

Sleep: so much more than rest

- **When we sleep, we lose weight.**
- **When we sleep, we fight infections.**
- **When we sleep, we repair structures.**
- **When we sleep, we rejuvenate.**
- **When we sleep, we consolidate learning.**

Are you getting enough sleep at night to fully function in the daytime? What else could you be missing out on?

How is sleep regulated?

The main hormone associated with sleep is called melatonin. Melatonin production in the brain is stimulated by darkness and suppressed by light. That is the reason behind the advice to avoid light exposure from screens such as phones and computers at night. The threshold to suppress melatonin has been estimated to be as low as 30 lux, which is well below normal fluorescent light of about 300-400 lux. The light picked up by our eyes informs the brain of how much melatonin to produce. Exposure to light at night will therefore suppress our ability to produce melatonin. With suppressed melatonin, we suppress sleep. With suppressed sleep, we may be missing out on a lot more than rest.

What else happens when we sleep?

The sleep hormone melatonin controls a whole load of other functions in the body. As the brain gets off to sleep and skeletal muscles remain still, the body switches to a completely different mode of action that allows for other parts of the system to boost. Some systems increase their activities whilst the brain and the muscles decrease the demand for energy. The brain is incredibly power hungry, and it consumes a lot of the available energy generated in the daytime to maintain cognitive and social activities. At night, during sleep, there is a shift in activity and even weight loss is promoted throughout the night – that is if you get a good night of sleep and respect your circadian rhythms. As we stop eating whilst we sleep, fat cells should come to the rescue and provide much of the energy necessary for running the system overnight. This is especially so when we stop eating early enough in the evening to allow a few hours before we go to bed. Not everyone manages to rely on their fat reserves to make it through the night though and this is one of the reasons why people might sometimes wake up in the middle of the night struggling to fall back asleep. When our fat cells are not flexible enough and we rely on constant food intake for energy, we train our bodies not to rely on stored fat and the result could be a rush of adrenaline late at night. When blood sugar falls below a certain level, adrenaline is released with an alert to the system of low energy to make it through the night. Adrenaline will trigger the release of emergency reserves of sugar stored in the liver but at the cost of stress to the system and inability to relax back into sleep.

Our natural daily rhythm – why is it important?

An energetic switch from brain to immune system also happens at night. During the day, and in health, the immune system works more in surveying mode which is cheaper and allows for the brain to be prioritised with energy during waking hours. At night, or when we fight infections or disease, the immune system behaves differently taking up more energy to increase its functions. The immune system gets on with a lot of housekeeping in preparation for the next day. It not only protects us from invading viruses, bacteria, and other microbes but also promotes repair and

rebuilding of structures that get damaged through wear and tear or injury. The switch from day to night, brain to immune function, food to fat is part of what we call circadian rhythm. Our bodies follow hormonal signals that keep this switch regularly aligned with the changes between light and darkness. A regular sleep pattern means we allow the body to attend to many maintenance functions that require night-time hormones and a resting brain for the work to be carried through.

Sleep and disease – how do they connect?

Sometimes the immune system might take over daytime activities and literally put us in bed. A good example of that is when we fall ill with the flu. Chemical reactions happen faster in higher temperatures, so we develop a fever to accelerate these reactions in the fight against infection. As the brain gives way to the immune system to defend the body, we develop what is known as 'sickness behaviour'. We literally become withdrawn and tend to stay in bed. When the fight is over and the inflammation starts to abate, the energetic drain is alleviated, and we regain the interest in social life and engagement with other complex cognitive activities. It is possible to notice how the need for sleep increases if the body is busy defending or repairing parts of the system.

When we disregard our needs for regular sleep, especially over prolonged periods, the whole system is impacted and desynchronised. It is no coincidence that, when health first starts to decrease, sleep problems tend to show up first. Soon, if unaddressed, these problems can progress towards inflammatory states that can lead to diseases, chronic pain and fatigue further down the line. Inflammatory chemicals increase in response to short or disturbed sleep. Ongoing states of low-grade inflammation are linked with increased risk of cardiovascular, neurodegenerative, auto-immune diseases, diabetes and chronic pain conditions.

So making an effort to keep to a regular sleep routine and respecting the time limit for exposure to light may be a worthy habit to maintain. As always, our bodies are highly dynamic and sophisticated systems that interconnect and self-adjust with a precision we are yet to appreciate. It pays to invest in a healthy lifestyle and to consider how our choices today may impact our lives tomorrow.

Part 2 – Practical Tips

Sleep Hygiene

Work on your sleep throughout the day so it can happen for you throughout the night.

Sleep is something that needs adjusting, like a clock that does not keep the time so well. The brain needs information from the outside to trigger the release of sleep and wake hormones every day in the right amount. If we do not keep up with the correct cues for sleep, the system gradually gets out of sync. Worse even, if we fail to work on our sleep patterns, we never feel refreshed in the morning and the body must function in a depleted state of energy. Over the years, this can lead to increased aging and susceptibility to the development of chronic diseases. A good night of sleep every night is a basic need and nobody can function well in the day without it though for some people the number of hours needed for rest may be less than average. But even for those who can function well on less sleep, regularity is still a must.

