Sleep Medicine 15 (2014) 71–75

Contents lists available at ScienceDirect

Sleep Medicine

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

Original Article

Sleep and eating in childhood: a potential behavioral mechanism underlying the relationship between poor sleep and obesity

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ARTICLE INFO

Article history:
Received 7 May 2013
Received in revised form 8 July 2013
Accepted 14 July 2013
Available online 11 October 2013

Keywords:
Sleep
Eating behaviors
Children
Emotional eating
External eating
Restrained eating

ABSTRACT

Objective: The goal of our study was to examine the associations between sleep and eating behaviors. Specifically, we examined associations between sleep duration and continuity with behaviors that promote eating regardless of true physiologic hunger state including emotional (food intake in response to emotional distress) external (eating in response to the sight or smell of food), and restrained eating (a paradoxical behavior; food intake is initially reduced to lose or maintain body weight, but followed by increased consumption and binge eating).
Participants: Fifty-six children (29 boys; 27 girls) ages 5 to 12 years participated in the study. Mean age was 7.7 ± 1.9 years, and average body mass index (BMI) was within the healthy range (17.8 ± 4.3 kg/m^2).
Methods: Sleep duration, continuity and schedule were assessed using actigraphy and self-reports. The Child Dutch Eating Behavior Questionnaire-modified version (DEBQ-M) was used to examine levels of emotional, external and restrained eating in the children.
Results: Associations between the sleep and eating behaviors were examined using partial correlations and multiple regression analyses. External eating score was negatively associated with sleep duration; emotional eating score was associated with lower levels of sleep continuity; and restrained eating score were associated with a later sleep start and later bedtime.
Conclusions: Short sleep duration and poor sleep continuity were associated with higher levels of eating behaviors shown to be associated with increased food intake. Therefore, sleep loss may be associated with diminished self-regulation of appetite in children, increasing the risk for overeating and obesity.

1. Background

The prevalence of childhood overweight and obesity has significantly increased in the past three decades, creating a major public health concern [1–3]. There is a substantial amount of evidence supporting the causal relationship between sleep deprivation, overeating, and obesity. Sleep plays a significant role in restorative processes in the body and energy metabolism; for example, it is a mediating factor in glucose metabolism [4] and controls the activity of the appetite-regulating hormones [5]. Sleep loss, in effect, has been linked to disturbances in metabolic function, such as increases in ghrelin (an appetite-stimulating hormone) and decreases in leptin (an appetite-suppressing hormone) that promote food intake [6]. Although the physiologic mechanisms that mediate the relationship between sleep deprivation, food intake, and obesity have been characterized, the psychologic and behavioral aspects of this relationship have not been investigated. Investigating this relationship is critical, as it will result in a better understanding of factors that are associated with increased eating, and therefore can help identify targets for the prevention of childhood obesity.

Psychologic aspects of eating behavior, such as eating in response to emotional states (for example, anxiety) or external cues of food (such as sight or smell) play a significant role in overeating and the development of excess body weight [7–11]. Higher levels of eating behaviors that promote food intake as a response to internal or external cues unrelated to the physiologic need to eat have been associated with increased body mass index (BMI) and waist circumference in individuals of all ages [7]. Specifically, behaviors that suggest diminished self-control in the presence of food, such as emotional (food intake in response to emotional distress), external (eating in response to the sight or smell of food), and restrained eating (a paradoxical behavior; food intake is initially reduced to lose or maintain body weight, but followed by increased consumption and binge eating) have all been associated

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http://dx.doi.org/10.1016/j.sleep.2013.07.015

with increased BMI and waist circumference in individuals of all ages [7–11]. For instance, Webber et al. [7] examined eating behavior and weight in children ages 7 to 9 years, and determined that obese subjects had increased scores for a variety of eating behaviors shown to promote food intake, such as emotional overeating [7]. This type of relationship has been observed throughout studies when controlling for confounding factors known to be associated with food intake and weight gain, including age, sex, ethnicity, parental education, television watching and physical activity. Although a strong relationship between sleep deprivation, increased food intake, and obesity has been documented, only a small number of studies have examined how aspects of eating behavior may be related to sleep quantity and quality. In healthy adults, it has been demonstrated that reduced subjective sleep quality scores are associated with increased behaviors that are shown to promote overeating, including cognitive restraint (the conscious restriction of food), binge eating (periods of uncontrolled, excessive food intake), and emotional eating (food intake in response to emotional distress) [10].

The objective of our study was to examine the relationship between sleep and emotional (food intake in response to emotional distress) external (eating in response to the sight or smell of food), and restrained eating (a paradoxical behavior; food intake is initially reduced to lose or maintain body weight, but followed by increased consumption and binge eating behaviors, all of which represent a disrupted self-control in the presence of food, causing an individual to eat regardless of true physiologic hunger state. We hypothesized that short sleep duration and decreased sleep continuity would be associated with increased levels of emotional, external and restrained eating in children.

