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Why Sleep Matters: How Sleep Influences Health and Happiness

Contents

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Introduction

Sleep experts agree that we need at least seven hours of sleep to function at our best.[1] If an uninterrupted seven hours of shut-eye sounds like an unusual luxury to you, you're not alone. In today's hectic society where 24/7 communication is the norm, sleep is an increasingly scarce commodity. Many scientists agree that we're sleeping less than we were 40 years ago.[2]

Sleep deprivation is common across OECD countries, but a 2016 report suggests that workers in Japan and the US fare worse than most; in a large multinational survey, 56% of Japanese workers and 45% of American workers reported routinely getting fewer than 7 hours sleep, compared with 35% in the UK and 26% in Canada.[3]

But does it really matter? Or is getting less sleep an acceptable sacrifice for squeezing more into the day? For generations, skimping on sleep has been portrayed as a sign of mental strength. But the latest science suggests the opposite: lack of sleep has negative consequences not only for our mental focus, but for emotional and physical health. A feeling of fatigue is just the tip of the iceberg: sleep deprivation takes its toll on our brains, our biology and our behavior.

This paper draws from the latest literature to investigate the impact of poor sleep on our health and happiness. We start by defining the two most common sleep issues: sleep deprivation and insomnia.

> **"There is really no reason why men should go to bed at all."**
>
> Thomas Edison, 1914
> Inventor of the commercial electric lightbulb

The Science of Sleep
Why do we neglect sleep?[4]

The more sleep deprived we are, the less likely we are to notice the effects.

In a famous experiment, 3 groups of volunteers slept for a maximum of 4 hours, 6 hours or 8 hours per night for 14 days. Each day participants completed a test of alertness, called the psychomotor vigilance test (PVT). This involves pressing a button as quickly as possible in response to numbers appearing on a screen.

The shortest sleepers always performed the worst on the PVT test, making the most errors. Performance worsened progressively each day: the greater the 'sleep debt' that accumulated over time, the more mistakes were made.

But when participants were asked how alert they felt, self-ratings of sleepiness only increased for 3 days - after that, perceptions of sleepiness stabilized. Participants felt as though they were adapting to short sleep, but their performance revealed otherwise.

It seems that we're hard-wired to underestimate sleep loss.

What is sleep deprivation and how common is it?

In 2015, US sleep experts reviewed all the scientific research about how much sleep we need for good health. The expert consensus was that 7 to 9 hours sleep is necessary for optimal health and wellbeing, for most adults.[1]

In working populations, as many as 4 out of 10 adults are sleep deprived, or regularly getting fewer than 7 hours sleep, leading the CDC to label sleep deprivation a serious public health concern.[5]

Roughly half of adults living with sleep deprivation, the 'Sleep Stealers', could sleep for longer if only they could find the time, but they borrow from sleep time to fulfill family, work or social commitments. Sleep Stealers may not realize that skimping on sleep is holding them back, and are unlikely to seek medical help.

For many people, short sleep is not a choice. Around 2 in 10 employees suffer from insomnia: a difficulty getting to sleep, staying asleep through the night, or waking up too early.[6]

Insomnia is diagnosed when sleep problems persist for months, or more, and have a distressing impact during the day. In chronic insomnia, the effects of short term sleep loss are reinforced over months or years.

Insomnia is the most common sleep disorder. Other medical conditions which can interfere with sleep include obstructive sleep apnea (OSA), a narrowing of the breathing passages which interferes with deep, restorative sleep. OSA affects around 3% of the US population and can be treated with a CPAP mask, which delivers air under pressure to make breathing easier.[8] Other sleep conditions include narcolepsy and restless leg syndrome which are even less common in the population.

The scale of sleep deprivation

What makes insomnia different from a lack of sleep?

It's common to cycle in and out of episodes of shorter sleep, for example, depending on the pressures of a young family, caring, work, or even a particularly addictive series on Netflix. But if you have insomnia, when you take away external pressures, sleep is still a problem.

