Original Research

Depression and sleep duration: findings from middle-aged and elderly people in China

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ABSTRACT

Objective: This study aims to investigate whether depression is associated with subsequent sleep duration among middle-aged and elderly people in China.

Study design: Cross-sectional study.

Methods: Data were obtained from the China Health and Retirement Longitudinal Study (CHARLS). Depression was evaluated from the 2011 baseline survey data using the Chinese version of the Center for Epidemiologic Studies Depression scale (CES-D). All other data were extracted from CHARLS 2013 survey data. Sleep duration was assessed according to the American National Sleep Foundation. Participants were divided into subgroups based on their gender (male or female) and age (45–59 years [middle-aged] or ≥60 years [elderly people]). The relative risk ratios (RRRs) were calculated using the multinomial logistic regression analysis method.

Results: No significant associations were found between depression and subsequent long sleep duration among middle-aged and elderly people in China; in addition, no association was found during subgroup analysis. The adjusted RRR (RRR = 1.71; 95% confidence interval [CI] = 1.56–1.88) shows there is a significant association between depression and subsequent short sleep duration among subgroups. The RRR of the male, female, middle-aged, and elderly people were 1.64 (95% CI=1.38–1.95), 1.74 (95% CI=1.56–1.95), 1.68 (95% CI = 1.47–1.92), 1.74 (95% CI = 1.52–1.99), respectively, which revealed that this association was still significant in subgroups.

Conclusions: Findings from this study suggest that there is a complex association between depression and subsequent alternations in sleep duration among middle-aged and elderly people in China.

Introduction

Depression is a common, but serious, mood disorder with symptoms impacting feelings, thoughts, drive, and the ability to handle daily activities and functions.[1] Depression is an important public health problem in both developed and developing countries. An estimation from the World Health Organization showed that 322 million people suffer from

depression;[2] and it is expected to be the second leading cause of disability by 2020.[3] Researches have shown that increases in depression are associated with increased healthcare costs longitudinally.[4] Depression is a very costly disorder in China. It is indicated that the total estimated cost of depression in China is 51,370 million Renminbi (RMB) [equivalent to US$6264 million at 2002 prices] with direct costs reaching 8090 million RMB [US$986 million] and indirect costs of 43,280 million RMB [US$5278 million].[5]

Sleep is another important public health topic, which is increasingly attracting research interest. Sleep alterations are common in people suffering from depression. Previous studies have shown that sleep duration is associated with many health problems, such as cardiovascular events[6,7] and mortality.[8]

Both short and long sleep duration were common for people with depression, and up to 90% of adults with depression complain about sleep quality.[9] However, previous studies investigating the association between depression and sleep duration have not reached an agreed conclusion. Some studies suggested that there is significant association between depression and short sleep duration,[10] while another study showed that depression was not associated with short sleep duration.[11] Similar results are also found on the associations between depression and long sleep duration. Plante et al. demonstrated a significant longitudinal association between increased subjective long sleep duration and depression.[12] However, Paudel et al. showed that long sleep duration was not associated with increased odds of depression.[13] Additionally, one study indicated that only when a critical level of depression reached did the sleep duration vary.[14] Thus, the association between depression and subsequent sleep duration needs further study.

The prevalence of depression in China is high and has become an important public health issue. A recent study showed that 30% of men and 43% of women in the middle-aged and elderly age categories in China suffered from depression.[15] However, whether the depression leads to sleep variation for middle-aged and elderly people in China remains unknown. Given the severe status of depression in China, it further highlights the need to investigate an association between depression and subsequent sleep duration. Thus, in this article, our purpose was to clarify the association between depression and sleep duration among Chinese middle-aged and elderly people. Considering previous studies have shown that people with mood disorders exhibited higher rates of sleep disturbance than the general population[16] and as many as 50% of older adults had habitual sleep problems,[17,18] we assumed that there was significant association between depression and sleep duration.

