Sightines Healthy Living Report

Research Update on Sleep

Marie Conley Smith

In a world full of opportunities, stressors, inequalities, and distractions, maintaining a healthy lifestyle can be challenging, and sleep is often the first habit to suffer. Good sleep hygiene is a huge commitment: it takes up about a third of the day, every day, and works best when kept on a consistent schedule. It does not help that the primary short-term symptoms of insufficient sleep can be self-medicated away with caffeine. However, the effects of sleep loss can range from inconvenient to downright dangerous; people have trouble learning and being productive, take risks more readily, and are more likely to get into accidents. These effects also last longer than it takes to get them, as recovering from each night of poor sleep takes multiple days. When it comes to sleep, every night counts. In this update, we will discuss what Stanford researchers have to say about sleep and why we need it, who is getting too little of it, and some of the latest findings that may help us sleep better.

We have not cracked the code on sleep

Scientists have devoted themselves to the study of sleep for over 70 years, but explanations about how and why we sleep remain elusive. What we have learned is that sleep is critical to brain function; in order for the brain to perform at its best, the average adult today needs 7-9 hours per night, every night. We know that the circadian rhythm, a near-24-hour "clock" inside the body that helps to anticipate when sleep should occur, uses environmental stimuli, especially light exposure, to synchronize itself to the outside world. Scientists typically break the sleep cycle into five stages, the most well-known of which are deep sleep and rapid eye movement (REM), which was discovered by the late Stanford Professor William Dement in the late 1950's.

The average adult needs

7-9 hours

of sleep every night

Despite this progress, scientists have not been able to crack the code of why sleep is critical to brain function. There is also little consensus about how sleep stages actually affect quality of sleep and how they affect us when we are awake.

Part of the challenge of cracking the code on sleep is how difficult it is to study. The gold standard of sleep study, polysomnography, developed by Dement in the 1960s,[1] is the most reliable tool for measuring many sleep characteristics and detecting sleep disorders such as obstructive sleep apnea and narcolepsy. However, it is expensive and time-consuming to run, which means that usually only a night or two is recorded. This snapshot of sleep may not reflect what normally occurs for a given person, and makes it difficult to draw conclusions about their behavior and performance in the days surrounding the sleep measurement.

The recent explosion in consumer wearable devices is a promising trend for researchers because of their potential to measure thousands of people's sleep in their natural environments. They have not yet been widely adopted as measurement tools by scientists, however, as it is unclear if they provide the level of precision and measurement consistency required for a scientific study. Researchers at Stanford have called for these devices to be cleared by the FDA before using them to assign a diagnosis.[2] The "holy grail" would be a wearable device that could track sleep accurately while also providing performance information about the rest of the day, which would allow researchers to recognize more nuanced relationships between how people sleep and how it affects their lives.

The short- and long-term effects of insufficient sleep

We all know anecdotally what it is like to get too little sleep; it might be described with words and phrases like "tired," "cranky," "sluggish," and "need caffeine." Review of the scientific literature reveals how wide-ranging these effects can be. With too little sleep, people have a harder time learning[3] and concentrating, and are more likely to take risks.[4,5] The likelihood of getting into an auto accident increases6. Sleep deprivation has a bidirectional relationship with depression,[7,8] in that insomnia often both precedes and follows a depressive episode. Short sleep also interferes with other Healthy Living behaviors: people are more likely to crave sweet and fatty foods[9] and to choose foods that are calorically dense,[10] are more prone to injury during exercise,[11] and have an increased risk of obesity.[12]

Sleep deprivation can even affect mundane daily activities. In 2017, then Stanford PhD candidate Tim Althoff and Professor Jamie Zeitzer of the Stanford Center for Sleep Sciences and Medicine took up the sleep measurement challenge by collaborating with Microsoft Research to examine the effects of sleep deprivation through a common daily activity: using an online search engine.[13] They paired users' Microsoft Band sleep data with their Bing searches among users who had agreed to share their activity for study. By linking quantity and timing of sleep with typing speed during the searches, they were able to draw a number of conclusions about how sleep quality affects performance.

In this study, the researchers captured the sleep duration and search engine interactions of over 31,000 people. The researchers measured the amount of time between keystrokes as people typed their search engine entries, and used this as a measure of daily performance (that is, how well people did after a night of sleep). They were able to track the people who had multiple nights of insufficient sleep (defined as 6 hours of sleep or fewer) to see if their typing speed changed. They found that, on average, one night of insufficient sleep resulted in worse performance for three days, and two nights of insufficient sleep negatively impacted performance for six days (Fig. 1). In other words, it took people almost an entire week to recover their performance after two consecutive nights of insufficient sleep. The implication is that the impact of sleep loss can persist for days.

