Sleep Medicine 54 (2019) 134–141

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Gender-specific prevalence of poor sleep quality and related factors in a Chinese rural population: the Henan Rural Cohort Study

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ARTICLE INFO

Article history:
Received 13 August 2018
Received in revised form
26 October 2018
Accepted 29 October 2018
Available online 22 November 2018

Keywords:
Sleep quality
Pittsburgh sleep quality index (PSQI)
Related factor
Rural population

ABSTRACT

Objective: To estimate the prevalence of poor sleep quality and identify related factors by gender in the Chinese rural population.
Methods: Overall, 27424 subjects (10881 males and 16543 females) aged 18–79 years were enrolled from the Henan Rural Cohort Study. Sleep quality was evaluated by the standard Pittsburgh Sleep Quality Index (PSQI) and global score>5 was classified as poor sleep quality. Logistic regression analysis was used to estimate the odds ratios (*ORs*) and 95% confidence intervals (*CIs*). A meta-analysis including 14 studies was used to validate the result of the cross-sectional study.
Results: The average PSQI score was 3.78 ± 2.72 in total, and the score of females (4.10 ± 2.90) was significantly higher than males (3.29 ± 2.33). The crude and age-standardized prevalences of poor sleep quality were 21.62% and 15.80%, respectively. The crude prevalence in females (25.73%) was significantly higher than males (15.38%). The results of meta-analysis showed that the pooled prevalence of poor sleep quality was 25.0% (18.8%–31.2%) in total sample, 31.7% (24.9%–38.5%) in male, and 38.2% (29.7%–46.7%) in females. Multivariate logistic regression identified that older age, being female, unmarried/divorced/widowed, low education level, low income, drinking, depression and dyslipidemia could increase the odds of poor sleep quality.
Conclusions: More than one fifth of the participants in a rural area of China slept poorly and the prevalence in females was significantly higher than males. Effective interventions are urgently needed to improve the sleep quality in resource limited areas.
Clinical trial registration: The Henan Rural Cohort Study has been registered at Chinese Clinical Trial Register (Registration number: ChiCTR-OOC-15006699). http://www.chictr.org.cn/showproj.aspx?proj=11375.

1. Introduction

Poor sleep quality was frequently found in the general population and increased the concern about the sleep health. In recent years, numerous epidemiological studies have suggested that poor sleep played a vital role in the development of many diseases, such as diabetes mellitus [1,2], depression [3] and hypertension [4,5].

A community study conducted in Germany showed that the prevalence of poor sleep quality was 36%, among 9284 adult residents aged 18–80 years, according to the cut-off (PSQI>5) [6]. An epidemiological study concerning the subjective sleep quality of general population conducted in Australia indicated that the overall prevalence of poor sleep quality was 31.85%, and the prevalence in females was higher than in males [7]. As the largest developing country, China is undergoing a huge demographic and economic transition, facing an emerging burden of non-communicable diseases. A previous study conducted in Hong Kong suggested that the overall prevalence of insomnia among general population was

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https://doi.org/10.1016/j.sleep.2018.10.031
1389-9457/

11.9% [8], while another cross-sectional study consisted of 5001 Chinese adults in Hong Kong showed that the prevalence of poor sleep quality was 39.4% [9]. A study conducted in the rural area of Anhui province found 49.7% of the participants slept poorly with the PSQI, however it only focused on elderly aged people [10].

Many factors are responsible for poor sleep quality. As we age, sleep duration and sleep stages will change (eg, longer sleep latency, shorter sleep duration and increased sleep fragmentation) [11]. Extensive data have emerged to show the relationship between psychological factors and sleep quality [12]. Apart from mental health, chronic diseases have been reported to be linked to poorer sleep [13]. In addition, marital status, education level and physical activity were frequently found to be associated with sleep quality [14].

