

Relationship between Sleep Duration and Sociodemographic Characteristics, Mental Health and Chronic Diseases in Individuals Aged from 18 to 85 Years Old in Guangdong Province in China: A Population-Based Cross-Sectional Study

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Abstract

Background: Sleep is vital for maintaining individual's physical and mental health. Prior studies have reported close relationships between sleep duration and chronic diseases. However, in China, the prevalence of irregular sleep duration and the associations between sleep duration and chronic conditions still merit studying in Guangdong province. This study aimed at examining the relationship between sleep duration and multiple dimensions of sociodemographic characteristics, mental health and chronic diseases in Guangdong province in China, with a large population-based data of individuals aged from 18 to 85 years old conducted in Guangdong province.

Methods: Multistage stratified cluster sampling was applied for this study. 13,768 participants from Guangdong province were interviewed with standardized assessment tools. Basic socio-demographic information, mental health and chronic diseases information were collected. Self-reported sleep duration was classified as three types: short (<7h), normative (7-8h) and long (>8h).

Results: The mean sleep duration was 6.75 ± 1.11 h. Short sleepers had a higher prevalence of chronic diseases, including anemia (6.2%, $P=0.024$), gout (2.8%, $P=0.010$), hyperlipidemia (3.9%, $P=0.003$) and low back pain (5.6%, $P=0.020$) than other types of sleeper. Multinomial logistic regression analysis revealed that short sleepers were more likely to have low income level, have depressive symptoms, be ex- or current drinkers and be overweight. Anemia, hyperlipidemia and low back pain were all risk factors for short sleep, while malignant tumor was risky for long sleep.

Conclusions: Low income level, drinking status, being overweight, and chronic conditions may be associated with abnormal sleep duration in Guangdong province general population. Short sleepers have a higher risk of suffering from anemia, hyperlipidemia, and low back pain, while long sleepers are more likely to have malignant tumor. Health professionals should value the sleep patterns in general health care and attach importance to conduct further epidemiologic surveys to explore the relationship between sleep duration and health.

Background

Sleep is vital for maintaining individuals' homeostasis. Previous studies have mentioned that people with irregular sleep duration have a higher risk of chronic comorbidities, including cardiovascular disease,¹ cerebrovascular disease,² hyperglycemia,³ hypertension,⁴ obesity,⁵ anemia,⁶ and respiratory disease⁷. Comorbidities of sleep problem have aroused people's attention. Short and long sleep duration have been suggested to be risk factors for chronic diseases. Based on one of the mechanisms of insomnia, short sleep duration has been considered to be associated with activation of the hypothalamic-pituitary-adrenal (HPA) axis.⁸ Multiple metabolic processes through the regulation of HPA axis could be affected. Changes in HPA axis function may negatively affect the cardiovascular system, leading to hypertension, atherosclerotic plaque formation, insulin resistance, dyslipidemia, and central obesity.⁹

Based on the data obtained from the National bureau of statistics of China, Guangdong province is the most populous province in China with a population of 113 million in 2018, leading Gross Domestic Product (GDP) growing in China for nearly 30 years. Meanwhile, based on the data in 2018, the death rate was higher than the previous 3 years and the proportion of elderly people in Guangdong province were higher than the previous 2 years.¹⁰ Given that the population of Guangdong province is aging rapidly, prevalence rate of chronic disease may comparably increase. Along with the rapid economic growth in Guangdong province, pressure that adults are having get larger and it is not surprising that their possibilities of suffering from sleep problems may increase.

Prior studies have investigated the relationship between sleep duration and chronic disease in the western countries and few areas of China.¹¹⁻¹⁴ However, the conditions of sleep duration, mental health and chronic disease in Guangdong province is relatively rare studied. The pattern of sleep duration and its associations with chronic disease and mental health status in Guangdong sample population is uncertain. This study used the cross-sectional data from the Guangdong Provincial Sleep and Psychosomatic Health Survey to investigate whether sleep duration and chronic disease prevalence were associated. We hypothesized that there would be a higher prevalence of chronic disease among short- and long-sleepers, which will also be associated with a few sociodemographic and clinical characteristics.

