome has a powerful influence on our health, and new research is revealing that this extends to our sleep, too. But it is a complex, two-way relationship. "The microbiome is influencing sleep, and sleep is influencing the microbiome," says Elizabeth Holzhausen at the University of Colorado Boulder. The good news is that there are ways we can intervene.

At first glance, the link between your stomach and sleeping patterns might not be obvious, but a growing number of studies are shedding light on the impact they have on each other. For instance, a 2023 study of 720 people found that greater diversity of microbes in the gut was associated with better sleep. Likewise, a look at nearly 1000 people by researchers at ➤



# 207,000

The number of workdays lost in the UK per year due to insufficient sleep

SOURCE: RAND EUROPE

King's College London (KCL) and other institutions, in association with the personalised nutrition company Zoe, found that irregular sleep patterns were linked to a boost in the number of "unfavourable" bacterial species associated with poorer health outcomes.

What's more, changes in the composition of the gut microbiome are associated with several sleep conditions. Rapid eye movement sleep behaviour disorder, for instance, which causes sleepers to physically act out their dreams during REM sleep, is linked to a depletion of gut bacteria that produce the short-chain fatty acid butyrate and a rise in bacteria that increase inflammation.

However, consistently pinpointing specific microbial species involved with sleep health hasn't proved possible. Teasing apart cause and effect is challenging too, especially when there are so many lifestyle factors that affect both sleep and our microbiome. In the Zoe-partnered study, for example, the people with the most irregular sleeping patterns – such as sleeping in at the weekend – also had the poorest quality diets, which could have had knock-on effects on the composition of their gut microbiome, rather than their microbiome causing their problematic sleep.

"Sleep impacts your dietary choices," says Sarah Berry at KCL, who worked on the study. "If you have a poor sleep, you make poorer dietary choices, and this will negatively impact the quality of your microbiome. It will reduce its diversity and change it to a less healthy composition."

Studies in animals can demonstrate some of the interactions between microbiome and sleep, and how they influence each other. In mice, depletion of the gut microbiota via long-term antibiotic treatment alters their wake/sleep pattern, while other studies in mice show that chronic sleep disruption alters the balance of their gut microbes. Even more interestingly, when faecal microbes from mice subjected to intermittent oxygen deprivation – mimicking symptoms of the condition obstructive sleep apnea, which is known to reduce sleep quality – are transplanted to other mice, the recipients develop disrupted, fragmented sleep.

These effects can result in a vicious cycle. For instance, studies in humans show that obstructive sleep apnoea alters the gut microbiome of people with the condition,

**"WE KNOW THE  
MICROBIOME HAS  
THE POTENTIAL  
TO HAVE A REALLY  
LARGE IMPACT  
ON SLEEP"**

which in turn exacerbates the symptoms.

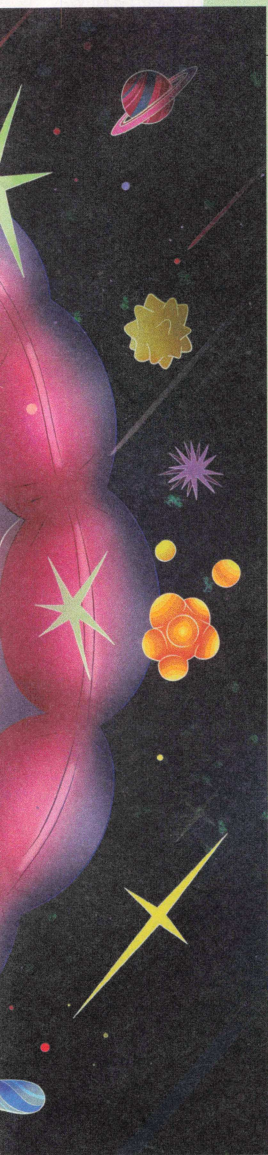
But what is the mechanism? There are several routes of communication between our gut microbiome and the brain that could influence sleep. Bacteria can directly correspond with the brain via the vagus nerves, key information routes of the parasympathetic nervous system; they also release inflammatory chemicals that modulate the immune system; and they can produce hormones that affect our circadian rhythms, including sleep/wake cycles.

This all begs the question of whether we could improve our sleep by improving our microbiome. There are early hints that we can. Last year, a trial of 89 adults with poor sleep quality found that taking a probiotic supplement of the bacterium *Bifidobacterium longum* 1714 for eight weeks resulted in some improvements in subjective and objective assessments of their sleep quality compared



DONG QIU





» important things: minimise light at night, maximise light in the morning.”  
**Christopher Depner, University of Utah**

#### **KEEP COOL**

“Sleep science has shown that your body [temperature] should drop a full degree centigrade while sleeping, and so I do try to keep the room very cold and very dark.”

