Appetite 80 (2014) 220–224

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Research report

The effects of extended bedtimes on sleep duration and food desire in overweight young adults: A home-based intervention ☆

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ARTICLE INFO

Article history:
Received 19 March 2014
Received in revised form 23 April 2014
Accepted 17 May 2014
Available online 21 May 2014

Keywords:
Sleep extension
Appetite
Food desire
Obesity
Sleep hygiene

ABSTRACT

Introduction: Sleep curtailment is an endemic behavior in modern society. Well-controlled laboratory studies have shown that sleep loss in young adults is associated with increased desire for high-calorie food and obesity risk. However, the relevance of these laboratory findings to real life is uncertain. We conducted a 3 week, within-participant, intervention study to assess the effects of extended bedtimes on sleep duration and food desire under real life conditions in individuals who are at risk for obesity. *Methods*: Ten overweight young adults reporting average habitual sleep duration of less than 6.5 h were studied in the home environment. Habitual bedtimes for 1-week (baseline) were followed by bedtimes extended to 8.5 h for 2-weeks (intervention). Participants were unaware of the intervention until after the baseline period. Participants received individualized behavioral counseling on sleep hygiene on the first day of the intervention period. Sleep duration was recorded by wrist actigraphy throughout the study. Participants rated their sleepiness, vigor and desire for various foods using visual analog scales at the end of baseline and intervention periods. *Results*: On average, participants obtained 1.6 h more sleep with extended bedtimes (5.6 vs 7.1; $P < 0.001$) and reported being less sleepy ($P = 0.004$) and more vigorous ($P = 0.034$). Additional sleep was associated with a 14% decrease in overall appetite ($P = 0.030$) and a 62% decrease in desire for sweet and salty foods ($P = 0.017$). Desire for fruits, vegetables and protein-rich nutrients was not affected by added sleep. *Conclusions*: Sleep duration can be successfully increased in real life settings and obtaining adequate sleep is associated with less desire for high calorie foods in overweight young adults who habitually curtail their sleep.

Introduction

Sleep curtailment has become an increasingly prevalent behavior in modern society. It is estimated that average sleep duration has decreased by 1.5–2 h in the past half century. Today, as many as one-third of American adults report obtaining less than 7 h of sleep. According to a recent survey by the National Sleep Foundation (Centers for Disease Control and Prevention, 2011), roughly one-third of Americans reported, "not getting enough sleep" by comparing the hours of sleep they say they need to the hours of sleep they are actually getting on workdays or weekdays. Overall, more than half of them agreed that "not getting enough sleep" affects their job performance, ability to carry out household duties, relationship with family or friends, and ability to perform everyday activities.

Substantial evidence from population studies suggests that young adults reporting short habitual sleep durations are at increased risk of developing obesity (McNeil, Doucet, & Chaput, 2013; Nielsen, Danielsen, & Sorensen, 2011; Patel & Hu, 2008). Well-controlled laboratory studies have demonstrated that sleep restriction in young adults is associated with alterations in appetite regulation, particularly with more desire for high calorie foods (Chaput, Klingenberg, & Sjodin, 2010; Greer, Goldstein, & Walker, 2013; Schmid, Hallschmid, Jauch-Chara, Born, & Schultes, 2008; Spiegel, Tasali, Penev, & Van Cauter, 2004), which may increase the risk for weight gain. However, the relevance of these laboratory findings to real life has not been studied. In other words, there has been no intervention study so far that has investigated whether sleep time can be improved in real-life settings and whether additional sleep has any beneficial effects in individuals who are at risk for obesity. This may be because it is commonly believed that increasing sleep duration may be difficult to achieve in real life where individuals have priorities and other responsibilities competing with sleep.

Therefore, we designed our study using a home-based intervention aimed at extending bedtimes and evaluated its effects on sleep duration and food desire in at-risk individuals, while they live in their

☆ *Acknowledgment:* This work was supported by an NIH grant to the National Center for Advancing Translational Sciences (CTSA-UL1 TR000430) at the University of Chicago.

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http://dx.doi.org/10.1016/j.appet.2014.05.021
0195-6663/

usual environment. We hypothesized that sleep duration can be increased in real life settings with a behavioral intervention to extend bedtimes through individualized sleep hygiene counseling. We further hypothesized that additional sleep has beneficial effects on appetite and decreases cravings for weight-promoting, high calorie foods in overweight young adults who habitually curtail their sleep.

Methods

Design overview

The study was approved by the University of Chicago institutional review board. We conducted a within participant, intervention study under real life conditions, beginning with habitual bedtimes (baseline period; nights N01–N07) for 1 week immediately followed by extended bedtimes (intervention period; nights N08–N21) for 2 weeks. Participants were unaware of the intervention until after the habitual bedtime period to ensure that they did not modify their habitual sleep–wake behavior, and thus their habitual sleep patterns were effectively captured at baseline. Participants were told that the purpose of the study was to collect information on their sleep–wake patterns at home. They were also told that they may be asked to modify the timing of sleep, but not that this change would result in a sleep extension. The advertisements stated that the study involves completing questionnaires and wearing a wrist watch at home for 3 weeks. Participants received individualized behavioral counseling about sleep hygiene on the first day of the intervention period. We objectively monitored sleep–wake patterns by continuous wrist actigraphy during the entire 3-week study. Participants rated their sleepiness, vigor and desire for various food items at the end of the baseline and intervention periods.

