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Lack of Sleep Can Lead to Weight Gain





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Opening Commentary

Dr. Stephen McDonough, Member
President's Council on Fitness, Sports & Nutrition

Guest Author

Jean-Philippe Chaput, PhD
Assistant Professor of Pediatrics, University
of Ottawa
Junior Research Chair, Healthy Active Living
and Obesity Research Group, Children's
Hospital of Eastern Ontario Research
Institute

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This excellent article on sleep deprivation and obesity, by Dr. Jean-Philippe Chaput of the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, provides a wonderful review of the science relating to this important issue.

As a pediatrician, I know firsthand the effects of sleep deprivation on myself and the parents and children who come to me for health care. Physicians often work long hours and can be up late at night admitting a patient to the hospital, attending a delivery, or doing shift work in the emergency room. For years I would overeat the evening I was up late, and then again the next evening when I returned home. My appetite was immense! I also was tired and would go to bed early, only to awaken during the night and be tired the next day. A vicious cycle would ensue, and it would take several days to recover my energy and deal with a weight gain of one or two pounds.

Years ago, one of my pediatric partners taught me a valuable lesson. He told me that when I was tired a day or weekend after being deprived of sleep, I should force myself to do something active early that evening. First it was playing racquetball with my pediatric partner; later in life it was going for a walk with my dog. Although I was tired, doing something gave me more energy that evening, and I slept better that night and was more functional the rest of the week. I also decreased my overeating and was able to control my weight.

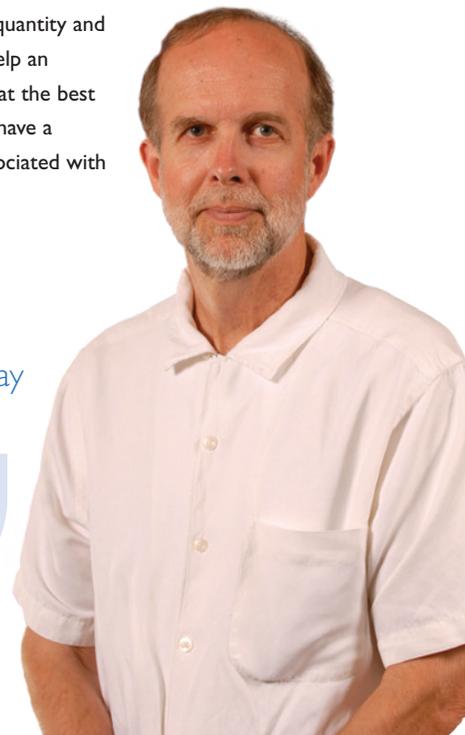
Sleep deprivation can lead to overeating and decreased activity, which can result in weight gain. Eating healthfully (five servings of fruits or vegetables a day) can help control weight and help you feel better. And when sleep deprivation can't be avoided, force yourself to be active the next evening: go for a walk or run, go to the gym, or get on your exercise machine at home. Regular habits and routines can help make getting to sleep easier and thereby result in enough sleep.

Although it may not seem to make sense, do something active when you are tired—you will get more energy and avoid overeating. Fight through the fatigue and you will be rewarded.

In his article, Dr. Chaput discusses the impact that lack of sleep has on an individual's weight. He discusses the importance of both sleep quantity and quality for good health, and the idea that sufficient sleep may help an individual avoid weight gain. The article offers the suggestion that the best way to improve sleep is to remain physically active, which may have a long-term impact on reducing the likelihood of weight gain associated with a lack of sleep.

“ The best way to improve sleep is to remain physically active, which may have a long-term impact on reducing the likelihood of weight gain. ”

Dr. Stephen McDonough



Lack of Sleep Can Lead to Weight Gain



Chronic sleep restriction is pervasive in modern societies, and there is robust evidence supporting the role of reduced sleep as contributing to the current obesity epidemic.

Introduction and Definitions

Good sleep hygiene and regular physical activity are key elements for the maintenance of optimal health and functioning throughout life. In contrast, excess body fat, especially when stored in the abdominal area, can be detrimental to health by increasing the risk for chronic diseases. It is well known that obesity prevalence rates have skyrocketed in the past 30 years.¹ Increased caloric intake and lower levels of physical activity are well-studied contributors to the “obesity epidemic,” among many other factors.