**Katherine Maki, US National Institutes of Health**

#### **EAT AND DRINK AT THE RIGHT TIME**

“I try to avoid eating after 9 o’clock at night and having caffeine after 5 o’clock, though how people metabolise caffeine is highly variable from one person to the next.”

**Sarah Berry, King’s College London**

#### **SWITCH OFF**

“Anything that triggers stress will trigger arousal, a state in which you feel excited or very alert. So you want to avoid stress before bedtime, including checking your emails.”

**Bill Wisden, Imperial College London**

#### **GO DARK**

“Personally, I love reading in bed, which is bad because of the light. Computers, scrolling on your smartphone, tablets, all that bright screen light, it just tells your brain to stay awake, so you should really try to avoid that as you’re going to bed. But listening to music, for instance, with »

## **WHAT DO HORMONES**

### **DO TO OUR SLEEP -**

### **AND VICE VERSA?**

IT MAY come as no surprise that hormonal upheaval – say, during puberty or menopause – can play havoc with sleep. But our hormones influence sleep all the time, not just during big changes. What’s more, we are starting to see that this relationship goes both ways: as much as our hormones affect how we sleep, how we sleep influences our hormones.

A better understanding of this relationship could improve both our sleep and our general health. But, like a lot of relationships, it is complicated.

There are two basic processes that regulate sleep. The first, known as process S, keeps track of how long we have been awake through the build-up of the neurotransmitter adenosine, a by-product of cellular metabolism. Once enough has accumulated, like sand piling up at the bottom of an hourglass, the pressure to nod off becomes difficult to resist. The second, called process C, is driven by our circadian system, the rhythms of activity in almost all our cells timed to Earth’s 24-hour cycle of day and night.

Process C, which is largely regulated by exposure to light, manages this through the release of two key hormones, melatonin and cortisol. Produced by the pineal gland during the dark hours, melatonin tells the parts of the brain that control sleep that it is night, so we fall asleep at the appropriate time. Cortisol picks up where melatonin leaves off, spiking in the morning and boosting our alertness to rouse us out of bed.

Production of these hormones changes throughout our lives. During puberty, melatonin levels decrease, although it is unclear what role this might play in the natural shift in circadian rhythm that many teenagers experience that has them falling asleep later in the night. Cortisol levels can increase with age, which may impact sleep quality and has been associated with a decline in rapid eye movement sleep. For women, who report more sleep complaints than men, the relationship between hormones and sleep is even more complex. For example, decreasing concentrations of melatonin post menopause may be related to difficulty falling or staying asleep and, although the mechanisms aren’t yet fully understood, higher levels of follicle-stimulating hormone, which occur during part of the menstrual cycle, for instance, appear to correlate with poor sleep quality.

Over the past decade or so, however, it has become apparent that hormones and sleep have a two-way relationship; it isn’t just that hormones control sleep, but poor sleep can also interfere with our hormones in surprising ways.

“How the body processes, metabolises and releases various hormones can be disrupted by a lack of sleep,” says Marie-Pierre St-Onge, director of the Center of Excellence for Sleep & Circadian Research at Columbia University in New York. For instance, people who experience poor sleep also tend to be deficient in human growth hormone, which is released during deep, or “slow wave”, sleep. »

with controls. This finding is in line with other research, such as a recent metanalysis of 15 trials of probiotics, which found that people taking one for at least four weeks had significantly better sleep quality than those who received a placebo.

Katherine Maki at the US National Institutes of Health says if we are looking to improve sleep, we might want to specifically target microbes that contribute to inflammation. She recommends eating foods rich in fibre, unsaturated fats and polyphenols, as well as not eating too early or late, to improve the capacity of the microbiome to produce substances that enhance sleep quality. “The microbiome, with all its interactions with the immune system, hormones and stress hormones, has the potential to have a really large impact on sleep,” she says.

**Alison George**



» your eyes closed, relaxing, something like that can be helpful if you're not somebody who can go immediately to sleep."

**Jocelyn Cheng, American Academy of Sleep Medicine**

#### TRAVEL SMART

"When I arrive in a new time zone, I consider my light exposure to try and help myself adapt as quickly as possible!"

