



Association between sleep time and depression: a cross-sectional study from countries in rural Northeastern China

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Abstract

Objective: To investigate the current situation of sleep status and examine its association with depression among counties in rural areas of Liaoning Province, China.

Methods: This cross-sectional study was conducted from January 2012 to August 2013 in Northeast China. A total of 11,276 subjects aged ≥ 35 years were surveyed and completed the Patient Health Questionnaire-9; each participant answered questions about their sleep duration.

Results: For individuals with a sleep time of ≤ 6 , 6–7, 7–8, 8–9, and ≥ 9 h, the respective risk of depression was 10.8%, 3.7%, 2.6%, 2.7%, and 5.7% in subjects younger than 65 years old and 15.2%, 5.4%, 3.2%, 6.5%, and 8.6% in those 65 years old or older.

Conclusion: In the rural population of Liaoning Province, sleep duration and depression are closely related. Both short sleep and long sleep are risk factors for depression. Optimizing sleep status may contribute to good physical and mental health.

Keywords

Sleep time, depression, rural, cross-sectional study

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Introduction

Sleep is an important part of life. It occupies approximately one-third of our life span and has been proven to be closely related to our health.¹ A large amount of evidence indicates that sleep has a moderating effect on the nervous, endocrine, and cardiovascular systems.² Additionally, a lack of sleep and hyperhypnosis can both increase the risk of developing diseases.³ Moreover, the core symptom of depression is a sleep disorder.

Of patients with depression, 90% have insomnia, while a small subset experience drowsiness.⁴ The incidence rates of depression and anxiety are significantly higher in

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people with a sleep disorder than those in patients without one.⁵ Furthermore, there is a bidirectional connection between insomnia and depression.⁶ Insomnia aggravates depression, and depression negatively affects the quality of sleep, creating a vicious circle. In this study, we have surveyed Chinese rural residents in Liaoning Province and have explored the correlation between sleep duration and depression. In China, most of the population is rural, so research focusing on rural areas is urgently needed. This epidemiological survey of rural areas in northeast China is representative of the northern rural population of China and is the largest study on the rural population to date.

Methods

Study population

The study was conducted from January 2012 to August 2013 in Northeast China, and a representative subject pool of individuals aged ≥ 35 years was selected to describe the prevalence, incidence, and natural history of cardiovascular risk factors in rural areas of Liaoning Province. The study adopted a multi-stage, stratified, random cluster-sampling scheme. In the first stage, three counties (Dawa, Zhangwu, and Liaoyang County) were selected from the eastern, southern, and northern regions of Liaoning Province. In the second stage, one town was randomly selected from each county (yielding a total of three towns). In the third stage, 6–8 rural villages from each town were randomly selected (yielding a total of 26 rural villages). Participants with pregnancy, a malignant tumor, or a mental disorder were excluded from the present study. All of the eligible permanent residents aged ≥ 35 years from each village were invited to participate in the study (a total of 14,016 participants). In total, 11,956 participants agreed and completed the

survey, with a response rate of 85.3%. In this report, only participants with a complete set of baseline data were analyzed, making a final sample size of 11,276 subjects. The sitting blood pressure (BP) was measured three times (with 5-min resting intervals) for each participant using a standardized electric sphygmomanometer, related medical histories were obtained using a standard questionnaire, and blood biochemical indices were collected. Fasting plasma glucose (FPG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglyceride (TG), uric acid, hemoglobin, and other routine blood biochemical indexes were analyzed enzymatically on an autoanalyzer. All laboratory equipment was calibrated and blinded, and duplicate samples were used. For all participants, anthropometric measures were collected by trained personnel using standard protocols. The study was approved by the Ethics Committee of China Medical University (Shenyang, China). All procedures were performed in accordance with ethical standards. Written consent was obtained from all participants after they had been informed of the objectives, benefits, medical items, and confidentiality agreement of personal information. If the participants were illiterate, we obtained their written informed consents from their proxies.

Measuring depression symptoms

Depression symptoms were assessed with the Patient Health Questionnaire-9 (PHQ-9).⁷ Its scores range from 0 to 27, with scores of ≥ 5 , ≥ 10 , and ≥ 15 , respectively representing mild, moderate, and severe levels of depression severity.⁸ Individuals with a PHQ-9 score greater than 10 are considered to be suffering from severe depression symptoms.⁹

Sleep duration

Sleep duration was determined for each participant by asking the following questions: “on average, how many hours of sleep do you usually have during one night?” and “how many hours of nap do you usually have during daytime?”. Participants were asked to answer these questions with one digit after the decimal place allowed. As with previous studies of sleep classification, the research subjects were divided into five classes of sleep duration: ≤ 6 , 6–7, 7–8, 8–9, and ≥ 9 h.¹⁰

Covariate measurements

Information on covariates, such as demographic characteristics, lifestyle-related factors, and medical history of disease, was collected during a single clinic visit with a face-to-face interview by cardiologists and trained nurses using a standard questionnaire.