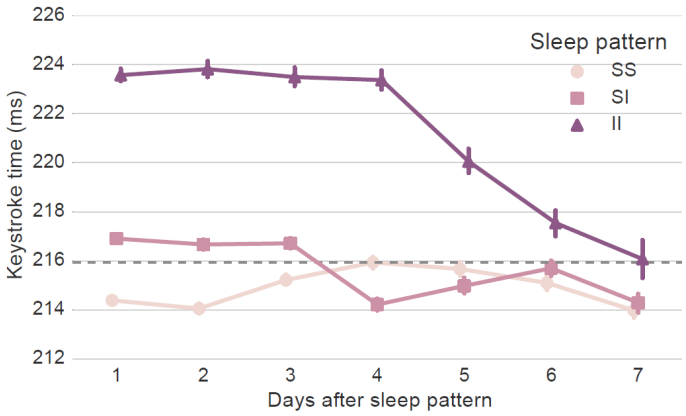

Figure 1. Insufficient sleep hurts daily performance (as measured by keystroke speed) for several days) [13]

SS = zero nights of insufficient sleep
SI = 1 night of insufficient sleep
II = 2 consecutive nights of insufficient sleep

Higher keystroke time indicates worse performance. The dashed line represents the worst performance for the group with zero nights of insufficient sleep (SS) and is used as the baseline performance level.

Recent Stanford solutions for better sleep

Ongoing research at Stanford has led both to treatments for sleep disorders and to recommendations for best sleep practices for the public.

Stanford Lifestyle Medicine best practices

LIFESTYLE MEDICINE

Stanford Lifestyle Medicine, led by Stanford Center on Longevity faculty affiliates Dr. Michael Fredericson and Dr. Douglas Noordsy, has compiled a list of best practice recommendations for individual behavior, such as adhering to a consistent sleep schedule and incorporating exercise, which can be viewed on page two of this report's data update, and on the Lifestyle Medicine website.

Cognitive Behavioral Therapy for Insomnia (CBTI)

Approximately 1/3 of adults report at least one symptom of insomnia,[14] which is characterized by difficulty falling and/or staying asleep. Sometimes this is due to a life event (acute insomnia), an underlying health issue, or it may be chronic, otherwise unexplained sleeplessness. The American College of Physicians recommends that adults try cognitive behavioral therapy for insomnia (CBTI) as their first approach to treating primary insomnia.[15] For people willing to do such therapy, CBTI has been found to be as or more effective than drug therapy for chronic insomnia.[16] CBTI has also been found to alleviate symptoms of insomnia during pregnancy[17] and in people with comorbidities such as obstructive sleep apnea.[18]

CBTI is a toolbox of techniques (see sidebar) that involve changing thoughts and behaviors that might be interfering with sleep, and instituting a sleep schedule focusing on matching sleep duration and time spent in bed. This therapy is not new, but has regained prominence as sleep experts emphasize the importance of psychological influences on sleep. CBTI works best when facilitated by a clinician trained in this practice, though CBTI-trained clinicians are somewhat sparse. Professor Rachel Manber and her team at Stanford recognized this and partnered with the Veterans Health Administration (VHA) to train mental health providers across the country to administer CBTI to veterans,[19] who typically suffer from insomnia at higher rates than civilians. The program resulted in reduced symptoms of insomnia in the majority of veteran patients, and showed that non-sleep specialists could be trained to effectively administer CBTI.

There are a few clinics and organizations that offer CBTI remotely in an effort to give more people access. There are apps such as SleepRate, which features content designed by Stanford researchers, Somryst, which was recently approved by the FDA, and Sleepio, which is offered by several large employers as an employee benefit. The Cleveland Sleep Clinic offers a 6-week online program called "Go! to Sleep," and the U.S. Department of Veterans Affairs offers one of the same duration called "Path to Better Sleep." A physician should be consulted before starting any of these programs to ensure there are not any underlying disorders that need to be addressed.

A Toolbox of Techniques

In Cognitive Behavioral Therapy for Insomnia, several sleep-related behavior categories are addressed:

- Stimulus control: keeping a consistent wake-up time and only getting into bed when sleepy
- Sleep restriction: reducing time spent lying awake
- Sleep-interfering arousal/activation: employing stress management and relaxation techniques
- Foods and substances: cutting down on alcohol and caffeine
- Biological clock: seeking professional help to shift one's circadian clock (e.g., with light exposure therapy)

Learn more about each of these categories at Stanford Healthcare.