**Victoria Revell, University of Surrey, UK**

#### BED IS SACROSANCT

"You should use your bed for sleeping and not for lounging in. I've become very good at not watching TV in bed, and I think that helps."

**Malcolm von Schantz, Northumbria University, Newcastle upon Tyne, UK**

#### GO WITH THE FLOW

"Like many people, I go through different stages of sleep. When I was a new mum, my sleep was terrible, but I've gone through that whole patch. So what I would like to say is keep an open mind about your sleep, because sleep does change quite a lot throughout the years."

**Nicole Tang, University of Warwick, UK**

resulting, perhaps unsurprisingly, in a raised risk of obesity and type 2 diabetes. We are just starting to unpick some hormonal mechanisms behind these changes.

For instance, when St-Onge and her colleagues restricted men and women to 4 hours sleep per night for four consecutive nights, they observed a rise in the appetite-stimulating hormone ghrelin in the men and a fall in the satiety-promoting hormone glucagon-like peptide 1 in the women. "At the end of the day, it means the same thing: people are more motivated to eat more, which can lead to increases in body weight and accompanying metabolic disorders," says St-Onge.

Disrupted sleep can cause metabolic changes surprisingly quickly. In one study, Christopher Depner and his colleagues at the University of Utah had participants reduce their sleep to 5 hours a night. "If we measure their insulin sensitivity, which is a risk factor for diabetes, we can see that some people go from perfectly healthy to a pre-diabetic state in three days," he says. Although the effects were reversible with catch-up sleep, it took six to 10 days for these people to return to baseline.

The good news is that it is possible to improve parts of the relationship between sleep and hormones. Our food choices affect how well we sleep (see "How does the microbiome influence our sleep?", page 35). Melatonin, for instance, is produced from an amino acid called tryptophan, which we get from protein-rich dietary sources, so eating more of these ensures that tryptophan is available to produce melatonin when night comes. Light also affects melatonin production, which is why dimming the lights and putting down your phone well before bedtime will help.

**Linda Geddes**

It promotes growth in children and regulates metabolism and supports cellular repair in adults. Studies have also linked poor sleep to hypothyroidism, where the thyroid gland doesn't produce enough of the hormones thyroxine, triiodothyronine and calcitonin, resulting in fatigue and weight gain.

An underactive thyroid isn't the only reason why the consequences of disrupted sleep can be seen in our waistlines. Various studies have suggested that both chronic sleep loss and circadian disruption can affect control of blood sugar levels and how efficiently we digest food,



IAKOVOS HATZISTAVROU/APP VIA GETTY IMAGES

Trying to sleep your way through jet lag might not actually work

## WHAT'S THE BEST WAY TO BEAT JET LAG?

IN THE first flush of our relationship, my husband began taking a series of photos of me during our travels. In every one, I am asleep: sat on a chair at the Musée d'Orsay in Paris. Head on my chest in the back seat of a car in Kiev, Ukraine. On a train in France, mouth open, drooling. He is lucky I still married him.

Jet lag certainly isn't pretty. Other than leaving you feeling exhausted – or wide awake – at the wrong time of day, a long flight across time zones can also cause gastrointestinal distress, off-kilter body temperature, headaches, irritability and cognitive impairment, all of which are much more serious for people who fly all the time, such as airline pilots. What can we do?

Many of us approach jet lag by prioritising sleep whenever we can, in order to counter the exhaustion. Even the National Health Service website for England recommends that you "change your sleep schedule to the new time zone as quickly as possible", and many of us try to just knock ourselves out on overnight flights (often with the help of over-the-counter medicines or in-flight refreshments).

While this approach isn't always wrong, it can sometimes do more harm than good. Instead, we need to think about jet lag in a more nuanced way, says Steven Lockley, a neuroscientist who was at Harvard University Medical School. "Jet lag really is about the body clock, it's not about sleep," he says.



Jet lag is the result of a sudden misalignment between the body's established circadian rhythms and the environmental day-night cycle at a new destination. "These symptoms occur because our circadian clock, which drives our 24-hour rhythms in nearly all aspects of physiology and behaviour, cannot instantly reset to the new time zone," says Victoria Revell at the University of Surrey, UK. This may seem obvious, but it points towards a different way of dealing with the problem: focus on resetting your body clock as efficiently as possible.