Methods

Study participants

We used the longitudinal data sets from middle-aged and elderly people who are living in China (China Health and Retirement Longitudinal Study, CHARLS). The aim of CHARLS was to collect a high quality nationally representative sample of Chinese residents aged ≥45 years.[19] The baseline national wave of CHARLS was surveyed in 2011. About 10,000 households, 17,500 individuals in 150 counties/districts and 450 villages/resident committees were included. To obtain a representative national data set, multistage stratified probability proportional to size sampling was adopted in CHARLS. Participants in CHARLS have been followed-up every 2 years since 2011. The aspects of the aging process investigated were (1) demographics; (2) family structure/transfer; (3) health status and functioning; (4) biomarkers; (5) health care and insurance; (6) work, retirement, and pension; (7) income and consumption and assets (individual and household); and (8) community-level information. More information about CHARLS can be found on the official website.[20] In this study, respondents aged ≥45 years were selected. For this study, with the aim to investigate the association between depression and subsequent sleep duration, we calculated the Chinese version of the Center for Epidemiologic Studies Depression scale (CES-D) score from CHARLS 2011 baseline data, and we extracted other variables from the CHARLS 2013 survey data. There were 18,175 people aged ≥45 years in the 2011 data; of whom, 13,859 people provided depression data in 2011, and 12,660 of whom provided sleep duration data in 2013. The dropout rate was 8.7%. It is a pity that 4316 participants did not provide depression data in 2011; we had to exclude this group. In addition, 3131 participants had missing data and were also excluded. In total, 9529 people were included in our study.

Study design

Cross-sectional study.

Outcome

Sleep duration was assessed based on the following question: 'During the past month, how many hours of actual sleep did you get at night (average hours for one night, this may be shorter than the number of hours you spent in bed).' This represented the average hours of a typical workday and rest day. According to the American National Sleep Foundation,[21] we divided the sleep time into three groups: short sleep duration group (≤6 h); reference group (7−9 h [6.5 h also included]); and long sleep duration group (>9 h).

Explanatory variable

The Chinese version of CES-D was used to identify the possible depressive symptoms. We confirmed its good reliability and validity with Cronbach's α, which reached 0.815 in CHARLS.[15] There were 10 questions with a scale of four points (CES-D 10). The cut-off point of depression diagnosis score was 10.[22]

Other covariates

We included covariates in the logistical regression model if it was associated with sleep or depression. We included the following three covariates: demographic and socio-economic characteristics; behavior factors; and health status.

For demographic and socio-economic characteristics, we included age, gender, marital status, education level, and annual household income. Marital status, mainly considering its current status, had two levels: married and unmarried. Respondents who were partnered were assigned to the married group and participants who were separated, divorced, or widowed were allocated to the unmarried group. There were five levels for education: (1) illiteracy; (2) primary school; (3) middle school; (4) high school; and (5) college and above. In our research, people who did not finish primary school were assigned to the 'illiteracy' group. Old-style private school was deemed as the same level as elementary school.

Behavior factors included smoking and drinking. Respondents who reported quitting smoking were not included in the current smoker group. Drinking had nine levels: (1) none or does not drink; (2) once a month; (3) 2 to 3 days a month; (4) once a week, (5) 2 to 3 days a week; (6) 4 to 6 days a week; (7) daily; (8) twice a day; and (9) more than twice a day. Similar to other studies, we considered people whose drinking frequency was once a week or more as regular alcohol drinkers.[22]

Health status was assessed through the following items: activities of daily living (ADL) and chronic disease. ADL indicated the respondent's physical function level. It was evaluated by the following question: 'Do you have any difficulty with (i) dressing, bathing, or showering; (ii) eating, such as cutting up food; (iii) getting into or out bed; or (iv) controlling urination and defecation?' For each item, '1' indicated the respondent had no difficulty in finishing it, while '0' suggested that the respondent had difficulty completing the task. ADL is a summary score of the above items. We calculated the total number of chronic diseases that had been diagnosed by a doctor. In CHARLS, the following 14 chronic diseases were included: (1) hypertension; (2) dyslipidemia; (3) diabetes or high blood sugar; (4) cancer or malignant tumor; (5) chronic lung diseases; (6) liver disease; (7) heart disease; (8) stroke; (9) kidney disease; (10) stomach or other digestive disease; (11) emotional, nervous, or psychiatric problems; (12) memory-related disease; (13) arthritis or rheumatism; and (14) asthma. The 11th item may overlap the depression; however, the CHARLS codebook showed that only 32 people responded 'yes' to this item, and thus we considered it not to overlap with depression.