2. Methods

2.1. Participants

This study comprised 56 medically healthy children aged 5 to 12 years. Children were recruited using newspaper advertisements. Exclusion criteria were as follows: (1) any medical condition that would interfere with study protocol and testing, including breathing problems such as asthma, diabetes mellitus, and epilepsy; and (2) food allergy or intolerance.

2.2. Procedure

To assess sleeping patterns, participant's sleep was evaluated for seven consecutive nights using actigraphy in the child's home environment. Children were asked to maintain normal sleep–wake patterns, and actiwatches were worn each night shortly before bed until shortly after waking. A daily sleep log was used along with actigraphy in which participants answered questions regarding sleep and wake times, sleepiness, overall mood, and medication intake. To evaluate eating behavior, parents filled out the child Dutch eating questionnaire (DEBQ-M) [12], which assessed levels of emotional, external, and restrained eating.

2.3. Measures

2.3.1. Eating behavior measure

2.3.1.1. Child Dutch Eating Behavior Questionnaire. The DEBQ-M, modified from the Dutch Eating Behavior Questionnaire for use in children [12] was used to examine the children's eating behavior. The DEBQ-M focuses on the three types of eating behavior, including emotional (food intake in response to emotional distress. For example: "Does feeling unhappy or upset ever make you want to eat?") external (eating in response to the sight or smell of food. For example: "If food smells and looks yummy, do you eat a lot of it?") and restrained eating (a paradoxical behavior; food intake is initially reduced to lose or maintain body weight, but followed by increased consumption and binge eating. For example: "Do you try to eat only a little when you want to eat a lot?"). All three eating behaviors induce increased food intake regardless of true physiologic hunger state. The scale includes 33 questions with three possible answers: yes (1 point), sometimes (2 points), and no (3 points) answered by participant's parents. The numbers were reversed when entered into the database so that a higher score would indicate higher levels of disordered eating. The modified DEBQ is deemed an appropriate measure to assess eating behavior in boys and girls, and both obese and normal weight children ages 7 to 12 years [12,13]. The DEBQ-M also shows good internal reliability and consistency between subscales, with Chronbach α values of 0.80, 0.82, and 0.68 for emotional, restrained, and external eating, respectively [12].

2.3.2. Sleep measures

2.3.2.1. Actigraphy. Actigraphs (AW64 series) were used to assess participants' sleep patterns in their natural home environment. These computerized wristwatch-like devices collect data generated by movements. They are minimally invasive and allow sleep to be recorded reliably without interfering with the family's routine. Actigraphy has been widely used to assess sleep and has been validated against polysomnography with agreement rates for minute-by-minute sleep–wake identification >90% [14,15]. One-minute epochs were used to analyze actigraphic sleep data. The reported bedtime and wake time (provided by the sleep logs) were used as the start and end times for the analyses. For each 1-min epoch, the total sum of activity counts was computed. If they exceeded a threshold (threshold sensitivity value = mean score in active period/45), then the epoch was considered waking. If it fell below that threshold, then it was considered sleep.

Actigraphic data were analyzed using sleep software (Actiware Sleep 3.4, Mini-Mitter) and included the following parameters: (a) bedtime – the time the child got in bed; (b) sleep start – the beginning of sleep; (c) sleep end – the end of sleep; (d) get up time – the time the child got out of bed; (e) actual sleep time – the amount of time (in minutes) between sleep start and sleep end, scored as sleep according to the Actiware-sleep algorithm; (f) assumed sleep – the difference in time between the sleep end and the sleep start times; (g) sleep efficiency – the percent time in bed that is actually spent sleeping and was calculated by dividing the actual sleep time by the time in bed and multiplying by 100; (h) sleep latency – the amount of time (in minutes) taken from bedtime until the subject falls asleep; (i) sleep bouts – the number of continuous blocks of sleep, one or more epochs in length, scored as asleep between sleep start and sleep end; (j) wake bouts – the number of continuous blocks of wakefulness, one or more epochs in length, scored as awake between sleep start and sleep end; (k) mean length of sleep bouts (mean sleep bout time) – the average length of blocks of continuous sleep, calculated by dividing the actual sleep time by the number of sleep bouts; and (l) mean length of awake bouts (mean awake bout time) – the average length of the blocks of continuous wakefulness, calculated by dividing the actual awake time by the number of wake bouts.

Bedtime, sleep start, sleep end, and get up time were used as measures of sleep schedule, actual sleep time was used as a measure of average sleep duration, and sleep efficiency, sleep latency, sleep bouts, and wake bouts were used as measures of sleep continuity.

Actual sleep time was chosen because we regarded the association between sleep and cognitive and physiologic processes as determined by the actual time spent asleep, rather than the overall time spent in bed.