Methods

Sampling and study setting

The study was conducted using data obtained from the Guangdong Provincial Sleep and Psychosomatic Health Survey, which was a public health research project organized and implemented by the Guangdong Provincial Health Commission and the Guangdong Provincial Mental Health Center. The study was approved by the Clinical Research Ethics Committee of Guangdong Provincial People's Hospital(Reference No.GDRE2018230H(R1)). The survey was conducted from January 2019 to October 2019, employing a sampling method involving multistage, stratified, probability-clusters to yield a representative sample of adult population in Guangdong province, China. In the first stage, twenty-one Enumeration Areas of Guangdong province were selected as the primary sampling units with cluster sampling method (Guangzhou, Shenzhen, Zhuhai, Foshan, Zhaoqing, Jiangmen, Huizhou, Dongguan, Zhongshan, Zhanjiang, Maoming, Yangjiang, Yunfu, Shaoguan, Meizhou, Heyuan, Qingyuan, Shantou, Shanwei, Chaozhou, Jieyang). In the second stage, three to four survey districts were selected by using cluster sampling method for each prefecture-level city, and a total of 72 survey districts/counties were selected. In the third stage, two to four neighborhood committees were selected from each selected district/county by simple random method. In the fourth stage, a simple random method was used to select one resident group unit from each selected neighborhood committee, and each resident group unit included 80–200 residents over the age of 18 for investigation. All participants provided informed consent after being informed of study information.

The sample size was calculated using the formula. The design effect was assigned as 2.5 and the confidence interval α was 95% of both sides. According to an estimate of the prevalence of depressive disorders in China in 2019, $p = 6.8\%$.¹⁵ The allowable error is $d = 0.1p$. According to the above parameters, the minimum sample size is calculated to be 13,706 people. Considering the response rate was 80%, the planned sample size of this survey was 17132 people. The survey was completed by 13,768 community-dwelling residents aged 18 years or older, with an effective response rate of 80.42%.

Procedures And Measures

The study based on each community healthcare center. The methods of combining the centralized survey and household survey were adopted. All of the investigators involved in this study received the required formal training. All the participants were asked questions by investigators face to face. They were also asked to complete the self-reported questionnaires. Trained investigators collected data on sleep duration, basic sociodemographic information, mental health status and history of chronic diseases.

According to recommendations from National Sleep Foundation, for adults aged from 18 to 64, the appropriate sleep duration range is 7 to 9 hours per day, and for older adults who aged over 65, it would be 7 to 8 hours per day.¹⁶ 7–8 h of sleep is considered to be most suitable duration for individuals' mental and physical health.¹⁷ In the survey, all participants were asked about the average number of hours of their sleep each day in the past month. Sleep duration was categorized as three groups: <7 h, 7–8 h, and >8 h of sleep per day. The groups of "<7 h", "7-8h", ">8 h" were separately called "Short sleeper group", "Normative sleeper group" and "Long sleeper group".¹⁸

The sociodemographic variables included gender, age, marital status, education and monthly income. Age was divided into three groups: 18–39, 40–59 and 60–85 years old. Marital status was categorized as married and divorced or single. The educational years are grouped into three categories: less than 9 years, 9–16 years and more than 16 years. Income classes are categorized as 6000 CNY per month and ≥ 6000 CNY per month. Two lifestyle factors including smoking status and drinking status were also included. Besides, body mass index (BMI) was calculated as weight/height^2 (kg/m^2) and examined in the study as a metabolic index. It was categorized as < 24 and ≥ 24 (kg/m^2). Unlike the definition of W.H.O, a $\text{BMI} \geq 24$ is considered to be overweight in China.