Ultrashort light flash therapy

Professor Jamie Zeitzer was interested in helping people who had a hard time sleeping because their circadian rhythm was not in sync with their desired sleep schedule. He discovered that ultrashort bursts of light directed into a person's closed eyes while they were sleeping was very effective at shifting the time a person starts getting sleepy. Sleep doctors had already been using continuous light to help people reset their internal clock while they were awake; this new short-flash method shows great promise not only because of its effectiveness, but because it can be administered passively while people are sleeping. The approach involves wearing a sleep mask that emits the bright flashes and has been shown to only wake individuals who are particularly sensitive to light.

Professor Zeitzer and his team administered these ultrashort light flashes to teenagers, whose natural circadian systems have shifted so that their sleep and wake times are considerably later than children or adults. The time structure of our society, and schools in particular, does not take this into account. Professor Zeitzer administered the light flashes to see if it would help teens go to bed earlier.[20] They found that, while the teenagers were getting sleepy earlier, the light flashes alone were not enough to get the teenagers to bed earlier. With a second group of teens, they combined the light therapy with cognitive behavioral therapy (CBT) sessions. The CBT sessions served to inform the teens about sleep health and hygiene and helped them schedule their activities to allow for their desired sleep hours. After this combined therapy trial, the teens went to bed an average of 50 minutes earlier, getting an average of 43 more minutes of sleep per night. The researchers found the CBT component to be integral to behavior change – without the added education and support, the teens were not motivated enough to change their behavior and would simply push past their sleepiness.

Lumos Smart Sleep Mask

This ultrashort light flash therapy can be used by anyone who may want to shift their sleep schedule; for example, to rebound from jet lag or to cope with a consistent graveyard shift at work. There is no evidence that other groups would require accompanying CBT like the teens, as long as they are self-motivated to change their sleep schedule. Zeitzer plans to test this technology next with older adults who wish to push their sleep time later. A company has spun out of this work, which Zeitzer advises but in which he has no financial interest, called Lumos. They are currently developing their product, and are hoping to make this intervention widely available.

Data Spotlight on: Black Americans

While most Americans have seen improvements in sleep over the past decade, Black Americans continue to sleep significantly less than other groups. This trend has been examined both by researchers and the popular press.[21,22] Researchers have found that Black Americans, in addition to getting shorter sleep, are also more likely to get poor quality sleep – spending less time in the most restorative stages of sleep[23,24] – and to develop obstructive sleep apnea.[25] Black Americans are also disproportionately affected by diseases that have been associated with poor sleep, such as obesity, diabetes,[26] and cardiovascular disease.[25]

The exact reason(s) for Black Americans' poor sleep is still unclear, though researchers have proposed potential contributing factors, largely related to the social inequality Black Americans face in the U.S.:

- *Experiences of discrimination*: the stress of racial discrimination has been associated with spending less time in deep sleep and more time in light sleep among Black Americans.[24]
- *Living environment*: neighborhood quality has been linked to sleep quality,[27] and Stanford researchers found that racial and income disparities persist in neighborhoods.[28] They found that while middle-income white families are more likely to live in resource-rich neighborhoods with other middle-income families, middle-income black families tend to live in markedly lower-income, resource-poor neighborhoods.
- *Work and income inequality*: for example, shift work can cause irregular working hours. This leads people to suffer "social jetlag,"; a discrepancy in sleep hours between work and free days,[29] leading to symptoms of sleep deprivation.
- *Lack of access to resources*: particularly sleep-related healthcare and education.

Some of these factors are being addressed directly. Professor Girardin Jean-Louis from New York University and his team have devoted themselves to addressing the access to healthcare and education issue among local black communities in New York by tailoring online materials about obstructive sleep apnea to the culture, language, and barriers of specific communities.[30] Professor Jamie Zeitzer and his team at Stanford recently completed an initial clinical trial of a drug (suvorexant), which was found to help people who work at night get three more hours of sleep during the day.[31] Professor Zeitzer's ultrashort light flash therapy (discussed above) may also help with shift work. These interventions could help to improve sleep for Black Americans, but they may not make up the whole picture; it could be that the underlying social inequality needs to be addressed in order to fully close the sleep gap.

