



Sleep

Volume 2

**The impacts of inadequate
sleep on overall health,
wellbeing, and lifespan**

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Foreword

Is inadequate sleep taking you down the road to a shorter life?

Will inadequate sleep kill you outright? Yes, on two counts. Firstly, progressive insomnia (a rare genetic disorder which stops a person sleeping altogether) and secondly, the deadly circumstance of getting behind the wheel of a vehicle or performing another safety critical task. You may have previously been guilty of using the old maxim of "I'll sleep when I'm dead!" But I am being quite serious now, this is mortally unwise advice, and we are realising this more and more. The research in this area is quite staggering and the evidence of studies on millions of individuals is overwhelming. There is a simple truth – the shorter your sleep, the shorter your life. Most alarmingly, if you are getting less than 6 hours of sleep per night your chances of dying at any time are 65% higher than a person who gets adequate amounts of sleep. That fact may be frightening to those who fail to achieve a regular sleep pattern consisting of approximately 8 hours sleep, but this research is well founded.

The reality is that we are not 'working' ourselves to death, but rather we are 'waking' ourselves to death. Humans are the only species on earth that continue to deliberately deprive themselves of sleep for no apparent reason and without any legitimate gain. Although we are biologically prepared to function on minimal sleep, our prehistoric blueprint for sleep hasn't evolved fast enough for 21st century life and in fact we now actually sleep on average, 1 ½ hours less than our grandparents did.

Modern research has shown that there is a direct causal link between inadequate sleep and poor health amongst those who frequently neglect to get a sufficient number of hours. Hopefully some of you will have previously read my first sleep booklet titled '*Sleep – A Basic Introduction*' which aimed to explain to readers the importance of sleep and included some useful hints and tips (based on recognised best practice) to try and improve their quantity, but more importantly, the quality of their sleep they were getting. This second booklet aims to go beyond the basic neuroscience of sleep and explore further the wonderfully good things that happen when we get good sleep, but also the alarmingly worrying things that happen when we don't get enough - for both our brains and our body.

The decimation of sleep throughout industrialised nations is having a catastrophic impact on our health, wellness, and safety. There is a silent sleep loss epidemic, and it is fast becoming one of the greatest public health challenges that we face in the 21st century. I believe it is now time to reclaim our right to a full night of sleep and without embarrassment, or that unfortunate stigma of laziness, and in doing so we can be reunited with the most powerful lifesaving tool, finally remembering what it is truly like to be awake during the day. Remember that your sleep is not an optional lifestyle luxury. Sleep is a non-negotiable biological necessity and your life support system. It is Mother Nature's best effort yet at immortality.



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Part 1

**Introduction and recap
on the basic principles
of sleep**

Introduction

In 1964, an American schoolboy, called Randy Gardner, his classmates and his college professor attempted to achieve the unthinkable – setting the world record for the longest time without sleeping. After day 1 his classmates and professor were slumped against the wall fast asleep, but Randy continued his world record attempt. After day 2 he couldn't complete simple sentences. By day 3 he was uncoordinated. By day 5 he was hallucinating. After the full 11 days and 25 minutes he was rushed to hospital where he spent the first night sleeping for 14 hours. Although he broke the world record, he unfortunately suffered the most severe physiological and behavioural consequences. As such, this world record has never been equalled since, nor should it. What we are learning more and more is that sleep deprivation has a profound effect on our physiological health and wellbeing.

As I explained in volume one, sleep is perhaps the single most important biological and behavioural experience that we all have. We know that the average person will spend approximately one third of their life asleep (36% to be exact). That means if you make it to the old age of 90, you will have spent just over 32 years of that senseless and paralysed (or so we think). Now what that tells us is that on some level sleep is important to us and yet for most of us we don't give sleep a second thought. However, our ignorance of sleep is quite profound, and we have started to treat sleep like the enemy. The way we perceive the importance of sleep in 21st century life is really quite fascinating.

For example, if we went out for a few drinks and I gave you your car keys, would you drive home? At the end of a long shift at work and I gave you your keys, would you drive home? In one of these situations, you will get arrested, in the other you will be thanked for your time and paid. Again, the answers to these questions tell us a lot about how we value sleep as a society and as individuals. We know that losing just two hours of sleep would make you behave and react in a way that is equivalent to being at the drink-drive limit. You would also see a 50% reduction in your reaction times.

Statistically, driving whilst tired is much more dangerous than driving whilst under the influence of alcohol and/or drugs. A recent study on drivers showed that those who were sleep deprived, compared to those who had an adequate night's sleep, were eight times more likely to be involved in an accident. Research also predicts that 30% of us will fall asleep at the wheel which is a serious concern. After only one night of sleep deprivation, people have episodes of sleep lasting a few seconds called micro sleeps. This is very much like daydreaming where we become disengaged from our surroundings and in some instances completely forget what we are doing.

Furthermore, research also suggests that people need to get at least four and a half hours of sleep each night (3 sleep cycles) as a minimum to be deemed as safe to work. Biologically, it would be a legitimate reason to phone in sick if we had less than that amount as it certainly wouldn't be safe to drive or work in a safety critical role. Technology has advanced so much that companies can now purchase devices that workers wear on their chest that indicate tiredness so the employee can be removed from the task before an accident happens.

Unfortunately, modern day society has created a perception that sleep is simply something that we can indulge in when we decide. There is also a perception that those who sleep longer are lazy. In fact, we play the 'who slept less' game – we aren't sympathetic when someone tells us they haven't slept. Instead, we try to beat them and say we slept less hours. I believe it is important for us to challenge

the modern-day perception that those who indulge in sleep are lazy. There is a lot that we can learn from these people as the health complaints associated with inadequate sleep cannot be underestimated.

Why do we sleep?

For those of you who have children, let me take you back to the moment your child came into the world. Imagine the doctor saying “congratulations you have a healthy baby. We have done all the routine health checks, and everything appears to be fine”. The doctor then heads for the door but turns round just before leaving and says “however, there is just one thing. From this moment forth, they will repeatedly and routinely lapse into a state of apparent coma. It might even resemble death at times. Although their body lies still, their mind will be filled with stunning memories and bizarre hallucinations. This state will consume one third of their life and I have no idea why he will do it. Good luck!”

Astonishingly, but until very recently, this was a reality. Neuroscientists still don't fully understand the reasons behind why we sleep and have many different conflicting theories. As a species we have understood the other three basic functions of human beings for hundreds of years – eating, drinking and reproducing – yet the fourth (sleep) continues to elude us. If we look at sleep from an evolutionary perspective, this only adds to the mystery. When you are asleep, you cannot gather food, you cannot socialise, and you cannot find a mate and reproduce, nor can you nurture or protect your offspring. And worse still, sleep leaves you vulnerable to predation. As such, sleep is still one of the most puzzling human behaviours. On these grounds, there should be a strong evolutionary pressure to prevent us from sleeping, yet sleep has persisted and so as such we can presume that it bestows huge benefits on those who indulge in it.

So when did life start sleeping? Without exception, every animal species studied to date sleeps, or engages in something remarkably like it. Sleep is universal. Many of the explanations for why we sleep circle around the common idea that sleep is a state that we enter in order to fix that which has been upset by wake. But if sleep is useful and beneficial to us as human beings then why did life ever bother to wake up in the first place? As the years have passed by, the demand for sleep has increased in order to tend to the needs of the brain.

Asking ‘why do we sleep’ implies that we are looking for a single reason, when in reality, we sleep to achieve a range of benefits that service both our brains and our bodies. There is not a single organ in the body, or process within the brain, that is not significantly enhanced by sleep and conversely detrimentally impaired if we fail to do so (see Part 3 of this booklet).

Changes in Sleep across the lifespan

Expecting parents will often thrill over the ability to elicit kicks and small movements from their unborn child. However, it is more than likely that the baby is fast asleep as in the foetal stage, they spend just about all of their time in a sleep-like state. A standard 24 hours inside the womb consists of 6 hours of NREM sleep, 6 hours of REM sleep and 12 hours of intermediary sleep. Any sensations the mother feels from the unborn child are likely to be the consequence of random bursts of brain activity during REM sleep. REM sleep is the fifth and deepest stage within our sleep cycle and is vital for brain

maturation. In the last 2 weeks of pregnancy, the foetus will ramp up its consumption of REM sleep to almost 9 hours a day. In the last week, the amount of REM sleep increases to a lifetime high of 12 hours per day and the foetus doubles its hunger for REM sleep just prior to entering the world.

Infants and young children tend to have several sleep phases and experience a number of sleep snippets throughout the day and night. The 24-hour clock that generates the body's circadian rhythm ('circa' meaning 'around' and 'dian' meaning 'day') takes a while to develop and not until the infant reaches 3 or 4 months of age will they start to show signs of being governed by a sleep-wake cycle. Slowly, the internal body clock begins to latch onto external cues such as daylight, temperature changes and feedings, which act as external cues and establish the 24-hour cycle. When they reach one year old, they will have fully developed their internal body clock and this means they will spend more of the day awake, interspersed with several naps, and more sleep at night. By the age of 4, the circadian rhythm becomes dominant in determining when the child sleeps, with a lengthy slab of night-time sleep frequently being achieved.

Sleep then becomes more problematic and disordered in older adults. The effects of certain medications more commonly taken by older adults, together with coexisting medical conditions, result in older adults being less able to obtain as much sleep, or as restorative a sleep, as younger adults. There is a misconception that older adults simply need less sleep which is simply not the case. Older adults appear to need just as much sleep as they do in midlife but are simply less able to generate that sleep. There are three key changes in adult sleep – reduced quality and quantity, reduced sleep efficiency and disrupted timing of sleep.

Let's explore the first of these key changes – reduced quality and quantity. As you enter your 40's you obtain fewer hours of deep sleep each night. In fact, as you transfer into your late 40's you will have lost approximately 60-70% of your total deep sleep that you were previously enjoying as a younger adult. By the time you reach 70 years of age you will have lost nearly 90% of this deep sleep. When we sleep at night, and wake in the morning, most of us do not have a good sense of the quality of sleep we have achieved. Frequently, this means that older adults progress through their later years not fully realising how degraded their deep sleep quantity and quality has become. This is important as it means older adults fail to connect their deterioration in health with their deterioration of sleep despite causal links between the two being made by scientists for many years. Adults therefore tend to complain about and seek treatment for their health issues when visiting their GP but rarely ask for help with their problematic sleep issues. Not all medical problems of ageing are attributable to inadequate sleep, but far more age-related physical and mental ailments are related to sleep impairment than many of us, and doctors, treat seriously.

The second hallmark of altered sleep as we age is fragmentation. The older we get, the more frequently we wake up throughout the night. There are many causes for this but one of the most influential is a weakened bladder as this results in more frequent trips to the bathroom during the night. Due to this fragmentation, older individuals will suffer a reduction in sleep efficiency – the amount of time you were asleep whilst in bed. As healthy teenagers, you will have enjoyed a sleep efficiency of approximately 95% and most sleep medicine specialists consider good quality sleep efficiency to be at 90% and above. By the time we reach our 80's, sleep efficiency has reduced to below 70% which sounds relatively good until you realise that this equates to approximately 90

minutes awake in bed per every 8 hours of aspirational sleep time. Research has shown that even when controlling for factors such as body mass index (BMI), gender, race, history of smoking, frequency of exercises and medications, the lower an individual's sleep efficiency, the higher their overall mortality rate, the worse their physical health becomes, the more likely they are to suffer from depression, the less energy they have and the lower their cognitive function. Any individual regardless of age will suffer the negative effects associated with inadequate sleep. However, the problem with ageing is that family members notice the symptoms listed above and immediately jump to a diagnosis of dementia, overlooking the possibility that bad sleep is an equally likely cause.