Mental health status was evaluated on depression and anxiety symptoms. The questionnaire used for evaluating depression was Patient Health Questionnaire-9 (PHQ-9) while the one for anxiety was Generalized Anxiety Disorder (GAD-7). The Patient Health Questionnaire-9 (PHQ9) was a widely used questionnaire and was designed to meet the nine criteria used from a diagnosis of DSM-IV depressive disorder. Participants rate the severity of each symptom item over the past 2 weeks on a 4-point Likert-type scale (from 0 to 3). Items can be summed up to generate a continuous measure of depressive symptoms. A cut-point of 10 is used to indicate at least moderate level of depressive symptoms.¹⁹ The Generalized Anxiety Disorder-7 (GAD7) was a reliable measure to access anxiety symptoms. It also used

4-point Likert type scale. A cut point of 10 is used to indicate at least moderate level of anxiety symptoms.²⁰

Questions about chronic disease in the survey were about the clinical history of anemia, arthritis, cerebrovascular disease, coronary heart disease, chronic obstructive pulmonary disease (COPD), diabetes mellitus, gout, hyperlipidemia, hypertension, low back pain, and malignant tumor. All disease in our study were classified according to the International Classification of Disease, 10th Revision (ICD-10). All participants self-reported the clinical history of chronic disease. The information was confirmed by their medical records.

Statistical analysis

We used a complex sampling design data analysis method based on multistage stratified probability-clusters sampling with the SPSS software (version 25.0). The continuous variables were shown by mean value and standard deviation. The categorical variables were shown by frequency and percentage. The comparisons between short, medium and long sleepers by all the characteristic variables was calculated by Rao-Scott Chi-square test. Multinomial logistic regression models were used to explore the correlates of short and long sleep duration. Each parameter was evaluated with univariate and multivariate analysis. A P value less than 0.05 was considered statistically significant. Due to the large sample size of this study, most of the differences observed might be statistically significant. Substantive or practical significance is another issue.

Results

A total of 13,768 individuals were included in the analysis. The average sleep duration was 6.75 ± 1.11 h. Table 1 represented the comparison between short, normative and long sleepers by sociodemographic characteristics and mental health status. Educational level, smoking status, drinking status, BMI, PHQ9 and GAD7 scores were significantly associated with sleep duration.

Table 2 represented the prevalence rates of chronic disease by sleep duration. Short sleepers had a higher prevalence of chronic diseases, including anemia (6.2%, $P = 0.024$), gout (2.8%, $P = 0.010$), hyperlipidemia (3.9%, $P = 0.003$) and low back pain (5.6%, $P = 0.020$) than other types of sleeper.

Table 3 showed the results from multinomial logistic regression models with odds ratios of the associations of short and long sleep duration with sociodemographic characteristics and mental health factors. The results revealed that lower income earners were likely to have short sleep (OR 1.13, 95%CI 1.01–1.27). Being overweight and having depressive symptoms were obviously risk factors for short sleep (BMI: OR 1.24, 95%CI 1.09–1.41; PHQ9: OR 1.75, 95%CI 1.52–2.02). Single or divorced individuals were at higher risk of having long sleep (OR 1.36, 95%CI 1.04–1.76).

Table 3

Odds ratios (OR) and 95% confidence intervals of sociodemographic factors and mental health factors in relation to sleep duration.

Variables	Short vs Normative sleeper	Short vs Normative sleeper	Long vs Normative sleeper	Long vs Normative sleeper
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Age				
18-39y	NA	NA	NA	NA
40-59y	1.17(2.05–1.29)	1.31(1.17–1.47)	0.79(0.60–1.02)	0.62(0.47–0.82)
60-85y	1.05(0.74–1.49)	1.30(0.90–1.87)	1.50(0.85–2.64)	0.96(0.51–1.82)
Gender				
Male	NA	NA	NA	NA
Female	0.95(0.85–1.06)	0.96(0.84–1.09)	1.06(0.83–1.36)	0.93(0.66–1.30)
Educational years				
≤ 9 years	0.87(0.71–1.07)	0.88(0.72–1.08)	1.79(1.28–2.52)	1.77(1.26–2.48)
10–15 years	NA	NA	NA	NA
≥ 16 years	0.97(0.87–1.07)	0.95(0.86–1.06)	0.82(0.61–1.09)	0.83(0.62–1.11)
Marital status				
Single or divorced	1.08(0.97–1.20)	0.99(0.89–1.11)	1.15(0.90–1.48)	1.36(1.04–1.76) *
Married	NA	NA	NA	NA
Income class (CNY)				
≤ 6000	1.07(0.95–1.19)	1.13(1.01–1.27) *	1.30(1.01–1.68)	1.09(0.83–1.43)
> 6000	NA	NA	NA	NA
Smoking status				
Ex- or current smokers	1.23(1.09–1.39) *	1.12(0.98–1.29)	1.12(0.86–1.46)	1.10(0.83–1.47)