Statistical analysis

We described the characteristics of participants based on two groups according to the respondent's CES-D score (CES-D <10). Mean values were used to display continuous variables, while categorical variables were displayed as percentages. The differences between the two groups were investigated through the t-test for continuous variables and the Chi-squared test for categorical variables.

Multinomial logistic regression models were used to investigate the association between depression and sleep duration. The relative risk ratios (RRRs) and 95% confidence interval (CI) were calculated. In the first model (Model 1), we adjusted for age and gender. In the second model (Model 2), we further adjusted for education level, marital status, annual household income, behavior factors, and health status.

We also investigated the difference of the association between depression and sleep duration in subgroups. The subgroups were divided based on their age (middle-aged [45−59 years] or elderly people [≥60 years]) and gender (male or female). Gender was excluded in the analysis of gender subgroup.

We considered it statistically significant when the P-value was less than 0.05. All the work was performed through the Stata, version 13.

Results

Characteristics of study population

Characteristics of the study population are shown in Table 1. The study population is 67.1% male, with a mean age of 60.2 years. Table 1 shows that 38.7% of CHARLS participants suffered from depression. In total, 55.7% of respondents suffered from short sleep duration. The percentage of people who experienced long sleep duration was only 3.5%. Compared with those who suffered from depression, people with a CES-D score of <10 were less likely to have short or long sleep durations and were more likely to have normal sleep duration. In total, 65.3% of participants with depression also experienced short sleep duration, while only 49.8% of participants who did not suffer from depression experienced short sleep duration; this difference is significant (P < 0.001). There was no difference between participants with or without depression in terms of long sleep duration, with the percentage in both groups being less than 4%. Respondents who suffered from depression were more likely to be female, older, unmarried, have more ADL difficulties, have more chronic diseases, and poor self-reported health.

Association between depression and sleep duration

The association between depression and subsequent sleep duration is shown in Table 2. It can be seen from the RRR values that subsequent long sleep duration is positively related with depression when the model does not adjust for other covariates. The RRR value ranks highest when the model is not adjusted. After the model adjusts for age and gender (Model 1), the RRR value becomes lower (RRR = 1.57; 95% CI = 1.24−1.99). When the model adjusts for all covariates (Model 2), the RRR value is lowest; participants who suffered from depression are 1.29 times more likely to experience long sleep duration (RRR = 1.27; 95% CI = 0.99−1.63), but this is not significant. In terms of the subgroup analysis, no significant association can be found in all subgroups when the model adjusts for all covariates.

Table 2 also presents the association between depression and subsequent short sleep duration. In contrast to the association between depression and subsequent long sleep duration, all RRR values for depression and short sleep duration are significant, which means that depression is significantly associated with subsequent short sleep duration. When adjusted for all covariates (Model 2), participants are 1.71 times more likely to suffer from short sleep duration after being diagnosed with depression (RRR = 1.71; 95%

Table 1 – Comparison of general characteristics of cases with CES-D ≥ 10 and CES-D < 10.[a]