In contrast, the possibility that sleep—the most sedentary activity of all—contributes to the obesity epidemic is only starting to be documented by scientists.² In a world that values productivity, time is a precious commodity. It is therefore not unusual for people to cut into their sleep time to finish everything they believe has to be done in a day, or to wind down before heading to bed. In fact, it is becoming more common for people to view less sleep as beneficial and associated with being “hardworking.”

Unfortunately, many people ignore the negative impact of this type of behavior on their health. Fortunately, recent research into the effects of sleep is helping people become aware of the benefits of good sleep hygiene for overall health.³

The term “lack of sleep” generally refers to an insufficient amount of sleep for optimal functioning. While the ideal amount of sleep per night varies from one person to another, research accumulated over the past 10 years consistently shows that adults who sleep fewer than seven hours a night and school-age children who sleep fewer than 10 hours a night are at higher risk of gaining weight and having poor health outcomes than those with adequate sleeping habits. According to widely used sleep recommendations issued by the National Sleep Foundation,⁴ adults should get between seven and nine hours of sleep a day (Table 1). However, unlike the *Physical Activity Guidelines for Americans*, sleep recommendations have been developed by expert consensus, and this approach cannot ensure that guidelines are necessarily based on the best available evidence. If sleep recommendations are to help us interpret normative values and drive



Table 1.
Sleep Recommendations Issued by the National Sleep Foundation

Age	Sleep Needs (hours/day)
Newborns (0–2 months)	12–18 hours
Infants (3–11 months)	14–15 hours
Toddlers (1–3 years)	12–14 hours
Preschoolers (3–5 years)	11–13 hours
School-age children (5–10 years)	10–11 hours
Adolescents (10–17 years)	8.5–9.25 hours
Adults (18–64 years)	7–9 hours
Elders (≥65 years)	7–9 hours

Adapted from the National Sleep Foundation.⁴

public policies and interventions, then sleep guidelines should be informed by a systematic review of the best available evidence in the field.⁵ Furthermore, we need to keep in mind that the vast majority of studies assess “sleep duration” (i.e., time in bed from bedtime to wake-up time) as it relates to health outcomes; however, an assessment of optimal sleep reaches well beyond the notion of sleep quantity, including sleep quality, timing, architecture (different sleep stages such as deep sleep, light sleep, etc.), consistency, and continuity.

Current Problem

It is increasingly recognized that we sleep less now compared to many decades ago.^{6,7} Multiple factors are responsible for this general decline in sleep duration, including artificial light, caffeine use, late-night screen time, irregular work shifts, medical disorders, and social jet lag (i.e., the modern tendency of living a lifestyle in dissonance with the inherent biological clock). The modern way of living, with its 24/7 lifestyle, thus appears to be an important driver of this “sleep deprivation epidemic.”³ However, few

people really understand the consequences of reduced sleep time on overall health. A growing body of experimental evidence shows that insufficient sleep exerts wide-ranging adverse effects on a variety of systems. For instance, hormonal changes can lead to poor health outcomes if poor sleeping habits are maintained on a regular basis.^{8,9} Epidemiological evidence also shows that short sleep duration (typically less than six to seven hours per night in adults) is associated with a higher risk of obesity,^{10,11} type 2 diabetes,^{12,13} coronary heart disease,^{14,15} hypertension,^{16,17} and premature death.^{18,19}

Although both short sleep and long sleep durations have been associated with adverse health outcomes in many observational studies (especially those relying on self-reported sleep), many experts agree there is minimal risk in sleeping too much, while the adverse effects of insufficient sleep are far more important to address in today’s environment.²⁰ Given that behavioral sleep restriction appears to be linked to our modern way of living, short sleepers may find it difficult to maintain a healthy lifestyle in the current environment that promotes overconsumption of food and lower levels of physical activity. But how can we gain weight by not sleeping enough?