Note: Univariate regression analysis and multinomial regression analysis were used in statistical analysis. Adjusted for educational level, smoking status, drinking status, BMI, PHQ9 and GAD7 factors. *P < 0.05.

Variables	Short vs Normative sleeper	Short vs Normative sleeper	Long vs Normative sleeper	Long vs Normative sleeper
Never smoke	NA	NA	NA	NA
Drinking status				
Ex- or current drinkers	1.31(1.15–1.50) *	1.18(1.02–1.37) *	0.89(0.66–1.19)	0.83(0.61–1.14)
Never drink	NA	NA	NA	NA
BMI				
≥ 24	1.20(1.06–1.37) *	1.24(1.09–1.41)*	0.92(0.67–1.27)	0.87(0.63–1.20)
< 24	NA	NA	NA	NA
PHQ9				
Have depressive symptoms	1.90(1.70–2.12) *	1.75(1.52–2.02) *	0.72(0.54–0.95) *	0.88(0.61–1.26)
No depressive symptoms	NA	NA	NA	NA
GAD7				
Have anxiety symptoms	1.69(1.50–1.89) *	1.15(0.99–1.33)	0.67(0.50–0.88) *	0.76(0.53–1.09)
No anxiety symptoms	NA	NA	NA	NA
Note: Univariate regression analysis and multinomial regression analysis were used in statistical analysis. Adjusted for educational level, smoking status, drinking status, BMI, PHQ9 and GAD7 factors. *P < 0.05.				

In Table 4, all the selected chronic diseases were included into analyze. Educational level, smoking status, drinking status, BMI, PHQ9 and GAD7 factors were included as covariates in the adjusted model. The crude and adjusted odds ratios of the associations between chronic diseases and sleep duration were listed. Short sleepers were more likely to have anemia, hyperlipidemia and low back pain (Anemia: OR 1.47, 95%CI 1.16–1.85; Hyperlipidemia: OR 1.53, 95%CI 1.10–2.13; Low back pain: OR 1.42, 95%CI 1.06–1.90). Meanwhile, compared to normative sleepers, long sleepers were more likely to have malignant tumor (OR 3.71, 95%CI 1.01–13.58).

Table 4

Odds ratios (OR) and 95% confidence intervals of chronic diseases in relation to sleep duration.

Variables	Short vs Normative sleeper	Short vs Normative sleeper	Long vs Normative sleeper	Long vs Normative sleeper
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Anemia	1.38(1.09–1.74) *	1.47(1.16–1.85) *	1.35(0.78–2.36)	1.23(0.71–2.13)
Arthritis	1.38(1.00-1.90) *	1.36(0.99–1.88)	2.22(0.95–5.18)	2.01(0.82–4.95)
Cardiovascular disease	1.41(0.72–2.78)	1.44(0.75–2.79)	0.42(0.12–1.47)	0.29(0.08–1.10)
Cerebrovascular disease	1.87(0.84–4.15)	1.82(0.79–4.17)	1.82(0.61–5.43)	1.58(0.50–4.94)
COPD	1.04(0.56–1.95)	1.04(0.57–1.90)	1.89(0.62–5.70)	1.75(0.56–5.45)
Diabetes	1.39(0.78–2.47)	1.33(0.74–2.38)	0.66(0.29–1.49)	0.53(0.21–1.37)
Gout	1.51(1.04–2.21) *	1.39(0.92–2.09)	0.34(0.10–1.11)	0.35(0.11–1.18)
Hyperlipidemia	1.65(1.19–2.29) *	1.53(1.10–2.13) *	0.59(0.19–1.82)	0.64(0.20–2.01)
Hypertension	1.20(0.90–1.59)	1.13(0.85–1.52)	1.03(0.57–1.86)	0.84(0.45–1.59)
Low back pain	1.46(1.09–1.94) *	1.42(1.06–1.90) *	0.65(0.24–1.81)	0.54(0.19–1.48)
Malignant tumor	0.97(0.39–2.43)	0.95(0.39–2.34)	3.27(0.88–12.10) *	3.71(1.01–13.58) *
Note: COPD: chronic obstructive pulmonary disease. Univariate regression analysis and multinomial regression analysis were used in statistical analysis. Adjusted for educational level, smoking status, drinking status, BMI, PHQ9 and GAD7 factors. *P < 0.05.				

