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Original article

The Impact of Sleep Improvement on Food Choices in Adolescents With Late Bedtimes

Lauren D. Asarnow, Ph.D. [a], Stephanie M. Greer, Ph.D. [b], Mathew P. Walker, Ph.D. [a,b], and Allison G. Harvey, Ph.D. [a,*]

[a] *Department of Psychology, University of California, Berkeley, Berkeley, California*
[b] *Neuroscience Department, Helen Wills Neuroscience Institute, University of California, Berkeley, Berkeley, California*

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A B S T R A C T

Purpose: The aim was to investigate the effect of sleep improvement on desire for and intake of weight gain–promoting foods in adolescents with late bedtimes.
Methods: A sample of 42 adolescents with late bedtimes was enrolled in an intervention designed to improve sleep. Their desire for and intake of food in the morning was assessed at before and after treatment.
Results: Adolescents with earlier bedtimes at post-treatment relative to pretreatment increased their caloric intake of low glycemic index, fruit, and dairy foods at post-treatment. This effect was not observed in adolescents who did not improve their bedtime at post-treatment.
Conclusions: These findings suggest that advancing bedtimes earlier can improve breakfast choices, an important meal for obesity prevention during adolescence.

IMPLICATIONS AND CONTRIBUTION

The unique contribution of the present study is to investigate the relationship between sleep and breakfast choices in adolescents and sleep improvement as a potential mechanism for changes in food choice. The data suggest that earlier bedtimes are associated with an increased intake of healthier foods for breakfast.

The average adolescent in the United States sleeps approximately 7 hours during the school year and 33% of adolescents go to bed later than 11:15 P.M. [1]. With the onset and progression through puberty, there is a biologic shift toward both going to sleep and getting up later, often referred to as an eveningness circadian preference, which when combined with early school start times are thought to be major contributors to this sleep deficit [2,3]. The combined picture is of concern given that both late bedtimes and short total sleep time (TST) are independently associated with a range of adverse outcomes [1,4], including higher risk of obesity [5,6].

Rates of obesity are rising rapidly among children and adolescents [7]. Eating behaviors tend to persist from adolescence into adulthood and thus adolescence is a particularly important period for obesity prevention [8]. Increased intake of low glycemic index (GI) foods has been linked to obesity prevention [9,10]. GI is a measure of how quickly blood glucose levels (i.e., blood sugar) rise after eating a particular type of food. Low-GI foods promote satiety by supporting fat instead of carbohydrate metabolism and higher levels of the satiety promoting hormone leptin [11]. Indeed, obese children who were given high-GI breakfasts ate 53% more throughout the day than those with medium or low-GI breakfasts [12]. Moreover, a small experimental study in nine healthy adult men indicated the timing and amount of leptin secreted were altered by consuming high-GI meals [13].

Conflicts of Interest: The authors have no conflicts of interest to disclose.
Present address: Lauren D. Asarnow is now at Stanford University School of Medicine, Psychiatry Department.

* Address correspondence to: Allison G. Harvey, Ph.D., Department of Psychology, University of California, Berkeley, 2205 Tolman Hall #1650, Berkeley, CA 94720-1650.
E-mail address: aharvey@berkeley.edu (A.G. Harvey).

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Accumulating evidence points to late bedtimes, shorter TST, and daytime sleepiness as independent risk factors for the selection and intake of more high-GI foods and fewer low-GI foods [5,14]. Late bedtime on nonschool days has been associated with greater "fast food" consumption in adolescents [15], which may be influenced by less availability of healthier food options at night. One experimental study involving adolescent participants found that short TST (defined as 6.5 hours of less hours) over 5 nights resulted in increased intake of high-GI foods [16]. Moreover, another group of researchers found that, in an experimental protocol, desire for weight gain–promoting foods increased after sleep deprivation in adults and was predicted by subjective daytime sleepiness [14].

To our knowledge, there are no published investigations as to whether sleep improvement results in healthier food choices in adolescents. There are several reasons why it is especially important to determine whether an intervention to improve sleep is effective in improving food choice in adolescents with an eveningness circadian preference (a risk factor for obesity) [5]; first, food intake plays a key role in the development and maintenance of obesity, [17] and second, there are few effective treatments for obesity [18,19].