New Information

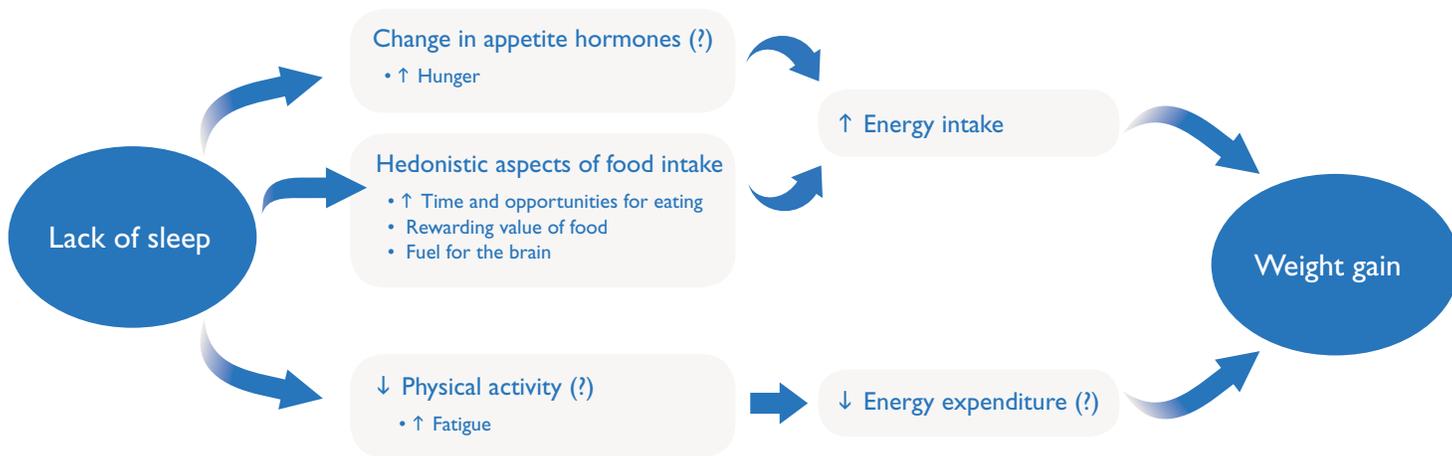
Mechanisms by Which Lack of Sleep Can Cause Weight Gain

In addition to longitudinal studies showing that insufficient sleep is associated with weight gain and obesity,^{21,22} recent experimental evidence shows that sleep restriction can lead to weight gain.^{23,24} Thus, the preponderance of the evidence taken as a whole suggests that insufficient sleep is a contributor to weight gain. There is also the possibility of bidirectional effects, such as insufficient sleep causing weight gain and obesity causing insufficient sleep, hence creating a setting for a vicious circle.²⁵ This article will focus on the different elements that might explain why a lack of sleep can cause weight gain.



Avoid caffeine consumption (e.g., coffee, soft drinks, chocolate) starting in the late afternoon.

Figure 1. Most Plausible Mechanisms by Which a Lack of Sleep May Lead to Weight Gain



Adapted from Chaput et al.² The symbol (?) means a lack of scientific support.

In order to induce weight gain, reduced sleep must either increase food intake and/or reduce energy expenditure. The mechanisms by which a lack of sleep can lead to weight gain are illustrated in Figure 1. On a hormonal level, lack of sleep may disrupt a number of hormones that affect our drive to eat. The seminal study by Spiegel et al.²⁶ published in 2004 helped to fuel this field of research and the interest for a hormonal explanation. Indeed, they showed that two consecutive nights of sleep restriction to four hours instead of 10 hours induced decreased levels of leptin (a hormone signaling fullness) and increased levels of ghrelin (a hormone signaling hunger) in energy-restricted adults.

In contrast, recent experiments similar to free-living conditions, which means studies not in a laboratory but in the natural environment (e.g., at home) have not been able to reproduce Spiegel’s findings and show either no change in ghrelin/leptin or increased leptin levels related to sleep restriction.²⁷⁻³² Thus, the consistent finding that sleep restriction is associated with increased caloric intake may, in fact, not be triggered by hormonal changes that increase hunger.³³

The idea for a “hedonic” rather than “hormonal” explanation can be explained as follows: less time spent sleeping translates into more time and opportunities for eating, particularly with sedentary activities like watching television and sitting at the computer.^{34,35} In an environment where energy-dense foods taste good and are readily available, caloric intake may be directly proportional to the time spent awake. Habitual short sleepers report eating more often (greater than three meals per day, with more frequent snacking or nibbling) than long sleepers.³⁶ Experimental curtailment of sleep is associated with a greater number of meals consumed daily in adults,²³ as well as increased consumption of desserts and sweets in teenagers.³⁷ Overall, lack of sleep seems to lead to an increase in food intake through more snacks consumed, more meals eaten per day, and the preference for energy-dense foods (i.e., unhealthy foods).³