Statistical analysis

All of the statistical analyses were conducted with SPSS statistical software (version 19). The level of significance was set at $P < 0.05$. A χ^2 test was used to measure the associations of each study variable. Univariate and multivariate logistic regression analyses were used to analyze the correlation between sleep time and depression; odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) were calculated.

Definitions

Based on the JNC-7 report,¹¹ hypertension was defined as having a systolic BP of ≥ 140 mm Hg and/or a diastolic BP of ≥ 90 mm Hg and/or requiring the use of antihypertensive medications. Dyslipidemia was defined according to the National Cholesterol Education Program-Third

Adult Treatment Panel (ATP III) criteria.¹² High TC was defined as $TC \geq 6.21$ mmol/L (240 mg/dL). Low HDL-C was defined as $HDL-C < 1.03$ mmol/L (40 mg/dL). High LDL-C was defined as $LDL-C \geq 4.16$ mmol/L (160 mg/dL). High TG was defined as ≥ 2.26 mmol/L (200 mg/dL). Diabetes mellitus was diagnosed according to the World Health Organization criteria¹³: having a FPG of ≥ 7 mmol/L (126 mg/dL) and/or being on treatment for diabetes. The glomerular filtration rate (GFR) was estimated using an equation originating from the CKD Epidemiology Collaboration (CKD-EPI) equation,¹⁴ and reduced GFR was defined as having an estimated GFR (eGFR) of < 60 ml/min/1.73 m².

Results

Demographic characteristics of the study subjects

A total of 11,276 Chinese people in rural areas of Liaoning Province were investigated in this study. For the 9,582 subjects who were less than 65 years old, the mean sleep time was 7.29 ± 1.66 h. There were 4,356 males and 5,226 females; 9,065 of these subjects were Han ethnic. For the 1,694 subjects who were 65 years old or older, the mean sleep time was 7.07 ± 1.88 h. There were 865 males and 829 females; 1,625 of these subjects were Han Chinese. The demographic characteristics according to each age group are presented in Tables 1 and 2.

Depression risk for different sleep durations

In the subjects who were less than 65 years old, sleep times of ≤ 6 , 6–7, 7–8, 8–9, and ≥ 9 h carried a respective risk of depression of 10.8%, 3.7%, 2.6%, 2.7%, and 5.7%. In the subjects who were 65 years old or above,

Table 1. Baseline characteristics of study population based on sleep duration among participants aged <65 years.

Variables	Sleep duration (h/d)					p-value
	≤6 (n = 2,728)	6–7 (n = 1,997)	7–8 (n = 2,807)	8–9 (n = 1,295)	>9 (n = 755)	
Age (year)	52.65 ± 7.60	50.57 ± 7.97	49.62 ± 8.05	49.98 ± 8.06	49.98 ± 8.16	<0.01
Male sex (%)	41.1	45.2	46.2	50.6	50.5	<0.01
Han ethnicity (%)	94.9	95.6	93.7	93.8	95.4	0.02
Current smoking status (%)	33.6	36.1	34.2	39.2	40.1	<0.01
Current drinking status (%)	20.6	23.9	24.1	25.2	24.5	<0.01
Education (%)						<0.01
Primary school or below	51.5	42.3	40.5	42.7	48.9	
Middle school	40	46.1	47.6	46.5	44.1	
High school or above	8.5	11.6	11.9	10.8	7	
Physical activity (%)						<0.01
Low	31.7	26.5	22.1	22.9	21.9	
Moderate	63.2	68.6	72.3	69.9	72.3	
High	5.1	4.9	5.6	7.3	5.8	
Family income (CNY/year, %)						<0.01
≤5,000	10.3	8.1	7.8	9	10.3	
5,000–20,000	58	53.3	55.9	52.2	53.4	
>20,000	31.7	38.6	36.3	38.8	36.3	
Diet score	2.27 ± 1.14	2.39 ± 1.12	2.40 ± 1.08	2.44 ± 1.13	2.52 ± 1.17	<0.01
SBP (mmHg)	139.92 ± 22.28	138.17 ± 21.91	139.27 ± 22.33	139.64 ± 22.39	140.85 ± 23.72	0.03
DBP (mmHg)	82.31 ± 11.74	81.71 ± 11.83	82.08 ± 11.70	82.57 ± 11.81	82.64 ± 11.62	0.14
BMI (kg/m ²)	24.75 ± 3.64	24.88 ± 3.64	24.99 ± 3.56	25.11 ± 3.82	25.10 ± 3.71	0.01
WC (cm)	81.81 ± 9.79	82.08 ± 9.85	82.44 ± 9.59	83.24 ± 9.24	83.52 ± 9.93	<0.01
TC (mmol/L)	5.28 ± 1.10	5.18 ± 1.06	5.16 ± 1.06	5.18 ± 1.08	5.21 ± 1.12	<0.01
TG (mmol/L)	1.63 ± 1.45	1.63 ± 1.47	1.61 ± 1.61	1.69 ± 1.65	1.70 ± 1.42	<0.01
LDL-C (mmol/L)	2.94 ± 0.82	2.87 ± 0.79	2.89 ± 0.82	2.90 ± 0.81	2.92 ± 0.88	0.09
HDL-C (mmol/L)	1.40 ± 0.36	1.38 ± 0.37	1.42 ± 0.89	1.42 ± 0.40	1.38 ± 0.39	<0.01
FPG (mmol/L)	5.89 ± 1.43	5.83 ± 1.56	5.82 ± 1.59	5.87 ± 1.66	6.03 ± 2.14	<0.01
Estimated GFR (ml/min/1.73 m ²)	93.03 ± 14.75	94.97 ± 14.83	97.49 ± 15.76	96.36 ± 12.92	96.20 ± 13.11	<0.01
History of heart disease (%)	19	13.1	10.1	11.2	11.5	<0.01
History of stroke (%)	8.9	5.9	5.9	6.9	7	<0.01

