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Author
Lingampalli, Nithya

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The Dangers of Sleep Deprivation

Nithya Lingampalli

During President Ronald Reagan's term as president, he went on a state visit to Paraguay. As cameras were documenting the occasion and broadcasting it for the world to see, a surprising shot was included. When the cameras focused on Reagan during the Paraguayan president's speech, he was asleep! His wife quickly woke him up, and then he ascended the stage to deliver his address. However, when he started speaking, he said that he was very happy to be in Uruguay while everyone else smiled politely (Schneider, 2014).

This instance illustrates a national health problem, often unrecognized as a severe issue, that many suffer from on a daily basis. Sleep deprivation, either a chronic or transient state, is when the lack of the requisite amount of sleep for upkeep causes the body to experience many physical and mental problems. According to data from the National Health Interview Survey, "nearly 30% of adults reported an average of ≤6 hours of sleep per day in 2005-2007. In 2009, only 31% of high school students reported getting at least 8 hours of sleep on an average school night" (Insufficient Sleep Is a Public Health Epidemic, 2014). Children appear to be most affected by sleep deprivation as a recent study from Boston College suggests that, "70 to 80 percent of school-aged children fall short of experts' recommendations," a higher percentage than any other country in the world (Liese, 2014).

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To put the severity of the problem into perspective, the recommended amount of sleep, as suggested by The National Institute of Health, is at least 10 hours for school-age children, 9-10 hours for teens, and 7-8 hours for adults (Insufficient Sleep Is a Public Health Epidemic, 2014). Although there is a variation from these standard times between individuals due to different body requirements, these represent the average amount of time necessary based upon a large sample of the population, and thus serve as a baseline to evaluate individual situations. We see that regardless of the age group, people are falling short of their recommended sleep quota by two hours or more, often on a daily basis.

The biological mechanism of sleep deprivation deals with the reduced amount of REM and deep sleep stages, hallmarks of healthy sleep. Normal sleep is divided into two stages, non-rapid eye movement (NREM) and rapid eye movement (REM). NREM sleep is further divided into three sub stages (N1, N2, and N3) that progress sequentially and represent an increasing degree of deep sleep. Stage N3, also known as delta-wave sleep, is the deepest stage of sleep and requires a very strong stimulus to be broken Although many areas of the brain are involved in sleep regulation, the hypothalamus seems to be the key component (Stevens, 2013).

"Some of the most interesting [causes] are broad scale societal factors such as the pervasive presence of technology and extremely busy schedules."

There are many causes, both direct and indirect, that contribute to sleep deprivation. Some of the most interesting are broad scale societal factors such as the pervasive presence of technology and extremely busy schedules.

Access to technology has never been as ubiquitous as it is today, and its influence is growing even more in our daily lives. Phones, tablets, laptops, television, MP3 players, and many more devices are always within reach, at any time of the day. They are alluring due to the vast amount of information they offer a portal to. As a result, many people find it increasingly difficult to separate themselves from their devices, and often use them right until the moment they sleep, or sometimes fall asleep using them. However, using technological devices right before bed, or even some time before, has been shown to negatively impact the ease and quality of sleep. The light from the devices suppresses the levels of melatonin, a hormone that signals to the brain to

cause an onset of sleep. With reduced levels of melatonin, not only is it harder to fall asleep, but it is also much more difficult to reach the deeper stages of sleep quickly (Brody, 2014).

Another societal factor that impacts sleep is the daily schedule. Sleep deprivation has been shown to be most prevalent in people that perform shift work or multiple jobs (American Academy of Sleep Medicine, 2014). The rational behind its frequency in people who perform multiple jobs is easily apparent; people who work multiple jobs often have very busy schedules and often find very little time for sleep. Personal obligations such as taking care of kids, caring for a loved one, or maintaining a household are activities that make schedules busy and can contribute to sleep deprivation in a similar manner. The reasoning behind those who work shift-jobs is more complicated, and not yet fully understood. It may be due to a disruption of the circadian rhythm, a natural biorhythm.

Sleep disorders are a leading cause of sleep deprivation because they, by definition, inhibit or disrupt an aspect of health sleep. Insomnia and obstructive sleep disorder are the most common, affecting an estimated 50-70 million adults (Insufficient Sleep Is a Public Health Epidemic, 2014).