Increased food intake associated with a lack of sleep can also be seen as a normal physiological adaptation to provide energy needed to sustain additional wakefulness. A recent experimental study reported that transitioning from an insufficient to an adequate sleep schedule decreased energy intake, especially fats and carbohydrates, and led to weight loss.²⁴ According to another study, people who experience daytime sleepiness may consume energy-dense foods to upgrade their energy level or alleviate their negative mood or psychological distress.³⁸



Increased food intake associated with a lack of sleep can be seen as a normal physiological adaptation to provide energy needed to sustain wakefulness.

Multiple factors are responsible for the general decline in sleep duration, including irregular work shifts, artificial light, caffeine use, late-night screen time, medical disorders, and social jet lag.



It is becoming more common for people to view less sleep as beneficial and associated with being “hardworking.”

Lack of sufficient sleep also seems to reduce dietary restraint (i.e., the intent to control food intake).²⁴ Likewise, recent evidence suggests that short-duration sleepers who are more predisposed to overeating in response to external cues, known as “disinhibited eating,” should be more prudent because this eating behavior is likely to be enhanced with reduced sleep.³⁹

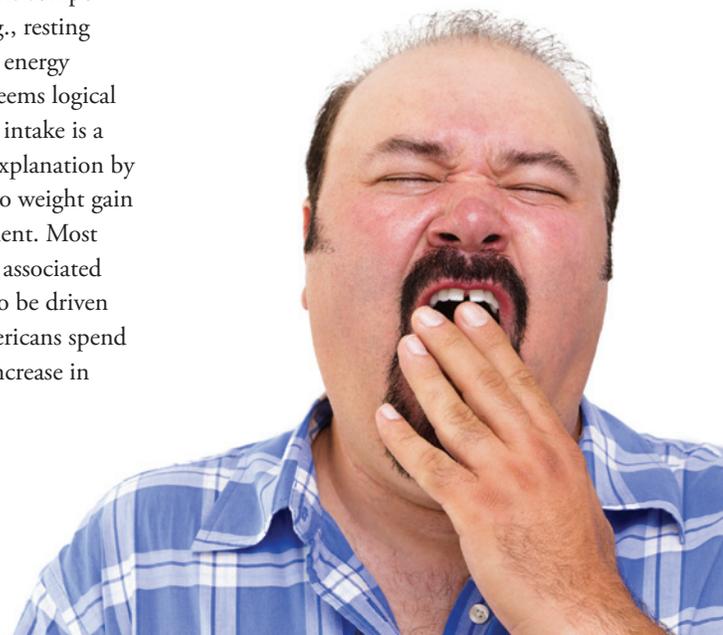
On the other side of the energy balance equation, decreased energy expenditure represents another possible explanation by which a lack of sleep can lead to weight gain. Using a whole-room calorimetric chamber—the gold standard to measure 24-hour energy expenditure in humans—Markwald et al.²⁴ showed that sleep restriction (five hours vs. nine hours of sleep per night) increased 24-hour energy expenditure by 5 percent, mainly due to the energy cost of additional wakefulness. However, the setting of a calorimetric chamber greatly limits physical activity levels, and it is possible that this component of energy expenditure is the one most likely to be influenced by a lack of

sleep. For example, sleep loss leads to a general feeling of fatigue, which can make us feel less inclined to want to do physical activity. In support of this idea, experimental sleep restriction under free-living conditions was accompanied by a decrease in spontaneous physical activity in a recent study, especially in high-intensity physical activities.³¹ However, the research is far from consistent and shows important variations between people. Studies investigating the effects of sleep restriction on physical activity energy expenditure have reported conflicting findings, with either an increase, a decrease, or no change in physical activity levels as a result of sleep restriction.⁴⁰ Our research team recently reviewed the research on short sleep duration and its association with energy expenditure and concluded that short sleep duration does not substantially affect total energy expenditure (i.e., amount of calories burned over 24 hours), nor is there sufficient evidence in support of any meaningful effect of restricted sleep on the different components of energy expenditure (e.g., resting metabolic rate, physical activity energy expenditure).⁴¹ Collectively, it seems logical to conclude that increased food intake is a more important and plausible explanation by which a lack of sleep may lead to weight gain and obesity in today’s environment. Most important, excess energy intake associated with insufficient sleep appears to be driven more by the fact that adult Americans spend more hours awake than by an increase in appetite hormones.⁴²

Do Sleeping Habits Influence the Success of Weight Loss Interventions?

