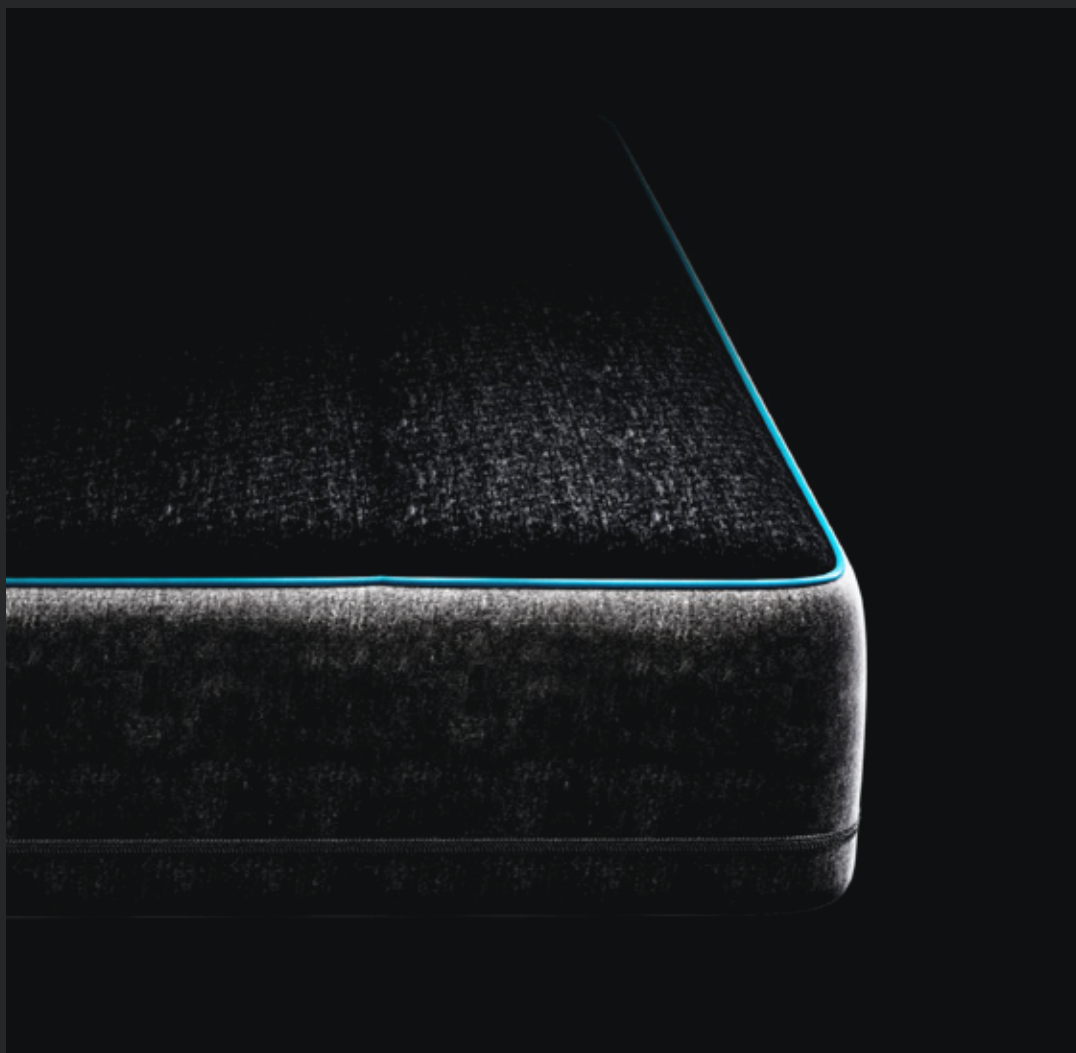




SLEEP FITNESS

The next wave in the
sleep revolution



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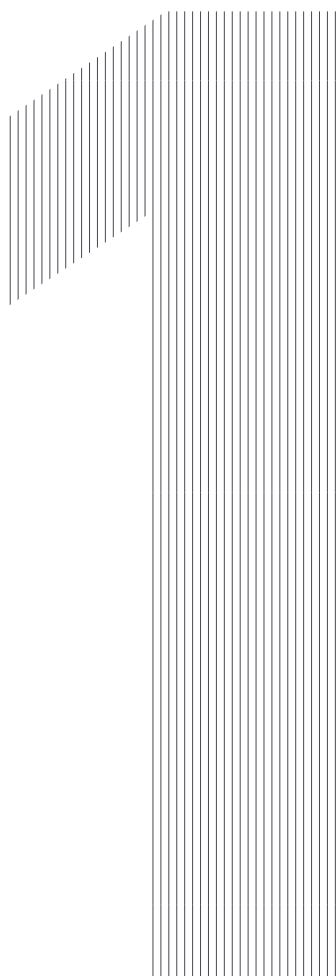
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INTRODUCTION: THE STATE OF SLEEP

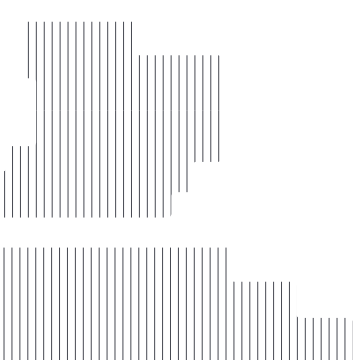


SLEEP IS AN OVERLOOKED PILLAR OF HEALTH.

Research and science have long suggested that your overall health and wellness rests on three pillars: nutrition, exercise and sleep. The importance of nutrition and exercise have become so omnipresent in our everyday thinking that we feel pressure to maintain health in both areas. From intermittent fasting to marathon running, countless fitness movements and diet fads have spawned and flourished as a result. The government even legislates these pressures with taxes on sugary drinks and mandated hours of physical education in our schools.

With sleep, there is a different story entirely. As a society, we've grown to expect more from our waking hours. We're made to think we need to hustle harder, work more, achieve greater things. We shrug off sleep as an activity that can be done when 'you're dead'. We're reminded we need it only when we feel the stinging under our eyes and the mental fatigue setting in. In fact, people are sleeping less now than any time in the last century. Research from Gallup shows that Americans average just 6.8 hours of sleep per night, down more than an hour since 1942 [1].

"I think there's almost no appreciation for the health benefits of sleep beyond as a cure to sleepiness," says Dr. Robert Stickgold, PhD and Director of Harvard Medical School's Center for Sleep and Cognition [2]. This isn't surprising if you consider that conversations around sleep health have long been dominated by defining, identifying and treating sleep problems [3]. That is to say, we don't talk about how the average person can get the most out of their sleep, we only talk about it in the context of illness.





