BIOLOGY

How Slight Sleep Deprivation Could Add Extra Pounds

New analysis shows that metabolic effects caused by even a couple nights with less than six hours of shut-eye may feed obesity

By Katherine Harmon on October 24, 2012

Getting seven to eight solid hours of sleep each night might seem an almost impossible luxury to many people. But not getting enough sleep is known to impair mental function and increase the risk for heart disease, among other ill effects. Accumulating evidence also suggests that even short-term, partial sleep deprivation could pave the way for weight gain and other negative metabolic consequences.

More than 28 percent of adults in the U.S. report that they get less than six hours of sleep a night, with this cumulative deprivation becoming more common in the past three decades. And now that more than 35 percent of U.S. adults are currently obese, researchers have been searching for potential links between the two conditions, in hopes of reducing the increasing health and economic burden of obesity. Establishing lack of sleep as a risk factor for weight gain could have important clinical and public health effects, possibly allowing people to make simple lifestyle changes to improve their metabolic health.

A new report, published online October 24 in the *Journal of the Academy of Nutrition and Dietetics*, reviews 18 carefully controlled laboratory studies that tested human subjects' physiological and behavioral responses to sleep deprivation as they relate to metabolic health.

Reena Mehra, an associate professor of medicine who studies sleep and health at Case Western Reserve University School of Medicine and who was not involved in the new analysis, notes that the new paper is "a well done review of the experimental data."

The researchers found that studies of people without sleep-related conditions who got consecutive nights of four to six hours of sleep revealed a wide range of negative effects

involving appetite hormone signaling, physical activity, eating behavior and even fat-loss rates. "From a population health perspective, this helps to get people to understand that sleep deprivation really does have an impact on your health," Mehra says.

To sleep, perchance to eat less

Perhaps some of the best-documented effects of sleep deprivation on weight are based on two powerful hormones: ghrelin and leptin. Ghrelin is involved in sending hunger signals and leptin helps to tell you that you are full. In one study, after just two consecutive nights of four-hours' sleep, test subjects had a 28 percent higher ghrelin (hunger) hormone level and 18 percent lower leptin (satiety) hormone level in their blood compared with subjects who had spent 10 hours a night in bed. In the same study, for those who were sleep deprived, "self-reported hunger and appetite ratings significantly increased by 24 percent and 23 percent, respectively," noted the authors of the review paper, which was led by Julie Shlisky, a researcher at The New York Obesity Nutrition Research Center at Saint Luke's-Roosevelt Hospital Center. "The greatest increase in appetite rating was for energy-dense, high-carbohydrate foods," Shlisky and her co-authors noted. Other studies found additional increases in fat and saturated fat consumed by those suffering from sleep deprivation. One study also found a change in another eating signal called peptide YY, which is thought to tell the body it is full after eating enough. It dropped off in a group of subjects who had been allowed only five hours in bed for two nights, suggesting that these sleepy subjects would be more inclined to eat more given the opportunity.

Not all of the studies found such drastic differences in hormone levels. But many have also documented study subjects eating more and/or more often in the lab after they have had consecutive nights of partial sleep deprivation. One study tested women, reducing their nightly sleep from seven to four hours over the course of four nights. During the sleep deprivation phase, women ate an average of about 400 more calories daily than they had at the beginning of the session—and even gained weight over the course of the short study.

As Shlisky and her colleagues point out in their paper, people who are awake longer simply have more opportunities to eat. "Partial sleep deprivation may increase the risk of overeating in the evening due to low circulating leptin levels and additional time spent awake," the researchers noted, adding that "evening and late-night hours are when overeating of less-healthful foods is most likely to occur." Furthermore, additional research that shows "impulse control and delayed gratification are lowered with sleep deprivation, perhaps making sleep-deprived individuals more vulnerable to hedonic eating," rather than resort to healthful foods to sate hunger.

Stressed and sleepy

Do these extra waking hours also help us get in more physical activity? As with eating, it might seem reasonable to think that being awake longer would lead to more beneficial

activity, resulting in more energy expended. Not necessarily, according to the researchers. One study found that after just two nights of being allowed only four hours asleep, subjects had "significantly lower activity" than those subjects allowed eight hours rest. Although lab study results on exercise levels after sleep deprivation have been mixed, people generally report feeling more lethargic and less capable of getting the recommended moderate- to high-intensity exercise. So, although one might spend an extra two to four hours prone in bed, during the 16 to 17 hours of wakefulness a well-rested person would be more likely to meet exercise recommendations and improve his or her metabolism.

Sleep deprivation can also lead to muscle loss and fat gain. With too little sleep, the body is also more likely to produce the stress-response hormone cortisol. After sleep deprivation, subjects in several studies had higher levels of cortisol later in the day, a time when it should be tapering off to prepare the body for rest. Heightened cortisol prompts the body to store more fat and be more inclined to use other soft tissue, such as muscle, as energy, which means that sleep-deprived dieters lose more muscle and gain more fat than do those who are well rested. One study found that after two weeks of minor calorie restriction (10 percent less than their daily energy expenditure), subjects who were getting 5.5 hours in bed a night lost just 0.6 kilogram of fat but 2.4 kilograms of other tissue, such as muscle; subjects who got 8.5 hours slumber each night lost 1.4 kilograms of fat and 1.5 kilograms of other tissue. "Some of these metabolic effects occur pretty quickly," Mehra notes.

Parsing zzz's

The studies reviewed in the current report were all small and of short duration. But larger, long-term epidemiologic studies have come back with similar results. Nevertheless, the relationship between sleep deprivation and weight gain is still not crystal clear. Obesity itself can contribute to sleep loss. Frequent co-occurring conditions, such as sleep apnea (disrupted breathing during sleep), are large contributors to disrupted and poor-quality sleep in the general population. So is obesity causing sleep deprivation, rather than the other way around? "There *could* be a bidirectional relationship," Mehra says. Although sleep apnea and other conditions can make for low-quality sleep, which can then also lead to heart disease, Mehra suggests that there is ample data that show people who began as normal weight and healthy but did not get enough sleep, over time developed worse health outcomes.

"I think there's room for us to learn more about the underlying mechanisms," Mehra says. But she notes that losing sleep is likely contributing to metabolic disregulation, at the very least: "I think we can pretty safely say, getting insufficient sleep is detrimental to your health," including metabolic health.

Not all doctors—and certainly not all patients—currently focus on sleep as a potentially important intervention for weight loss and metabolic health. For example, people trying to lose weight, especially via calorie reduction and exercise, might find it particularly difficult to

feel full, ignore cravings for unhealthful foods and get enough high-energy exercise if they are short on sleep. "Clinicians assisting in weight-loss interventions may improve patient outcomes by discussing sleep time within a healthy lifestyle intervention," the researchers noted. Mehra adds that many of the patients referred to her for sleep-related concerns seem surprised to hear they should be getting more sleep.

Of course, getting more sleep can be difficult, especially with perpetually lit indoor environments and the glow of screens confusing our circadian rhythms. "Demands of a modern lifestyle, excessive time in front of brightly lit computer and television screens, shift work and jet lag, among other factors, result in partial sleep deprivation," Shlisky and her colleagues noted. But this new report, and other accumulating studies, suggest that it might be an important, and relatively simple step—compared with eating well and exercising—in the battle against the bulge, and for a healthy life in general.

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