The final sleep change is the disrupted timing of sleep, leading to earlier and earlier bedtimes as we age. This causes an earlier evening release of melatonin instructing an earlier start time for sleep. What we find is that older adults want to stay awake later into the evening to enjoy social activities such as going to the theatre, reading, or watching television. However, they find that they awake on the sofa or in a theatre seat having inadvertently fallen asleep mid-evening. This increase in melatonin made them sleepier and in effect they had no choice. This type of innocent doze can lead to damaging consequences. The early evening snooze allows the sleep pressure (which has been building throughout the day) to be released meaning when the individual goes to bed later in the evening, they can't fall asleep as easily. So napping, not just in the evening, can be a source of sleeping difficulty eventually leading to insomnia. A compounding problem arrives in the morning. Despite having problems falling asleep the previous evening (thus generating a sleep debt) the circadian rhythm of the older adult means they will start to rise at approximately 05:00am – leading to the classic daytime schedule of early wakers in elderly adults. Making matters worse, the amount of night-time melatonin released tends to decrease as we get older, so all these factors add up to create a vicious cycle of wakefulness.

Self-identifying sleep

Let's create a scenario. You walk into your living room one night whilst chatting to a friend. You notice a family member lying still on the sofa, not making a noise, body recumbent and head leaning to the side. Immediately you turn to your friend and say "shhhhhh, they're sleeping". How did you know? Your response was instinctive and there was little doubt in your mind about the person's state. Why did you not think they were dead? Your immediate assessment was likely to be correct as over time we have become incredibly good at recognising several signals that suggests another individual is sleeping including the stereotypical sleeping position, lowered muscle tone and responsivity. But how do you know that you have personally slept?

You make this self-assessment even more frequently than that of sleep in others. When we get up each morning, we return to the waking world knowing whether we have slept and we start to make an assessment on the quality of our sleep. Firstly, this is determined by whether we lost consciousness with our surroundings. Although our ears are still hearing, our nose still smells, and our skin feels physical sensations. The thalamus, a central structure in the brain, only allows some sensory signals through to the brain. If this brain structure imposed a sensory blackout, we lose contact with our surroundings and we are asleep. Secondly is a sense of time distortion in which we lose track of time and the amount of time we have been asleep. If you have ever fallen asleep on a plane or train, you may wake and check your watch immediately. Why? Because you lost track of time while you slept,

and this feeling of a time cavity makes you confident that you have slept. But while conscious mapping of time is lost during sleep, at a subconscious level the brain continues to catalogue time with precision. If you have ever been in a situation where you had to be up the next morning at a certain time, maybe to catch a flight, before bed you diligently set your alarm for 06:00am. Miraculously, you found that you woke up in the morning at 05:59 unassisted by an alarm clock. It appears that the brain is still capable of logging time even when you are asleep. Conversely, clocks and other devices that tell us the time can cause frustration and issues with sleeping. As human beings, we always need to know what time of day it is, including during the night. When we are struggling to sleep, we wake up and immediately check the time which simply reinforces that we aren't sleeping. My advice...ditch these devices immediately and let your internal body clock tell you the time.

Some people with a certain type of insomnia are not able to accurately gauge whether they have been asleep or awake at night and as a consequence of this 'sleep misconception' they underestimate how much sleep has actually been obtained. So how do you know if you are routinely getting enough sleep? While a clinical sleep assessment is needed to thoroughly address this issue, as an easy rule of thumb is to answer these simple questions:

1. After waking up in the morning, could you fall back asleep at 10-11am? – If yes, you aren't achieving sufficient sleep
2. Can you function optimally without caffeine before noon – If no, then you are self-medicating your state of chronic sleep deprivation.
3. If you didn't set an alarm clock, would you sleep past your wake-up time?
4. Do you sit at your computer desk reading the same line of an email repeatedly, or find yourself struggling to concentrate on tasks?

The Sleep Cycle

As human beings, most of us cross the bridge between the conscious and unconscious on at least a daily basis. Yet we rarely give a second thought to the countless processes that occur within our bodies and brains when we are deep in slumber. It is essential for us to better understand the sleep process, and what happens biologically as we prepare ourselves for rest, in order to ensure that we get a regular amount of good quality sleep.

At this very moment, a chemical called adenosine is building up inside your brain and will continue to increase in concentration with every waking minute that elapses. The longer you are awake, the more adenosine you will accumulate. One consequence of increasing adenosine in the brain is an increasing desire to sleep. This is known as 'sleep pressure' and determines when you are sleepy and when you should go to bed. An irresistible urge to sleep will take hold and this tends to happen to most people after twelve to sixteen hours of being awake. During sleep, a mass evacuation gets under way as the brain has the chance to remove the day's adenosine accumulations. This process lifts the heavy weight of 'sleep pressure' and takes approximately eight hours of healthy sleep to complete this process in the average adult.

The sleep process occurs in 5 distinct stages and includes two different types of sleep – NREM (for restorative functions) and REM for processing memories and dreaming. For information can be found in Volume 1 – A Basic Introduction into the Neuroscience of Sleep. In stage one, we transition to sleep, and some people experience a jumping or falling sensation when they fall asleep known as a hypnic jerk. This is the brains way of waking you up as you are falling asleep too quickly and is a clear sign of sleep deprivation. The best sleepers tend to fall asleep within 20 minutes rather than straight away. As we move into stage two, we begin to become disengaged from our surroundings. Steg three is our deep sleep phase where we have no eye or muscle movements. A person is more difficult to awaken in this stage but may be prone to parasomnias such as sleepwalking, or bedwetting. Stage four is described as intense deep sleep and is our most restorative phase of sleep where tissue growth and repair occur, and energy is restored. The fifth and final stage is our REM sleep. Most dreams and nightmares occur during this stage. In effect, the body becomes paralysed and if a person is woken in this stage, they are likely to remember their dreams. REM sleep plays an important role in emotional venting and our mental health (See Part 3 below). However, we now also know that REM sleep is directionally proportional to your life span. In other words, the more REM we get the longer our life span. The shorter the REM sleep, the shorter our life span. There is a clear linear relationship.

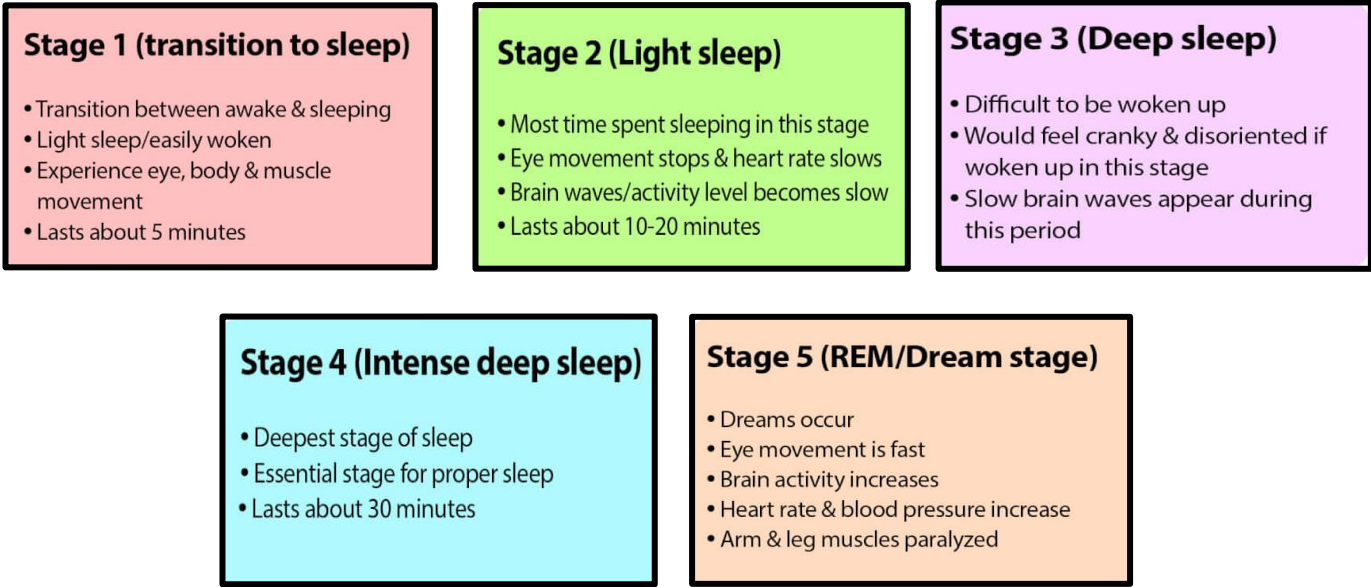


Figure 1: The five phases of sleep that constitute our sleep cycle.

These five stages of sleep form a single sleep cycle and the average person will have five sleep cycles in a single night. Each sleep cycle takes 90 minutes, after which we ascend back through the stages. It is believed that the reason we go from deep sleep back up to the lighter stages of sleep is thought to be because of our evolution as a species. It is suggested that, even though we are physically asleep during these periods of light sleep, we routinely scan the environment for unusual noises just to make sure that is safe to continue sleeping. This makes sense, as it would be unwise to progress into deep sleep, where we would be less responsive if a predator entered our cave.

Understanding our sleep cycle can inform us about two very important things. The first is determining how much sleep we need as a human being. We know that a human adult needs 7 ½ hours' sleep per night (5 cycles of 90 minutes = 450 minutes = 7 ½ hours). Anything shorter than this means we are not completing full sleep cycles which can be detrimental to our health and wellbeing. Remember that you cannot condition yourself to need less sleep contrary to popular belief as I have previously explained. The harsh reality is that as we get older, we unfortunately get less sleep due to an array of reasons, and our ability to sleep for long periods of time and to get into the deep restful stages of sleep decreases. Older people have more fragmented sleep and are more easily disturbed by light, noise, and pain. They also may have medical conditions that contribute to sleep problems and their sphincter in the bladder becomes weaker meaning more toilet trips.

The second thing our understanding of sleep tells us is why we are frequently waking during the night. For most people, this is typically around 03:00am. People worry that because they are waking up every day at this time that they have a sleep problem. This is not the case. This is all part of the body's natural sleep pattern as is being shown above. At 03:00am you are at your lightest sleep and so it is normal for a person to be awake at this time. For example, if we went to bed at 10:30 in the evening, we would have completed our first cycle by midnight, our second cycle by 01:30am and then our third cycle at 03:00am. As such, at this time we return back to our lightest phase of sleep and for most people this is the time when we go to the toilet. It is rare that people can sleep uninterrupted for long periods of time. However, if you wake up during the night and fail to fall back asleep within 20-45 minutes this is indicative of insomnia.

The brain has 2 centres involved in the sleep wake cycle – 'The Alertness Centre' – which keeps us awake, and 'The Sleep Centre' – which puts us to sleep. For the sleep centre to dominate the alertness centre we need to be tired, calm and relaxed, our brain not to be active and a quiet and dark environment, which is comfortable and the right temperature. These are the preconditions of sleep. External stimuli such as noise, light and worrying, activate the alertness centre of the brain and prevent us from sleeping. Furthermore, neuroscientists now know the exact location of the internal body clock within the brain structure, and it lies just behind the eyes in the area of the brain known as the 'Superchiasmatic Nucleus' - a bundle of neurons in the hypothalamus. This is known as our 'endogenous pacemaker' and regulates the circadian rhythm. We know this through studies on hamsters. When we remove this structure from Hamsters they stop sleeping altogether, and if we transfer the SCN from one species to another they develop the same sleep patterns as the donor. Although we have an internal body clock, this is regulated by exogenous zeitgebers – or light cues – and light exposure has a huge influence on regulating our sleep-wake pattern. Sources of light, including the sun or more artificial light sources, tell the body what time of day it is. Special photoreceptors in the retina regulate the effects of light on the body's circadian rhythms. When darkness falls, signals from these special photoreceptors are relayed via the optic nerve to the SCN which in turn informs the pineal gland (a cone shaped and light sensitive gland at the top of the brain stem – also referred to as our 3rd eye) to secrete melatonin. Melatonin helps us regulate our sleep pattern and builds sleep pressure making us feel sleepy. As melatonin in the blood increases, mental alertness decreases, and we eventually fall asleep. Melatonin levels begin to rise usually 2 hours before usual bedtime and this point is known as the 'sleep gate' or 'sleep onset zone'. This direct pathway from the light receptors in the eyes to the SCN has been identified in starting this biological process.

