



## Research paper

# Sleep behavior and depression: Findings from the China Kadoorie Biobank of 0.5 million Chinese adults



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## ABSTRACT

**Background:** Mixed results have shown the association between sleep behavior and depression, but evidence relating the joint effect of sleep duration and sleep disturbances is limited, especially in Chinese population.

**Methods:** A total of 512,891 adults aged 30–79 years from China Kadoorie Biobank (CKB) were included. Depression was defined by Composite International Diagnostic Inventory-short form (CIDI-SF). Sleep duration and sleep disturbances, including difficulty initiating and maintaining sleep (DIMS), early morning awakening (EMA), daytime dysfunction (DDF) and any sleep disturbances (ASD), were obtained by a self-reported questionnaire. Logistic regression was applied to examine the association between sleep behavior and depression.

**Results:** About 23.1% of participants reported short sleep duration ( $\leq 6$  h), and 5.1% reported long sleep duration ( $> 9$  h). Compared with normal sleep duration (7–9 h), both groups were associated greater likelihood of having depression (short sleep: OR = 2.32, 95%CI: 2.14–2.51; long sleep: OR = 1.56, 96%CI: 1.34–1.81). Participants reported sleep disturbances were significantly associated with depression (odds ratios ranged from 3.31 to 4.17). Moreover, the associations tended to be stronger for those who reported both abnormal sleep duration and sleep disturbances ( $p$  for interactions  $< 0.05$ ), especially for those who slept long.

**Limitations:** The cross-sectional nature of the study design limits the interpretation of the results.

**Conclusions:** Abnormal sleep duration and sleep disturbances were associated with depression. The associations were stronger for abnormal sleep duration accompanied with sleep disturbances, especially for a long duration. More attention should be paid on these persons in clinical practice.

## 1. Introduction

Depression is one of the most common mental diseases. A meta-analysis estimated that the global point prevalence of depression was 4.7% (4.4–5.0%) and annual incidence was 3.0% (2.4–3.8%) (Ferrari et al., 2013). Meanwhile, the rank of depression in causes of death has been ascending (Theo Vos et al., 2016a). According to the Global Burden of Disease 2016 study, depression was the third leading cause of disability in 2015 (Theo Vos et al., 2016b). Sleep, on the other hand, is one of the most important health issues and attracted people's

increasing concern recently. Researchers have indicated that sleep duration and sleep disturbances have great effects on total mortality (Liu et al., 2016; Parthasarathy et al., 2015) and several common chronic diseases (Li et al., 2014; Meng et al., 2013; Shan et al., 2015).

Previous researchers have also explored the association between sleep and depression, but the results were equivocal. Some researchers suggested a U-shaped relationship between sleep duration and depression (Kim et al., 2014; van den Berg et al., 2009; van Mill et al., 2010; Zhai et al., 2015), while others found only short sleep duration was related to depression (Lee et al., 2015; Sakamoto et al., 2013).

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Meanwhile, a strong relationship between insomnia and depression has been demonstrated in recent meta-analyses (Baglioni et al., 2011; Li et al., 2016), and several studies probed into the association between specific symptoms of sleep disturbances and depression (Almeida et al., 2011; Jaussent et al., 2011; Salo et al., 2012; Szklo-Coxe et al., 2010; Yokoyama et al., 2010). However, they mainly focused on the geriatric population with small sample size (Almeida et al., 2011; Szklo-Coxe et al., 2010), which was not appropriate to be generalized to a general population. Recently, several studies have explored the joint effect of sleep duration and insomnia, and found short sleep duration combined with sleep disturbances had an elevated risk of having depression (Chang et al., 2012; Fernandez-Mendoza et al., 2015), but didn't examine the effect of long sleep duration combined with sleep disturbances.

Therefore, the aim of the current study was to examine the relationships between sleep behavior and depression among Chinese adults using the baseline data of half a million adults from the China Kadoorie Biobank (CKB) Study, and to clarify the joint association of both short and long sleep duration and sleep disturbances with depression.

## 2. Methods

### 2.1. Study population

The baseline survey of the China Kadoorie Biobank (CKB) Study enrolled over 0.5 million adults from 10 geographically defined regions of China interviewed between 2004 and 2008. Further details of the CKB study have been described elsewhere (Chen et al., 2011, 2005). Briefly, a total of 512,891 adults aged 30–79 years completed a standardized laptop-based questionnaire to collect detailed information by a face-to-face interview, including demographic and socioeconomic characteristics, behavior factors, sleep behavior, physical and mental health status. A range of physical measurements were also undertaken for each participant by trained staff, using standardized instruments and protocols at baseline. The Ethical Review Committee of the Chinese Center for Disease Control and Prevention (Beijing, China) and the Oxford Tropical Research Ethics Committee, University of Oxford (UK) approved the study. All the participants provided written informed consent.