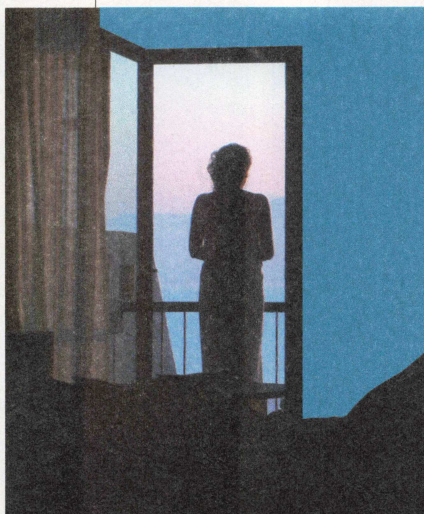
The most powerful way to do that is to strategically control exposure to light. Bright light tells the suprachiasmatic nucleus, a brain structure that sets the internal clock, to suppress the sleep-signalling hormone melatonin (see "What do hormones do to our sleep – and vice versa?", page 37). But the blanket advice to get outside during the day in the new time zone isn't always right. "Exposure to bright light at the wrong time of day can actually push your clock in the wrong direction and prolong jet lag," says Revell.

Imagine you leave New York at 7 pm on a 7-hour flight to London. You land at 7 am local time, but your body thinks it is 2 in the morning. Exposure to bright light at that time would tell your body clock to stay up even later, explains Lockley. "So now, instead of having a 5-hour jet lag challenge, you might have a 6, 7, 8-hour jet lag challenge." In this scenario, he suggests avoiding bright light by wearing sunglasses, even indoors, until around 10 am local time – or 5 am in your body's circadian time – to reduce that effect.

Light isn't the only factor worth considering. Research by Revell and her colleagues has found that the best way to reduce circadian misalignment is a combination of strategic light exposure, gradually changing your sleep schedule before travel, and taking melatonin at the right time. Other cues can also help nudge your circadian clock in the right direction, including avoiding heavy meals late in the evening of your home time and taking caffeine early in the day, she says.

Even so, it can be hard to calculate and keep track of when to do all these things, especially when you are tired. There is, of course, an app for that, in fact several, with anecdotal evidence of efficacy, even if clinical trials are lacking. Lockley has developed one of these, called Timeshifter, that runs all the numbers for you, based on your flight plan and sleep patterns, and provides a bespoke timetable. All this starts a few days before your trip, to help minimise the cliff-edge transition from one time zone to another. The algorithms behind the app were partly developed to help astronauts regulate their circadian rhythms while in space.

Another is FlyKitt, which offers similar



PAUL BRIGSHAW/MILLENNIUM IMAGES UK

Exposure to light is the most powerful regulator of your circadian rhythm

scheduling, but also recommends a regimen of supplements meant to be taken at specific times to alleviate symptoms of jet lag. These include vitamin C with tart cherry powder and melatonin with magnesium, and there is some evidence that they could help. For example, tart cherry juice – which went viral as the sleep-improving ingredient in TikTok's "sleepy girl mocktail" – was found to increase overall sleep time and sleep efficacy, according to a 2023 analysis of several studies and a small, randomised controlled study. This might work by increasing the tryptophan available to be converted into melatonin (see "How does the microbiome influence our sleep?", page 35). Melatonin can augment light exposure to shift circadian rhythm, but beware: the evidence for other supplements is less robust.

The next time I fly, I am going to focus on shifting my circadian clock – if only to lessen the chance of my husband catching me napping at yet another tourist spot.

Linda Rodriguez McRobbie

**35%**

Percentage of people in the US who have used a sleep tracking app

SOURCE: AMERICAN ACADEMY OF SLEEP MEDICINE

**15 to 20**

Minutes taken for most adults with healthy sleep patterns to nod off

SOURCE: THE SLEEP FOUNDATION

**1/5**

Maximum reduction in heart disease risk, if you are sleep deprived, from sleeping later at the weekend

SOURCE: BRITISH HEART FOUNDATION

## CAN YOU EVER PAY OFF YOUR SLEEP DEBT?

WHAT'S the difference between your time spent in bed and your bank balance? No, this isn't the start of a terrible joke – and the answer is less than you might think.

We all have the odd occasion when we stay up too late and don't sleep enough. Think of this as the equivalent of splurging on an expensive dinner: you probably shouldn't have, but your bank balance hopefully won't suffer too much.

But regularly going without enough sleep – a problem for many people, with the US Centers for Disease Control reporting that a third of adults there get less than 7 hours a night – could have you racking up a sleep debt, with real

consequences for physical and mental health (see "How much sleep is the right amount for you?", page 32). Like paying back a financial debt, catching up on sleep takes planning.