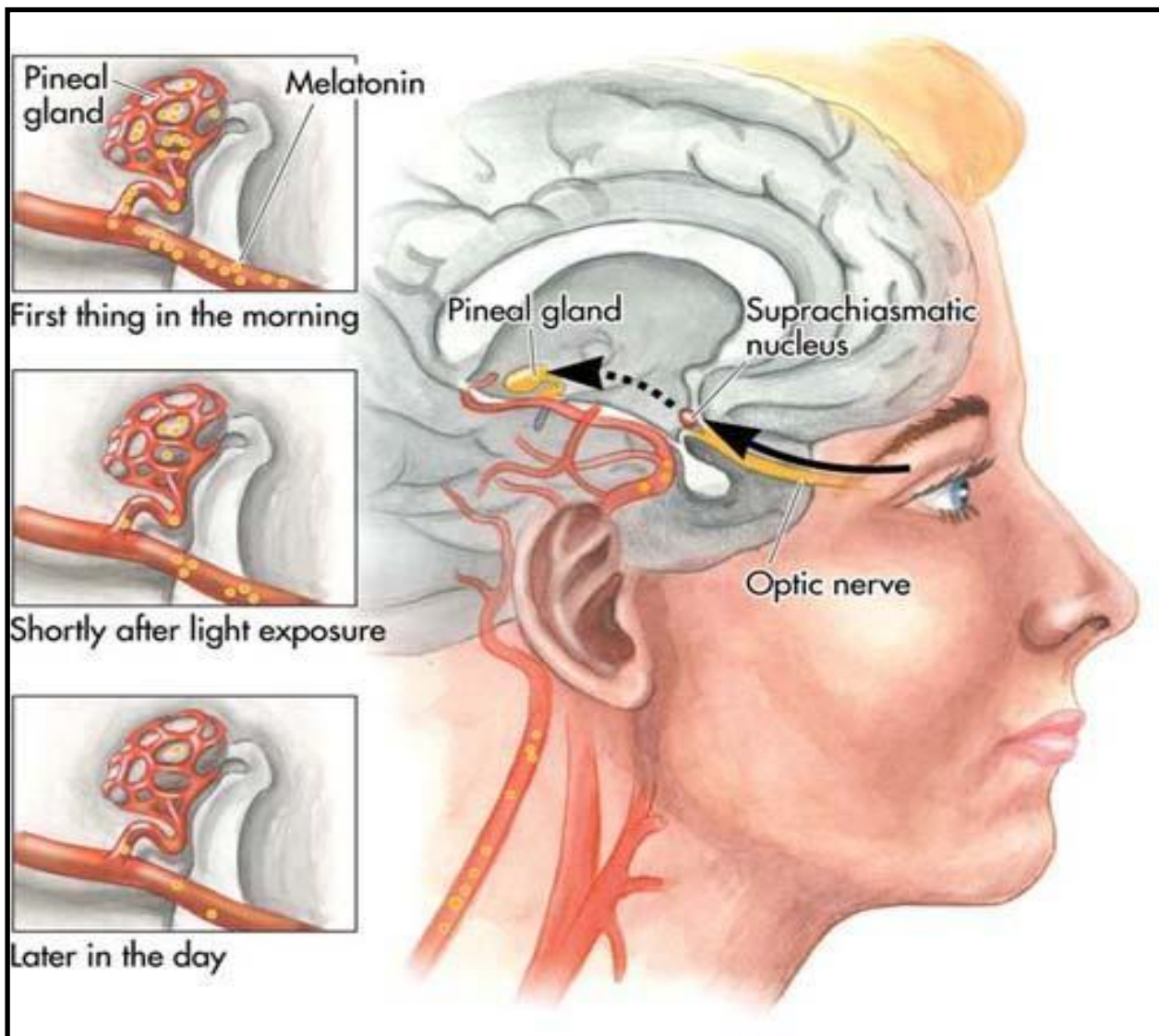


Figure 2: The SCN and pineal gland both play a pivotal role in regulating the body's sleep-wake pattern and regulate sleep pressure.

Daily exposure to bright light, especially sunlight, helps keep the body's circadian rhythms synchronized and operating on a 24-hour schedule. We know how light synchronizes our body clock due to a study conducted in 1972. Michel Siffre, a French cave explorer spent 7 months underground with no cues about the time of day. He lived his life underground under close watch of scientists. His only contact with the outside world was through a manned 24-hour telephone. He organised his life into normal pattern with alternate periods of activity and sleep. What scientists found was that he chose to live a 25-hour day. What I mean by this is that the length of time he was awake increased, and, on a few occasions, he was awake for 36 hours and slept for 14 hours as there were no external cues to inform him of the time of day. For each day that passed, he got up 1 hour later proving the clock in his brain was running a little bit slow. He eventually sat down to celebrate the new year with champagne and oysters but was unfortunately three days late.

The Impact of the COVID-19 Pandemic on Sleep

The COVID-19 pandemic has impacted our sleep in four main ways and has impacted sleep quantity, sleep quality, the timing of sleep, and our dreaming.

Following the COVID pandemic, people reported that they were sleeping a bit longer each night, between 20-25 minutes extra. This extra sleep has many benefits for health and has probably resulted from changes to our social and work schedules, with less of a rush to wake and commute each morning.

However, despite the increase in quantity, people have unfortunately reported a reduction in the quality of sleep being achieved. This may be due to the time that people are choosing to get to sleep. What we know about sleep is that as the night progresses the ratio of NREM to REM sleep reduces, that being that we experience a greater amount of REM sleep towards the end of our sleep. REM sleep is our deepest phase of sleep and is understood to have many benefits to human health. So, if you have a person who usually goes to bed at midnight and usually wakes up at 08:00am (but loses a couple of hours because they must make an early meeting for example), how much sleep have they lost? You will say 2 hours out of their usual 8 hours or 25% of their total sleep. You would be correct in part, but this doesn't tell us the whole story. In fact, they may have lost approximately 80% of their REM sleep because they haven't slept during the REM-rich phase of their night which we know is the most beneficial type of sleep. This also works another way in that the brain has an appetite for certain types of sleep. So, if you go to sleep at 04:00am and sleep all the way through the morning your brain loses its appetite for deep sleep because it prefers to get this in the early hours of the morning. This may be why people's sleep quality has reduced.

The timing of sleep has also been impacted by the pandemic. People are going to bed a little bit later but waking up significantly later and adding more sleep to their schedule. People don't have to commute and there is more freedom for 'night owls' to live in synchrony and harmony with their pre-determined chronotype. I mentioned chronotypes in volume one, but this is your natural propensity for being either a morning person or an evening person. Your chronotype will be hard wired into your genetics and you will either be an owl (someone who goes to bed late but struggles to get up in a morning), a lark (someone who goes to bed early and rises early in a morning), or an ambibenevolent (someone who doesn't really have a strong preference). Unfortunately, you cannot change your chronotype and in most instances our sleep habits replicate those of our parents. Although you may think your sleep habits have changed as you get older, the reality is that changes in your sleep schedule are being caused by our 'social jet lag' – the things we must do or enjoy doing in life – but our chronotype never changes. Consider our cultural sleep norms. Midnight is no longer 'mid-night'. For many of us, midnight is the usually the time where we consider checking our email one last time. We then do not sleep longer in the morning hours to accommodate these later sleep-onset times. We simply cannot do this as our early morning demands of a working life prevent us from doing so and denies us the sleep that we all vitally need. Owls typically try to go to bed early but because they are designed not to fall asleep at that time they will just lay in bed. Many owls think they have insomnia, but they don't. They are just going to bed at the wrong time. When I mentioned above about the impact of COVID improving sleep quantity and quality for people, it is the revenge of the night owls in that they can now go to sleep and wake up each morning at their preferred times. What is also interesting is that we kin-select people who have the opposite chronotype to ourselves as it is an

evolutionary choice. We need people to look after the chicks around the clock. If you were both the same there would be a time where the chicks are vulnerable. However, this creates a problem in relationships because we try to go to sleep at the same time as our partners even though we are not ready. If we do this over a long period of time this can lead to conditioned insomnia which it is why it is important to only sleep when you and your body are personally ready to sleep.

Finally, people have reported that they are dreaming more post-pandemic. This may be because people are sleeping later into the morning and are therefore pushing themselves further into the REM rich phase of their sleep cycle. Ultimately, they are getting more dream sleep.





Part 2

**The 'wellbeing trinity'
and the intimate
association between
sleep, diet, and exercise**

The 'Wellbeing Trinity'

Similar to the 'fire triangle', if we remove, or more appropriately, neglect one of these three key pillars we compromise our overall health and wellbeing.

Diet, exercise, and sleep are so closely related to each other that they form the three pillars of a healthy life. While improving just one of these lifestyle factors can help people lead longer lives, several recent studies have suggested that improving all three may be a better way to improve both physical and mental health. A good diet and regular exercise are the most potent sleep inducers and all three together is a prescription for good health. If you have trouble sleeping, consider your diet. Food items you eat can cause a poor night of sleep, such as too much sugar, alcohol, or caffeine. Including regular exercise helps you sleep soundly, and when you sleep well you tend to eat smarter. Examining these three aspects of your life—diet, sleep and exercise—to enable you to attain or maintain a healthy body weight and good health. Diet, exercise, and sleep influence one another in complex and innumerable ways. Learning about how these activities affect one another is an important part of understanding why research has shown that the more of these lifestyle behaviours you improve, the better your wellbeing.

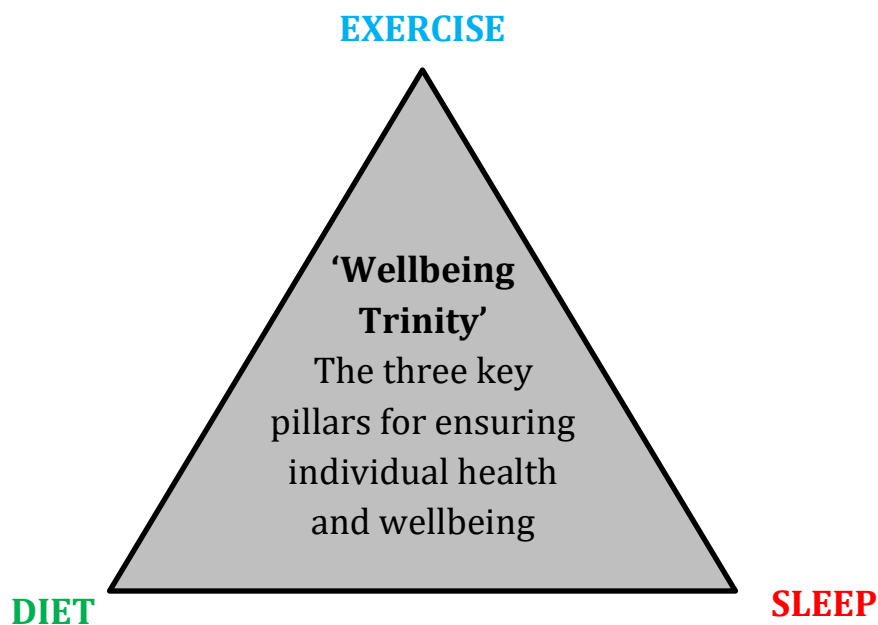


Figure 3: The 'Wellbeing Trinity' consists of three vital pillars of wellbeing – sleep, diet, and exercise.

Diet

Diet and nutrition affect virtually all aspects of our health. Eating a healthy, balanced diet has been shown to reduce the risk of a myriad of health conditions, from heart disease and stroke to diabetes and obesity. Diet can also affect our mental health with several studies suggesting that certain diets may reduce the risk of developing depression and anxiety. Food can either fuel or foil a workout, and research shows that combining a healthy diet with adequate exercise offers more benefits than improving diet alone. The right combination of fluids, carbohydrates, and protein, eaten at the right time, can improve athletic performance and decrease fatigue. Poor dietary choices, like eating right

before a high-intensity cardio workout, can lead to increased nausea and make exercise more challenging.

