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## Original Article

## Sleep duration associated with body mass index among Chinese adults

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## ABSTRACT

**Objective:** The objective of this study was to investigate the relationship between sleep duration and obesity among Chinese adults.**Methods:** A community-based cross-sectional study was conducted among Chinese adults in 2008. In total, 3225 participants were selected by a multistage cluster sampling method. Self-reported sleep duration was measured by a standardized questionnaire. Logistic regression models were used to estimate the odds ratios (ORs) (95% confidence intervals, CIs) of obesity with sleep duration, separated by gender, and adjusted for age, education, occupation, marriage, smoking, drinking, body pain, and health status. **Results:** The mean sleep duration was 7.8 h. Among the 2962 participants, 7.2% had short sleep duration ( $\leq 6$  h/day). There were 171 obese participants (5.7%) in this population. After adjustment for age, short sleep duration ( $< 6$  h) was significantly associated with obesity among men (OR: 2.15; 95% CI: 1.193–90), but not among women; additional adjustment for potential confounders did not attenuate the association among men. Increasing sleep duration (a continuous variable) was significantly and negatively associated with obesity in women after adjustment for education level, occupation, marital status, smoking, drinking, body pain, and health status. The adjusted OR per-hour increase in sleep duration was 0.74 (0.56–0.97) for obesity, suggesting that for a 1-h increase in sleep duration among women, obesity risk decreased by 26%.**Conclusion:** Short sleep duration was associated with increasing obesity in Chinese men, and sleep duration was associated with obesity in Chinese women, although the underlying mechanism is unclear. This possible gender difference warrants further studies.

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## 1. Introduction

Obesity is an important public health issue in China. According to the Chinese National Survey, 23.2% of Chinese adults were either overweight or obese [1]. Obesity has been shown to be associated with an increased risk of mortality and fatal health outcomes such as cancer and cardiovascular disease [2–4]. Although the evidence for an association of sleep duration and obesity in children is

stronger [5–8], the association may also exist among adults. For example, Gildner et al. conducted a cross-sectional study by using nationally representative datasets from six countries and they found that shorter sleep duration in both men and women is significantly associated with higher body mass index (BMI) in older adults (>50 years) [9]. However, longitudinal evidence is less conclusive [8,10,11].

Moreover, the sleep–obesity association may vary across race and gender groups [12–14]. There is a need to examine the associations in an Eastern population given the differences in sleep patterns [15], body composition [14], and other relevant lifestyle/sociocultural factors; these differences could mean that the sleep–obesity relationship varies by culture. In addition, it is conceivable that occupational stress and eating habits, which may underlie the sleep–obesity relationship, differ significantly across countries/race groups [16]. Most studies that examined this issue were conducted in a Western setting; data on Eastern settings are scarce [17,18]. In addition, Xiao et al. observed a gender difference in the relationship between sleep duration and BMI in a cohort of 83,377 American adults aged 51–71 years [12]. To our knowledge, there is no evidence regarding gender differences among Eastern populations.

In this study, we investigated the relationship between sleep duration and obesity indexed by BMI in a large community-based sample from the general Chinese population. We also examined whether these associations varied by gender.

## 2. Methods

### 2.1. Participants

A random multistage cluster sampling method was used to select the study population in Beijing (China's capital city) from April to October 2008. The city was classified into urban and suburban areas according to administrative subdivisions. We randomly selected one urban district (Chongwen) and one suburban district (Tongzhou) as the study fields to represent both urban and suburban populations. In each field, college students, local residents, local government staff, and workers were cluster-selected. In total, 3800 participants aged 18–55 years were included. We excluded those younger than 16 years or older than 65 years. We also excluded shift workers or those with diseases (eg, depression and insomnia), which could have an effect on sleep duration. There were 2981 participants who remained in the final analysis. Data on demographic characteristics, medical history, time to fall asleep, sleep time, sleep efficiency, drug use, etc. were obtained via a self-administered standard questionnaire and were overseen by trained study investigators.

### 2.2. Body mass index

Based on recommendations from the Working Group on Obesity in China [19], BMI was categorized as follows: underweight: <18.5; normal: 18.5–23.9; overweight: 24.0–27.9; and obese: ≥28. The normal group was used as the reference group. The cutoff point for obesity was 28.

### 2.3. Sleep timing

We used the modified Pittsburgh Sleep Quality Index to measure the timing of sleep. The questionnaire was translated into Chinese for use in this study population [20]. Participants reported their time of going to bed and the time of arising. Sleep duration was calculated according to the following equation: sleep

duration = (preferred arising time + 24) – (preferred time of going to bed).

### 2.4. Statistical analysis

Statistical Analysis System (SAS) for Windows Statistical Software Package Version 8.2 (SAS Institute, Cary, NC, USA) was used for data processing and analysis. Obesity was analyzed as a binary outcome variable and sleep duration, categorized into five groups (<6, 6–7, 7–8, 8–9, and ≥9 h), which was investigated as a categorical variable. Chi-squared tests were used to compare participants' characteristics by BMI. Logistic regression models were applied to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) of obesity by sleep duration adjusted for potential confounders. Men and women were presented separately because of gender differences in sleep duration. Two sets of potential confounders were used in the adjusted models. Model 1 was adjusted for age. Model 2 was further adjusted for education level, occupation, marital status, smoking, drinking, body pain, and health status. Health status was assessed by self-reported chronic illness including hypertension, diabetes, coronary heart disease, hypercholesterolemia, hepatitis, and others. Participants with any of the above chronic diseases were categorized as unhealthy. All potential confounders are summarized in Table 1. All the tests were two-sided and the significance level was set at 0.05.

The study was approved by the Ethics Committee, Beijing Union Medical College University, and it followed the tenets of the Declaration of Helsinki. Written informed consent was obtained from all participants after the nature of the study was explained.

## 3. Results

Of 2981 participants, 19 were excluded because of missing information on potential confounders and 2962 (1344 men and 1618 women) were included in this analysis. Among the 2962 participants, there were 171 participants (5.74%, 95% CI: 4.90–6.58%) with obesity (111 men (8.26%, 95% CI: 6.79–9.73%) and 60 women (3.71%, 95% CI: 2.79–4.63%)).

The average sleep duration (mean ± SD) was 7.75 ± 1.06 h for men, 7.84 ± 1.04 h for women, and 7.80 ± 1.05 h for all. Approximately, 67.06% of study participants reported normal daily sleep duration (6–8 h), 7.15% reported short sleep duration (≤6 h/day), and 25.80% reported long sleep duration (≥8 h/day).

Table 1 shows that obesity was more common among those who reported short sleep duration, who were older, or who were in poor health.

We have tested the interaction between genders and sleep duration in the association with obesity. The *p* value for interaction was 0.02, suggesting that the sleep–obesity association was modified by gender. Table 2 shows that in Model 1, after adjusting for age, short sleep duration (<6 h) was significantly associated with obesity among men but not among women. In Model 2, additional adjustment for education level, occupation, marital status, smoking, drinking, body pain, and health status did not attenuate the association, such that short sleep duration remained significantly associated with obesity (OR: 2.15; 95% CI: 1.19–3.90) among men.

Table 2 also shows that sleep duration (a continuous variable) was negatively associated with obesity in Model 1 in both men and women. After further adjustment for education level, occupation, marital status, smoking, drinking, body pain, and health status (Model 2), the association among men for obesity was not statistically significant, but was significant among women, where the adjusted OR per hour of sleep duration was 0.74 (0.56–0.97) for obesity, suggesting that for a 1-h increase in sleep duration among women, obesity risk decreased by 26%.

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