Thanks to Jamie Zeitzer and Ken Smith for their insights and edits on this report.

References

1. Deak, M., & Epstein, L. J. (2009). The history of polysomnography. Sleep Medicine Clinics, 4(3), 313–321.
2. Cheung, J., Zeitzer, J. M., Lu, H., & Mignot, E. (2018). Validation of minute-to-minute scoring for sleep and wake periods in a consumer wearable device compared to an actigraphy device. Sleep Science and Practice, 2(1), 11. https://doi.org/10.1186/s41606-018-0029-8
3. Gao, C., Terlizzese, T., & Scullin, M. K. (2019). Short sleep and late bedtimes are detrimental to educational learning and knowledge transfer: An investigation of individual differences in susceptibility. Chronobiology International, 36(3), 307–318. https://doi.org/10.1080/07420528.2018.1539401
4. O'Brien, E. M., & Mindell, J. A. (2005). Sleep and risk-taking behavior in adolescents. Behavioral Sleep Medicine, 3(3), 113–133. https://doi.org/10.1207/s15402010bsm0303_1
5. Rusnac, N., Spitzenstetter, F., & Tassi, P. (2019). Chronic sleep loss and risk-taking behavior: Does the origin of sleep loss matter? Behavioral Sleep Medicine, 17(6), 729–739. https://doi.org/10.1080/15402002.2018.1483368
6. Bioulac, S., Micoulaud-Franchi, J.-A., Arnaud, M., Sagaspe, P., Moore, N., Salvo, F., & Philip, P. (2017). Risk of motor vehicle accidents related to sleepiness at the wheel: A systematic review and meta-analysis. Sleep, 40(10). https://doi.org/10.1093/sleep/zsx134
7. Franzen, P. L., & Buysse, D. J. (2008). Sleep disturbances and depression: Risk relationships for subsequent depression and therapeutic implications. Dialogues in Clinical Neuroscience, 10(4), 473–481.
8. Tsuno, N., & Ritchie, K. (2005). Sleep and Depression. The Journal of Clinical Psychiatry, 16.
9. Lv, W., Finlayson, G., & Dando, R. (2018). Sleep, food cravings and taste. Appetite, 125, 210–216. https://doi.org/10.1016/j.appet.2018.02.013
10. Pardi, D., Buman, M., Black, J., Lammers, G. J., & Zeitzer, J. M. (2017). Eating decisions based on alertness levels after a single night of sleep manipulation: A randomized clinical trial. Sleep, 40(2). https://doi.org/10.1093/sleep/zsw039
11. Chennaoui, M., Arnal, P. J., Sauvet, F., & Léger, D. (2015). Sleep and exercise: A reciprocal issue? Sleep Medicine Reviews, 20, 59–72. https://doi.org/10.1016/j.smrv.2014.06.008
12. Cappuccio, F. P., Taggart, F. M., Kandala, N. B., Currie, A., Peile, E., Stranges, S., & Miller, M. A. (2008). Meta-analysis of short sleep duration and obesity in children and adults. Sleep, 31(5), 619-626.
13. Althoff, T., Horvitz, E., White, R. W., & Zeitzer, J. (2017, April). Harnessing the web for population-scale physiological sensing: A case study of sleep and performance. In Proceedings of the 26th international conference on World Wide Web (pp. 113-122).
14. Roth, T. (2007). Insomnia: Definition, prevalence, etiology, and consequences. Journal of Clinical Sleep Medicine, 3(5 Suppl), S7–S10.
15. Qaseem, A., Kansagara, D., Forciea, M. A., Cooke, M., & Denberg, T. D. (2016). Management of chronic insomnia disorder in adults: A clinical practice guideline from the American College of Physicians. Annals of Internal Medicine, 165(2), 125–133. https://doi.org/10.7326/M15-2175
16. Jacobs, G. D., Pace-Schott, E. F., Stickgold, R., & Otto, M. W. (2004). Cognitive behavior therapy and pharmacotherapy for insomnia: A randomized controlled trial and direct comparison. Archives of Internal Medicine, 164(17), 1888–1896. https://doi.org/10.1001/archinte.164.17.1888
17. Manber, R., Bei, B., Simpson, N., Asarnow, L., Rangel, E., Sit, A., & Lyell, D. (2019). Cognitive behavioral therapy for prenatal insomnia: A randomized controlled trial. Obstetrics & Gynecology, 133(5), 911–919. https://doi.org/10.1097/AOG.0000000000003216