An abundance of literature surrounding the associated factors of poor sleep quality in the western general population have been done so as to reduce social burden and improve work efficiency. However, the racial and ethnic diversity between western and Asia cannot be neglected, as well as the economic and geographic differences between rural and urban areas. Therefore, previous studies may not completely reflect the characteristics of sleep of Chinese general population. Furthermore, correlational researches pertaining to Chinese mainland are limited, especially about the gender difference of sleep quality in the underdevelopment rural area suffering poverty and inadequate resources. Understanding what affect the sleep quality will enable the development of strategies to improve the quality of life. Therefore, the aims of this study were to estimate the prevalence of poor sleep quality in Chinese rural population and explore the related factors.

2. Methods

2.1. Study participants

The Henan Rural Cohort Study was a population-based study with a large sample of rural people living in the Suiping country, Yima city, Xinxiang country, Kaifeng country and Yuzhou country of Henan Province in China from July 2015 to October 2017, which has been registered in Chinese Clinical Trial Register (Registration number: ChiCTR-OOC-15006699) before the onset of patient enrollment. A total of 39259 people completed this study and the age range of the participants were 18–79 years. The participants were excluded if they: (1) had shift work (n = 1525); (2) were diagnosed with malignant tumor (n = 285); (3) did not have complete information about sleep (n = 9514); (4) were diagnosed with kidney failure (n = 18), had heart failure (n = 53), pulmonary tuberculosis (n = 252), emphysema (n = 131), cirrhosis (n = 35), or chronic obstructive pulmonary disease (n = 22). Thus, 27424 (10881 male and 16543 female) adults remained and were included in the final analysis to estimate the prevalence of poor sleep quality and explore the related factors. This study was approved by the Zhengzhou University Life Science Ethics Committee (Code: [2015] MEC (S128)). Informed consent was signed by all study participants. The present study was conducted according to the 1975 Declaration of Helsinki.

2.2. Instrument

The sleep quality was assessed with Pittsburgh Sleep Quality Index (PSQI), a validated self-report questionnaire consisting of 19 elements. The 19 elements were grouped into seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleeping medication and daytime dysfunction. The score range of each component is 0–3. The global score is summed up by each component score, ranging from 0 to 21. The higher score indicate that the sleep quality is poorer. The global score >5 is classified as poor sleep quality and ≤5 is classified as good sleep quality with the sensitivity (89.6%) and specificity (86.5%) [15]. The Chinese version Pittsburgh sleep quality index has been widely used to assess sleep quality in other areas of China with good overall reliability (r = 0.82–0.83) and test-retest reliability (r = 0.77–0.85) [16,17].

2.3. Data collection

In the Henan Rural Cohort Study, face-to-face interviews were administered by well-trained staffs using a standard questionnaire to obtain information about demographic characteristics, life styles, the history of disease and medication, family history of disease, emotion and stress condition. The demographic data included sex, age, ethnic, religion, educational level, socioeconomic status and marital status. Lifestyles included smoking, drinking, diet habits, physical activity and sleep condition. Education level was classified into three categories: elementary school or below, junior high school and high school or above. Smoking was defined as at least one cigarette per day for sequential or cumulative six months. Drinking was defined as at least consuming alcohol 12 times per year. Physical activity was classified as low, moderate, high level according to International Physical Activity Questionnaire (IPAQ) [18]. High fat diet was defined as the meat of livestock and poultry taken by a person was more than 75 g/day. More vegetable and fruit intake was defined as the vegetable and fruit taken by a person was more than 500 g/day.

Weight was measured twice with a weight measurement device (V. BODY HBF-371, OMRON, Japan) and the reading was taken to the nearest 0.1 kg. Height was measured twice to the nearest 0.1 cm with shoes off by a standard right-angle device.

