



Disordered eating partly mediates the relationship between poor sleep quality and high body mass index



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ABSTRACT

Objective: We evaluated the relationship between poor sleep quality and high body mass index (BMI) in a community-derived sample. In addition, we explored the premise that disordered eating (i.e. eating late at night and/or binge eating, which can occur at night) may partly explain the relationship.

Method: An online survey asked 330 participants about their height and weight, recent sleep quality, and recent experiences of binge-eating and night-time eating.

Results: Using multiple regression analyses, high BMI was shown to be related to shorter sleep duration, increased sleep latency, use of sleeping medications and worse binge-eating, whereas worse sleep quality was related to worse night-eating, after controlling for depression and demographics. Using mediational analyses, binge-eating was shown to partly mediate the relationship between worse sleep quality to higher BMI, whereas night-eating mediated the reverse association of high BMI to worse sleep quality.

Discussion: The results suggest that night- and/or binge-eating may partly explain the observed relationship between worse sleep quality and overweight/obesity. Thus, the relationship may simply reflect that overweight people are more likely to binge-eat while they wait for sleep to come, and this may contribute to weight gain over time. In addition, the results may indicate that eating rather than weight gain or obesity may be responsible for causing the sleep deficits in overweight people.

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1. Introduction

A number of recent studies have reported the existence of a relationship between specific sleep deficits and overweight/obesity, or its proxy measure of high body mass index (BMI). For example, *insufficient sleep* has been shown to be associated with overweight/obesity (Vorona et al., 2005). In particular, sleeping less than 6 h/night and falling asleep after midnight are related to an increased risk of obesity (Shigeta, Shigeta, Nakazawa, Nakamura, & Yoshikawa, 2001). Similar results have been obtained in relation to sleep problems and long-term weight gain (Patel, Malhotra, White, Gottlieb, & Hu, 2006). In addition, a recent large meta-analysis of sleep data obtained from children and adults found a significant relationship between obesity and shorter sleep duration (Cappuccio et al., 2008).

However, the relationship between overweight/obesity and other sleep parameters is less clear. For example, overweight/obesity has been shown to predict worse sleep problems (Patel & Hu, 2008),

although the *sleep disturbance* appears to decrease as a person's weight decreases, suggesting that weight gain may contribute to sleep disturbance (Dixon, Schachter, & O'Brien, 2001). In contrast, Owens and Matthews (1998) failed to find any association between waking in the middle of the night or earlier than intended and high BMI, in a sample of healthy women. Similarly, the relationship between longer *sleep latency* (i.e., time to fall sleep) and overweight/obesity is unclear, with one study showing similar sleep latencies in obese and control subjects (Resta et al., 2003), and another showing that obese people have trouble falling asleep relative to non-obese controls (Pearson, Johnson, & Nahin, 2006). Other than these sleep parameters, few aspects of sleep have been evaluated in relation to overweight/obesity. However, excessive *daytime sleepiness* has been observed in obese people with sleep-breathing problems (Resta et al., 2003) and obese women have been shown to use fewer *sleeping pills* than lean older women (60–64 years) (Asplund & Åberg, 1995).

Thus, there is a lack of clarity as to which aspects of sleep are impaired in overweight/obese people, although a robust link has been reported between shorter sleep duration and overweight/obesity or weight gain (Cappuccio et al., 2008; Patel et al., 2006; Vorona et al., 2005). Therefore, a broader examination of a variety of sleep parameters is certainly required. In this study, we used the Pittsburgh Sleep Quality Index (PSQI), a well-validated self-report measure of sleep that assesses

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seven subjective domains of sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

Furthermore, few studies have sought to explain the relationship between sleep deficits and overweight/obesity, other than by referring to sleep apnea (Owens & Matthews, 1998). Sleep apnea is the repeated interruption of airflow through the nose and mouth for at least 10 s on at least 30 occasions during REM and non-NREM sleep (Guilleminault, Tilkian, & Dement, 1976). It is a relatively infrequent condition occurring in about 5–10% of the population (Tishler, Larkin, Schluchter, & Redline, 2003), although poor sleep quality is much more common at 10–40% (Simon & VonKorff, 1997; Ustun et al., 1996). Thus, only a proportion of overweight people who suffer from poor sleep are likely to meet diagnostic criteria for sleep apnea; and there are likely to be other possible explanations of their documented sleep deficits.

However, no other potential clinical or statistical mediators appear to have been investigated in this regard, despite a recent review suggesting that the relationship is likely to be mediated by other factors (Owens & Matthews, 1998). Thus, in this study we explored the premise that *night-time eating* might mediate the relationship between worse sleep quality and high BMI, in a community-derived sample. For example, a delayed sleep onset and shorter sleep duration may simply provide an overweight person with more time in which to eat, thereby, contributing to an increase in their weight over time. Such an assertion is corroborated by the results of recent studies indicating that night-time eating is associated with later weight gain in obese people (Andersen, Stunkard, Sørensen, Petersen, & Heitmann, 2004). Night-eating is also related to less weight loss during weight-loss programs (Gluck, Geliebter, & Satov, 2001), suggesting that a person's excessive eating at night may partly explain their weight gain over time.

