

## Lack of Sleep May Impede Fat Loss

Nedeltcheva A, Kilkus J, Imperial J, et al. Insufficient sleep undermines dietary efforts to reduce adiposity. *Ann Intern Med* 2010;153:435–41.

### Study Overview

**Objective.** To examine the effect of sleep on body adiposity in an experimental setting.

**Design.** Randomized, 2-period, 2-condition, inpatient cross-over study in which subjects were assigned to each of two 14-day conditions during separate time periods. The first condition allowed 8.5 hours of nighttime sleep while the second condition allowed only 5.5 hours. During both conditions, subjects were placed on a moderately-caloric-restricted diet. The diet was similar for each of the subjects, with variations based only on the caloric content, which was set at 90% of each individual's baseline resting metabolic rate.

**Setting and participants.** 10 patients (3 women, 7 men) in one university clinical research center and sleep laboratory. Inclusion criteria were physical inactivity, nonsmoker, age 35 to 49 years, body mass index of 25 to 32 kg/m<sup>2</sup>, and a typical sleep duration of 6.5 to 8.5 hours daily. Exclusions were made for a history of sleep problems, nighttime employment, variable sleep habits, excessive alcohol or caffeine intake, use of medications that could affect sleep, physically demanding occupations, pregnancy, or any abnormalities found on the screening medical history, physical exam, or laboratory work.

**Main outcome measures.** The primary measures included loss of fat and fat-free body mass. Secondary measures were energy expenditure, hunger, 24-hour metabolic hormone concentrations, and change in substrate utilization (respiratory quotient, which demonstrates whether fat or protein is primarily utilized).

**Main results.** During the reduced sleep phase, subjects lost less fat (0.6 kg vs. 1.4 kg for the 8.5 sleep-allowance phase;  $P = 0.043$ ) but lost more fat-free body mass (2.4 kg vs. 1.5 kg;  $P = 0.002$ ). During this phase, subjects also showed evidence for more hunger and more endocrine and metabolic adaptation to the circumstances of caloric restriction, including a higher ghrelin level, a lower resting metabolic rate, lower epinephrine levels, and higher fasting and non-fasting re-

spiratory quotients. Levels of leptin, norepinephrine, growth hormone, and thyroid hormone were no different between the sleep duration conditions.

**Conclusion.** Reduced sleep impairs the ability to lose body fat.

### Commentary

Sleep duration has emerged as a potentially important risk factor for overweight and obesity. The reduction in average sleep duration over the last several decades, during the development of the obesity epidemic, has heightened interest in this association [1]. Studies have demonstrated links between sleep and weight among both adults and children [2–6], and at least one clinical trial is underway that will encourage increasing sleep duration as a means of facilitating weight loss [7]. Several endocrine and metabolic mechanisms have been hypothesized as mediating factors between the association of sleep and weight. For example, one prior experimental study of 12 healthy men found that during reduced sleep, men had more hunger, a higher appetite, higher levels of ghrelin (a hormone that induces appetite), and lower levels of leptin (a hormone that induces satiety) [8]. How this relationship changes during periods of caloric restriction is still somewhat unclear.

The study by Nedeltcheva et al set out to examine the interplay of caloric restriction, adiposity, and sleep in an experimental setting. They provided subjects with a reduced calorie diet—a mean of 1450 calories daily—while observing them in an inpatient setting during each of the two 2-week observation periods. They found that during reduced sleep duration (5.5 hours in bed with a mean of 5 hours, 14 minutes of sleep), certain adaptations, such as elevated ghrelin, lower epinephrine, high respiratory quotient, and lower resting metabolic rate, were coupled with less loss of fat when compared with the phase during which subjects had higher sleep duration (8.5 hours in bed, 7 hours, 25 minutes of sleep). The amount of fat lost during the reduced sleep duration was significantly lower, with a mean of 0.8 kg more fat lost during the extended sleep duration phase. Overall weight loss during the 2 sleep phases was similar; however, during the reduced sleep phase, subjects lost more fat-free

mass than during the extended sleep phase.