Another factor that is being given increasing attention and research in the last few years is the effect of competition and parental pressure on children to succeed. In a 2005 study of 1400 adolescents in South Korea, a society in which academic success is highly valued and sought after, revealed that the children only had 4.9 hours of sleep on average every night (Brody, 2014). Although a similar study has not been conducted in relation to students in the United States where the academic environment is also very highly competitive, it would be interesting to see how the results compare.

Many of the immediate effects of transient sleep deprivation, such as drowsiness and irritability, are well recognized and readily apparent. One key symptom that is also very dangerous to public health is daytime sleepiness. In the United States, almost 40% of adults involuntarily fall asleep during the day at least once a month (What Are Sleep Deprivation and Deficiency?, 2012). This has far-reaching effects in terms of the alertness of individuals and public safety. This issue is common enough that, "the U.S. Department of Transportation has determined that what might be called D.W.D.—driving while drowsy—causes forty thousand injuries a year in the United States and more than fifteen hundred deaths" (Kolbert, 2013). As illustrated in this example, not only is sleep deprivation dangerous for the individual experiencing it, but also unsafe for those around them.

Apart from the immediate effects, there are also many long-lasting social effects of sleep deprivation that can significantly affect one's character and their quality of life. Some of the most common ones are lack of motivation, increased errors, forgetfulness, lack of coordination, and poor decisions (American Academy of Sleep Medicine, 2014). An exceptionally worrisome and representative example of the negative social and cognitive effects of social deprivation is prevalent in police departments. Officers that experience sleep deprivation exhibit a significant decrease in their reaction times and an increase in judgment errors. A study conducted by David Blake, a retired police officer, and Dr. Edward Cumella, a psychology professor at Kaplan University, followed the effect of fatigue due to sleep deprivation on 53 police officers over the course of a week. They found that a lack of sleep, "impacted 53 officers decision-making and reaction-

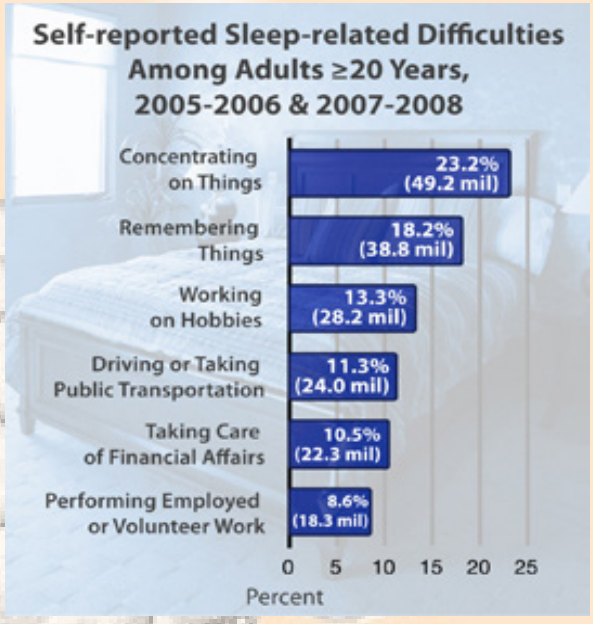

Figure 1. Sleep deprivation affects a wide-range of mental cognitive abilities which in turn impair day-to-day functions.

times when responding to shoot or don't shoot situations. 'Their decision-making and reaction-time slows down when they become more and more fatigued,' said Blake." Almost 69% of the officers reported that they performed at least 1 mistake due to fatigue on the job. An even more worrisome result is that 40% of the officers did not even recognize that their performance and judgment were being affected by their lack of sleep. There was an average decrease of 12 seconds in the reaction time, a difference that may seem insignificant. However, considering the fact that these shoot/no-shoot situations are determined by judgments made in a matter of a few seconds, a 12 second increase in reaction time is a significant value that gives cause for worry (Kovaleski, 2014).

The physical effects of sleep deprivation range from minor, fleeting impediments to severe, permanent inflictions depending on the severity and duration of the condition. One of the most readily observable physical effects is a lack of

attention, especially for tasks that require sustained attention, because as sleep deprivation increases, the focus required for such tasks decreases. Other more severe effects, "reported in earlier studies...visual illusions and hallucinations. At least two investigators reported extreme confusion and delusions of persecution" (Morris, Williams, Lubin, 1960). Long-term health effects of sleep deprivation include, "chronic diseases such as hypertension, diabetes, depression, and obesity, as well as from cancer, increased mortality, and reduced quality of life and productivity" (Insufficient Sleep Is a Public Health Epidemic, 2014). In fact, a recent study has found a strong correlation between both short-term and long-term sleep deprivation and an increased risk of contracting diabetes, regardless of any other features, suggesting that sleep deprivation can be used as a diagnostic risk factor for diabetes (Yaggi, Araujo, McKinlay, 2006).

