

Sleeping more to improve appetite and body weight control: dream or reality?^{1,2}

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Short sleep duration as a possible cause of obesity has received considerable attention in the media and scientific literature over the past 10 y. Interest in this topic area has been partly fueled by the observation that decreases in sleep duration occurred concurrently with increases in obesity prevalence (1, 2). Epidemiologic studies have consistently shown that short sleep duration is associated with obesity and weight gain (3), whereas short-term experiments have provided valuable mechanistic explanations (4). Recent intervention studies have also shown that sleep restriction leads to weight gain in humans (5, 6). Thus, there is a preponderance of evidence to suggest that insufficient sleep is a contributor to weight gain and that healthy sleep habits should be recommended to facilitate body weight control.

In this issue of the Journal, Dashti et al. (7) examined associations between sleep duration, body mass index (BMI), and macronutrient intake and assessed whether *CLOCK* (circadian locomotor output cycles kaput) variants modify these associations. The authors tested their hypotheses in large cross-sectional meta-analyses of population-based cohorts including 14,906 participants of European descent. They found that longer sleep duration was associated with lower BMI and with age- and sex-specific favorable dietary behaviors. Moreover, they found that *CLOCK* variants could modify the associations between sleep duration and dietary intake; however, the results were only nominally significant (i.e., at $P < 0.05$, and not at the prespecified Bonferroni-corrected significance level of $P < 0.002$). Nevertheless, the authors' conclusion was that "longer habitual sleep duration could ameliorate genetic predisposition to obesity via a favorable dietary profile."

The main strength of this study was its multinational assessment of sleep duration, BMI, macronutrient intake, and *CLOCK* variants in a large number of participants. Key limitations to keep in mind include the use of self-reported sleep duration (different questions used) and dietary intake (food-frequency questionnaires), the failure to adjust for important confounding variables (e.g., socioeconomic status and physical activity level), and the use of a cross-sectional study design precluding causal inferences. Furthermore, it is unclear as to whether the authors looked at possible U-shaped associations between sleep duration and BMI, as generally reported in previous studies, especially in studies using self-reported sleep duration.

Results observed in this well-powered study are consistent with an accumulating body of evidence showing that short sleep

duration is associated with excess weight and higher food intake (8, 9). Other authors also reported that short sleep duration activates obesity-related genes, whereas longer sleep duration may be protective by suppressing genetic influences on body weight (10). The observation of a gene-environment interaction between sleep duration and BMI suggests that recommendations for sleep should be individualized, with an emphasis on individuals having genetic vulnerabilities for obesity.

Previous research has been instrumental in showing that increased food intake is the main mechanism by which short sleep duration leads to weight gain (9). More recently, studies have provided important information to the effect that the hormonal explanation (e.g., changes in leptin and ghrelin concentrations) is probably not the most important mechanism to explain the link between reduced sleep and increased food intake. Indeed, in real-life conditions with free access to food, excess energy intake associated with sleep curtailment appears to be preferentially driven by hedonic rather than hormonal factors (9, 11). Although food intake may be directly proportional to the time spent awake in the current obesogenic environment, studies consistently show that shortened sleep increases snacking, the number of meals eaten per day, and the preference for energy-dense foods (9). Interestingly, new neuroimaging experiments show that sleep restriction enhances hedonic stimulus processing in the brain underlying the drive to consume foods (12–14). Accordingly, scientists who wish to investigate the mechanisms linking insufficient sleep to weight gain should focus more on understanding the rewarding aspects of food that accompany sleep loss.

The growing body of evidence in this field of research reminds us that sleep is not a "waste of time" after all and the maintenance of healthy eating behaviors is compromised by not getting adequate sleep. It is now time to better understand the clinical benefits of increasing sleep duration on eating behaviors and body weight control (15). Furthermore, we need to better understand the importance of adequate sleep to improve the treatment of

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obesity (16). Finally, better marketing campaigns and dissemination strategies are needed to promote the importance of a good night's sleep for overall health from a population standpoint. Many people living in modern societies are sleep-deprived, and they generally underestimate the fact that sleep is as important as healthy eating and physical activity for good health. This observation is perhaps a wake-up call to better integrate our approaches to maximize success in our interventions aimed at managing weight problems and improving health outcomes.

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