Sleep and mental health.

Sleep and mental health go hand in hand and people who suffer with insomnia are 10 times more likely to develop mood disorders. Sleep disturbance is a strong risk factor for the development of major depression and patients are less likely to respond to treatment for depression if they have chronic sleep problems. Addressing sleep as a priority may be the first step towards improved health and wellbeing. It can seem difficult to improve sleep as if it is something out of our control, but by following the steps listed below it is possible to start making gradual improvements until a new night-time routine is established.

Good sleep happens with routine – mornings are not for catching up on missed sleep.

Waking up at the same time every day is a simple trick that many people miss out on. We tend to think that if we are sleep deprived, we ought to catch up on sleep by staying in bed and getting up later the next morning or on weekends for many who work long hours during the week. However, by creating this contrast between weekdays and weekends, we actually promote sleep dysregulation and risk insomnia becoming a long-term problem. Even if it makes us tired, it is much better to keep to the same wake up time and get up as a routine every day. To catch up on sleep, try instead to go to bed half hour earlier over the course of a few days. If you cannot afford going to bed earlier, keeping to a regular sleep routine, however many hours you can manage, is an important factor. Even if you did not get a nice rest, you should get up at the usual time. Working on a bedtime routine which helps the brain to wind down is a big help to set up a regular sleep pattern. There are countless free apps which provide guided meditation for free. Setting 5 minutes aside for a quick but regular meditation practice in bed is a simple and yet transformative practice to achieve better sleep.

The contrast between light & dark/ day & night helps the brain to switch sleep on and off.

To promote sleep at night, the best strategy is to get exposure to sun light outdoors as early as possible. When the weather is overcast, we can maximise the effect by prolonging the exposure. But even if time is limited, a brief exposure to natural light first thing in the morning will still be helpful. Viewing bright light suppresses sleep whilst total darkness promotes sleep. Avoiding light at night, especially avoiding light from electronic devices such as phones and computers is very important for the brain to switch on the sleep hormone melatonin. However, that is not the whole story. The amplitude is also a factor. Natural sunlight exposure during the day and avoidance of artificial light at night is a strong predictor of an ideal night of sleep. The brain looks for the contrast between bright and dark and the bigger the contrast between day and night, the stronger our drive to sleep at night. You will notice that from days out in the country or holidays abroad when you stayed outdoors for long. There is a guaranteed good night of sleep at the end of days like that. Not just because you moved about and were active, though that counts as well, but especially because you were out receiving natural light through your eyes most of the day. Of course, we cannot always spend most of our time outside during the day but getting some exposure first thing in the morning and perhaps again at lunch time or at the time of sunset is an extremely powerful aid to sleep.

There is a reward system in the brain for viewing light early in the day (dawn) and then again at the time the sun is setting (dusk). The configuration of light, combining different spectrums of blues and yellows at the beginning and end of each day is very informative for the brain. Those moments send signals to our internal clocks and promote synchronicity with our environment. If we dedicate some time to do that every day, sleep becomes like clockwork. On the other hand, there is a punishment system in the brain for when we expose our eyes to bright light in the evenings. Human brains were not designed to see bright light after sunset and if we expose our eyes to bright or artificial light other than a candle or fireplace after dark, we are sabotaging the quality of our own sleep, depriving ourselves and impairing our ability to recharge and repair our bodies.

Bed for sleeping, not for browsing.

About 130 years ago, we used to sleep around 9 hours on average. These days, the average is 6.5 hours and that is thanks to electricity. The issues around light exposure at night are not just about 'blue light' from screens and computer. Blue light does have the strongest effect in suppressing the sleep hormone melatonin, but it is not the only frequency that can affect us. Ideally, we should set an early finish with phones, laptops, computers, and screens 3 hours before bedtime. If browsing the phone in bed is a habit hard to break, it is much better to do it in the morning. But the best is to leave the phone charging downstairs or away from the bedroom. Bed should not be associated with

screen activities. Avoiding screen related activities in bed helps the brain to create patterns that associate bed with sleep. For the same reason, staying in bed for too long whilst trying to fall asleep when not tired may not be helpful. Instead, getting up early the next day will set the brain on a mission to make an early appointment with bedtime for the next time.

The more you move during the day, the more you sleep during the night.

Exercising early is good to help with sleep later but vigorous exercise in the evening is likely to release the wrong chemical signals and keep you awake beyond the point you should. Although exercise is good to promote sleep, timing is also important for that matter. Ending exercising up to 3 hours before bed is a good cut off point to prevent triggering alertness at the wrong time.

The less you sleep, the more you want to eat.

Another problem that comes from bad sleep is the tendency to eat more junk foods. When we manage to fall asleep, it means the body can relax and let go. When we cannot sleep, the body interprets that as a need to stay alert and restless. Skipping on relaxation at night informs the body of some danger or threat we need to prepare for (even if that is not the case). Because of old mechanisms of survival hardwired into our brains, sleeping less is interpreted by the brain as pressure to move more (as in running away or running after something we need). This pressure can sometimes be translated in the body as stress and anxiety. For that reason, our brains will seek to find quick energy supplies to keep up with the anticipation for increased demands (including energy demands for a quick escape or physical engagement). We then develop an increased appetite for salty, fatty and sugary foods – all the main ingredients of junk high calorie foods.