Despite the lack of societal appreciation of sleep, Dr. Philip Gherman, PhD and Professor of Psychiatry at University of Pennsylvania insists that, "sleep is akin to a performance enhancing drug [4]." It's restorative effects and ability to improve the quality of waking hours is well known. Yet, Dr. Gherman believes that there is a strange paradox around sleep whereby people prioritize waking hours and in doing so, sacrifice the quality of those hours.

It is time to change the conversation around sleep entirely. We should view it as an activity with enormous power to improve the quality of the human experience. Sleep should be something that is prioritized, measured and worked on the same way that nutrition and exercise are.



Sleep Fitness White Paper

Sleep Fitness As The Solution

SLEEP FITNESS AS THE SOLUTION



So how do we change the societal mindset around sleep? The first step is viewing it through the same lens with which we view fitness and nutrition. Sleep fitness is a real thing. It's a state of overall health and well-being fueled by quality sleep. Being sleep fit results in a feeling of restoration, elevated energy levels and confidence. In short, being sleep fit enhances performance in everything we humans do. Dr. Gehrman defines sleep fitness as, "the extent to which we are getting sufficient quantity and quality of sleep to be energized and functioning at peak levels during the day [4]."

Most of all, sleep fitness is actionable, measurable and achievable. It opens room in the conversation for positive reinforcement and advocacy around sleep, something that is missing from the current dialogue.

Sleep Fitness

/slēp 'fitnəs/

A state of overall health and well being fueled by quality sleep; feeling of restoration and elevated energy levels; confidence to take on the day.