Foods that promote and hinder sleep

What we eat also impacts sleep quality and duration. There are four main vitamins and minerals that can be found in food that aid in promoting sleep. Some of these substances help the body produce melatonin – the hormone that is responsible for regulating your circadian rhythm. Tryptophan is an amino acid that when ingested gets turned into serotonin and then converted into melatonin. Foods that contain tryptophan include dairy products such as milk and yoghurt, poultry such as turkey and chicken, seafood including shrimp, salmon, halibut, tuna, sardines and cod, nuts and seeds including flax, sesame, pumpkin, sunflower, cashews, peanuts, almonds and walnuts, legumes including kidney beans, lima beans, black beans, split peas and chick peas, fruits such as apples, bananas, peaches and avocados, vegetables such as spinach, broccoli, turnips, asparagus, onions and seaweed, and finally grains such as wheat, rice, barley, corn and oats. Magnesium is often referred to as the ‘sleep mineral’ because it is a natural relaxant that helps deactivate adrenaline. A lack of magnesium can be directly linked to difficult going and staying asleep. Foods that contain magnesium include dark leafy greens such as spinach and kale, nuts, and seeds such as almonds, sunflower seeds, Brazil nuts, cashews, pine nuts, flaxseed and pecans, fish such as salmon, halibut, tuna and mackerel, soybeans, bananas, avocados and low-fat yoghurt. Calcium also helps the brain make melatonin. A lack of calcium can cause you to wake up in the middle of the night and have difficulty returning to sleep. Calcium rich diets have been shown to assist patients suffering from insomnia. Dairy products that contain both tryptophan and calcium are among the best sleep inducers. Sources of calcium include dark leafy greens, low fat milk, yoghurt, sardines, fortified cereals, soybeans, fortified orange juice, enriched breads and grains, green snap peas and broccoli. Finally, vitamin B6 helps convert tryptophan into melatonin. A deficiency in B6 has been linked with lowered serotonin levels and poorer sleep. A deficiency in B6 is also linked to symptoms of depression and mood disorders which can both lead to insomnia. The highest sources of B6 are, sunflower seeds, pistachio nuts, flaxseed, fish such as tuna, salmon and halibut, meat including chicken, lean pork and lean beef, dried prunes, bananas, avocado and spinach. More information on foods that promote, and hinder sleep can be found in my other guide titled ‘Food for Thought’. In summary, there are certain foods and drink that are proven to induce sleep such as kiwi’s, bananas, camomile tea, almonds, turkey, fatty fish, cheery juice, walnuts, and white rice. However, there are certain foods that hinder sleep such as spicy foods, foods that are protein-rich or fatty (as having too many calories or fats in your diet may make it harder to get enough sleep), caffeine, dark chocolate, and ice cream. Foods including cheese, chocolate, pickles, and tomatoes contain tyrosine which cause the brain to produce dopamine which stimulates. In addition, remember that eating too close to bedtime can lead to sleep disruptions.

Sleeping pills

As a side note about sleeping pills, these are blunt instruments that do not produce naturalistic sleep. Doctors and sleep hygienists will only recommend these for short term use and unfortunately people develop a dependency over time. Like any tablet or medication, the more that they are used, the less effective they become. Unfortunately, when you stop using them, you go back to the bad sleep you were having and develop rebound insomnia where sleep is even worse.

Consumption of water

Most people these days have become obsessed with consuming at least two litres of water each day. However, they forget that much of this water is contained within the food we eat. If your water consumption is impacting on how much you go to the toilet to urinate, particularly during the night, it may be time to consider water restriction. We know that the sphincter muscles in the bladder become weaker as we get older, and for those with incontinence issues it is advisable not to drink anything within two hours of going to bed. Remember that there is no need to drink so much water each day to stay healthy, especially if you have an issue with going to the toilet.

Alcohol

Scientists have found a link between alcohol and REM sleep. You may feel that alcohol puts you to sleep but it actually prevents you from having the REM sleep required to provide benefits to your health. Alcohol is in a group of drugs known as the sedatives and so sedates the body rather than putting you to sleep. People mistake sedation for sleep. Sedation switches off the firing of brain cells in the cortex which is not natural sleep. Alcohol activates the fight and flight region of the brain causing sleep to become fragmented and wakes us up frequently during the night. It can increase the amount of alerting chemicals released by the brain. In addition, alcohol is also a diuretic which means we are more likely to get up in the middle of the night for the toilet.

Mothers are warned not to drink alcohol during pregnancy. Mothers that drink alcohol whilst pregnant can cause the foetus to have its REM sleep inhibited and so as such, their brain does not develop at its normal rate which can lead to longer term learning difficulties and brain problems once born. In one study, scientists observed the foetuses of women who were alcoholics and found that the amount of foetal REM sleep was significantly lower than that of a woman who did not drink at all during pregnancy. But the odd glass of wine can't possibly have an effect, right? Wrong! A second study gave the pregnant women approximately 2 glasses of wine (the volumes were controlled) and compared the sleep patterns of their unborn child with those of mothers who drunk non-alcoholic fluids only. The study found that even a small amount of alcohol reduced the amount of time that unborn babies spent in REM sleep and also noted a reduction in breathing rate during sleep. Also worthy of note at this point is that almost half of lactating women consume alcohol in the months during breastfeeding. Alcohol is also readily absorbed into a mother's breast milk and the concentrations of alcohol in that breast milk closely resemble that in the mother's bloodstream. A 0.08 blood alcohol level (approximately the equivalent of the UK drink drive limit) in the mother will result in approximately 0.08 alcohol levels in breast milk). Many mothers know that once breastfeeding stops, their child is likely to fall asleep straight away. When they do this, they will go straight into REM sleep. A once-common myth was that the baby would sleep better after breastfeeding if the woman had consumed an alcoholic drink. We now know this to be scientifically incorrect. Several studies have fed infants breast milk containing either a non-alcoholic flavour, for example vanilla, or a controlled amount of alcohol. When infants consume the alcohol laced milk, their sleep became fragmented, and they suffered a 20-30% reduction in total REM sleep.

Caffeine

Can you recall the last time you woke up without the alarm clock reminder feeling refreshed, not needing caffeine? If the answer is 'no' you are not alone. Caffeine is notorious for making it more difficult to fall asleep and most health experts recommend avoiding caffeine prior to sleeping.

Most of us will try and mute our sleep signals by using caffeine to make us feel more awake and alert. Caffeine is not a food supplement, rather, it is the most widely used and abused psychoactive stimulant in the world. The consumption of caffeine represents one of the largest and longest unsupervised drug problems in the history of the human race. Caffeine – which is not only prevalent in coffee, certain teas, and many energy drinks, but also foods such as dark chocolate and ice cream, as well as drugs such as weight loss pills and pain relievers – is one of the most common culprits that keep people from sleeping.

At this very moment, a chemical called adenosine is building up inside your brain. It will continue to increase in concentration with every waking minute that elapses. The longer you are awake, the more adenosine will accumulate. One consequence of increasing adenosine in the brain is an increasing desire to sleep. This is known as 'sleep pressure' and determines when you are sleepy and when you should go to bed. Using a clever dual action effect, the high concentrations of adenosine simultaneously deactivate the wake-promoting regions of the brain and activate the sleep-inducing regions. As a result of this sleep pressure, when adenosine concentrations peak, an irresistible urge to sleep will take hold and this tends to happen to most people after twelve to sixteen hours of being awake. During sleep, a mass evacuation gets under way as the brain has the chance to remove the day's adenosine accumulations. This process lifts the heavy weight of 'sleep pressure' and takes approximately eight hours of healthy sleep to complete this process in the average adult (the same amount of time as the recommended number of sleep hours). Caffeine works by successfully battling with the adenosine to activate the wakefulness areas of the brain. Once caffeine occupies these areas, it does not stimulate them like adenosine. Rather it blocks and effectively deactivates the receptors, acting as a masking agent. By doing this, caffeine blocks the sleep signal normally communicated to the brain by adenosine. In effect, the caffeine is only tricking you into feeling alert and awake.

Levels of circulating caffeine peak approximately 30 minutes after consumption. However, what is problematic is the persistence of caffeine in the human body. In pharmacology, a drug's efficacy is discussed using the term 'half-life'. Put simply, this refers to the length of time it takes the body to remove 50% of the drug's concentration. Caffeine has an average half-life of approximately five to seven hours. So, if you have a cup of coffee after your evening meal (perhaps 19:00), 50% of the caffeine you consumed will still be active and circulating in the brain at approximately 1:30 in the morning. In other words, at 1:30 you are only halfway through the cleansing process of removing the caffeine from your system. As such, sleep will not come easily or be smooth throughout the night as your brain continues to battle against the opposing force of caffeine. For this reason, it is advisable that any individual suffering from a sleep problem does not consume caffeine after midday. Please also be aware that 'decaffeinated' does not mean 'non-caffeinated' as one cup of decaf contains 15-30% of the caffeine of a normal cup of coffee. Therefore, 3 cups of decaf equate to the same as a normal cup of coffee and will result in the same outcomes.

You may be thinking, “well I have 5 cups of coffee a day and I have no trouble getting to sleep”. In part that is true, but what we know about coffee is that, similarly to alcohol, it actually inhibits our ability to have restorative deep sleep and the amount of it we get in stages 3 and 4 of our sleep cycle. You can wake up the next morning not feeling refreshed, yet we don’t remember we have woken up during the night, so we don’t make the connection but nevertheless, we then reach for extra caffeine the next day. Not enough sleep may then lead to the use of caffeine and other stimulants to maintain wakefulness. This is a vicious cycle as these substances prevent us sleeping later in the day.

The ‘jolt’ of caffeine does eventually wear off. Caffeine is removed from the system by an enzyme within the liver which gradually degrades the caffeine over time. Some of us will have a more efficient version of the enzyme meaning we can rapidly remove the caffeine from our bloodstream and thus tend not to experience the sleep side effects regardless of the coffee we drink. However, others have a slower acting enzyme, and it takes far longer for their system to remove the same amount of caffeine and so find themselves more vulnerable to caffeine’s effects on sleeping. Age also alters the speed of caffeine clearance. The older you are, the longer it takes the brain and body to remove caffeine and the more sensitive you become in later life to caffeine’s sleep-disrupting influence.

If you are the sort of person who purposely tries to use coffee as a means of staying awake, you need to be prepared for the nasty consequence caused when your liver successfully evicts the caffeine from the body. This is a phenomenon known as ‘caffeine crash’. Your energy levels plummet rapidly. You find it difficult to function and concentrate. You may experience a strong sense of sleepiness again. This happens because the entire time that caffeine is in your system, the sleepiness chemical it inhibits (adenosine) continues to build up and your brain is not aware of this as the wall of caffeine is holding it back out of your perception. Once the liver dismantles the caffeine, you feel a vicious backlash and you are hit with a wave of sleepiness that you had experienced a few hours ago before you drank the coffee as the accumulated adenosine rushes back into the brain. Unless you consume even more caffeine to counteract this effect (which would start a dependency cycle) you are going to find it increasingly difficult to stay awake.



You may also feel that consuming caffeine allows you to remain productive, but this is not the case. In the 1980’s, NASA conducted an experiment on spiders by exposing them to different types of drugs (including LSD, amphetamines, marijuana, and caffeine) and then observing the webs they constructed. The researchers noted how strikingly incapable the spiders were in constructing anything resembling a logical or normal web when given caffeine, even compared to other potent drugs tested. This may indicate that although we believe that caffeine is keeping us focused and able to perform, it may be counterproductive.