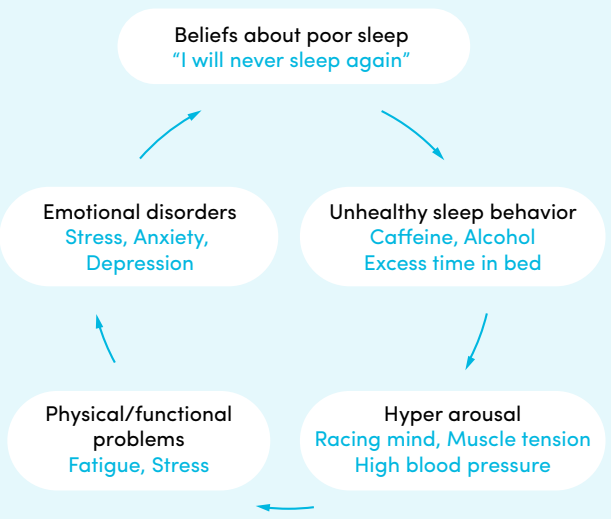
Insomnia is often triggered by an illness or a stressful event. Insomnia is more common in people with chronic health conditions; for example, insomnia affects 1 in 2 people with diabetes.[9] Before long, worry about not sleeping starts to keep people awake.

Many people try and cope by self-medicating with alcohol or over the counter sleep remedies, which don't tackle the root causes of insomnia, and can be harmful. In fact, many of the methods used to compensate for poor sleep, such as boosting energy with caffeine or sugar, napping or going to bed early, can make insomnia worse.

Insomnia is a condition of hyperarousal: both the brain and body are hyperactivated.[10] This leads to both a racing mind and physical symptoms such as raised blood pressure, and increased levels of the stress hormone, cortisol. Over time this increases the risk of stress-related physical conditions and mental health disorders. Emotional disorders can further worsen insomnia symptoms, creating a vicious cycle.

Without effective treatment, insomnia is remarkably persistent, with at least 60% of sufferers still suffering from the same symptoms a year later.[11]

The vicious cycle of insomnia



The Science of Sleep Diagnosing Insomnia

According to the latest diagnostic advice (DSM-5),[7] insomnia is defined as dissatisfaction with sleeping for 3 nights or more per week, for 3 months or more, which has a negative impact on daytime function, despite adequate opportunity to sleep.

Negative daytime impacts could be social, occupational, educational, behavioral, or other important areas of functioning.

How do sleep problems influence health outcomes?

Sleep plays an essential role in regulating our emotions, behavior, and physiology. In fact, lack of sleep has been linked with seven of the fifteen leading causes of death in the United States, including heart disease, cancer, stroke, accidents, diabetes, septicaemia and hypertension.[12]

Here we go through the influences of sleep on a selection of key health outcomes.

> **"Innocent sleep...**
> **Balm of hurt minds,**
> **great nature's second course,**
> **Chief nourisher in life's feast."**
>
> William Shakespeare
> Macbeth, Act II scene 2

Mental health

Sleep and mental health are intimately linked. Typically two thirds of patients suffering from clinical levels of anxiety or depression also have insomnia.[13] The medical profession used to view insomnia as a symptom, or consequence, or poor mental health, but in the last 10 years, sleep problems have increasingly become recognized as a causal factor in the development of mental health disorders.[14]

In the short term, a bad night's sleep can cause impatience, irritability, and lack of energy. Short sleepers are more likely to remember negative events, and less able to focus on the positive.[15] They also report lower levels of optimism and self esteem.[16] Those with chronic sleep problems are more likely to report feeling stressed at work and are at higher risk of burnout.[17] Insomnia more than doubles the risk of future depression and anxiety.[18]

Poor sleep is also an obstacle to treatment for depression and a risk factor for relapse.[19]

Insomnia is also an important risk factor for more severe psychiatric disorders: schizophrenia, psychosis, and even suicide attempts.[22] On a positive note, however, sleep and mental health have a two-way relationship: psychological treatment which targets sleep disorders has been found to reduce symptoms of anxiety, depression, and other mood disorders - meaning improved sleep acts as a "trojan horse" for better mental health.[23]

The Science of Sleep
Why does sleep loss make us more vulnerable to stress?[20,21]

Brain imaging studies show that short sleep makes us unusually reactive to negative events.