Data are expressed as the mean ± SD or n.

Abbreviations: CNY, China yuan (1 CNY = 0.161 USD); SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; WC, waist circumference; TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FPG, fasting plasma glucose; GFR, glomerular filtration rate.

Each p-value was calculated by an ANOVA test for continuous variables or a chi-squared test for categorical variables.

Table 2. Baseline characteristics of study population based on sleep duration among participants aged ≥ 65 years.

Variables	Sleep duration (h/d)					p-value
	≤ 6 (n = 604)	6–7 (n = 332)	7–8 (n = 373)	8–9 (n = 246)	> 9 (n = 139)	
Age (year)	71.18 \pm 4.78	71.13 \pm 5.03	71.00 \pm 4.99	71.39 \pm 5.31	71.40 \pm 5.05	0.83
Male sex (%)	37.9	59	56.8	56.9	63.3	<0.01
Han ethnicity (%)	96	97	95.7	95.1	95	0.78
Current smoking status (%)	31.3	34.9	37.3	36.6	30.2	0.24
Current drinking status (%)	13.7	19.6	21.7	24.4	23	<0.01
Education (%)						<0.01
Primary school or below	81.6	74.4	73.2	72	82.7	
Middle school	15.4	21.1	20.9	21.1	14.4	
High school or above	3	4.5	5.9	6.9	2.9	
Physical activity (%)						<0.01
Low	57.9	44.3	48.3	48	57.6	
Moderate	38.1	50.3	43.4	46.7	33.8	
High	4	5.4	8.3	5.3	8.6	
Family income (CNY/year, %)						0.15
$\leq 5,000$	35.9	28.3	28.2	32.9	32.4	
5,000–20,000	47.7	51.5	55.2	48.4	53.2	
$> 20,000$	16.4	20.2	16.6	18.7	14.4	
Diet score	1.99 \pm 1.10	2.06 \pm 1.09	2.08 \pm 1.14	2.05 \pm 1.13	2.28 \pm 1.09	0.07
SBP (mmHg)	154.39 \pm 25.23	151.44 \pm 23.35	155.65 \pm 24.67	156.22 \pm 26.79	155.78 \pm 25.30	0.24
DBP (mmHg)	81.17 \pm 11.98	80.57 \pm 11.22	80.81 \pm 12.23	81.30 \pm 11.78	82.98 \pm 11.59	0.51
BMI (kg/m ²)	23.98 \pm 3.81	24.24 \pm 3.54	23.99 \pm 3.51	24.03 \pm 3.81	24.43 \pm 3.43	0.63
WC (cm)	81.93 \pm 10.54	83.32 \pm 10.04	81.83 \pm 10.08	83.55 \pm 11.12	84.91 \pm 9.64	<0.01
TC (mmol/L)	5.51 \pm 1.17	5.22 \pm 1.05	5.47 \pm 1.09	5.30 \pm 1.00	5.49 \pm 1.12	<0.01
TG (mmol/L)	1.68 \pm 1.27	1.56 \pm 1.01	1.59 \pm 1.48	1.58 \pm 1.05	1.73 \pm 2.02	0.06
LDL-C (mmol/L)	3.09 \pm 0.88	2.90 \pm 0.78	3.08 \pm 0.80	3.05 \pm 0.81	3.16 \pm 0.86	<0.01
HDL-C (mmol/L)	1.42 \pm 0.41	1.39 \pm 0.37	1.45 \pm 0.39	1.45 \pm 0.41	1.41 \pm 0.39	0.11
FPG (mmol/L)	6.12 \pm 1.58	6.22 \pm 2.17	6.10 \pm 1.75	6.10 \pm 1.84	6.04 \pm 1.70	0.21
Estimated GFR (ml/min/1.73 m ²)	75.65 \pm 14.53	80.14 \pm 14.66	79.56 \pm 13.49	81.15 \pm 11.22	80.72 \pm 14.32	<0.01
History of heart disease (%)	28.6	22.9	19.3	18.7	26.6	<0.01
History of stroke (%)	19.4	16.6	18.8	17.9	23.7	0.47

