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SLEEP HEALTH



Duration, timing and quality of sleep are each vital for health, performance and safety

Charles A. Czeisler, PhD, MD

National Sleep Foundation; Division of Sleep and Circadian Disorders, Departments of Medicine and Neurology, Brigham & Women's Hospital; Division of Sleep Medicine, Harvard Medical School

More than 30 years ago, Rechtschaffen et al¹ demonstrated that sleep is just as necessary as food for bodily survival. Yet, as recently as 2005, Hobson² has argued that “sleep is of the brain, by the brain, and for the brain.” In 2007, systems biologist Van Savage and theoretical physicist Geoffrey West concluded that the reason why small mammals with a high metabolic rate like the mouse sleep so much longer, approximately 14 hours per day, than large mammals with a low metabolic rate like the elephant, which sleeps only 3.5 hours per day, is that the core function of sleep is to repair, reorganize, and maintain the brain's neurons, which burn more energy per unit mass than any other tissue.³ The landmark discovery that sleep facilitates the clearance of toxic metabolic debris, including amyloid β , that is generated by neural activity and accumulates during wakefulness, supports and extends that theory.^{4,5} Evidence of the crucial role that sleep plays in brain development, synaptic pruning, plasticity, rehearsal, memory consolidation, learning, and insight further supports the conclusion that sleep is critical for brain functioning,^{6–11} rather than simply serving to keep us out of trouble at night.¹² Moreover, in the 15 years since Eve Van Cauter and her colleagues at the University of Chicago discovered that sleep deficiency adversely impacts metabolic and endocrine functions,¹³ it has been demonstrated unequivocally that the duration, timing, and quality of sleep also critically affect physical health, mental health, performance, and safety.¹⁴ Thus, it is clear that sleep is critical not just for optimal brain functioning but also for optimal functioning of the body as well.

Sleep duration and health

Recent data indicate that 28% of Americans report obtaining insufficient sleep on most nights, and only 31% of Americans report consistently obtaining sufficient sleep.¹⁵ In fact, 30% of civilian workers and 44% of night shift workers in the United States are sleeping less than 6 hours per night,¹⁶ and this fraction is only likely to rise.¹⁷ Rigorous physiological studies have demonstrated that just a week or two of sleep curtailment increases appetite and food intake,^{18,19} decreases insulin sensitivity and glucose tolerance^{13,20}—even in adipose tissue removed from sleep-deprived participants,²¹ impairs the immune response to vaccination,²² degrades the ability to resist infection,²³ disturbs mood,²⁴ increases the vulnerability to attentional failures,^{24–26} and, when combined with prior chronic circadian disruption, impairs

pancreatic β -cell responsiveness.²⁷ Concurrently, epidemiologic studies have revealed that habitually short sleepers have an increased prevalence of obesity,²⁸ that short sleep duration in young children confers an increased risk of obesity in older children^{29,30} and adults,³¹ and that habitually short and habitually long sleepers are at increased risk for incident calcification of the coronary arteries,³² incident coronary heart disease,³³ incident type 2 diabetes,^{34–37} incident stroke,³⁶ and death.^{38,39}

Sleep timing and health

During that same time interval, emerging evidence that chronic exposure to recurrent disruption of sleep and circadian timing induced by night shift work increases the risk of breast cancer,^{40,41} endometrial cancer,⁴² colorectal cancer,^{43,44} and prostate cancer^{45–47} has led the World Health Organization to classify night shift work as a probable carcinogen.⁴⁸ Moreover, extended duration (>24 hours) work shifts have been associated with poorer performance on clinical tasks^{49,50} and increased risks of serious medical errors, preventable adverse events, self-inflicted percutaneous injuries, and motor vehicle crashes among resident physicians;⁵¹ and 12-hour shifts and frequent overtime are associated with an increased risk of making an error⁵² and having an occupational injury.⁵³

Laboratory studies have demonstrated that misalignment between the timing of the sleep-wake cycle and endogenous circadian rhythmicity disturbs energy metabolism,⁵⁴ adversely affects both glucose metabolism and cardiovascular regulation;^{27,55} and impairs attention, neurobehavioral performance, mood, and cognition.^{56–58} Epidemiologic studies reveal that night shift work is associated with increased odds of obesity,⁵⁹ a 5-fold increase in the risk of progressing from impaired glucose tolerance to diabetes;⁶⁰ an increased risk of blood pressure elevation;⁶¹ incident hypertension;⁶² incident coronary heart disease, including fatal and nonfatal myocardial infarctions;⁶³ and that a decade of exposure to shift work chronically impairs cognition.⁶⁴ It has even been reported that 5 years of exposure to recurrent transmeridian travel (jet lag) produces atrophy of the brain's temporal lobe.⁶⁵