The present study was designed within the context of an National Institute of Child Health and Human Development–funded trial designed to improve sleep for 10- to 18-year olds with an eveningness circadian preference. The aim of the present study was to investigate the effect of sleep improvement (indexed by three sleep and circadian markers derived from sleep diary), following six sessions of either an active sleep or control treatment, on (1) desire for and (2) intake of weight gain–promoting foods in the morning. The hypothesis tested is that sleep improvement from pretreatment to post-treatment, across treatment groups, will be associated with both decreased desire for and intake of weight gain–promoting foods.

Methods

Participants

The data for the present study were collected as part of a larger research project. Adolescents were eligible for the study if they scored within the lowest quartile, the cutoff for eveningness circadian preference, on the Children's Morningness Eveninigness Preference Scale [20]. In addition, the adolescent must have had the current pattern of late bedtimes for the last 3 months based on self-report and parent report. Adolescents were ineligible to participate, if (1) they could not communicate in English or Spanish; (2) they had an active, progressive physical illness, or neurological degenerative disease directly related to the onset and course of the sleep disturbance; (3) there was evidence from clinical diagnosis or report of sleep apnea, restless legs, or periodic limb movements during sleep; (4) they had an intellectual disability, autism spectrum disorder, or any other significantly impairing pervasive developmental disorder; (5) there was evidence from clinical diagnosis or report by youth or parent of bipolar disorder or schizophrenia; or (5) they had a history of substance dependence in the past 6 months.

Participants were recruited for the present study via administrators and parent groups at local schools as well as advertisements on list serves, Craigslist, and Facebook.

Design

All procedures were approved by the University of California, Berkeley, Committee for the Protection of Human Subjects (protocol ID 2012-02-4007).

For adolescents who met eligibility criteria after an in-person assessment, 7 to 10 days of sleep diary was collected. Participants then spent the night before the food desire and snack tasks in the laboratory. In the laboratory, each participant went to bed at their average weekday bedtime and woke at their average weekday rise time as defined by their sleep diary. In the morning, a standardized breakfast of one slice of toast and jam was provided. The food-desire task followed by the snack task was then administered. An identical protocol was repeated after completion of 6 weeks of intervention.

Using a computer-generated random numbers list, a research assistant conducted randomization of adolescents to either an active sleep or psychoeducation (PE) condition, stratified by age and sex. In the present study, adolescents were collapsed across conditions. Forty-two adolescents participated in the present study.

Measures of demographic characteristics

Demographic characteristics assessed included parent reports of the adolescents' age, biological sex, race/ethnicity, and household income.

Investigators measured height and weight, from which BMI was calculated. BMI was transformed into z-scores for age and sex.

Sleep measures

Sleep diary. The daily sleep diary is a valid and sensitive measure in the detection of differences due to weekends, age, gender, sleep timing, and sleep quality [21–23]. In the present study, trained research assistants called the adolescents to collect their sleep diary each morning at an agreed-upon time.

While the full sleep diary was administered, based on a review of the literature [24,25], bedtime and TST were determined to be the strongest risk factors for weight gain–promoting food choice and thus were selected as the sleep parameters of interest for the current investigation. Bedtime and TST difference scores were calculated by subtracting average pretreatment scores from average post-treatment scores. Earlier bedtimes at post-treatment compared with pretreatment constituted the "Bedtime Improvement Group" (n = 22); the same or later bedtimes at post-treatment compared with pretreatment constituted the "No Bedtime Improvement Group" (n = 20). Longer TST at post-treatment compared with pretreatment constituted the "TST Improvement Group" (n = 24); the same or shorter TST at post-treatment compared with pretreatment constituted the "No TST Improvement Group" (n = 18).

Sleepiness scale. The sleepiness scale is a well validated and widely used measure used to quantify subjective sleepiness throughout the day [26]. The sleepiness scale showed a Pearson *r* test-retest reliability correlation of .65 ($p < .01$), and based on the criterion of .70, the internal consistency coefficients of the subscale are near (.65) or above (.70), acceptable standards for the control and clinical samples, respectively [26]. The sleepiness scale asks, "During the last two weeks, have you struggled to stay