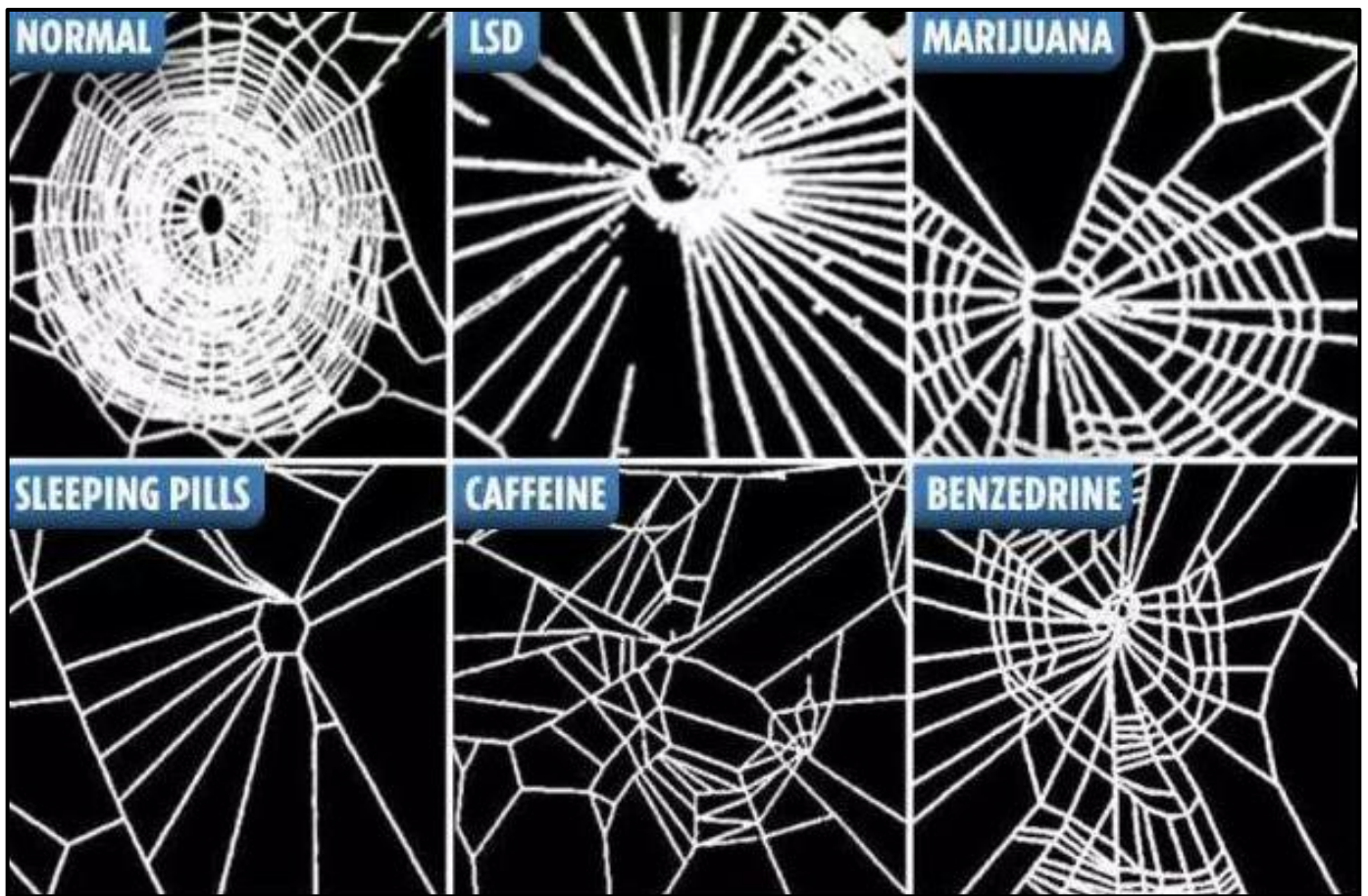


Figure 4: Notice that the ‘web’ does not resemble the normal construction when exposed to caffeine in comparison with other drugs and harmful substances.

Exercise

Exercise is a cornerstone of health and benefits nearly every system in the body. Many of the benefits are seen immediately, like reduced anxiety, lowered blood pressure, and better sleep. Consistent exercise offers even more long-term benefits, including better weight management, stronger bones, and a reduced risk of more than 35 diseases.

High intensity exercise decreases appetite, often for at least 30 to 60 minutes after finishing a workout. Physical activity can also help you feel more satisfied and fuller after a meal. Unfortunately, sedentary activities appear to have the opposite effect. Research has shown that people who spend more time watching television consume more calories and are more likely to be overweight.

A substantial amount of research has shown that getting regular exercise can improve sleep. Both aerobic exercise (like cardio and running), as well as resistance exercise (like weightlifting) can improve sleep quality. Any amount of movement may improve sleep, although younger people usually require more exercise than older people to see the same benefits. Usually, exercise in the afternoon or early evening helps with sleep. Exercise done just before sleep will increase stress hormones, which can worsen sleep problems.

Working out can also reduce the risk of sleep problems, like insomnia, obstructive sleep apnoea (OSA) and restless leg syndrome (RLS). Multiple studies have shown that exercise can reduce pre-sleep anxiety and improve sleep quality in people with insomnia. One study found that a 12-week regimen of aerobic and resistance training led to a 25% reduction in the severity of OSA, while also improving sleep quality and reducing daytime fatigue. A similar study in people diagnosed with RLS found that a 12-week exercise regimen reduced the severity of this condition by 39%.

Exercise is an activity that can facilitate or inhibit sleep quality. People who exercise experience better quality of sleep than those who do not but exercising too late in the day can be activating and delay falling asleep. 20 minutes of gentle aerobic exercise during the day releases endorphins into the body which make us feel good and ultimately sleep better. We know that simply walking for 30 minutes a day is the single most beneficial thing that you can do for both your mental and physical health. However, exercise should not be undertaken within 3 hours of bedtime as this stimulates the body and the mind, preventing sleep. Participating in 'wind-down activities' that reduce physiological arousal and cognitive activity will promote falling asleep and so engaging in relaxing activities before bedtime is recommended as this calms the body and mind prior to sleeping.

Sleep

Sleep offers the body and brain time to restore and recover, affecting nearly every tissue in the body. According to the National Sleep Foundation most adults need at least 7 to 9 hours of sleep, yet almost one third of Britain's are getting less than 6 hours per night. Sleep deprivation increases the risk of many health conditions like diabetes, heart disease, and stroke (which is covered in more detail in part 2 of this volume). Prolonged sleep deprivation can also affect concentration and other cognitive functions.

In terms of sleep and its impact on diet, we know that without enough sleep, people tend to overeat and choose unhealthy foods. Sleep deprivation affects the body's release of ghrelin and leptin, two neurotransmitters that tell our brain when to consume calories. People who are sleep deprived are more drawn towards high-calorie foods. Chronic sleep loss has been linked to having a larger waist circumference, and an increased risk of obesity.

In terms of sleep and its impact on exercise, sleep allows muscle tissue time to recover between workouts. Sufficient sleep is also important in having the energy to exercise. Not getting enough sleep can lead to being less physically active during the day and reduced muscle strength during workouts. Sleep deprivation can also affect the safety of exercise with increased sports injuries reported in those who are under slept.



Part 3

**The impact of sleep
deprivation on human
health**

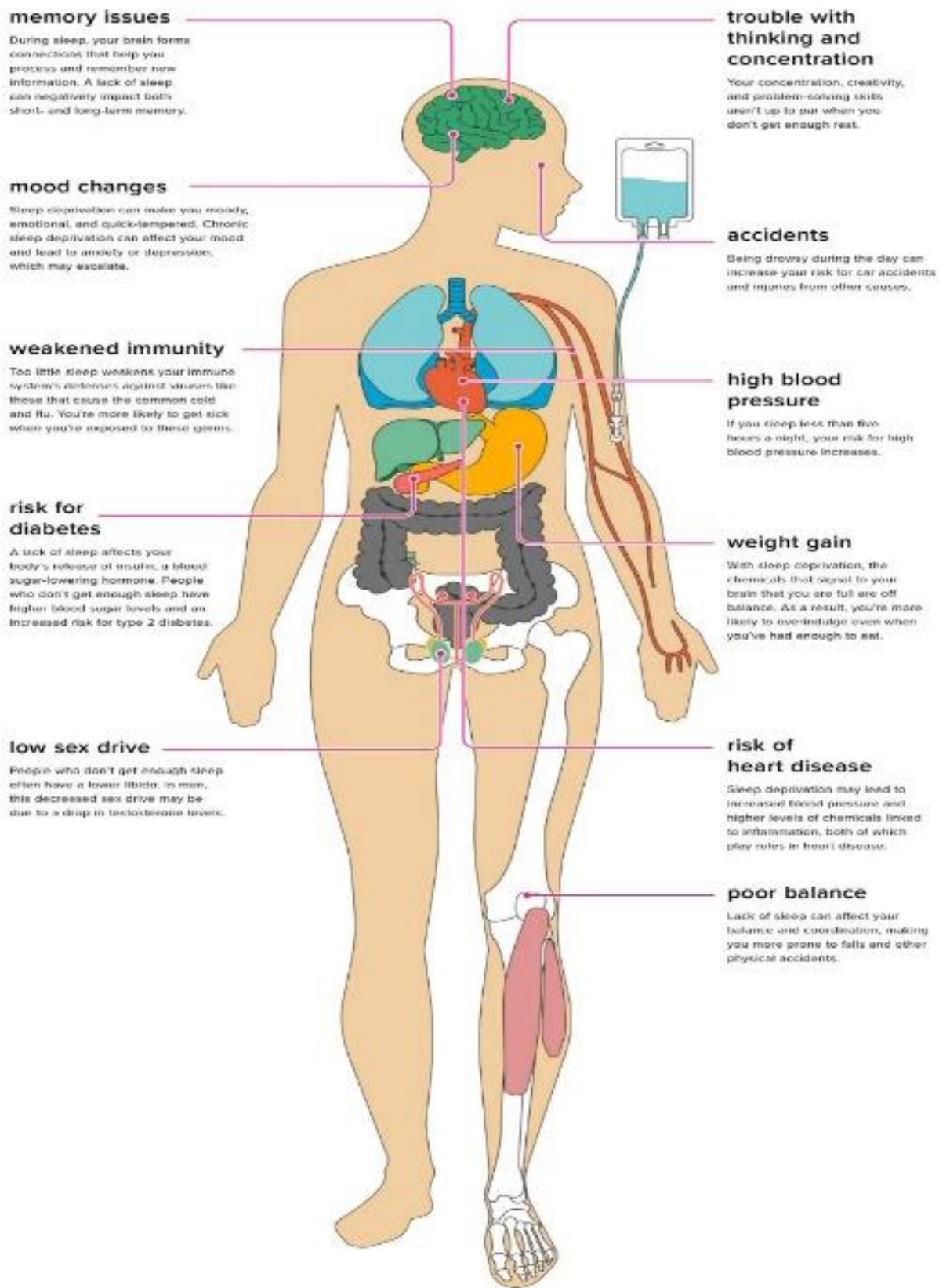
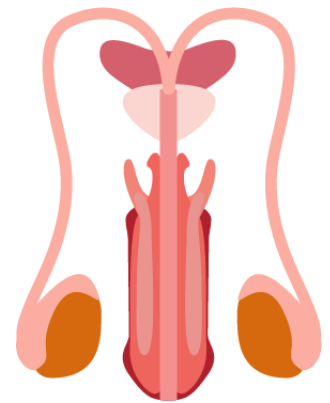


Figure 5: Inadequate sleep has a profound effect on all aspects of human health and wellness.

Sleep and reproductive health

Let's start with testicles. Men who sleep for only five hours a night have significantly smaller testicles than those who sleep for 7 hours or more. There is a massive 20% reduction which also affects a male's fertility. In addition, men who routinely sleep between 4-5 hours per night will have a level of testosterone equivalent to that of someone ten years their senior. Because of this, a lack of sleeping will age a man by a decade in terms of that critical aspect of wellness. We also see equivalent impairments in female reproductive health caused by a lack of sleep.



Sleep and our weight

The next aspect of wellness impacted by our sleeping habits is our weight. People think that sleeping longer makes you gain weight when in reality, we experience the opposite. Getting just one hour of extra sleep per day means you can burn up to one pound in weight over the week. Perhaps you have noticed the desire to eat more when you feel tired? This is no coincidence. Sleep regulates our appetite, helping control body weight through healthy food selection rather than rash impulsivity for junk food. Conversely, if you don't get enough sleep your leptin levels spike as your body craves the energy lost through not sleeping.