Data are expressed as the mean \pm SD or n.

Abbreviations: CNY, China yuan (1 CNY = 0.161 USD); SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; WC, waist circumference; TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FPG, fasting plasma glucose; GFR, glomerular filtration rate.

Each P-value was calculated by an ANOVA test for continuous variables or a chi-square test for categorical variables.

sleep times of ≤ 6 , 6–7, 7–8, 8–9, and ≥ 9 h carried a respective risk of depression of 15.2%, 5.4%, 3.2%, 6.5%, and 8.6%.

Logistic regression analysis

Among subjects who were less than 65 years old, compared with a sleep time of 7–8 h, the ORs for sleep times of ≤ 6 h, 6–7 h, and ≥ 9 h, which are 4.10 (95% CI: 3.14–5.36), 1.40 (95% CI: 1.00–1.95), and 2.36 (95% CI: 1.60–3.48), respectively, are statistically significant ($p < 0.01$). Even after the multivariate logistic regression adjusted for differences in the variables of age, race, diabetes, TC, TG, HDL-C, LDL-C, education, diet score, income, current smoking, current drinking, activity group, BMI, mean WC, GFR, history of heart disease, and history of stroke, there was still a significant association between sleep time and depression. Specifically, compared with a sleep time of 7–8 h, the ORs for sleep times of ≤ 6 h and ≥ 9 h, which are 3.67 (95% CI: 2.80–4.81) and 2.22 (95% CI: 1.50–3.30), are statistically significant.

In the subjects who were 65 years old or older, compared with a sleep time of 7–8 h, the ORs for sleep times of ≤ 6 h and ≥ 9 h, which are 4.65 (95% CI: 2.50–8.65) and 3.11 (95% CI: 1.35–7.15), are statistically significant ($p < 0.01$). Even after the multivariate logistic regression adjusted for differences in the variables of age, race, diabetes, TC, TG, HDL-C, LDL-C, education, diet score, income, current smoking, current drinking, activity group, BMI, mean WC, GFR, history of heart disease, and history of stroke, there was still a significant association between sleep time and depression. Compared with a sleep time of 7–8 h, the ORs for the sleep times of ≤ 6 h, 8–9 h, and ≥ 9 h, which are 4.48 (95% CI: 2.36–8.48), 2.25 (95% CI: 1.02–4.97), and 2.57 (95% CI: 1.08–6.10), respectively, are statistically significant (Table 3).

Discussion

This investigation found that excess or lack of sleep increased the risk of depression. Specifically, the risk of depression is

Table 3. Multivariate regression analysis of the association between sleep time and depression.

	OR value (95% CI)				
	≤ 6 (n = 3,332)	6–7 (n = 2,329)	7–8 (n = 3,180)	8–9 (n = 1,541)	> 9 (n = 894)
<65 years old					
Single factor	4.10 (3.14–5.36)	1.40 (1.00–1.95)	1 (ref)	1.08 (0.72–1.63)	2.36 (1.60–3.48)
Multivariate factor	3.67 (2.80–4.81)	1.35 (0.96–1.89)	1 (ref)	1.01 (0.66–1.53)	2.22 (1.50–3.30)
≥ 65 years old					
Single factor	4.65 (2.50–8.65)	1.76 (0.83–3.73)	1 (ref)	2.12 (0.98–4.57)	3.11 (1.35–7.15)
Multivariate factor	4.48 (2.36–8.48)	1.89 (0.88–4.07)	1 (ref)	2.25 (1.02–4.97)	2.57 (1.08–6.10)

^aMultivariate factors included: age, race group, diabetes, high total cholesterol, high triglyceride, low high-density lipoprotein cholesterol, high low-density lipoprotein cholesterol, education, diet score, income, current smoking, current drinking, activity group, body mass index, mean waist circumference, decreased glomerular filtration rate, history of heart disease, and history of stroke.