The amygdala, the part of the brain which helps control emotions, becomes hyperactive. The brain is more likely to interpret new challenges as threat, so we're more likely to feel defensive, anxious, and depressed.

This 'amygdala hijack' increases our 'fight or flight' stress response, which results in raised blood pressure, a racing pulse, and release of the stress hormone: cortisol.

Immune defenses

Short sleepers are more susceptible to infectious diseases. Even restricting sleep for a single working week alters the body's production of proteins which are needed to fight infection.[24] When researchers exposed healthy students to the cold virus, those who slept for fewer than 5 hours per night were four times more likely to develop a cold than those who slept for 7 hours or more.[25] Similar links have been observed for the risk of pneumonia.[26]

The Science of Sleep
Can better sleep boost the power of a vaccine?[27]

The hepatitis B vaccine consists of three injections over six months. A healthy immune system reacts by producing enough antibodies to be clinically protective.

123 adults aged 40 to 60 received the hepatitis B vaccine and monitored their typical sleep patterns. Six months later, researchers found that habitually skipping out on a full night's rest had taken a toll on the vaccine's effectiveness; those who typically slept for less than 6 hours were significantly less likely to have a protective response to the vaccine.

Weight gain and obesity

Appetite is under the control of two main hormones: 'greedy' grehlin, which makes you hungry, and 'lean' leptin which suppresses appetite and helps you feel full. Lack of sleep alters the balance of hormones: we produce more grehlin and have stronger cravings for calorie-laden foods.[28]

Eating during the night, when the body is not adapted to metabolize food, may also promote weight gain.[29] In the long term, the shorter the sleep, the greater the risk of obesity.

For example, in one study 500 teens were followed for 13 years. By the time they were 27 years old, participants who slept for less than 6 hours on average were 7.5 times more likely to have a high body mass index (BMI), even after taking into account their level of physical activity and other possible contributing factors.[30]

The Science of Sleep
Why do we crave burgers when we're short of sleep?[31]

Researchers at the University of California Berkeley probed this question by looking at how the sleep deprived brain responded to pictures of healthy green vegetables and junk food.

After a night of complete sleep deprivation, activity in the frontal lobe (which is responsible for complex decision making) was impaired.

Pizzas, burgers, and doughnuts sparked strong activity in the reward centers of the sleepy brain, indicating a strong desire. Fruit and vegetables did not create the same excitement.

The researchers reasoned that short sleep creates strong motivation for high calorie foods and interferes with our ability to resist cravings.

Type 2 diabetes

Insulin resistance is a condition in which the body doesn't use insulin efficiently to move glucose out of the bloodstream and is a characteristic feature of Type 2 diabetes. Even in healthy people, restricting sleep to 5 hours for a week can significantly reduce insulin sensitivity.[32]

In the long term, both short sleep and poor sleep quality predict a higher diabetes risk: a study of 100,000 nurses in the US found that those reporting insomnia at baseline were 1.5 times more likely to develop diabetes over 10 years than good sleepers.[33]

There is growing interest in improving sleep to help improve self-care and metabolic control in diabetes.[34]

> **"There's something in the New York air that makes sleep useless; perhaps it's because your heart beats more quickly here than elsewhere"**
>
> **Simone de Beauvoir, 1954**
> **America Day by Day**

Cardiovascular disease

Both insomnia symptoms and short sleep duration predict higher risks of developing cardiovascular disease (CVD), which includes heart attacks, angina, heart failure, and stroke.