Little sleep swells concentrations of a hormone that makes you feel hungry while suppressing a companion hormone that signals food satisfaction. Despite being full, you still want to eat more. It is a proven recipe for weight gain in sleep deficient adults and children alike. Running low on rest can increase the production of ghrelin, also known as the hunger hormone, in your gut. Too much ghrelin makes your body crave fatty and sugary foods so conversely, we actually put on weight when we don't achieve adequate sleep. When you're not sleeping properly you tend to eat more of what you're craving because you're not feeling the signals to stop eating. Furthermore, should you attempt to diet but don't get enough sleep whilst doing so, it is futile, as most of the weight you lose will be from lean body mass rather than fat. What we also know from research is that those who have less than 7 hours have an increased chance of becoming diabetic or could potentially already be pre-diabetic. After just one week of short sleep, your blood sugar levels are disrupted so profoundly that if you were tested by a doctor, they would be classified as being pre-diabetic. Research has shown that the beta cells in the pancreas that detect high levels of glucose in the body and trigger the release of insulin stop working.



Sleep and its impacts on memory and learning

Sleep has a huge impact on our health from the perspective of your brain and its functions of learning and memory. There is a perception that when we sleep our brain rests in some way and becomes inactive. This is false and it is more active when you are asleep than when you are awake as it undergoes vital maintenance and consolidates memories. We know that we need sleep after learning to essentially hit the save button on those new memories, so we don't forget things. But we are now learning more and more about the importance of sleep before learning to prepare our brains (like a dry sponge) ready to soak up

new information. Without sleep the memory circuits of the brain become waterlogged and we become unable to absorb new memories. In one recent study, researchers placed two groups of people – those who got 8 hours sleep and a sleep deprived group - into an MRI scanner and monitored their brain activity to determine their ability to learn a group of facts. What they found was that the sleep deprived group had a 40% deficit on their ability in comparison with the control group. In essence, that is the difference between passing an exam with top marks and failing it miserably.

The hippocampus (a central region of the brain) is like an informational inbox. It is good at receiving new memory files and holding on to it. When we look at this structure in the brain for those who have a full 8 hours you will see healthy learning related activity. In those who are sleep deprived you won't see a signal altogether. It's almost as if sleep deprivation shuts down the memory inbox and any new information is bounced right off. Neurologically, when we are in this state, we cannot commit new information to memory.

Alternatively, what is it about the physiological quality of your sleep when you get it that restores and enhances learning ability? Well, we have big powerful brain waves when we experience the deepest stages of sleep known as 'sleep spindles' which are spectacular bursts of energy. These act as a file transfer mechanism at night shifting information from short term memory (where they could be lost) into long term memory. In effect, this hippocampus acts like a secretary to tidy up the office of memories in our mind. Every thought we have creates a piece of paper that needs to be filed. Recent research suggests that the average person will have 32,000 memories each day – some are important, and some are not. The brain gets rid of our trivial memories that are not important to us. If something disrupts our sleep in the night, our ability to do this is reduced and so we become dysfunctional the next day. As a result of this research, neuroscientists have now moved this sleep research around memory into the context of aging and dementia (see below).



Sleep and the risk of developing Dementia and Alzheimer's

It is no secret that as we get older our learning and memory abilities begin to fade and decline. A physiological signature of aging is that as we get older our sleep unfortunately gets worse, particularly the deepest quality of sleep. Age and sleep quality are not just co-occurring factors; they are significantly interrelated. It suggests that the disruption of deep sleep is an underappreciated factor that contributes to cognitive decline, particularly related to dementia and Alzheimer's disease. This may be why Margaret Thatcher, who said "sleep is for wimps" after boasting about only getting four hours of sleep per night, developed the disease in her later years as she routinely neglected her sleep.

We now know that sleep flushes the toxins in the brain built up during wakefulness from our system. This is done by the glymphatic system in the brain. Research has shown that this cleansing system

does not work 24 hours a day but rather becomes activated during sleep. One of these toxins is particularly interesting – beta amyloid. This is a protein that builds up throughout lifetime and build ups are linked to plaque accumulations in the brain which are predictive of cognitive impairment and are a tell-tale sign of both Alzheimer’s disease and dementia. Researchers believe that these plaques in the brain may occur years before symptoms emerge.

Scientists are currently developing a method called ‘direct current brain stimulation’ which involves administering small voltages into brain which are unrecognisable but have a measurable impact. What they have found in younger healthy adults is that if they apply this stimulation during sleep, we can amplify the size of the deep sleep brain waves doubling the amount of memory benefit. Scientists are seeing if this can be translated into older adults, and specifically those with dementia, to restore some healthy quality of deep sleep and in doing seeing if they can salvage parts of their memory function.

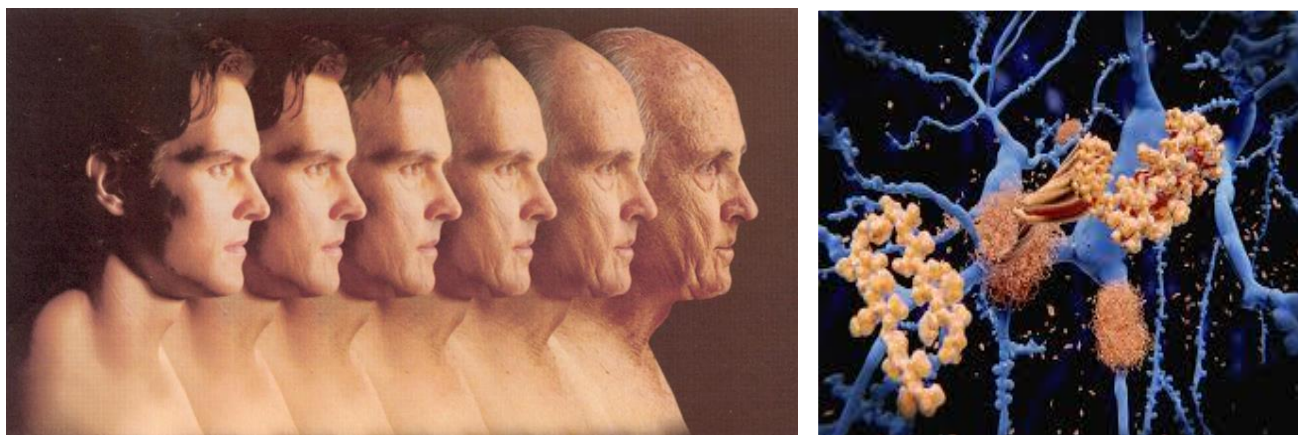


Figure 6: Cognitive abilities naturally decline over time as we get older. Accumulations of Beta-Amyloid protein (shown on the right) in the brain are predictive of dementia and Alzheimer’s.

Sleep and mental health

E. Joseph Cossman said that “the best bridge between despair and hope is a good night’s sleep”. Neuroscientists are learning more and more that sleep plays a huge part in a person’s mental health and is essential for stabilising your emotional state. Neuroscientists know that over the past 20 years they have not been able to discover a single psychiatric condition in which sleep is normal. That by itself tells us something profound – there is an intimate association between your sleep health and your mental health.

REM sleep, which is our dream sleep, provides a form of overnight therapy. Dream sleep is emotional first aid. During this phase of sleep the brain takes the difficult, traumatic, and painful experiences during the day and acts like a nocturnal soothing balm taking the sharp edges of those experiences so when we wake the next day they don’t seem as emotional anymore. So, in effect, it isn’t ‘time that heals all wounds’, its actually ‘time during REM sleep’ that provides the first form of emotional healing. REM sleep also involves emotional venting. For example, the guy that cut me up on my drive to work, I can pull him out of the car and punch him in the mouth without being arrested. Or we can scream in the boss’s face without getting fired. It is all about venting the stresses that we have experienced in our lives and processing out the trauma of when we are awake. If we can do this each

night, then we can wake and have strong emotional wellbeing. As such, we need to have REM each night. Conversely, a lack of sleep makes us irrationally emotional and hyperreactive. MRI scanning of sleep deprived persons has found that the amygdala gland at the base of the brain, a central structure that generates strong emotional reactions, is 60% more reactive than in those who get a full night's sleep. We see an overactive fight and flight response in people who don't sleep. Cortisol naturally drops near bedtime but what we see in people who don't get enough sleep, or who are inherently stressed, is that cortisol levels start spiking in the evening preventing sleep. If we can settle this down, then we are definitely on a better path towards a good night's sleep. This is a neurological signature in the brain that is not too dissimilar to numerous psychiatric disorders and in fact inadequate sleep is fast becoming a significant predictor of conditions such as anxiety, depression, and suicide.



Figure 7: The amygdala gland is a central structure in the brain responsible for our innate stress response to external stimuli.

Sleep and our cardiovascular health

Inadequate sleep also affects our cardiovascular system and all it takes is one hour of sleep either way. There is an experiment performed on 1.6 billion people across 70 countries twice a year and that is called 'daylight savings time'. In the spring when we lose an hour of sleep, we see a 24% increase in heart attacks that following day. In the autumn when we gain an hour of extra sleep, we see a 21% reduction in heart attacks. Isn't that incredible. We also see the same profile for car crashes, strokes, and suicide rates. This is how fragile our brains and bodies are when it comes to sleep loss.

Furthermore, people who get less than 6 hours per night have a 50% increased chance of developing or dying from heart disease or another similar condition and a 12.5% increased chance of dying before the age of 65. Short sleeping also increases the likelihood of your coronary arteries becoming blocked and brittle, setting you on a path towards cardiovascular disease, stroke, and congestive heart failure. Sleep, particularly deep sleep, is the best form of natural blood pressure medication you could wish for.

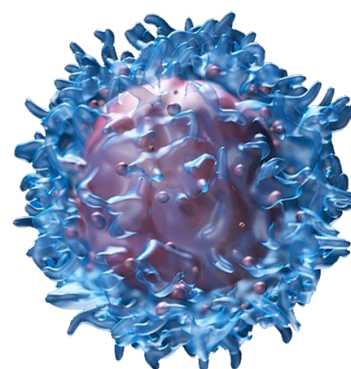


Figure 8: 'Daylight savings time' has a profound impact on cardiovascular health for at least 1.6 billion people.

Sleep and our immune system

There is a very intimate association between our sleep health and our immune health. For example, we know that individuals reporting less than 7 hours of sleep per night are three times more likely to develop the common cold. When we get ill all we want to do is curl up in a ball and go to sleep. In effect, we are trying to sleep ourselves well. The body tries to put us to sleep to focus on healing when it identifies an unwanted intruder, such as a virus or infection, that is harming us in some way. Cytokines are released by the immune system, which promote sleepiness.

In adequate sleep also affects our levels of natural killer cells in the body. The blue elements in the image shown on the right are called natural killer cells. You can think of these almost as if they were the secret service agents of your immune system. They are very good at identifying dangerous unwanted elements in your body and eliminating them. In fact, what is being shown here is them destroying a cancerous tumour mass within the body. We should hope to always have a virile set of these immune assassins but tragically this is what we don't have if we aren't sleeping enough. In a recent study, when researchers reduced the quantity of people's sleep to four hours, they found a 70% reduction in natural killer cell activity creating immune deficiency. That is a concerning



state of immune deficiency. This may be why people who sleep less than 6 hours a night double their risk of developing cancer. There is a significant link between short sleep duration and the risk of developing various forms of cancer including bowel, breast, and prostate. The link between inadequate sleep and cancer is now so strong that the World Health Organisation (WHO) have classified any form of night-time shift working as a probable work-related carcinogen because of a disruption of your sleep-wake rhythms.

Another study revealed that those who slept for only 4 hours before having a flu vaccination actually produced less than 50% of the usual anti-body response in comparison to those who had a full nights sleep beforehand. This may suggest that sleep deprivation renders vaccinations far less effective consequently. During sleep at night, particularly deep sleep, the body restocks its defensive immunity weapons. This research is now being extended to determine the effectiveness of the COVID vaccine.

Sleep and its impacts on our DNA genetic code

As if all of the above wasn't bad enough, a lack of sleep will even erode the very fabric of biological life itself. Your DNA genetic code.