Abbreviations: OR, odds ratio; CI, confidence interval; ref, reference value.

significantly higher in people with less than 6 h or more than 9 h of sleep compared with those with 6–8 h of sleep. Additionally, the risk of developing depression is four times higher in residents with less than 6 h of sleep than in those with 7–8 h of sleep. In subjects with the same amount of sleep, having an age of 65 years or above was a risk factor for depression. Our survey also revealed that for people who are 65 years old or younger, there is no significant difference in the risk of developing depression for sleeping times of 6–7, 7–8, and 8–9 h. Furthermore, for individuals who are 65 years old or older, there is no significant difference in the risk of developing depression for sleeping times of 6–7 and 7–8 h, but there is a significant difference in this risk for 8–9 h of sleep. The scale of this study in China is unprecedented.

Other studies have proven that too little sleep will lead to depression, and depression can also cause insomnia; these conditions interact as both cause and effect, mutually enhancing each other and thus delaying recovery, further aggravating and causing relapses of both conditions.^{15,16} Furthermore, insomnia, a well-known risk factor of late stage depression, lowers the quality of life and physical skills and also increases the suicide risk in elderly depressed patients.¹⁷ At the other end of the sleep spectrum, hyperhypnosis causes longtime central nervous system inhibition. After awakening, the patient feels dizzy due to a slowed down blood circulation, which reduces the nutrient and oxygen supply to the brain, thus lessening the activity of the individual. The low oxygen and nutrient supply can also cause muscle and tendon tissue weakness, leading to sensations of fatigue. In addition, hyperhypnosis disturbs the resting and activity pattern of the heart. Because the heart is continuously at rest, heart contraction asthenia eventually results. Therefore, at times of activity, there is an onset of palpitation and fatigue, among other symptoms. Furthermore, because of

the excess sleep, the patient cannot eat on time, which causes hunger peristalsis, thus disturbing the gastric acid secretion pattern and influencing digestion. All of these symptoms can increase the risk of depression.

Elderly people have a shorter duration of sleep, and their sleep is easily disturbed by environmental factors, making them prone to developing various types of sleeping disorders. The fact that elderly people are at a higher risk of suffering depression might be related to their special physiological features. In the face of mental stress, diseases, and environmental changes, the elderly are more prone to develop sleep rhythm disorders. As their physiological function declines with age, they are often faced with a frustrating inability to perform desired tasks. Many diseases more commonly afflict this group, frequently resulting in a decline in independence and an increase in reliance on others, which can cause these individuals to feel helpless and inferior, leading to the development of depression. They elderly are often less involved in daily societal activities due to physical limitations. Coupled with the death of friends and colleagues, loneliness is inevitable in this group. Depression in elderly people is closely related to the frequent occurrence of difficult life events and a lack of social support. Depression further aggravates underlying sleeping disorders, creating a vicious cycle, which decreases their life quality. Therefore, having a sleeping disorder is a risk factor for depression.

In conclusion, problems relating to sleep are prevalent in the population. Too much or too little sleep can increase the risk of depression. Getting adequate but not excessive sleep may help to prevent the onset of depression.

Limitations

In our study, sleep time was recorded by investigators during interviews, and this may have led to individual differences.

Additionally, although most people need 7–8 h of sleep per day, sleep time requirements vary from person to person. Therefore, no matter how we set the definitions for lack of sleep and hyperhypnosis, they cannot fully reflect the differences in individual sleep time requirements. Moreover, our study did not evaluate sleep quality along with sleep duration. A sleep disorder or the use of sleeping pills could have compromised the results, but these factors were not included in this study. Furthermore, mental diseases are a relevant factor in sleep disorders, but we did not evaluate our subjects for the presence of any mental diseases. Lastly, defining depression by a PHQ-9 score of greater than 10 points may not be very comprehensive.

Authors' contributions

All authors made contributions to design, data acquisition, and data analysis.

Guo Xiaofan and Sun Yingxian participated in the design of the study and performed the statistical analyses. Jiang Mohan conceived the study, participated in its design and coordination, and helped to draft the manuscript. All authors read and approved the final manuscript.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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