Part of the problem is that we might not know how much sleep debt we have accrued and how badly it is affecting us. In one study, for instance, participants were randomly selected to get 4, 6 or 8 hours per night for 14 days straight. By the end, those getting 6 hours or less exhibited a cognitive deficit equal to missing up to two entire nights of sleep. However, despite feeling worse after a couple of days, from then on the restricted sleepers didn't necessarily notice their cognitive abilities continuing to decline. "The tired brain can't detect how tired it is," says Russell Foster, a neuroscientist at the University of Oxford and author of *Life Time*.

Most sleep scientists will tell you that if you need an alarm clock to wake up, ➤





Strategic napping  
can aid recovery from  
sleep deprivation

# 1/3

The proportion of adults  
in the US who report not  
getting enough rest or sleep

SOURCE: US CENTERS FOR DISEASE CONTROL

# 300%

Maximum increase  
in heart disease risk in  
adults who sleep no more  
than 5 hours a night

SOURCE: UNIVERSITY OF CHICAGO MEDICINE

# 34%

Percentage of those aged 7  
to 16 in England who had a  
problem sleeping on three  
nights out of seven

SOURCE: NHS ENGLAND

## "YOU COULD TRY BANKING SLEEP AHEAD OF TIME"

weekend, they are often unable to fully pay back the debt. Work by Christopher Depner at the University of Utah and his colleagues found that when people got the chance to sleep in at the weekend, they stayed up and slept in very late, some until 2 or 3 in the afternoon. By Monday morning, this could leave people with "social jet lag" that is equivalent to waking up on the other side of the US, says Depner.

The truth is, we aren't sure what is the best option for paying down that sleep debt, says Depner. "Getting more sleep is typically going to be better, so I think we're hesitant as a field to recommend that you shouldn't get more sleep on the weekend. I think the reality is, we just don't know exactly the best way to do it."

That said, if you are trying to catch up on missed sleep, a good approach may be to add a bit of extra sleep around the hours you usually go to bed and wake up, rather than in a large dose one morning. If you do try to reduce sleep debt at the weekend, the US National Sleep Foundation says to sleep for just 1 or 2 hours more than you would during the week.

If you are still in arrears, take some tips from the US military, which suggests its soldiers use "tactical naps" to boost performance during operations. Research suggests that short sleeps can help bolster recovery in situations where longer, consolidated sleeps aren't possible; Foster recommends napping for no more than 20 minutes and not too close to bedtime.

The military also suggests "sleep banking", topping up the coffers before going into a period where you aren't likely to get adequate rest. Going to bed earlier or waking up later than usual in the weeks beforehand can help foster resilience against the negative effects of sleep debt and aid recovery from sleep deprivation.

Although it may not always be within our control, the ideal would be to avoid building up a sleep debt in the first place. "It's all about taking sleep seriously. In an already over-packed day – children, work and all the rest of it – what's the first victim? It's always sleep," says Foster. "I think we've got to possibly be stronger about saying: 'Nope, I've got to get my sleep.'"

**Catherine de Lange**

you probably aren't getting enough sleep. But there are other questions to ask yourself, says Foster: "Do I oversleep at weekends? Do I oversleep when I go on holiday? Have my friends or family commented on changed behaviours such as irritability, lack of social connectivity?"

It doesn't take long to start seeing negative effects from shortened sleep – and it can take time to recover. In one recent study, 83 adults were allowed a restful night of 12 hours in bed. They were then either deprived of sleep for 36 hours or had it restricted to just 4 hours a night for five consecutive nights. Both groups experienced significant cognitive decline, as well as decreases in energy and reaction times, during their sleep trials. Participants then had four nights of recovery sleep, with 12 hours in bed each time. Although their cognitive function was more or less restored after one night, those in the sleep-restricted group still had impaired reaction times even after four nights of recovery and the sleep-deprived group never recouped its energy levels in that time.

This is bad news when it comes to the strategies that many of us use to pay down sleep debt: sleeping in at the weekend and the odd nap might not be enough to undo the damage.

Though studies have linked sleeping more at the weekend with everything from an increased risk of heart disease to worse period pain, more recent studies have brought better news. One found no increase in mortality or cardiovascular disease risk, while another revealed that staying in bed longer like this could cut the risk of heart disease by a fifth compared with remaining sleep deprived.

While the jury is still out on the health impacts, it is also unclear whether sleeping in is an effective strategy. When people try to catch up at the