Sleep Fitness White Paper

Indicators Of Sleep Fitness

INDICATORS OF SLEEP FITNESS



“We are a very sleep deprived society, and technology has the potential for helping us measure and understand that in a new way.”

Dr. David Rapoport, MD and Professor of Medicine and Pulmonary Disease at Icahn School of Medicine at Mount Sinai

A key to achieving sleep fitness is knowing where you currently stand. “We are a very sleep deprived society,” shared Dr. David Rapoport, MD and Professor of Medicine and Pulmonary Disease at Icahn School of Medicine at Mount Sinai, “and technology has the potential for helping us measure and understand that in a new way [5].” Experts agree that there is not one single thing that determines sleep fitness, rather it is a combination of different factors that will lead to you to be sleep fit. Here is a breakdown of those factors:

SLEEP DURATION

Necessary sleep duration varies based on individual differences such as age and biological make up. The National Sleep Foundation recommends that adults between the ages of 18 to 64 years get between 7 and 9 hours of sleep per night [6]. Dr. Rapoport puts the window of sleep need a bit tighter, saying that “the average adult needs somewhere in the 7.5 to 8 hours of sleep range per night [5].” While there is room for debate on the exact amount required for sufficient rest, there is general agreement that sleeping less than 6 hours per night and more than 10 hours per night regularly is damaging to overall health [6].

SLEEP CONTINUITY

“In addition to how much sleep we’re getting, it’s important to consider the continuity of that sleep,” explains Dr. Stickgold [3]. He shares that interruptions during the night play a role in determining the quality of your rest. These breaks in sleep can take the form of ‘awakenings’, which he defines as periods of wakefulness that are longer than 30 seconds or ‘micro-arousals’ which include movements like tossing and turning. “The more times people wake up during the night, the less rested they tend to feel in the morning,” shared Dr. Gherman [4].

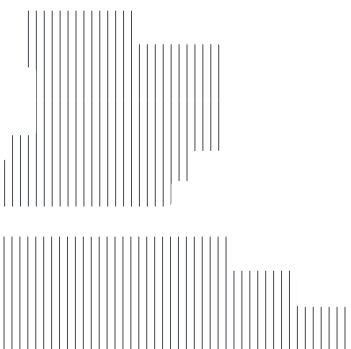
SLEEP STAGE CONTINUITY

To the naked eye, a person at sleep may appear to be doing nothing. But in fact, sleep is a time of high activity and recovery for the brain and body. As humans, we pass through five distinct sleep stages continuously throughout the night. Stage 1 is considered to be the lightest sleep, during which we are not completely disengaged from our environment and are easily aroused [7]. Stage 2 is also considered light sleep, with the additional appearance of short bursts of brain activity [7]. Stage 3 and 4 are called slow wave or deep sleep and are associated by a slowing down of heart and respiratory rate [7]. Finally, rapid eye movement (REM) sleep is the part of the night when we have dreams. During this stage, brain activity looks similar to that of a person who is awake[7].

Throughout the night, a person cycles through all five stages and the level of fluctuation between the stages is shown to impact sleep fitness. "The degree of consolidation of a period of REM sleep, for example, will affect the quality of rest," said Dr. Stickgold [3]. In short, ideal sleep stage continuity will not involve someone quickly cycling back and forth to deep sleep within a given period of REM sleep.

SLEEP REGULARITY

The experience of sleep and wakefulness are associated with a physiologically regulated internal clock known as circadian rhythm [8]. That is to say that your body has a tendency to want to do the same activities during the same points of a given 24-hour period. It serves to keep balance between the many biological processes that occur every day. Therefore, keeping your body on a regular clock allows it to optimize internal processes. So, for example, you're more likely to fall asleep faster if you keep a regular bedtime of 10pm each night rather than if you sleep at 6pm some nights and 11pm on other nights. Further, keeping a consistent wake-up time allows the body to go through sleep stages more efficiently. Dr. Rapoport suggests that you "sleep the same amount of hours every night during the same time period [6]."



AMOUNT OF DEEP SLEEP

“Literature shows that slow wave or deep sleep is most strongly correlated with the perception of feeling rested,” says Dr. Gherman [4]. What’s more, amount of deep sleep has been shown in studies to correlate with better memory the next day. In one study, participants with more deep sleep performed better on a memory retrieval task [9].