Participants and setting

Overweight adults (age range: 21–40 years; body mass index range: 25.0–29.9 kg/m^2) reporting an average habitual sleep duration of <6.5 h were recruited through local advertisements. Exclusion criteria were insomnia, regular napping, shift work, extreme chronotype, travel across time-zones within the past 4 weeks, history of eating or psychiatric disorders, acute or chronic medical condition, alcohol abuse, smoking, pregnancy or childbirth (past year), any prescription medications, and current enrolment in diet or exercise programs. Eligibility was established by a structured survey and a brief interview. Eleven participants, who met the eligibility criteria, were enrolled. Wrist actigraphy recordings failed and were incomplete in one woman, who was excluded from the analysis. Data from the remaining 10 participants (five men, five women), who completed the study, are presented. Throughout the entire study, the participants followed their daily routine activities and slept in their usual home environment.

Intervention: extended bedtimes

During the first week of the study, participants were asked to continue their habitual bedtimes at home. On the first day of the intervention period, participants met with the study investigators in an office setting to receive individualized behavioral counseling on sleep hygiene through a structured interview. First, all social and environmental factors related to habitual sleep patterns were discussed in detail. Actigraphy data from baseline period was briefly reviewed. Next, individualized behavioral counseling on sleep hygiene was provided with the goal of accommodating the extended bedtimes in the participant's lifestyle in the best possible way. Participants also received counseling about potential modifiable factors and other barriers in their lifestyle that may prevent them from extending bedtime duration. As necessary, factors related to sleep partner, children, other family members and pets were considered and individual recommendations were provided to better implement extended bedtimes into the daily routine. At the end of the interview, participants were provided with individualized recommendations to follow at home for 2 weeks, aiming to extend bedtime duration to 8.5 h (with the intention to increase sleep duration to the healthier length of 7–8 h per night). Bedtimes and wake-up times were individually designed, taking into account personal schedules and priorities. At the end of the first week of the intervention period, the participants returned for a brief follow-up visit. Actigraphy data from the first week of the intervention period was reviewed and further counseling was provided, as needed.

Data collection

Participants were asked to wear a wrist activity monitor (Actiwatch 64, Mini-Mitter Respironics, Inc) on the nondominant arm throughout the study. This monitor detects participants' movement via accelerometers and has a built-in event marker. Participants were asked to press the event-marker button when they went to bed to sleep each night and when they got out of bed each morning. Participants also kept daily sleep logs to indicate the times when they went to bed and got out of bed. At the beginning of the study, participants completed the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) to assess overall sleep quality and Morningness–Eveningness questionnaire (Horne & Ostberg, 1976) to determine chronotypes.

At the end of each study period, participants completed validated visual analog scales of vigor (Monk, 1989) and appetite (Spiegel et al., 2004) in the morning before eating their breakfast. Sleepiness was determined from the response to the question "How sleepy do you feel?" on a 10-cm scale (with "very little" and "very much" as limits). Food desire was assessed by asking the participants to mark their ratings of how much they would enjoy eating various food items on a 10-cm scale (with "not at all" and "very much" as limits). Participants were asked to provide their ratings at the moment, without concern for calories, fat, or a healthy diet.

Data analysis and statistics

Sleep was automatically scored by Actiware Version 5 software (Respironics, Inc), an actigraphy-based sleep-scoring program using previously described and validated algorithms (Ancoli-Israel et al., 2003). Sleep duration was calculated as the sum of all epochs scored as sleep during the time in bed. Variability across nights in a participant's sleep duration was summarized using the coefficient of variation. Sleep data were averaged across nights in each participant for each study period. Sleep efficiency (reported as percentage) was defined as the total sleep time divided by the total time spent in bed multiplied by 100. Sleep latency was defined as the time in minutes before sleep onset following the bedtime. Comparisons between habitual bedtime and extended bedtime periods were performed using a two-sided paired t-test with a significance level of 0.05 (JMP 9.0.2, SAS Institute). Results are reported as mean ± SE.

Results

Participants had a mean age of 28.6 ± 1.7 years and mean body mass index of 28.0 ± 0.6 kg/m^2. Five had full-time and two had part-time jobs, two were working from home, and one was a student. The sample was comprised of three Caucasian, four African-American, one Asian and two Hispanic participants. At the beginning of the study, the average Pittsburgh Sleep Quality Index score was 5.1 ± 0.5. None of the subjects were extreme chronotypes as as-