A recent review combined all the data from 15 studies looking at the link between insomnia and CVD, resulting in a massive data set of 160,000 people. The researchers found that difficulty getting to sleep, staying asleep, and non-restorative sleep were all associated with increased risks of heart attacks, coronary heart disease, heart failure, and stroke.[35] People who reported difficulty in initiating sleep had a 27% higher risk of any cardiovascular events.

The Science of Sleep
Why is poor sleep bad for the heart?

The mechanisms aren't yet well understood but inflammation is a likely culprit.

Inflammation is a key process underlying the thickening of the arteries in heart disease, which leads to a narrowing of blood vessels. Both short and long sleep (more than 9 hours) have been linked to raised inflammatory markers in the blood.

Increased inflammation has recently been detected in teenagers with insomnia who slept for fewer than 7 hours per night.[36] Treating poor sleep with Cognitive Behavioral Therapy has been shown to reduce inflammatory markers, even 12 months later suggesting this is a promising route for reducing long term disease risk.[37]

Hypertension, or high blood pressure

Hypertension is the most important risk factor for cardiovascular disease. During normal sleep, blood pressure typically falls by about 10%.

Chronic insomnia sufferers who sleep for fewer than 6 hours per night are 3-4 times more likely to have high blood pressure than good sleepers.[38] The combination of insomnia and short sleep is also a risk factor for developing future hypertension.[39]

Cognitive decline

Both short sleep and poor sleep quality in midlife and old age have been linked to greater risks of cognitive decline and dementia, including Alzheimer's disease.[40]

For example, in one study of 17,000 older adults, complaints of sleep quality or taking sleeping pills were associated with a 23% higher risk of dementia or Alzheimer's disease over 4 years.[41]

It's not yet clear whether improving sleep quality could have a protective effect on long term cognition, but it's an exciting area for research.

The Science of Sleep
How might sleep protect the brain from cognitive decline?[42]

Studies in animals suggest that during natural sleep, the spaces between brain cells open up, allowing more fluid to circulate.

Circulating cerebrospinal fluid helps to reduce the build-up of beta amyloid, a toxic waste product which increases the risk of dementia. Part of the protective function of sleep may therefore be to remove harmful waste products from the brain that accumulate while we're awake.

Chronic pain

At least 1 in 10 adults experience chronic pain, and it's estimated that almost half of them suffer from insomnia.[9] While pain is an obvious obstacle to sleeping at night, what is less well known, is that sleep deprivation significantly increases sensitivity to pain.[43]

A recent study of 1,800 adults found that both insomnia and short sleep predicted an increased risk of developing chronic musculoskeletal pain over 6 years.[44]

Cancer

The jury is still out on whether insomnia, or short sleep, predicts an increased risk of cancer; different studies have had contradictory findings. Night shift work, which is associated with both poor quality sleep and short sleep, was classified as a 'probable' carcinogen by the World Health Organization in 2007. Studies in animals had suggested that exposure to light at night could promote cancer, especially breast cancer.

However, in 2016 a large UK study which combined data from over 1 million women found no evidence of a link between shift work and new cases of cancer.[45]

It may be that only long term exposure to night shifts carries an increased risk. For example, data from 16 studies combined found that night shift work increased the risk of breast cancer by: 1.9% for 5 years, 2.5% for 5-10 years, 7.4% for 10-20 years, and 8.8% for more than 20-years exposure.[46] Rotating night shift work was associated with the highest risk (8.9%).

Fertility

Lack of sleep can interfere with the odds of successful reproduction in more ways than one; as little as two nights of 4 hours sleep can significantly reduce your attractiveness to the opposite sex![47] In women, short sleep also makes the idea of sex less desirable and less satisfying.[48] In men, it has been suggested that both short sleep and long sleep (>9 hours) are associated with lower fertility.[49]

How does poor sleep affect health behaviors?

In most of the studies described above, the links between sleep and health were independent of lifestyle behaviors, such as smoking and exercise, meaning that poor sleep alone is sufficient to drive the negative health outcomes that were observed.