These mechanisms are old and they have been with us for thousands of years, even though, in modern day life, we hardly ever need to run away from things to survive. We are much more likely to eat all the extra energy and just accumulate more weight because of bad sleeping habits. The take home message is: if you do not sleep well, your body interprets that as a signal for physical engagement and need for sugar. Moreover, if you do not sleep well and do not exercise the next day, you can see you will be left with the inevitable consequences of gaining extra weight.

The right time for caffeine (coffee, black or green tea).

Caffeine is a powerful aid in staying awake and it is no wonder coffee is so commonly taken first thing in the morning everywhere in the world. But to continue to take caffeinated drinks throughout the day is a mistake when you wish for a good night of sleep. Caffeine has a chemical that occupies the receptors for adenosine. Adenosine is the breakdown product of energy. The more tired you get, the more adenosine you accumulate through the day. Nothing gets rid of adenosine except for sleep. However, although caffeine cannot eliminate adenosine, it can block its signals. So by drinking caffeine, we can remain awake but not because we are not tired. We remain awake and build up sleep deprivation. As soon as the caffeine wears out, we need more to avoid crashing.

Some people are particularly fast in processing caffeine and they can drink coffee and go to sleep without any difficulty. For them, caffeine does not occupy the receptors for adenosine because these receptors are slightly different. That is down to genetics, but for most people, caffeine interferes with sleep. If you are not sure, experiment and check for yourself: are you building up an energy deficit and masking it with caffeine every day? Or are you managing to sleep and restore your energy waking up refreshed every morning? If you are rested, you can take it or leave it when it comes to coffee. Caffeine is not the villain and you don't need to eliminate it from your life, but if you are dependent on it to function, you may benefit from changing how you use it. For most people, caffeinated drinks are best taken in the first part of the day, ideally up until noon. In the afternoon, non-caffeinated drinks such as water and herbal teas will be more helpful to allow the body to build up its adenosine stores and let the brain gradually wind down in preparation for sleep

later. If you work with your body, you will have better results. Sometimes all that is missing is that we notice some signals given out by the body day by day but missed out as we simply did not know their meanings. Try and find out whether you are missing out on any clues your body has been offering.

Remember that if you decrease your intake of caffeine and especially if you withdraw from caffeine completely it will take a few days for the body to adjust. Stay with it until you reach the other side and work on as many other aspects of sleep as you can. In a couple of weeks, you can look back at your experience and see if there was something there you were meant to learn.

References

1. Bray, MS and Young, ME (2007) **Circadian rhythms in the development of obesity: potential role for the circadian clock within the adipocyte.** *Obes Rev* 8(2):169-181.
2. Johnston JD, Frost G, Otway DT (2009) **Adipose tissue, adipocytes and the circadian timing system.** *Obes Rev* 10 Suppl 2:52-60.
3. Kiehn, J-T et al (2017) **Circadian rhythms in adipose tissue physiology.** *Compr Physiol* 7(2):383-427.
4. Straub, RH, Cutolo M, Buttgereit F, Pongratz G (2010) **Energy regulation and neuroendocrine-immune control in chronic inflammatory diseases.** *J Intern Med* 267:543-560.
5. Cardinali, DP and Hardeland, R (2017) **Inflammaging, Metabolic Syndrome and Melatonin: a call for treatment studies.** *Neuro-endocrinology* 104:382-397.
6. Manka, S, Majewska, E (2016) **Immunoregulatory action of melatonin. The mechanism of action and the effect on inflammatory cells.** *Postepy Hig Med Dosw* 70(0):1059-1067.
7. Haack, M et al (2020) **Sleep deficiency and chronic pain: potential underlying mechanisms and clinical implications.** *Neuropsychopharmacology* 45(1):205-216.
8. Andersen, ML et al (2018) **Sleep disturbance and pain: a tale of two common problems.** *154(5):1249-1259.*
9. Harden, LM et al (2015) **Fever and sickness behavior: Friend or foe?** *Brain Behav Immun* 50:322-333.
10. Vollmer-Conna U et al (2004) **Production of pro-inflammatory cytokines correlates with the symptoms of acute sickness behaviour in humans.** *Psychol Med* 34(7):1289-97.
11. Konsman, JP et al (2002) **Cytokine-induced sickness behaviour: mechanisms and implications.** *Trends Neurosci* 25(3):154-9.
12. Dantzer, R (2004) **Cytokine-induced sickness behaviour: a neuroimmune response to activation of innate immunity.** *Eur J Pharmacol* 500(1-3):399-411.
13. Pollak, Y and Yirmiya, R (2002) **Cytokine-induced changes in mood and behaviour: implications for 'depression due to a general medical condition', immunotherapy and anti-depressive treatment.** *Int J Neuropsychopharmacol* 5(4):389-99.