In a recent study, researchers subjected people to only 6 hours of sleep for one week and monitored the genetic activity in the persons DNA. What they found was that a sizeable 711 genes of DNA were distorted in their activity due to a lack of sleep. 50% of these attributed to a reduction in a person's immune system ability (supporting the research above regarding the association between sleep deprivation and immune deficiency), whilst the other 50% increased their activity on things such as tumour promotion, long term chronic inflammation within the body, and genes associated with stress and, as a consequence, cardiovascular disease.

Hopefully you can see that there is simply no aspect of your wellness that is not affected by inadequate sleep. It is very much like a burst pipe at your home - sleep loss will leak down into every aspect of your health and physiology, even tampering with your very DNA which spells out your health profile.



Figure 9: Inadequate sleep will negatively impact on our genetic code, and in turn, our wider health.



Part 4

**Unlocking the secrets
to a better night's sleep**

Improving your sleep

So, after all that depressing news you are probably thinking, “well how can I improve my sleep?” There are several scientifically sound tips which are fundamental for unlocking the secrets to a good night’s sleep. What I will say is that if you are suffering from a sleep disorder, maybe insomnia, these tips might not help you. If I was a sports coach, I could give you a lot of tips to improve your performance but if you have a broken ankle, they aren’t going to make much of a difference. We must treat the ankle first before we can get back to improving the quality of performance. The same applies to sleep. It is always best to seek further advice from a GP or sleep hygiene professional for any long-term issues. Further detail and additional tips for achieving a better night’s sleep can be found in my other guide – ‘*how to get a good night’s sleep*’.

Strive for sleep during a ‘dip’

One of the key reasons people develop insomnia is through frustration. We try to force ourselves to sleep which is counterproductive. People don’t have a good understanding of their sleep process or what we refer to as ‘sleep dips’. As part of our circadian rhythm, as human beings we have a sleep peak and a sleep dip every 45 minutes (this forms our 90-minute cycle). This also applies to hunger, urine production and other biological functions. It is important to work out when you are having a sleep dip and try to sleep during this time. We know that after every 90 minutes we will begin to feel sleepy. A key behavioural indicator of a sleep dip is yawning, and we can track the best time to achieve sleep by noticing when we yawn in the evening and then trying to sleep every 90 minutes afterwards. Some people will even keep a yawn diary to assist them in identifying their dips, helping them to dictate when the best time is to go to sleep. The advice is straightforward - catch your dips, get to sleep quicker. Trying to force yourself to sleep when you are experiencing a ‘peak’ of arousal is simply futile. In this stage we are experiencing biological wakefulness and it will not happen. It is about being patient for 45 minutes and waiting for your next dip. Keep calm and relaxed and try a relaxing activity.

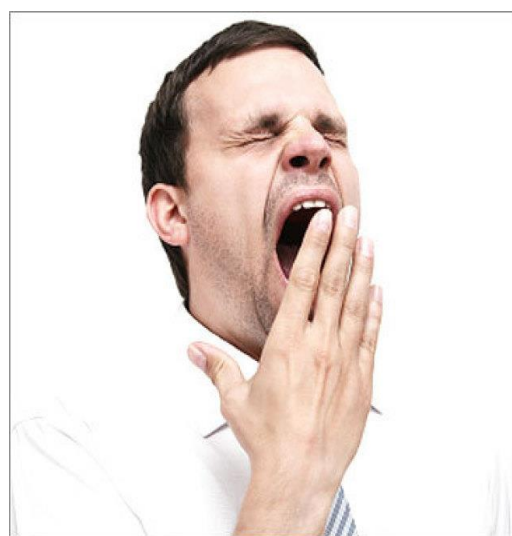
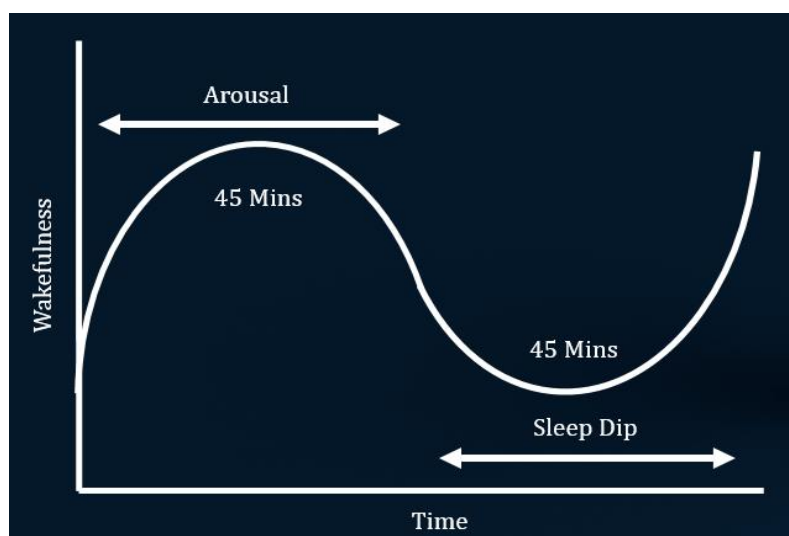


Figure 10: We experience a sleep ‘dip’ and then a sleep ‘peak’ every 45 minutes as part of our natural circadian rhythm. Yawning is a fantastic behavioural indicator of tiredness.

Regularity

The next scientifically sound tip is establishing regularity in our sleeping routine. Humans are creatures of habit, so it is important that you go to sleep and get up at the same time every day, including weekends. We have one body clock – not one for weekdays and another for the weekend. Sometimes we experience the ‘Monday morning blues’ because the body is crying out for the extra hours you gave it over the weekend. Our ‘social jet lag’ causes us to behave in this way, but a regular routine sleep schedule is important.

Sleep is not like going to the bank. What I mean by that is you can’t keep going to accumulate a debt and then hope to pay it off later down the line. For example, you may have found yourself dosing off in a meeting and thought it was because it was boring, or because the room was too warm. This is not the case. The reality is that you are sleep deprived. I previously mentioned microsleeping or daydreaming as it is more commonly referred to as, where your body is crying out for just a few extra moments of rest as is an indicator of sleep deprivation.

It is also important not to try and catch up on lost sleep by sleeping longer. This may seem counter intuitive but actually when the clocks go forward or if you have a bad night’s sleep, your best course of action is to do absolutely nothing – don’t go to bed early and certainly don’t have a nap. What we know is if an individual pulls an all-nighter and loses approximately 8 hours sleep, when we measure them over the next few nights, they do sleep longer and also sleep longer in the deeper phases of sleep, but they never get back the sleep they have lost. This is the same for doctors and other similar professions. When they work a 72-hour shift, they don’t then sleep extra hours the following night. The brain self-adjusts the type of sleep it is getting and places us in the deepest and most restorative phases of sleep for longer – this is known as REM rebound. The same self-adjustment process is also seen in patients who suffer drug overdoses, and they experience prolonged REM to improve and repair their brain.

If we can keep a regular sleep routine, we can begin to train the brain to give us melatonin at night to make us sleepy, and then cortisol in the morning to stimulate arousal and wake us up. Cortisol is the stress hormone, which is why when we are stressed, we struggle to sleep because it stimulates arousal in the brain. In establishing this routine, and embedding it into practice, I want you to think about babies. If you want to get your baby to sleep you will give it a good meal, then give it a bath or shower before bed to reduce the core body temperature, read them a book and take them to a room that is dark, comfortable, quiet, and cool and then repeat this pattern on a daily basis. However, we forget about ourselves and fail to behave in the same way when it comes to our own pre-sleeping habits.

Napping

Most people aim to get their 7 ½ hours’ sleep in one long stretch. This is known as monophasic sleep – a single bout of sleep at night. But we may not necessarily be programmed to sleep in this way.

You may feel a drop in alertness in the early afternoon. This is not due to the big lunch you had eaten. Instead, this is hard wired and affects all humans. As part of our circadian rhythm, we experience a ‘2 o’clock trough’, also referred to as the ‘circadian trough’. This may actually indicate that we were

designed to sleep in a bi-phasic pattern. This is to do with the body clocks circadian cycle telling you that you need a break and automatically wants to take a nap in the afternoon because you got up early for work. Your core body temperature falls at this time signalling the brain to release melatonin, making you feel sleepy. This is the optimum time to take a nap if you can.

After a bad night's sleep, naps can be useful to recharge. Napping is beneficial to us in terms of our health and cognitive functioning and can help us get through the day. However, if we are going to indulge in it then we need to do it properly understanding our sleep processes. Through a greater understanding of our sleep cycle, we know that after 20-30 minutes we end up in deep sleep and so when we then wake, we feel groggy (resulting in lower performance) and actually feel worse than when we went for a nap. It is always best to have two 10-minute naps or one long nap no longer than 20 minutes. Alternatively, if you would like a longer nap on a weekend, it is better to have a full cycle of sleep – in other words a 90-minute nap – to truly get the greatest benefits from napping.

Towards the turn of the millennium, there was an increasing pressure to abandon siestas in Greece. A team of researchers decided to quantify the health consequences of this radical change in cultural practice by observing 23,000 Greek adults over a 6-year period. None of the individuals had a history of coronary heart disease or stroke at the start of the study. However, the researchers found that for those who abandoned regular siestas went on to suffer a 37% increased risk of death from heart disease compared to those who engaged in afternoon naps. The effect was particularly strong in manual workers who's risk of early death increased by over 60%. Interestingly, some of the smaller Greek islands who frequently nap are 4 times more likely to reach the age of 90 than the average adult.

If we use an analogy, sleeping is similar to food in that the longer we go without food, the hungrier we get. If we have a large breakfast, that will impact on our hunger at lunchtime so we may miss that meal but we will be hungry at teatime and so we eat again. But if we had a buffet at lunch, that is likely to affect our hunger at teatime. So, in other words, if we have a long nap at lunchtime are we going to be able to sleep later in the day? Probably not. That is why napping should be avoided for anyone who has bouts of insomnia, particularly those who struggle to get to sleep late at night.



Light exposure

There has been extensive research on the impact of blue light emitted from electronic devices and the adverse impact such devices have on our sleep. The issue is not so much to do with the blue light that these devices emit, but more about how activating and engaging they are. These devices are stimulating, and can sometimes be stressful, causing us to activate our stress response and release cortisol which promotes wakefulness. I previously discussed the importance of diet in terms of the food and drink we consume, but the use of electronic devices contributes to our mental diet which is incredibly important. It is more than likely that these devices are simply masking our tiredness. I would predict that if there was a nationwide blackout and you could no longer use these devices late at night, after ten minutes or so you would say “actually I do feel tired”.

Technology is too smart for our biology. All of you will have a wonderful device held on your person at all times – the mobile phone. They are fantastic. They allow your boss to come into your bedroom at 10:00pm at night and tell you that the deadline has changed for tomorrow’s report. They allow your friends to tell you about the amazing food they have just cooked for their tea. Technology is great for keeping everyone and everything available to us. But this is counterproductive for sleep.

It is important to cut out light sources before bed, particularly blue light devices. We live our lives in conditions of artificial light. One of the last things we will all do before going to bed is brush our teeth in a brightly lit bathroom. Even when we get up for the toilet during the night, many of us will reach for the light switch and illuminate our path to the bathroom. Both practices tell the brain that it is time to get up and the light levels in our environment will immediately reduce the melatonin levels in our body promoting wakefulness. As a result, we then return to bed and struggle to get back off to sleep. It is therefore recommended that you reduce light exposure at least 30 minutes before bed.

It is also important to use natural light, particularly early in the morning, to synchronise the body clock. We measure light levels in lux. In indoor environments, such as an office, we are getting between 300-500 lux of light exposure. However, outdoors on a nice day in the UK, we are exposed to 50000-60000 lux. Even on the cloudiest day in the UK we would get 3000 lux which is ten times greater than indoor environments. Doing things outdoors, particularly walking as I have previously mentioned, is a great sleep intervention. Have you ever been for a day at the seaside and then said - “I’ll have a good night’s sleep tonight because of that sea breeze” – it’s not the air, it’s the light.