Sleep quality and health

Sleep disruption caused by a variety of sleep disorders has been associated with adverse consequences on health, performance, and

safety. Chronic insomnia, which affects approximately one-tenth of the US population,⁶⁶ is both a symptom of and a risk factor for anxiety and depression.^{67,68} Difficulty initiating or maintaining sleep is associated with an increased risk of incident type 2 diabetes³⁶ and incident prostate cancer, including advanced prostate cancer.⁶⁹ Chronic insomnia is associated with an increased risk of developing or dying of cardiovascular disease.⁷⁰ In a prospective 20-year follow-up study, Parthasarathy et al⁷¹ recently found that participants with persistent insomnia had higher serum C-reactive protein levels and were more likely to die than participants without insomnia.

Now that the definition of obstructive sleep apnea (OSA) has been corrected such that it no longer requires a concomitant complaint of excessive daytime sleepiness, it is recognized that the prevalence of OSA is much higher than the oft-quoted underestimate of 4% of men and 2% of women that was based on that erroneously restrictive definition.⁷² Moreover, over the past 20 years, the prevalence of OSA (Apnea-Hypopnea Index, AHI >5) with or without the complaint of daytime sleepiness has risen from 24% of men and 9% of women to 34% of men and 17% of women, with 13% of adult men and 6% of adult women in the United States having moderate-to-severe OSA,^{72,73} which can have serious health and safety consequences. In children, OSA is associated with attention deficit hyperactivity disorder and poorer academic performance.⁷⁴ In adults, OSA is associated with disturbed glycemic regulation and an increased risk of diabetes,⁶⁶ increased risk of incident nonalcoholic fatty liver disease and liver fibrosis,^{75, 76} incident ventricular arrhythmias,⁷⁷ incident cardiovascular risk,⁷⁸ risk of motor vehicle crashes,⁷⁹ stroke,⁸⁰ and all-cause mortality.^{80,81} Remarkably, in an 18-year follow-up to their landmark 1993 OSA population prevalence study, Young et al⁸¹ found that, among participants in their cohort, who had an average age of 48 years in 1988, only 58% with severe OSA (AHI, ≥ 30) were still alive 18 years later as compared with 94% of those without OSA (AHI, <5), reflecting 3.8-fold greater adjusted hazard ratio for all-cause mortality and a 5.2-fold greater adjusted hazard ratio for cardiovascular mortality.⁸¹ Recent data suggest that OSA may even play a causal role in Alzheimer disease.⁸²

Drowsy driving symptomatic of pervasive sleep deficiency

Despite these recent advances in understanding the health, performance and safety impacts of sleep loss, sleep deficiency—a deficit in the quantity or quality of sleep obtained vs the amount needed for optimal health, performance, and well-being—is increasing in our society. As noted in the 2011 National Institutes of Health Sleep Disorders Research Plan, “sleep deficiency may result from prolonged wakefulness leading to sleep deprivation, insufficient sleep duration, sleep fragmentation or a sleep disorder, such as in OSA, that disrupts sleep and thereby renders sleep nonrestorative.”⁸³ Unfortunately, as noted above, sleep deficiency from each of those causes is on the rise. Although some contrarians continue to argue that health concerns about sleep deficiency are overrated,⁸⁴ the fact that an estimated 58.8 million of America’s licensed drivers report driving while drowsy each month⁸⁵ and that 7.5 million of them lose that struggle and fall asleep at the wheel each month,⁸⁶ causing more than 50,000 debilitating injuries and 6400 traffic fatalities annually,^{14,87} demonstrates that many Americans are not even obtaining the sleep that they need to conduct routine daily functions like driving, let alone maintain optimal mental and physical fitness.

Compelling evidence thus reveals that sleep is vital for both the brain and the body. For this reason, the National Sleep Foundation has launched *Sleep Health*, a new journal dedicated to ensuring that research addressing the broader public health implications of the epidemic of sleep deficiency has a permanent home.

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