Characteristic	Total (N = 9529)	CES-D ≥ 10 (n = 3658)	CES-D < 10 (n = 5871)	P-value
Age	60.2 ± 9.2	61.0 ± 9.2	59.7 ± 9.2	<0.001
Gender (male)	33.4%	25.3%	38.5%	<0.001
Marital status (married)	86.5%	82.3%	89.2%	<0.001
Education level				
Illiteracy	48.5%	58.7%	42.2%	<0.001
Elementary school	21.0%	20.4%	21.4%	0.274
Middle school	19.7%	15.1%	22.5%	<0.001
High school	9.4%	5.3%	11.9%	<0.001
College and above	1.4%	0.4%	2.0%	<0.001
Current smoker	16.0%	14.4%	16.9%	0.001
Regular alcohol drinker	13.4%	10.4%	15.2%	<0.001
Work status				
Never work	1.3%	1.6%	1.0%	0.019
Agricultural work	49.3%	53.9%	46.4%	<0.001
Non-agricultural employed	10.7%	6.6%	13.2%	<0.001
Non-agricultural self-employed	5.5%	3.4%	6.9%	<0.001
Non-agricultural family business	1.9%	1.9%	1.9%	0.9223
Retired	31.3%	32.6%	30.5%	0.035
Annual household income (RMB)				
≤20000	39.2%	47.0%	34.4%	<0.001
(20000, 30000)	8.3%	8.0%	8.5%	0.450
(30000, 50000)	35.9%	34.7%	36.6%	0.064
>50000	16.6%	10.2%	20.5%	<0.001
ADL summary score[b]	0.3 ± 0.9	0.6 ± 1.2	0.2 ± 0.6	<0.001
No. of chronic disease[c]	1.9 ± 1.6	2.4 ± 1.8	1.6 ± 1.5	<0.001
CES-D score	8.6 ± 6.3	15.3 ± 4.5	4.5 ± 2.8	<0.001
CES-D ≥ 10	38.4%	100%	0	<0.001
Sleep duration/day				
≤6 h (short sleep duration)	55.7%	65.3%	49.8%	<0.001
7–9 h (normal sleep duration)	40.8%	31.2%	46.9%	<0.001
≥9 h (long sleep duration)	3.5%	3.5%	3.3%	0.664

ADL, activities of daily living; CES-D, Center for Epidemiologic Studies Depression Scale; RMB, Renminbi.

[a] Continuous variables are presented as mean ± standard deviation, and categorical variables are displayed as percentage.

[b] ADL is a summary score. For each of the following items, score '1' if the respondent had no difficulty in finishing it, or '0' if the respondent had difficulty completing the following tasks: (i) dressing, bathing or showering; (ii) eating, such as cutting up food; (iii) getting into or out bed; and (iv) controlling urination and defecation.

[c] In the China Health and Retirement Longitudinal Study (CHARLS), the following 14 chronic diseases were included: (1) hypertension; (2) dyslipidemia; (3) diabetes or high blood sugar; (4) cancer or malignant tumor; (5) chronic lung diseases; (6) liver disease; (7) heart disease; (8) stroke; (9) kidney disease; (10) stomach or other digestive disease; (11) emotional, nervous, or psychiatric problems; (12) memory related disease; (13) arthritis or rheumatism; and (14) asthma.

CI = 1.56–1.88). Also, this significant association exists in all subgroups. Males have a lower probability of suffering from short sleep duration than females (male [RRR = 1.64; 95% CI = 1.38–1.95] vs female [RRR = 1.74; 95% CI = 1.56–1.95]). In addition, middle-aged people are just as likely to have short sleep duration as elderly people (middle-aged people [RRR = 1.68; 95% CI = 1.47–1.92] vs elderly people [RRR = 1.74; 95% CI = 1.52–1.99]).

Discussion

Depression was found to be closely associated with sleep behavior. Depression can negatively alter sleep behavior because an estimated 90% of depressed people complained about sleep quality;[9] however, the understanding of this relationship among the Chinese population remains limited. To our knowledge, the current study is the largest investigation of the relationship between depression and subsequent sleep duration in a Chinese population. Here, we found that depression was significantly associated with subsequent short sleep duration among Chinese middle-aged and elderly people, independent of gender, age, and other confounders. However, we did not observe a similar association with long sleep duration.

We presented the sleep duration profiles of Chinese middle-aged and elderly people. In line with other nationalities, both short and long sleep duration were severe in Chinese middle-aged and elderly people. A study from Nevada showed that 35.3% of participants suffered from short sleep duration, and 2.8% had long sleep duration.[7] Our research is also consistent with other studies of the Chinese population;[23] Sun et al. used the China Kadoorie Biobank study and found that 23.1% of participants reported short sleep duration, and 5.1% reported long sleep duration. Using the CHARLS baseline data from 2011, 51.36% of participants had short sleep duration and 7.6% had long sleep duration.[24] Differences between the Nevada study and that of Sun et al. may be due to the

Table 2 – Multinomial logit regression analysis of depressive mood (CES-D ≥ 10) and sleep duration.