EXPERIENCE OF WAKEFULNESS

Perhaps most of all, a tell tale sign of someone’s sleep fitness is how energized they feel during the day. Though this is more of a qualitative measurement of how sleep fit someone is, experts agree that the intuitive feeling you have as to how adequately rested you are is not something that should be ignored. Dr. Rapoport insists that with sleep, “there is a parallel to exercise where people can tune into what their body is telling them through how they feel [5].”



Sleep Fitness White Paper

Achieving Sleep Fitness

ACHIEVING SLEEP FITNESS



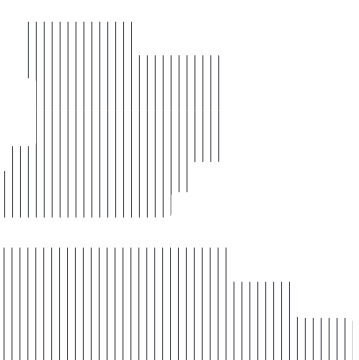
By working to improve sleep quality, humans are able to improve their overall life quality. With the lens of sleep fitness, we turn sleep into something that is not only measurable, but also actionable and achievable. Research and experts agree that there are certain actions that will lead and individual to become more sleep fit. Below includes a breakdown of those different actions:

SLEEP COOLER

Controlling temperature is key to achieving sleep fitness. In fact, literature shows that thermal environment has one of the biggest impacts on human sleep [10]. The National Sleep Foundation recommends to keep room temperature between 60 F and 67 F [11], since research links the rapid decline in core body temperature, to an increased possibility of sleep initiation and sleep maintenance [12][13]. Further, this drop in body temperature may also enable the brain to more easily enter the deeper stages of sleep [12]. Other studies have demonstrated a positive correlation between amount of slow wave sleep and body temperature at sleep onset [13]. Sleeping in a cooler environment has even been shown to prevent certain types of insomnia [14]. Thus, a cooler temperature is better for overall sleep quality and facilitates larger quantities of REM and deep sleep [13].

MAINTAIN CONSISTENCY IN BEDTIME AND WAKE UP TIME

Keeping a consistent bedtime and sleep duration increases overall sleep efficiency and quality [15]. "A lot of people work long hours and stay up late during the weekdays and then try to compensate for the loss by sleeping in on the weekends", says Dr. Rapoport [5]. But, in his professional experience, this is not an effective way to improve sleep fitness, as the practice throws off the regularity needed to maintain a healthy circadian rhythm.



GET ENOUGH SLEEP

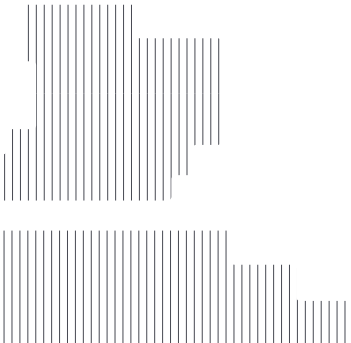
There is consensus among sleep researchers and experts that a major factor that prevents people from being sleep fit is that they are simply not making enough time for sleep [3] [4] [5]. “Getting yourself into bed at an earlier and more reasonable time,” Dr. Stickgold says is crucial for achieving sleep fitness [3]. Dr. Rapoport calls this problem “sleep opportunity” and explains that people don’t have enough of it [5]. It’s true that you can only sleep as many hours as you allow yourself. To exacerbate the issue, people are notoriously bad at knowing how many hours of sleep they are actually getting, which naturally makes it hard to benchmark any improvement [3].

SET THE RIGHT ENVIRONMENT

Individuals can facilitate sleep fitness through optimizing environmental factors. According to Dr. Stickgold, this includes “having a good mattress, creating a quiet environment and controlling light exposure [3].” There is research to suggest that introducing white noise into the bedroom helps to neutralize other distracting sounds and even reduce sleep latency [16]. Any exposure to light before bed has the potential to interfere with sleep onset, but studies have demonstrated that exposure to blue wave light, from cellphones, computers or tablets, may suppress the production of melatonin in the brain for twice as long as other light, from the sun or a lamp [17]. Melatonin is a critical hormone secreted from the pineal gland that tells your body when it’s time to sleep. Dr. Gehrman suggests that, “if you want to scroll on your phone before bed, you should at least make sure that you’re filtering out the light in some way [4].”