Discussion

The purpose of this study was to investigate the prevalence and correlation of short and long sleep duration among individuals aged from 18 to 85 years old in Guangdong province in China. To the authors' knowledge, it is the first study using complex stratified sampling method in southern China, aiming at examining whether sleep duration was associated with sociodemographic characteristics, mental health and chronic diseases. We tested our initial hypothesis and the results supported partially for the hypothesis. People who had lower income, who were ex- or current drinkers, who were overweight, and who had depressive symptoms were at higher risk of having short sleep duration. Single or divorced one were at higher risk of having long sleep duration. Furthermore, short sleepers were more likely to have anemia, hyperlipidemia and low back pain, and long sleepers had close relationship with malignant tumor.

Firstly, seeing from the side of overall length of sleep duration, the average sleep duration of this study was 6.75 h, which was lower than in a similar-scale cross-sectional study in Jilin province in China (7.3 h),¹² a community-based study in Beijing (7.8 h)²¹ and a Singapore Chinese study (7.0 h).²² Considering multiple factors, spatial regional difference, cultural characteristics, the mean age of sampling population, sampling method and inconsistency of definition of short and long sleep duration were the main reasons of the inconsistency of the results. In the study conducted in Singapore, only elderly people aged more than 60 years old were included and change in sleep was categorized as short sleep duration which was < 6 h, long sleep duration which was > 8 h and stable sleep duration which was 6–8 h.²² The study¹² conducted in Jilin province in China had similar sample size and sample method comparing to this study. However, the results still showed diversity in distinct areas of the same country.

Regarding sociodemographic characteristics, low-income earners reported more short sleep in our study. Short sleep duration had been suggested to be positively associated with low income level in western and east Asia studies.^{23,24} In China, a monthly salary below 6000CNY is at relatively low income level. Industrial workers, left-behind farmers, migrant workers, disabled, elderly and so on accounted for the vast majority of low-income earners, which are also vulnerable groups. Most of the low-income earners are blue-collar workers, whom have more physical activities, long working time and irregular working rhythm. This may explain the increasing odd ratio of short sleep duration in low-income earners. Income level and educational level are both indicators of socioeconomic position, which is closely associated with living pressure and sleep duration.²⁵ However, we did not find any differences in educational level factor, which was inconsistent with some of previous studies^{26,27}. Besides, people who were single or divorced had a higher risk of long sleep. Differences in daily activities between married people and single or divorced people may contribute to the result.

Unhealthy lifestyle factors contribute certain possibilities to short sleep duration. In our study, associations were found between short sleep and drinking as well as smoking. The first possible reason is that for alcohol users, drinking may mediate their sleep homeostasis through adenosine and the wake-inducing cholinergic neurons in the basal forebrain.²⁸ For alcoholics, drinking can alter the sleep architecture, lead to insomnia and difficulty maintaining sleep. For healthy non-alcoholics, although the NREM of the first part of sleep can be promoted and consolidated, the second part of the sleep can be disrupted.²⁸ For the relationship between smoking and sleep duration, significant link between cigarette use and sleep duration has been reported in adolescence²⁹. Our study illustrated a link between smoking and short sleep in adults, which added the proof of this relationship in adult age group. Inadequate sleep duration has been particularly linked with substance use, especially alcohol and cigarette. People who were overweight had high risk of short sleep. weight gain is associated with short sleep duration, which is consistent with a cross-sectional study conducted in Taiwan of China.³⁰ Given that energy consumption is abnormal in people suffer from obesity, energy balance should be considered into account. Leptin and ghrelin are hormones recognized to have influence on energy balance,³¹ which play roles in mediating appetite and energy balance.³¹