Insufficient sleep is gaining attention and recognition as a behavioral factor that can impede weight loss.⁴³ Indeed, sleeping habits should not be overlooked when prescribing a weight loss program. Interest in this area came with the publication of an experimental study showing that participants under the same energy-restricted diet lost more body fat with eight and a half hours of sleep per night compared to only five and a half hours.⁴⁴ The authors observed that participants in the shorter sleep group had higher ghrelin levels than participants in the longer sleep group. Mechanisms that may explain why insufficient sleep could compromise the efficacy of weight loss interventions are still under investigation but may include higher ghrelin levels in short sleepers (ghrelin facilitates the retention of fat) and increased hunger, making adherence to diet plans more difficult.

In agreement with these novel findings, our research team recently assessed in a real-life setting whether adequate sleep might be an important factor in successful weight loss in overweight and obese adults undergoing moderate caloric restriction. We observed that both sleep quantity and sleep quality predicted loss of fat mass, with short sleep duration and poor sleep quality being associated with less fat lost.⁴⁵ Other studies have yielded similar results.⁴⁶⁻⁴⁸ Overall, mounting evidence emphasizes the need to consider sleep hygiene as part of any weight loss program.



Can We Lose Weight by Sleeping More?

The idea that increasing sleep duration may impact body weight is a new area of research. However, clinical trials measuring the effects of sleep extension on weight change and appetite control among obese people having short sleep durations have not been published, so the answer to this question is not yet available. However, preliminary observations from a randomized controlled trial aimed at examining the effects of extending sleep on body weight in short-duration sleepers who are obese suggest that the participants reported more willingness to exercise and fewer cravings for sweets and salty foods during the evening.⁴⁹ In that study, behavior-based interventions are used to increase sleep duration to a healthy length (approximately seven and a half hours) in obese adults sleeping less than six and a half hours per night. The effects of sleep prolongation on body weight from this trial are not published yet.

Interestingly, our research team recently examined whether a favorable change in sleep duration over six years could affect body weight in adults. We observed that shifting

Insufficient sleep can increase sedentary behaviors and reduce physical activity participation.

One of the best strategies to improve sleep is to be physically active (especially through aerobic exercise) every day.

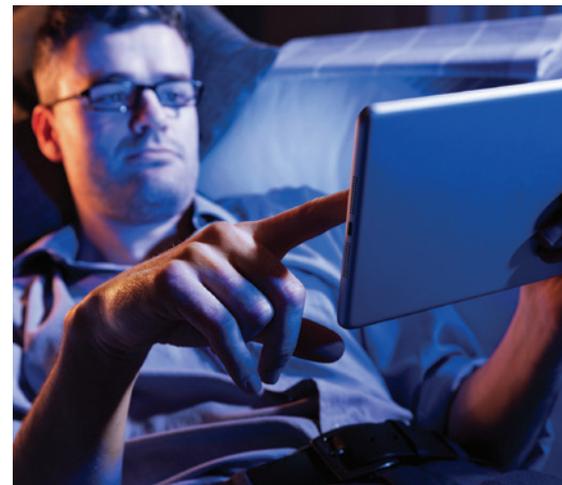


sleep duration from a short to a healthier amount of time (from less than or equal to six hours per day to seven to eight hours per day) was associated with less gain in body fat over time (2.4 kg less in people who increased their sleep duration compared with those who maintained their short sleep duration).⁵⁰ Likewise, we also reported in another study that a spontaneous change in sleep duration (from a short to an adequate duration) can limit intra-abdominal fat accumulation in adults (i.e., “bad fat”).⁵¹ Although the mechanisms have yet to be explained, achieving healthy sleep patterns

could facilitate appetite control and positively impact certain behaviors such as eating habits and physical activity to limit body fat gain over time. Overall, current observations do not suggest that people can expect to lose weight by sleeping more. Instead, sleep extension might help to prevent future weight gain, a finding of high clinical relevance.