However, having less energy and willpower during the day can also interfere with our best intentions when it comes to healthy living, decreasing our ability to engage in health-promoting behaviors and increasing our susceptibility to health degrading behaviors.

Smoking

Poor sleep and smoking often co-occur; nicotine acts as a stimulant which can make it harder to switch off at night. In addition lack of sleep also interferes with quit attempts, and increases the chance of relapse.[50]

Exercise

Sleep and exercise strongly influence each other through a number of pathways.[51] Regular exercise has been found to have beneficial effects on sleep quality, especially in older adults.[52]

Lack of sleep, on the other hand, is associated with fatigue and low motivation so perhaps unsurprisingly, insomnia is typically linked to lower levels of physical activity. Sleep deprivation also increases the odds of exercise-induced injuries and interferes with stamina.

Alcohol

Poor sleepers are more likely to drink in excess. Alcohol's relaxing properties are well known, so many insomnia sufferers increase their alcohol intake before bed to help them get to sleep. Unfortunately, alcohol interferes with natural sleep cycles, resulting in less restorative sleep. Alcohol also acts as a diuretic, increasing the likelihood of getting up at night to use the bathroom. In the long term, both adults and teenagers with sleep problems are more likely to start drinking heavily. Insomnia also interferes with treatment for substance misuse.

Diet

As explained in the section on obesity and weight gain above, lack of sleep disrupts the hormones controlling appetite. In one study in which volunteers were restricted to two thirds of their normal sleep time for 8 days, they spontaneously ate more than 650 calories extra per day, compared with days they were not sleep-deprived - that's equivalent to about 3 bagels!

The Science of Sleep
Why does lack of sleep interfere with self control?[57]

During sleep, we recharge the brain's capability to regulate our emotions and behavior in a number of ways that could influence lifestyle choices. When we're sleep deprived, we're less able to focus and more likely to be distracted by emotional stimuli - 'stress eating', for example.

Emotional reactivity has been linked to both a more sensitive amygdala (which controls our perception of threat), and a reduction in the connectivity between the pre-frontal cortex and the amygdala.[58] The pre-frontal cortex is heavily involved in planning and self regulation. When we're short of sleep, we have less glucose fueling the pre-frontal cortex, making us more susceptible to forgetting our best intentions, and giving in to cravings.[59]

So what does this mean for employers?

As you can imagine, the variety of impacts that sleep deprivation and insomnia have on mental health, concentration, energy, and immune defenses can lead to meaningful impacts on productivity, absenteeism, and workplace errors and accidents for employers.

At the same time, the contributions of insomnia to a variety of chronic health conditions can result in substantially higher healthcare costs - some studies show that healthcare costs are 75% higher on average for those with insomnia.[60]

Given the multitude and magnitude of work-relevant impacts, sleep deprivation and insomnia have become issues that employers can no longer afford to ignore. To learn more, stay tuned for our next white paper describing how exactly these effects of poor sleep go on to impact productivity, absenteeism, safety, and healthcare expenditures.

The cost impact of insomnia

Individuals with insomnia each year cost their employers in healthcare expenditure...

+75%

more than good sleepers

+$3,855

more than good sleepers

Interested in improving your employees' sleep?
Contact us at workplace@bighealth.com

About the Author

Sophie is a Sleep Evangelist at Big Health, the digital medicine company behind sleep improvement program, Sleepio.

Sophie's research interests include on the impacts of improving sleep for performance and health. With the Sleepio team, she has collaborated with researchers around the world, including trials to explore the impact of sleep improvement in the workplace with Foster Business School, Henry Ford Health System, and the University of Oxford, where she is an honorary research fellow.

Sophie has featured as a sleep expert in the media including for BBC World, ITV, and TEDxNHS. She has also been recognised by the NHS as an Innovation Accelerator Fellow, helping to promote the uptake of digital medicine.

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