18. Ong, J. C., Crawford, M. R., Dawson, S. C., Fogg, L. F., Turner, A. D., Wyatt, J. K., Crisostomo, M. I., Chhangani, B. S., Kushida, C. A., Edinger, J. D., Abbott, S. M., Malkani, R. G., Attarian, H. P., & Zee, P. C. (2020). A randomized controlled trial of CBT-I and PAP for obstructive sleep apnea and comorbid insomnia: Main outcomes from the MATRICS study. Sleep. https://doi.org/10.1093/sleep/zsaa041
19. Karlin, B. E., Trockel, M., Taylor, C. B., Gimeno, J., & Manber, R. (20130415). National dissemination of cognitive behavioral therapy for insomnia in veterans: Therapist- and patient-level outcomes. Journal of Consulting and Clinical Psychology, 81(5), 912. https://doi.org/10.1037/a0032554
20. Kaplan, K. A., Mashash, M., Williams, R., Batchelder, H., Starr-Glass, L., & Zeitzer, J. M. (2019). Effect of light flashes vs sham therapy during sleep with adjunct cognitive behavioral therapy on sleep quality among adolescents: A randomized clinical trial. JAMA Network Open, 2(9), e1911944. https://doi.org/10.1001/jamanetworkopen.2019.11944
21. Resnick, B. (2015, October 27). The Racial Inequality of Sleep. The Atlantic. https://www.theatlantic.com/health/archive/2015/10/the-sleep-gap-and-racial-inequality/412405/
22. Resnick, B., & Barton, G. (2018, April 12). Black Americans don't sleep as well as white Americans. That's a problem. Vox. https://www.vox.com/science-and-health/2018/4/12/17224328/sleep-gap-black-white-minority-america-health-consequences
23. Beatty, D. L., Hall, M. H., Kamarck, T. A., Buysse, D. J., Owens, J. F., Reis, S. E., Mezick, E. J., Strollo, P. J., & Matthews, K. A. (2011). Unfair treatment is associated with poor sleep in African American and Caucasian adults: Pittsburgh SleepSCORE project. Health Psychology, 30(3), 351–359. https://doi.org/10.1037/a0022976
24. Tomfohr, L., Pung, M. A., Edwards, K. M., & Dimsdale, J. E. (2012). Racial differences in sleep architecture: The role of ethnic discrimination. Biological Psychology, 89(1), 34–38. https://doi.org/10.1016/j.biopsycho.2011.09.002
25. Olafiranye, O., Akinboboye, O., Mitchell, J., Ogedegbe, G., & Jean-Louis, G. (2013). Obstructive sleep apnea and cardiovascular disease in blacks: A call to action from association of black cardiologists. American Heart Journal, 165(4), 468–476. https://doi.org/10.1016/j.ahj.2012.12.018
26. Jackson, C. L., Redline, S., Kawachi, I., & Hu, F. B. (2013). Association between sleep duration and diabetes in black and white adults. Diabetes Care, 36(11), 3557–3565. https://doi.org/10.2337/dc13-0777
27. Hale, L., Hill, T. D., & Burdette, A. M. (2010). Does sleep quality mediate the association between neighborhood disorder and self-rated physical health? Preventive Medicine, 51(3–4), 275–278. https://doi.org/10.1016/j.ypmed.2010.06.017
28. Reardon, S. F., Fox, L., & Townsend, J. (2015). Neighborhood income composition by household race and income, 1990–2009. The ANNALS of the American Academy of Political and Social Science, 660(1), 78–97. https://doi.org/10.1177/0002716215576104
29. Wittmann, M., Dinich, J., Merrow, M., & Roenneberg, T. (2006). Social jetlag: Misalignment of biological and social time. Chronobiology International, 23(1–2), 497–509. https://doi.org/10.1080/07420520500545979
30. Jean-Louis, G., Robbins, R., Williams, N. J., Allegrante, J. P., Rapoport, D. M., Cohall, A., & Ogedegbe, G. (2020). Tailored Approach to Sleep Health Education (TASHE): A randomized controlled trial of a web-based application. Journal of Clinical Sleep Medicine. https://doi.org/10.5664/jcsm.8510
31. Zeitzer, J. M., Joyce, D. S., McBean, A., Quevedo, Y. L., Hernandez, B., & Holty, J.-E. (2020). Effect of suvorexant vs placebo on total daytime sleep hours in shift workers: A randomized clinical trial. JAMA Network Open, 3(6), e206614. https://doi.org/10.1001/jamanetworkopen.2020.6614