Table 2.
General Tips for Having Healthy Sleep Hygiene

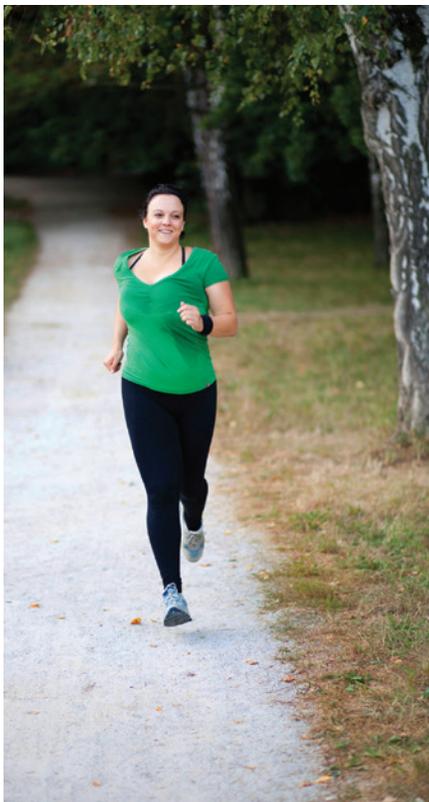
- Go to bed and wake up at the same time every day (even on the weekends!).
- Avoid caffeine consumption (e.g., coffee, soft drinks, chocolate) starting in the late afternoon.
- Avoid drinking alcohol in the evening.
- Avoid smoking cigarettes.
- Expose yourself to bright light in the morning—sunlight helps the biological clock to reset itself each day.
- Make sure your bedroom is conducive to sleep—it should be dark, quiet, comfortable, and cool.
- Sleep on a comfortable mattress and pillow.
- Exercise regularly during the day or at least three hours before going to bed.
- Develop a relaxing routine before bedtime—ideas include bathing, music, and reading.
- Don't go to bed feeling hungry, but also don't eat a heavy meal right before bed.
- Reserve your bedroom for sleeping only—keep cell phones, computers, televisions, and video games out of your bedroom.



Develop a relaxing routine before bedtime, but avoid screen time directly before sleep.

Conclusions

Increased food intake appears to be the main explanation as to why a lack of sleep can lead to weight gain. Mounting evidence suggests that a “sleep duration” of seven to eight hours per night in adults is associated with the maintenance of good health. In addition to short sleep duration, poor sleep quality and later bedtimes are also associated with increased food consumption, poor dietary habits, and obesity. Insufficient sleep can also increase sedentary behaviors and reduce physical activity participation so that the maintenance of overall health can be compromised by not getting adequate sleep. One of the best strategies to improve sleep is to be physically active (especially through aerobic exercise) every day.^{52,53} There are also other tips for maintaining good sleep hygiene (see Table 2). Collectively, it is evident that sleep should be included as part of the lifestyle package that has traditionally focused on diet and exercise. Sleep is not a waste of time, and efforts should aim to promote a good night’s sleep for overall health on a population level.⁵⁴



Scientific Summary

Daniel L. Hurley, MD

PCFSN Science Board

Consultant in the Division of Endocrinology, Diabetes, Metabolism, and Nutrition at the Mayo Clinic, Rochester, Minnesota

Chronic lack of sleep (called “sleep deprivation”) is common. Sleep deprivation is related to an increased risk of obesity, diabetes, hypertension, and heart disease. Obesity also may cause insufficient sleep, creating a vicious cycle. Modern lifestyle factors responsible for less sleep include artificial lighting, caffeine use, increased television viewing, and irregular work shifts.

In this article, Dr. Jean-Philippe Chaput notes that sleep deprivation seems to affect the amount and type of food we eat—lack of sleep is linked to eating more daytime meals and snacks, with a preference for high-calorie foods—but is not related to any known hormone defect. Sleeping well for seven and a half hours a night has been shown to promote exercise and decrease snack cravings; however, studies suggest that sleeping longer will not necessarily help lose weight, although it may help avoid weight gain.

Chaput also notes that both sleep quantity and quality are important for good health. Lack of sleep can lead to reduced daytime activity, but it does not substantially affect the way we burn calories. Still, a good night’s sleep is important to maintain health. The National Sleep Foundation recommends between seven and nine hours of sleep each night for adults. One of the best ways to improve sleep is to be physically active every day.

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