In the adjusted analysis, this study only found that anemia, hyperlipidemia and low back pain were associated with short sleep while malignant tumor were associated with long sleep. Chronic disease and sleep duration are bidirectionally connected with each other.²² Short sleep can be a consequence of chronic disease, or a marker of chronic disease. In this study, strong link between short sleep and anemia was found. Consistent with prior findings, sleep duration is associated with lower hemoglobin levels.³² Fatigue is an important factor mediating the link between short sleep and anemia. Studies have noted that patients with anemia may have fatigue,^{33,34} and that fatigue could lead to physical activities decreased directly and affect the circadian rhythms and sleep duration.³⁵ Consideration of anemia has been recommended as part of the clinical evaluation of patients with insomnia. As for hyperlipidemia, long sleep duration has been reported to be associated with higher risk of hyperlipidemia,³⁶ while some studies observed positive association between short sleep duration and high TG or TC levels³⁷. In our study, short sleeping habits may predispose individuals to hyperlipidemia risk. Other metabolic diseases like hypertension and diabetes mellitus have been mentioned to be associated with irregular sleep duration in previous epidemiologic studies. However, after we adjusted confounders, hypertension and diabetes mellitus have no significant associations with irregular sleep duration. Individuals with low back pain were at high risk of having short sleep. Insomnia was commonly reported by patients with low back pain.³⁸ Since pain experience is closely associated with fatigue, we speculate that back pain and fatigue experienced by patients were strong factors for predicting short sleep.

Malignant tumor had positive relationship with long sleep, which was also mentioned in the study conducted in the UK and USA.³⁹ The relationship between long sleep and malignant tumor incidence may vary depending on the course of the disease.³⁹ numerous studies have confirmed that chronic disease were risky predictors for short or long sleep duration.^{40,41} The U-shaped relationships between chronic diseases and sleep duration has been investigated in several studies,^{42,43} suggesting the importance of sleep health. Furthermore, a U-shaped distribution across short and long sleep duration has also been found for mortality.⁴⁴ The mechanism that leads to mortality is not known, and perhaps the co-occurrence of sleep problems (and other problems) may provide clues to pathophysiology.⁴⁴

Several limitations should be clearly mentioned in this study. First, the study sample only covered the adult population of Guangdong province in China so that the results may not represent the general population of China. Second, participants may misunderstand the definition of actual sleep duration and time of lying in bed. And without objective sleep measurement, the self-reported sleep duration may not represent the real situation, or even overestimated. Future studies are warranted to investigate changes to multiple aspects of sleep with objective assessments. Third, the study was designed as a cross-sectional study, and thus the causation of chronic disease and sleep duration could not be examined. Furthermore, other relevant sleep variables were not included into analysis, such as use of hypnotic medication, treatments for specific chronic disease, living conditions, night shift work, cultural factors and so on. All these variables may have confounded the results in this study.

Conclusions

This study found sociodemographic characteristics were associated with potential risk for short and long sleep duration. Anemia, hyperlipidemia, low back pain and malignant tumor, were confirmed associated with short and/or long sleep duration. Longitudinal studies are needed to gain a better understanding of possible associations, and to figure out the causations between chronic diseases and sleep duration.

Declarations

Declarations

Ethics approval and consent to participate

The study was approved by the Clinical Research Ethics Committee of Guangdong Provincial People's Hospital [Reference No.GDRE2018230H(R1)]. This was an observational study using anonymized data. All participants signed informed consent before participation.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interest in regard to this work.

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Authors' contributions

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