Sleep Hygiene

Do you sleep better in a hotel room or at home? This basic assessment may indicate whether your sleeping environment is appropriate for inducing sleep. The concept of sleep hygiene has been in the public domain for many years now and there are many online assessments available to you to assess your sleeping habits looking at five key areas – our thoughts towards sleep, our sleeping environment, our behaviours in terms of the things we do before going to bed, exercise levels, and diet. More information on these five factors can be found in Volume one.

In terms of the optimum sleeping temperature, we know that we need to drop our core body temperature by approximately one degree centigrade to fall asleep and then stay asleep throughout the night. This is one reason why we often struggle to get to sleep in a room when it is too hot but find

it much easier to induce sleep when it is colder. A cold room takes us in the right thermal direction for good sleep. The ideal sleeping temperature is somewhere between 15-18 degrees centigrade.

Our sleeping position even dictates the quality of sleep we achieve. Although individual preferences play an important role in choosing sleep position, the side position seems to be linked to highest quality of sleep. Setting up our sleeping environment to induce sleep is important. The recent shift to hybrid or home working has resulted in many people setting up workstations in their sleeping environment which is not recommended. Keep your bedroom tidy as even when the eyes are closed the brain still scans the sleeping environment. A messy room is a messy mind. Research even suggests that the paint on our walls has an impact on our sleep. Blue colours calm the nervous system, green colours reduce stress, white colours minimise distractions, beige colours create balance, and pink colours may even contribute to lower blood pressure. It is important to get a mattress that suits you and if you have a tendency to steal the duvet in the night, make sure you get two or an extra-large one. If you can bend your pillows in half that indicates that the pillow is dead and needs replacing. Men have tendency to keep the same pillows for long periods of time and if they are not suitable, then long-standing sleep problems may persist until these are replaced accordingly. It is also important to consider our behaviours and understand what we can do before going to bed to stimulate sleep. Having a bath or shower before bed reduces our core body temperature which is what happens naturally when we fall asleep and so induces a state of sleep. It is important to avoid taxing tasks before bed such as work, sudoku's or crosswords and these stimulate the brain and keep us awake. Although exercise is beneficial for health, and sleep more specifically, we should avoid exercising a few hours before we go to sleep as this creates an active metabolism which actually prevents sleep. Finally, don't allow pets to sleep in the same room as you whilst sleeping. Most pets are either nocturnal or have different sleep-wake patterns to humans and so they are awake when we are trying to sleep which may prevent sleep from being achieved.

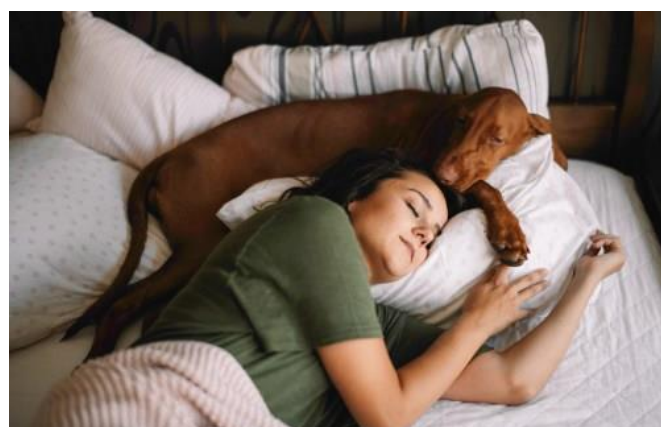


Figure 11: Good sleep hygiene is one of keys to achieving a better night's sleep. Although our furry friends are great companions, its probably best to keep them out of our sleeping environment.

Conditioning

In the 1890's there was a Russian behavioural scientist called Pavlov. Pavlov had some dogs, some bells, and some meat. Every time he rang the bell the dog would get some meat and that would make the dog salivate. With enough pairings of the stimulus (the bell) with the reward (the meat) he could make the dog salivate simply by presenting the bell. Whether you like it or not, you are an animal. So, you can train yourself behaviourally in this way as well – either positively or negatively.



Figure 12: Through ‘classical conditioning’ Pavlov was able to demonstrate that animals (and humans) can be conditioned to respond in a certain way to stimulus in their environment.

From a sleep perspective, as human beings, if we start to associate the bedroom with not sleeping, then every time we enter this space unfortunately sleep will not be achieved. This reiterates the importance of separating our work from the sleep environment. If you are the sort of person who can fall asleep on the sofa watching TV, but when you get up and go to bed you are suddenly wide awake, unfortunately you may have negatively conditioned yourself. In this scenario, there may be no other option but to start again with our sleeping environment. Choose a new space where you aspire to achieve good sleep. Ensure this space is boring, dark, quiet, comfortable, and the right temperature and only use this space for sleeping – this is known as ‘stimulus control’. Absolutely nothing else. When you feel tired, enter this room to sleep rather than staying on the sofa. As soon as you feel you can no longer sleep in the room, get up and leave the space. Over time, your brain will positively reconnect the association between this new sleeping environment and the desire to sleep, creating a potent sleep drive. As I have explained previously, the key time is 20 minutes. If you get into bed and don’t achieve sleep within that time, leave the space and then only return when you feel tired again.


To use another analogy, you wouldn't wait at the dining room table waiting to get hungry, so why would you lie in bed waiting to go to sleep? You wouldn't, so don't.

Relaxation

I mentioned the importance of relaxation in volume one and there are many ways that this can be achieved. Relaxation promotes sleep by relaxing the muscles and calming the mind. Relaxation can also include light aerobic activities such as walking to clear the mind, yoga and stretching and adopting good body posture. There are several other relaxation techniques that can be used in order to promote sleep including mindfulness and meditation, as well as progressive muscle relaxation technique (which I have previously provided instructions for in Volume one). Using soothing music, such as crashing waves or whale song, can help some individuals get to sleep. Research suggests that listening to any kind of music for 30 minutes before bed can help achieve better quality sleep. Using visualisation techniques, which involves thinking of pleasant things such as lying on a beach in the sun, can help focus the mind on one thing at a time, filtering out distractions which may be preventing you from sleeping. Using aromatherapy, such as using smells such as lavender, can also be used to naturally relax the body and induce sleep. If none of this works for you, a technique I have used for many years is something known as 8-8-8 breathing. The concept of this is that you inhale for 8 seconds, hold the breath for 8 seconds, and then finally exhale for 8 seconds, and then repeat as many times as necessary. This technique is scientifically proven to reduce pulse and breathing rates to calm us down and is used in a variety of therapies, including stress management. The technique also requires concentration which focuses the mind on a single object in the same way as visualisation.

In conjunction with relaxation techniques, you may need to adopt other strategies to take control of the wandering mind. There are several ways of achieving this – the first is cognitive control, also referred to as journaling. Set aside time to write down all the things that are in your head and could be troubling you making a list of all the things you are either concerned or worried about that might be keeping you up at night and preventing you sleeping. Writing these in a book, and then closing the book each night, is a symbolic gesture to yourself to say, "I have finished today and I am giving myself permission to switch off". If we are going to use this technique to remove all negative thoughts from our mind, we may need to adopt cognitive distraction techniques to fill the void. To do this, you will have all probably tried to count sheep. Does this work? Absolutely not, because it is too simplistic. An alternative technique I have tried many times is counting back from 1000 in 7's. This may seem a bit difficult, but that is the point, and this mental exercise works in two ways – firstly, you will either get bored of doing the maths that you fall asleep, or secondly, you eventually become so exhausted from calculating the sums that you fall asleep.

Another technique which again is being utilised in a variety of fields is tapping therapy. There is a phenomenon in the brain called the 'frequency following response'. The brain loves to follow repeating rhythmic patterns. The brain notices there is a pattern, connects with it and then follows it. Frequency following response works the same as yawning. The association of yawning and sleep is so strong that simply saying the word, or watching someone else yawn, causes us to copy that behaviour and feel tired. Mirror neurons in the brain help us experience what others feel and we are the only species, with the exception of chimpanzees, that can do this. In terms of improving sleep, over time we can activate this response and then slow down brain activity by slowing down the rhythm. You can do



this by placing your fingers on what we call our 'sore spots'. The best ones to use are either the forehead, temple regions, or collar bones. If you accompany the tapping with a simple breathing practice, such as 8-8-8 breathing, over time you can create a condition where simply tapping this designated area of your body can stimulate sleepiness. This technique is not a quick fix to improving your sleep and can take several times to get this working effectively.

The final technique is something known as 'paradoxical intention', which to me, provides a fascinating insight into the quirkiness of the human mind. To explain what this principle is, I want you to not think about the purple elephant. What are you thinking of? The purple elephant! So, the behaviour I asked you not to do, you have automatically done. Now think about the most boring thing you have done on an evening, perhaps watching a boring film or theatre production late at night, or when you were perhaps sat after a large meal. You may have told yourself "*Don't you dare fall asleep*" but the likelihood is that you will have probably nodded off. Remember, your brain controls you, not the other way round. So, if we apply this to sleep, try getting into bed as normal, turn off the lights and get everything ready for sleep. However, keep your eyes open letting go of any thoughts about getting off to sleep. Instead, ask yourself to stay awake for just a little bit longer. You will quickly notice that your eyes begin to feel heavy, and you may be unable to stop yawning. If we can purposely force ourselves to stay awake, rather than fighting ourselves to get to sleep, the brain eventually deactivates, and we finally relax allowing sleep to happen. Through reducing the effort spent on trying to sleep, we find that we can get to sleep easier.

Summary

In summary...

- There is a simple truth – the shorter your sleep, the shorter your life!
- There is a silent sleep loss epidemic, and it is fast becoming one of the greatest public health challenges that we face in the 21st century.
- Sleep is not an optional lifestyle luxury. Rather it is a non-negotiable biological necessity and Mother Nature’s best effort yet at immortality.
- Anyone who has difficulties sleeping is suffering from insomnia. There are two primary issues – sleep onset insomnia (a difficulty getting to sleep) and sleep maintenance insomnia (a difficulty staying asleep).
- The three pillars, which form the wellbeing trinity – sleep, diet, and exercise – are closely interrelated to each other and we need to give all three elements appropriate consideration to maintain our health and wellbeing.
- Inadequate sleep adversely affects the reproductive health of both males and females and is known to impact fertility.
- Sleeping longer helps us to lose weight. Inadequate sleep causes our hunger hormones to spike, increasing our desire to eat and causing us to crave junk food. Sleep reforms the body’s metabolic state by fine-tuning the balance of insulin and circulating glucose.
- Inadequate sleep affects our memory and ability to learn. If we don’t have sufficient quantity and quality of sleep, we fail to transmit short term memories into the long-term memory bank.
- During sleep, the brains glymphatic system drains beta-amyloid from the cortex. This protein is known to cause plaque accumulations which are predictors of dementia and Alzheimer’s.
- There is an intimate association between your sleep health and your mental health. REM sleep provides a form of overnight emotional therapy taking difficult, traumatic, and painful experiences during the day and allowing for emotional venting.
- People who get less than 6 hours per night have a 50% increased chance of dying from heart disease and a 12.5% increased chance of dying before the age of 65.
- Sleep reboots our immune system, helping fight malignancy, preventing infection and fighting all manner of sickness.
- There is no aspect of your wellness that is not affected by inadequate sleep. Sleep loss will leak down into every aspect of your health and physiology, even tampering with your very DNA which spells out your health profile.

We can all benefit from improving the quantity and quality of our sleep and in most cases, it is simply a case of making small adjustments to our bedtime routines and sleep habits. Sleep is the best prescription for health and should be taken every 24 hours. I’m not here to tell anyone how to live, and life is to be lived to a degree. What I have tried to do with all these guides is give you all the science behind sleep so you can be empowered with the knowledge to make your own choices. Using the advice and knowledge provided in this booklet should help you to understand why sleep is important and how to get the best sleep for you. Sleep is a pragmatic response to good health and has many benefits, so remember to take your sleep seriously as it is vitally important for your overarching health, safety, and wellbeing. But, above all else, I do hope you sleep well.