The results demonstrate several mechanisms whereby reduced sleep may impair the loss of fat mass above and beyond behavioral factors that could link reduced sleep to weight, such as fatigue contributing to poor dietary decisions or reluctance to participate in physical activity [9]. A lower metabolic rate and epinephrine level should reduce energy expenditure regardless of physical activity levels, making it more difficult to lose weight. The higher respiratory quotient should increase the breakdown of protein rather than fat, a finding that was evident in the results showing a higher reduction in lean body mass (instead of fat) in the reduced sleep duration phase. A preferential reduction in lean body mass may lead to a quicker plateau in weight loss versus reductions in body fat because of the limited ability to continually reduce lean body mass.

The design of this study was robust. The crossover design allowed for complete control of in-person differences. The use of an experimental design, with subjects spending two 2-week periods within the study center, also facilitated control over activity levels and food intake. This level of precise control over conditions makes the changes found between sleep duration phases much more compelling.

This study also has several limitations. First, the small sample size greatly limits generalizability. Also, despite the level of control in this study being a strength for the internal validity of the results, the artificial nature of the study make this a weakness as well, for subjects will experience widely divergent conditions in their home environment. These are factors that are typical for experimental studies and are to be expected. Second, subjects had a baseline lower body weight and lower body fat at the beginning of the reduced sleep duration phase, a fact that may at least in part contribute to the smaller change in body fat during this phase. Authors did control for baseline weight in analyses, at least partly offsetting this baseline difference. Third, the changes noted during the reduced sleep phase should have translated into a lower calculated energy expenditure during this phase, but no significant differences in energy expenditure were noted, perhaps, as the authors state, because of excess variation in energy expenditure over what they hypothesized.

This study contributes greatly to the understanding of the role that sleep may play in blunting or facilitating loss of adiposity. Its results are far from definitive, as an accom-

panying editorial states clearly [9]. Not only do population studies need to thoroughly investigate the role of sleep duration during weight loss efforts, but these experimental results must be replicated as well. Regardless of the limitations and need for additional research, the results are thought-provoking from a clinical perspective. Applying these results to clinical practice is perhaps premature but also has very low risk associated with its incorporation into routine advice. Patients who are committed to weight loss should know that inadequate sleep may impact negatively their chance for success.

### **Applications for Clinical Practice**

Clinicians should consider incorporating advice about sleep duration into their routine advice to patients about weight loss strategies.

—Review by Jason P. Block, MD, MPH

### **References**

1. National Sleep Foundation. 2005 Sleep in America Poll. Accessed 10 Oct 2010 at [www.sleepfoundation.org/sites/default/files/2005\\_summary\\_of\\_findings.pdf](http://www.sleepfoundation.org/sites/default/files/2005_summary_of_findings.pdf).
2. Anic GM, Titus-Ernstoff L, Newcomb PA, et al. Sleep duration and obesity in a population-based study. *Sleep Med* 2010;11:447-51.
3. Watson NF, Buchwald D, Vitiello MV, et al. A twin study of sleep duration and body mass index. *J Clin Sleep Med* 2010;6:11-7.
4. Watanabe M, Kikuchi H, Tanaka K. Association of short sleep duration with weight gain and obesity at 1-year follow-up: a large-scale prospective study. *Sleep* 2010;33:161-7.
5. Taveras EM, Rifas-Shiman SL, Rich-Edwards JW, et al. Association of maternal short sleep duration with adiposity and cardiometabolic status at 3 years postpartum. *Obesity* 2010 [Epub ahead of print].
6. Taveras EM, Rifas-Shiman SL, Oken E, et al. Short sleep duration in infancy and risk of childhood overweight. *Arch Pediatr Adolesc Med* 2008;162:305-11.
7. Cizza G, Marincola P, Mattingly M. Treatment of obesity with extension of sleep duration: a randomized, prospective, controlled trial. *Clin Trials* 2010;7:274-85.
8. Spiegel K, Tasali E, Penev P, et al. Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med* 2004;141:846-50.
9. Taheri S, Mignot E. Sleep well and stay slim: dream or reality? *Ann Intern Med* 2010;153:475-6.