DISCONNECT THE MIND

“Writing down a to-do list before going to sleep, practicing deep breathing, meditation, light reading, listening to music or anything else that gives you the opportunity to physically and mentally unwind before bedtime is really healthy,” shares Dr. Gehrman [4].



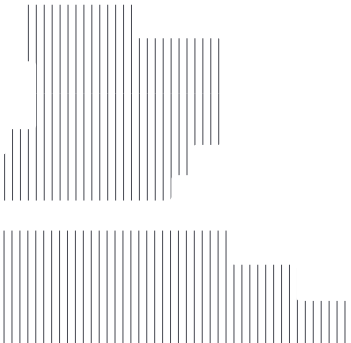
The connection between mental state and sleep is well documented, with research demonstrating that relaxation practices such as meditation are an effective treatment for insomnia [18].

MOVE AROUND DURING THE DAY

There is solid empirical evidence that links exercise to faster sleep onset and overall improved sleep quality [19]. Further this is a clear connection between moderate aerobic activity and increased periods of deep sleep [19]. The caveat around exercise, is that if done too close to bedtime, it also has the potential to keep your central nervous system in a state of activity, which can make it difficult to fall asleep [19].

AVOID STIMULATING DRUGS

“People should stay away from caffeine, alcohol and nicotine. All of these things combat sleep and prevent people from having restful slumber,” stresses Dr. Rapoport [5]. Other practices to avoid include taking too many naps during the day and consuming food that can trigger indigestion [20].





Sleep Fitness White Paper

The Advantages Of Being Sleep Fit

THE ADVANTAGES OF BEING SLEEP FIT



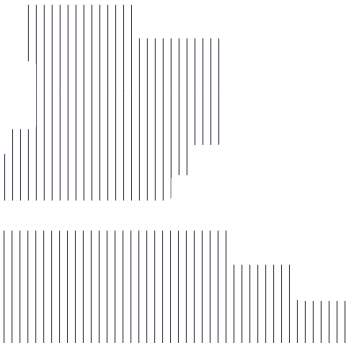
Like exercise and nutrition, the advantages of being sleep fit are well researched and wide reaching. From improved physical performance to heart health, sleep fitness is a lifestyle choice that has the power to improve overall well being. Dr. Rapoport explained that people who are sleep fit are, “sharper, faster, less likely to be depressed, less argumentative, less grumpy, have better social skills and perform both physically and mentally better [5].” Dr. Stickgold says that the benefits associated with being sleep fit can be summarized by heightened resilience in an individual [3].

ATHLETIC EDGE

Sleep is arguably the most important part of recovery that enables peak physical performance. Inadequate sleep has been shown to decrease the body’s ability to make new proteins and accelerate the process of muscle degradation, in effect hindering muscle recovery after damage induced by exercise [21]. This is a phenomenon that has long been noticed by the athletic community. One study, which looked at the relationship between sleep fitness and athletic performance among the Stanford University men’s varsity basketball team, found that when players had sufficient sleep, they were able to sprint faster, reported improved ratings of physical and mental well-being and increased their free throw and field goal percentage by about 9% [22]. Another research team studied five years of regular season NFL, NBA and NHL teams and discovered that teams who traveled from the east to west coast had higher percentages of game losses, a correlation believed to be caused by the disruption of the athlete's circadian rhythm [23]. The connection between sleep fitness and athletic performance has resulted in many professional sports teams employing sleep experts or coaches to train athletes [24].