Subgroup and sleep duration[a]	Unadjusted model[b] [RRR (95% CI)]	Model 1[c] [RRR (95% CI)]	Model 2[d] [RRR (95% CI)]
Total (N = 9529)			
Short vs normal	1.97 [1.81–2.15] P < 0.001	1.93 [1.77–2.11] P < 0.001	1.71 [1.56–1.88] P < 0.001
Long vs normal	1.59 [1.26–2.01] P < 0.001	1.57 [1.24–1.99] P < 0.001	1.27 [0.99–1.63] P = 0.063
Pseudo R^2	0.0154	0.0209	0.0321
Gender subgroups			
Female (n = 6343)			
Short vs normal	2.04 [1.84–2.27] P < 0.001	2.01 [1.80–2.23] P < 0.001	1.74 [1.56–1.95] P < 0.001
Long vs normal	1.60 [1.19–2.17] P = 0.002	1.49 [1.10–2.02] P = 0.009	1.22 [0.89–1.68] P = 0.220
Pseudo R^2	0.0181	0.0220	0.0362
Male (n = 3186)			
Short vs normal	1.77 [1.50–2.08] P < 0.001	1.75 [1.49–2.06] P < 0.001	1.64 [1.38–1.95] P < 0.001
Long vs normal	1.76 [1.21–2.56] P = 0.003	1.67 [1.15–2.43] P = 0.008	1.35 [0.90–2.03] P = 0.141
Pseudo R^2	0.0094	0.0154	0.0290
Age subgroups			
Middle-age (45–59) (n = 4842)			
Short vs normal	1.87 [1.65–2.11] P < 0.001	1.86 [1.64–2.11] P < 0.001	1.68 [1.47–1.92] P < 0.001
Long vs normal	1.66 [1.14–2.42] P = 0.008	1.71 [1.17–2.50] P = 0.006	1.26 [0.84–1.89] P = 0.259
Pseudo R^2	0.0131	0.0136	0.0254
Elderly people (≥60) (n = 4687)			
Short vs normal	2.04 [1.80–2.31] P < 0.001	2.00 [1.76–2.27] P < 0.001	1.74 [1.52–1.99] P < 0.001
Long vs normal	1.46 [1.08–1.96] P = 0.014	1.55 [1.15–2.11] P = 0.004	1.27 [0.92–1.75] P = 0.140
Pseudo R^2	0.0168	0.0247	0.0411

ADL, activities of daily living; CES-D, Center for Epidemiologic Studies Depression Scale; CI: confidence interval; RRR: relative odds ratio.
[a] Sleep duration categories: Short ≤6 h; normal 7–9 h (6.5 h also included); and long >9 h.
[b] Unadjusted model: CES-D ≥10 alone.
[c] Model 1 covariates: age and gender.
[d] Model 2 covariates: age, gender, marital status, education, annual income, current smoker, regular alcohol drinker, ADL, chronic disease status, and work status.

different population selection criteria: the study from Nevada included adults aged 18 years or older who were not institutionalized,[7] while Sun et al. included Chinese adults aged 30–79 years from the China Kadoorie Biobank. Thus, both the present study and that of Sun et al. showed the severe sleep duration status among the Chinese population. In addition, a study from Daqing City, China, showed similar results that indicated 64.5% of participants suffered from short sleep duration, and 1.5% had long sleep duration.[25]