Even more permanent, long-term effects of sleep deprivation are seen at the genetic level. Based on studies conducted in rates, severe long-term sleep deprivation has been proven to have, "dramatic physiological changes including increase in energy expenditure, decrease in body weight, and death after 2–3 weeks." After studying the changes at the genetic level, researchers found that, "several plasticity-related genes were strongly induced after acute sleep deprivation only, and several glial genes were down-regulated in both sleep deprivation conditions, but to a different extent." Based on these results, there is a genetic basis to speculate that sleep deprivation causes a general stress response in the brain, and as a result, the body responds which a general inflammatory response. When this inflammatory response is sustained, many negative effects in terms of cell viability and genetic transcription are observed. In the case of neural stress, extended wakefulness not only increases the brain's energy demand and expenditure, but also increases the cellular stress placed on the neurons and the supporting glial cells. Although the exact mechanism has not yet been elucidated, this inflammation pathway is thought to play a role (Cirelli, Faraguna, and Tononi, 2006). According to another study, "consequences of chronic sleep deprivation impair brain functions and contribute to allostatic load throughout the body. Allostatic load refers to the cumulative wear and tear on body systems caused by too much stress and/or inefficient management of the systems... Taken together, these changes in brain and body are further evidence that sleep deprivation is a chronic stressor and that the resulting allostatic load can contribute to cognitive problems, which can, in turn, further exacerbate pathways that lead to disease" (McEwen, 2006).

"A common but incorrect belief is that lost sleep can be "made up" by sleeping for an extended period of time on another day."

A common but incorrect belief is that lost sleep can be "made up" by sleeping for an extended period of time on another day. However, this can actually increase the negative effects of the sleep deprivation. By sleeping in, at times when one is normally not asleep, the biological sleep-wake cycle is further disturbed and extended implementation of this practice can shift the internal clock, making it harder to sleep and wake up at previously normal times. This can be comprised to the point that there is permanent jet lag and the internal clock remains permanently shifted (Brody, 2014).

Some preventative measures to avoid the immediate negative effects of sleep deprivation include caffeine, a prophylactic nap, and naps during the deprivation. Caffeine works to mask tiredness and increase alertness, however the effect does wear off and one is left feeling tired again. A prophylactic nap is the act of getting extra sleep before a period of anticipated sleep loss. This can reduce some of the negative effects of sleep deprivation on performance such as drowsiness and loss of attention. Brief naps during the time of sleep deprivation, up to thirty minutes, can help boost alertness and decrease drowsiness. However, extending the nap beyond this ideal time range can have the opposite effect of making it more difficult to wake up and causing increased drowsiness when awake, a state known as "sleep inertia" (American Academy of Sleep Medicine, 2014).

Beyond these preventive measures, there are also many chemical treatments that can aid in increasing the amount and quality of sleep one receives to decrease the negative effects of sleep deprivation. Some natural sleeping aids include Valerian, chamomile, and melatonin. Chemical sleeping aids are divided into two major classes, the old and new. The older class generally consists of the benzodiazepines (ex. Valium, Xanax) Although these chemicals did help induce sleep, they also affected the actual stages of sleep as well, decreasing the amount of time spent in deep sleep stages. They were also highly resistant to degradation in the body, meaning that their half-life was extremely long and their effects were prolonged, producing a "hangover effect" (Abraham and Sheppard, 2014). The newer class of sleep medications generally consists of non-benzodiazepine hypnotics (ex. Ambien, Rozerem, Sonata, and Lunesta). Compared to their predecessors, they have a much shorter half-life and quickly degrade in the body meaning that their effects are brief and not as prolonged. They also are more specific than the older class, only acting on specific receptors in the brain, hence reducing the likelihood of addiction or tolerance (Agrawal, 2006).

Sleep deprivation, both short-term and chronic, is a serious health problem is society that is often overlooked due to its pervasiveness. Furthermore, its most apparent symptoms such as drowsiness, tiredness, and irritability are often perceived as normal responses in stressful lives and are quickly covered up by caffeine. However, it is very important to recognize the physical, mental, and genetic effects that such sleep deprivation could have and work toward reducing its negative effects on one's performance and health.

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http://www.cdc.gov/features/dssleep/

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