In addition, excessive *night-eating* is well known to be related to sleep problems (e.g. reduced sleep efficiency, increased sleep latency) (Crispim et al., 2011). In fact, sleep problems are a key symptom of *night-eating syndrome* (NES), a disorder characterized by the delayed consumption of food during the day resulting in hyperphagia (i.e., increased appetite and food consumption) in the evening or after waking at night on three or more occasions/week (Stunkard, Grace, & Wolff, 1955). NES has a reported prevalence of about 1.5% in the population (Rand, Macgregor, & Stunkard, 1997), although several clinical studies suggest that overweight/obese people may be at an increased risk of developing NES (Stunkard et al., 1955). In this study, we operationalized night-eating in terms of the above-described eating patterns seen in NES patients.

Binge eating might also potentially explain the relationship between poor sleep quality and overweight/obesity, since binge-eating can occur at night, and it is known to be related to nocturnal eating (i.e. eating after awakening at night then returning to sleep) (Striegel-Moore et al., 2010). Consistent with this interpretation, obese women who are binge-eaters have been shown to experience worse insomnia than those who are not binge-eaters (Bulik, Sullivan, & Kendler, 2002). However, the relationship between *binge eating disorder* (BED) and overweight/obesity is less clear. For example, one study found that people with BED were more likely to have a BMI ≥ 40 than those without BED (Hudson, Hiripi, Pope, & Kessler, 2007), whereas in another, the prevalence of BED was similar in overweight/obese and normal weight women (Kinzi, Traweger, Trefalt, Mangweth, & Biebl, 1999).

BED is characterized by impaired control over binge-eating (e.g., eating very quickly until excessively full) that can occasion significant distress (e.g., depression), without any compensatory behavior (e.g., purging, over-exercising) to offset the binge-eating, once or more times weekly for three months or more (American Psychiatric Association, 2013). The person must also exhibit three or more of the following symptoms: eating hastily till uncomfortably full, consuming large amounts of food even when they are not physically hungry, eating alone due to self-embarrassment or self-disgust, and feeling depressed and/or guilty after binge-eating (Lundgren, Rempfer, Brown, Goetz, & Hamera, 2010). The lifetime prevalence estimate of BED is reported to be about 2.8% in the population (Hudson et al., 2007).

Finally, regarding *potential confounders*, depression is a well-known correlate of overweight/obesity, binge- and night-eating, and sleep disturbance. For example, overweight/obesity has been shown to be related to worse clinically-relevant depression (Bulik et al., 2002); binge-eating is associated with a higher lifetime risk of major depression (Specker, de Zwaan, Raymond, & Mitchell, 1994) and worse depression (Bulik et al., 2002); night-eaters are reported to experience more severe depression than non-night eaters (Gluck et al., 2001); and, depression is reliably linked to sleep disturbance (Owens & Matthews, 1998; Taylor, Lichstein, Durrence, Reidel, & Bush, 2005). Thus, we controlled for depression in all the planned regression analyses in this study.

In summary, the abovementioned sleep and weight problems associated with NES and BED are consistent with the premise that disordered eating at night (i.e. night-eating and binge-eating) may explain the relationship between poor sleep quality and high BMI. In accordance with the limited available literature, we expected that: (1) shorter sleep duration and more binge- and night-eating will be associated with high BMI; (2) higher BMI and more binge- and night-eating will be associated with worse total sleep quality; (3) binge- and night-eating will mediate the relationship between total sleep quality to high BMI; and, (4) binge- and night-eating will mediate the relationship between high BMI to worse sleep quality.

2. Method

2.1. Participants

Potential participants were recruited via advertisements placed at the Australian National University (ANU) campus and on a number of online platforms (e.g., ANU Notices webpage, Facebook event and pages, and health webpages). Participants were encouraged to email snowball the imbedded study link to their friends and colleagues. First-year psychology students at ANU who participated in the study could receive 30 min course credit for their participation, although they had a large number of studies to choose from. No reimbursements were provided to other participants. Study inclusion criteria were an age of 18 years or older and a BMI of 18.5 or more. The study took approximately 30 min to complete.

Six-hundred-seventy-eight people entered the study webpage by clicking on the study URL, of whom 312 immediately exited (i.e. non-responders), leaving 366 participants (i.e. response rate = 54%). Of these, 35 cases were eliminated due to a BMI less than 18.5 and one case was eliminated due to an age of 17 years, leaving 330 participants. Of these, 107 (32.4%) were males and 223 (67.6%) were females. The mean age of the participants was 27.42 years ($SD = 10.36$, range: 18–87).

Most participants were never married ($N = 238$, 72.2%) and the remainder were married/living de facto ($N = 64$, 19.4%), divorced/separated ($N = 12$) or other ($N = 16$). Most participants held a university/college degree ($N = 137$, 41.5%), postgraduate degree ($N = 59$, 17.9%) or trade certificate/diploma ($N = 35$, 10.6%), and the remainder had completed part ($N = 7$) or all of high school ($N = 92$). Nearly one-half of the participants were university students ($N = 161$, 48.4%) or they worked full-time ($N = 97$, 29.4%) or part-time ($N = 46$, 13.9%), with the remainder being unemployed ($N = 16$), retired ($N = 2$), volunteers ($N = 2$), unable to work ($N = 3$) or completing home duties ($N = 3$).

2.2. Procedure

Interested people were asked to access the online study by clicking on the imbedded URL in the advertisement (https://anupsych.us.qualtrics.com/SE/?SID=SV_1HZrb18I7ZcrxPe). They were asked to read the information page which explained the study, its purpose and format. They were asked if they were 18 years or older, and if not,

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