Compromised sleep increases food intake in humans: two sexes, same response?

Dear Sir:

In the August issue of the Journal, we read with great interest the article by St-Onge et al (1). In this study, the authors showed that 4 d of limited nocturnal sleep (4 h/night) in humans were linked to increased intake of food, especially those rich in fat, without any significant change in total energy expenditure. These findings provide further mechanistic insight into why chronically sleep-deprived people are more prone to develop obesity.

Although this study provided important information linking chronic sleep curtailment with obesity, one important determinant of the study design that was not addressed in the article requires more detailed discussion. In addition to male volunteers, the authors also included premenopausal women to examine how recurrent partial sleep deprivation modulates food intake and total energy expenditure in humans. However, they did not measure gonadotropic hormones, such as estrogen, which would have allowed them to control for the effect of the menstrual cycle. This point appears to be relevant because Lyons et al (2) previously showed that in circulating estrogen concentrations across the menstrual cycle exerts a strong influence on energy consumption in eumenorrheic women, in that the food intake was lowest at the time of ovulation. Furthermore, recent findings in eumenorrheic lean women showed that high, compared with low, circulating estradiol concentrations may reduce food intake by decreasing neural activity to food cues in visual cortical pathways associated with reward (3). Bearing these results in mind, it cannot be differentiated whether the findings of St-Onge et al have been biased by uncontrolled variations in circulating concentrations of ovarian hormones. Although the results of enhanced food intake in sleep-deprived humans are in line with previous findings (4), more research is definitely needed to examine how a reduction in sleep may influence energy balance in women, and whether the influence of compromised sleep on food intake varies across the menstrual cycle.

None of the authors reported any biomedical financial interests or any potential conflicts of interest.

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Reply to N Herzog et al

Dear Sir:

We would like to thank Herzog et al for their interest in our article (1) and for raising questions regarding the role of sex hormones on the effects of sleep duration on energy balance. As highlighted in their letter, we did not measure sex steroid hormones in our study and acknowledge that this may have affected our results. However, to account for potential intraindividual variations in physiology and behavior across the menstrual cycle, each study phase was conducted 4 wk apart. Assuming that the average menstrual cycle length is ~27 d (2), women would have been in the same phase of their menstrual cycle in both of our study conditions. Moreover, because roughly half of the women underwent short sleep first, whereas the other half underwent habitual sleep first, and our data were adjusted for phase order, any systematic bias in our data is unlikely.

Of additional note is the lack of effect of sleep duration on energy expenditure. These results are relevant in this argument because resting metabolic rate is also affected by fluctuations in hormone concentrations over the menstrual cycle (3, 4). Therefore, if women were in different phases of their menstrual cycle, and there was a bias in the menstrual cycle phase order, then a difference in resting metabolic rate between study phases would be expected. This was not the case in our study. Moreover, whereas the short sleep condition in our study (sleep times: 0100–0500 h) necessarily resulted in a reduction of rapid eye movement (REM) sleep, the observed reduction was not modulated as a function of sex (data not reported in the original article). Specifically, in the short sleep phase, 5-d REM sleep duration
was (mean ± SEM) 44.05 ± 2.51 and 43.55 ± 2.52 min in men and women, respectively (t(24) = −0.141, P = 0.89; unpaired sample t test). Likewise, no sex differences in REM sleep were observed in the habitual sleep duration condition. This is pertinent because, like resting metabolic rate, REM sleep varies across the menstrual cycle with significant reductions observed during the postovulatory luteal phase compared with the preovulatory follicular phase (5). Therefore, if sex hormone status across menstrual phases was confounding the data previously reported, we would also expect to see sex differences in REM sleep, which were not observed.

Nevertheless, the comments by Herzog et al raise important questions. We have proposed that short sleep duration may be more closely related to body composition in women than in men (6), and it has been reported that hormonal changes across the menstrual cycle can interfere with food intake, including preferences for sweet and fat, as well as energy expenditure (4). However, it remains to be determined whether sleep duration, which has been shown to alter leptin and ghrelin concentrations (7), affects energy balance in women differently across the menstrual cycle. This area of research deserves further attention because studies have found that leptin concentrations differ across the menstrual cycle in normal-weight women (8), and there are conflicting reports on the role of sex steroid hormones on ghrelin concentrations (9, 10).

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