SHARPENED MEMORY

The physiological processes that occur during sleep play an important role in consolidation, a necessary cognitive step for stabilizing new memories over time and making them resistant to deterioration. [25]. Spindles, which are bursts of neural activity that

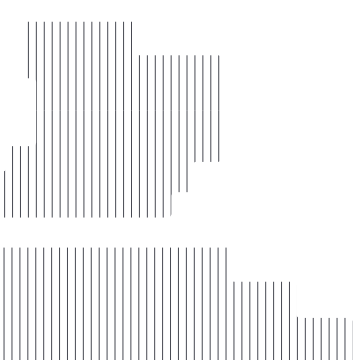


appear first during stage 2 of sleep, are considered to be a necessary for consolidating new learnings [26]. Studies have shown that sleep spindle frequency increases on nights when someone has learned something new [27]. Deep sleep is also thought to solidify long term memory. Among the research suggesting this, is one study demonstrating that brain activity in the hippocampal region observed while someone is learning a route along a virtual town is also observed during periods of slow wave sleep. The same study found that increased hippocampal mirroring during deep sleep correlated with better performance in recalling the same virtual route the following day [28].

ENHANCED COGNITIVE FUNCTIONING

Sleep deprivation negatively impacts alertness and cognitive performance in human subjects. Specifically, poor sleep is associated with diminished activity in both the thalamus and prefrontal cortex, regions of the brain that are crucial for higher order cognitive processes such as critical thinking and problem solving as well as aptitude for alertness and attention [30]. In addition to reduced activity in the thalamus and prefrontal cortex, sleep deprived individuals exhibit an overall decrease in brain activity [3]. Some studies have shown stark differences between sleep fit people and sleep deprived people, with the sleep fit group demonstrating the capacity for more sustained attention and a greater acceleration of processes needed to solve novel cognitive tasks [31].

IMPROVED PHYSICAL HEALTH



Literature shows that sleep fit individuals have better physical health outcomes when it comes to both acute and chronic illness. Lousy sleep is correlated with a reduction in immune system functioning, including lower counts of immune cells and a reduction in their capacity to produce cytokine, a group of proteins critical to a properly working immune system [32]. One study has revealed that a group of insomniacs were significantly less able to build immunity to the flu after receiving a flu vaccine than a control group [33].



When it comes to longer-term illness, chronically sleep deprived individuals are more likely to develop heart disease, Alzheimer's and cancers [5].

BETTER MENTAL HEALTH

Similar to physical health, mental health is affected by sleep quality in both the long and short term. After a night of poor sleep, people tend to be crankier, less empathetic, more irritable and more aggressive towards others [34]. Ample sleep, in essence, increased our ability to cope with stress in a productive way [34]. Sleep has also been connected to enhanced creativity [35], a mental state critical for problem solving. In the long-term, chronic lack of sleep correlates with higher rates of depression, anxiety disorders and mood disorders [36].



Sleep Fitness White Paper

About Eight Sleep

ABOUT EIGHT SLEEP





Eight Sleep is the world's first sleep fitness company. It leverages technology, innovation, and personal biometrics to restore individuals to their peak energy levels each morning. Founded in 2014 and based in New York City, Eight Sleep has been named by Fast Company as one of the Most Innovative Companies of 2018. Its signature product the Smart Mattress has been awarded by Time magazine as one of the top inventions of 2018. Eight Sleep is backed by leading investors including Y Combinator, Stanford University, and Khosla Ventures. To learn more about Eight Sleep visit eightsleep.com



Sleep Fitness White Paper

About The Experts

ABOUT THE EXPERTS



The sleep experts interviewed for inclusion of this paper are all members of Eight Sleep's Scientific Advisory Board (SAB). The SAB members serve as strategic partners in guiding the direction of Eight's product development and growing research and scientific programs. Bios of SAB members quoted for this paper are below:

**Robert Stickgold, PhD**

Dr. Stickgold is an Associate Professor of Psychiatry at Harvard Medical School and Director at the Center for Sleep and Cognition. His research seeks to describe the nature of cognition during sleep.

**Philip Gehrman, PhD**

Dr. Gehrman is an assistant professor in the Department of Psychiatry at the University of Pennsylvania's Perelman School of Medicine. He has used clinical research to study cognitive behavioral intervention for sleep disorders.

**Dr. David Rapoport, MD**

Dr. Rapoport is a Professor of Medicine, Pulmonary, Critical Care and Sleep Medicine at Mount Sinai. He has a long standing interest in the physiology of sleep disordered breathing and has accumulated a body of research on the topic.

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