### 2.2. Measurement

#### 2.2.1. Sleep assessment

Sleep duration was self-reported at baseline by the question of “On average, how many hours of sleep do you get in a 24-h period (including naps)?” Respondents could report in only 1-h increments. We categorized it into 6 or fewer hours, 7–9 h, or more than 9 h, and defined 7–9 h of sleep as the reference group in present study according to the American National Sleep Foundation (Hirshkowitz et al., 2015).

Participants were requested to answer “yes” or “no” to whether they had experienced three forms of sleep disturbance in the past month. If they reported “having trouble falling asleep (sleep onset latency  $\geq$  30 min) after going to bed or waking up in the middle of the night at least 3 days a week”, they were classified as having disorders of initiating and maintaining sleep (DIMS); those reporting “waking up too early and not being able to get back to sleep at least 3 days a week” were classified as having disorders of early morning awakening (EMA); those who reported “having trouble keeping sober-minded during daytime because of bad sleep at least 3 days a week” were classified as having daytime dysfunction (DDF); and those reporting one or more of the three aforementioned disorders were classified as any sleep disturbances (ASD).

#### 2.2.2. Definition of depression

Past year major depression episode (MDE) at baseline was defined

using the Chinese version of the computerized Composite International Diagnostic Inventory-short form (CIDI-SF) using face-to-face interviews by trained clinicians. The CIDI-SF is a fully-structured diagnostic instrument based on criteria from the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) (Kessler and Mroczek, 1998). The Chinese version of the CIDI (calibrated as part of the World Mental Health Surveys) produces similar population estimates of MDE to the Structured Clinical Interview for SCID (Kessler et al., 2004). An MDE was defined by the presence of dysphoria and/or anhedonia for  $\geq$  2 weeks during the past 12 months, and accompanied by at least 3 of 7 following symptoms, including weight or appetite change, sleeping problems, psychomotor changes, fatigue, concentration problems, feelings of guilt or worthlessness and thoughts of suicide (Mezuk et al., 2013).

#### 2.2.3. Other covariates

Demographic and socioeconomic characteristics including age (continuous, years), gender, survey sites, marital status (married, widowed, divorced or separated, or never married), level of education (no formal school, primary school, middle school, high school, college, or university or higher), occupation (manual workers, non-manual workers or others, such as retired, unemployed or housewife/husband), living alone (yes or no) and household income (< 10,000, 10,000–19,999 or  $\geq$  20,000 yuan (CNY)/year). Behavior factors including alcohol consumption (not weekly drinking, ex-regular drinkers, not daily, daily and < 15 g/day, daily and 15–29 g/day, daily and 30–59 g/day, or daily and  $\geq$  60 g/day), smoking status (never/occasional, former, current and 1–14 cigarettes/day, current and 15–24 cigarettes/day, or current and  $\geq$  25 cigarettes/day), tea consumption (never or seldom, always), physical activity estimated as metabolic equivalent task (continuous, MET-h/day) and intake frequencies of red meat, fresh fruits, vegetables and milk (daily, 4–6 days/wk, 1–3 days/wk, monthly, or rarely or never). Physical and mental health status included the history of common chronic diseases (yes or no), anxiety status, stressful life events and self-rated health (poor, fair or good). At baseline, body weight and height were measured using calibrated instruments by trained staff. Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters squared.

### 2.3. Statistical analysis

Characteristics of participants were described according to different sleep durations and different status of sleep disturbances, using adjusted means and percentages for continuous and categorical variables respectively. General linear models or logistic models were used to test differences in these variables between subgroups, adjusting for age, gender and survey sites.

Logistic regression models were used to estimate the association between sleep behavior (include sleep duration, subtypes and number of sleep disturbances) and MDE. Each model included known and potential confounders. Model 1 adjusted for baseline social-demographic factors and behavioral factors. Model 2 further adjusted for physical health status. Model 3 further included mental health status. We also explored the linear trend between the numbers of sleep disturbance and MDE.

We further examined the joint association of sleep duration and sleep disturbances with MDE, we performed logistic regression models including five dummy variables to represent all six possible combinations of sleep duration and sleep disturbances, Take ASD as an example, normal sleep duration without ASD (reference group), normal sleep duration with ASD, short sleep duration with or without ASD and long sleep duration with or without ASD.

To examine the robustness of our findings, we conducted several sensitivity analyses by restricting analyses to participants without a history of psychological diseases ( $n = 505,468$ ), those reported sleep duration between 4 h and 12 h ( $n = 509,150$ ) and participants who had never used sleep medications ( $n = 506,461$ ). Furthermore, we re-

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