Our results indicate that depression could lead to subsequent short sleep duration, which is consistent with the literature. Previous studies on sleep behavior have often focused on insomnia. It has been shown that adolescents who suffered from depressive symptoms had a higher probability of developing sleep problems than those who did not suffer from depression.[26] A meta-analysis indicated that people with depression experienced significantly more wakefulness in bed and lighter sleep. And, at follow-up, depressed people suffered from longer sleep onset, more wake after sleep onset, and lower sleep efficiency.[27] A study conducted by Yang et al. determined that depression was the cause of significant sleep instability and hindered people from having the sleep duration that they required.[28] Also, it was suggested that depressive symptoms were associated with the development and persistence of sleep problems at follow-up.[26] In particular, people who suffered from depression often had difficulties with getting to sleep, frequent awakenings during the night, and early morning awakening.[29–31] Furthermore, depression was considered to be one of the causes of insomnia. Vollrath

et al. showed that 25% of patients complaining of chronic insomnia suffered from depression.[32] Also, Sivertsen et al. indicated that depression significantly predicted the onset of insomnia.[33] The findings in our study provide further support for this conclusion.

Compared with short sleep duration such as insomnia, long sleep duration was less studied, although this is still a sleep-related health issue. Research has shown that long sleep duration can lead to important health issues such as an increased risk of depression,[34] severe health outcomes such as mortality,[35] cardiovascular diseases,[36] stroke,[37] and diabetes mellitus.[38] It is important to explore whether depression is associated with subsequent long sleep duration. In this study, we did not observe a significant association between depression and subsequent long sleep duration, which is in contrast to other research.[12] Two reasons may explain our results: first, the number of people who suffered from long sleep duration in this study was minimal, which may lead the statistical results to non-significant power and second, the depression level in our study did not reach a critical level. One study pointed out that sleep disturbance arose only after the level of depression reached a critical level.[14] In our study, the people who suffered from depression may not have reached this critical level. A further content-related explanation may be that long sleep duration was independently associated with depression or psychiatric disorders. This explanation was supported by studies, even after adjusting for severity of psychiatric symptoms.[39] Further research is required into whether depression is associated with long sleep duration.

The underlying mechanism for the association between depression and short or long sleep duration remains unclear. Several potential mechanisms could help explain the observed association between depression and short sleep duration. Neuroendocrinal factors such as corticotropin-releasing hormone, adrenocorticotropin, and cortisol may play an important role in the sleep abnormalities of participants with depression.[16,40] Elevated levels of cortisol and adrenocorticotropin hormones were observed and are markers of depression.[41] In addition, elevated cortisol levels were associated with an increased number of intermittent awakenings and increases time in phases N1 and N2.[42,43] Some authors have also suggested that a genetic control of biological rhythms could determine the association between depression and short sleep duration. Studies indicated that people with depression varied in the polymorphism of the CLOCK genes and thus suffered from short sleep duration.[44] Currently, no mechanism has been presented for the association between depression and long sleep duration.

Our results have important health policy implications for healthy aging in China, especially for depression screening projects. We have shown the severe depression status of older adults in China, thus emphasizing the need to prevent people suffering from depression. Considering the huge costs incurred as a result of depression, prevention programs would be beneficial and cost effective. Positive psychology interventions can lead to better health outcomes in quality of life, such as sleep quality improvement. Policy-makers should be forward-looking in depression screening and prevention.

Our study has some limitations. First, approximately 30% of participants were excluded from this research because of lack of critical data. Therefore, our results may be biased. Lack of data may underestimate the association between depression and long sleep duration, thus leading to an insignificant conclusion. Second, we only used CES-D to assess the depressive symptoms. CES-D is not a gold-standard method to diagnose depression, and it may overestimate or underestimate the depressive symptoms. However, other measurement methods for depression are not used in CHARLS. Third, psychiatric medications used to treat depression may play a role in sleep duration alteration; however, only a small number of participants provided a response to this survey item. Fourth, the data source limited the generalizability of our results because we only used CHARLS, which is focused on the Chinese population. Fifth, many studies indicated that depression and sleep had bidirectional associations. In this study, we did not investigate the association between sleep duration and the subsequent onset of depression since it was beyond the scope of our research. Further research is this area is still required.

Conclusions

In conclusion, our results show that depression was significantly associated with subsequent short sleep duration after controlling for potential confounders, and depression was not associated with subsequent long sleep duration. Both these associations were also observed in subgroup analyses. Clinicians should pay attention to sleep duration and its association with depression.

Author statements

Competing interests

The authors declare that there is no conflict of interest.

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