Body mass index (BMI) was calculated as body weight (kg) divided by height square (m^2). According to the criteria recommended by Working Group on Obesity in China, BMI was divided into four levels: low weight was defined as BMI <18.5 kg/m^2, normal weight was defined as 18.5 ≤ BMI <24.0 kg/m^2, overweight was defined as 24.0 ≤ BMI <28.0 kg/m^2, and obese was defined as BMI ≥28.0 kg/m^2. Blood pressure (BP) was measured using electronic sphygmomanometer (HEM-770A Fuzzy, Omron, Japan), following the American Heart Association's standardized protocol [19]. Additionally, blood pressure was measured three times at 30-s intervals in the sitting position after the subjects had rested for 5 min. The mean values of the measurements were used for analysis. Hypertension was defined as systolic blood pressure ≥140 mmHg, and/or diastolic blood pressure ≥90 mmHg, or the use of antihypertensive medication in the last two weeks. After overnight fasting, the venous blood samples were collected from the participants and were separated by centrifugation. At the same time, fasting blood glucose was measured via glucose oxidative method (GOD-PAP) using ROCHE Cobas C501 automatic biochemical analyzer. Diabetes was defined if the fasting blood glucose ≥7.0 mmol/l or having a self-reported previous diagnosis of diabetes by a physician or self-reported use of insulin or anti-diabetic medications in the last two weeks. The Patient Health Questionnaire (PHQ-2) was used to assess major depression disorder with the score of 3 or higher. Dyslipidemia was defined as serum total cholesterol (TC) ≥ 6.22 mmol/L (240 mg/dl) or triglyceride (TG) ≥ 2.26 mmol/L (200 mg/dl) or high-density lipoprotein cholesterol (HDL-C) < 1.04 mmol/L (40 mg/dl) or low-density lipoprotein cholesterol (LDL-C) ≥ 4.14 mmol/L (160 mg/dl) or the use of lipid-lowering drug in the last two weeks.

2.4. Meta-analysis

A meta-analysis was conducted according to the guideline of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). Previous studies on the prevalence of poor

sleep quality assessed by PSQI in Web of science, PubMed, CNKI (China National Knowledge infrastructure) and Wanfang library databases were searched from 1 January 2010 to 4 May 2018 and the search terms were 'sleep quality, sleep disturbance, sleep disorder, insomnia, or sleep problem' and 'prevalence, incidence, or rate' and 'Pittsburgh Sleep Quality Index, or PSQI'. Articles were included if they accorded with the following criteria: (1) the participants of studies were from the Chinese population; (2) the study had to report the number of the sample and the prevalence of poor sleep quality in the rural area; and (3) the study was based on general population samples from a rural area. The excluded criteria were: (1) the study was based on particular population (eg, children, pregnant women, volunteers, or age groups); (2) the study was based on population from foreign countries; and (3) the participants were from an urban population. Two investigators independently extracted data information from the studies and the disagreements were settled by discussion. The extracted information from selected studies included the first author, year of publication, study location, sample size of total sample and by sex, range of age, prevalence of the total sample and by sex in the rural areas.

2.5. Statistical analysis

All analyses were performed separately for males and females. Continuous variables were expressed in mean ± standard deviation, and compared by Student's t-tests, while categorical variables were expressed in percentage and compared by chi-squared test. The age-standardized prevalence of poor sleep quality was computed according to the data of Population Census 2010. The multivariable logistic regression model was used to examine the association between factors and sleep quality based on odds ratio and 95% confidence intervals. Statistical analyses were performed by SAS 9.1 software package (SAS Institute, USA) and two-tailed $P < 0.05$ was applied to assess the statistical significance.

Stata Software Package, V11.2 (Stata Corp, College Station, Texas, USA) was used to execute the meta-analysis. The pooled estimates of prevalence about poor sleep quality among the total sample; males and females were calculated according to the random effect model, respectively. To examine the heterogeneity, I^2 statistic was used. The publication bias was explored by Begg's and Egger's tests.

3. Results

3.1. Characteristics of participants

Among the 27,424 participants, 16,543 (60.32%) were female. The mean age of participants was 55.85 ± 12.22 years. Compared with male participants, females were more likely to be of lower education level, lower proportion of current smoking and current drinking, lower high physical activity, lower high fat diet and higher BMI. In addition, females were more likely to have depression (Table 1).

3.2. Components of sleep quality by gender

The global score among overall participants was 3.78 ± 2.72. The score in female (4.10 ± 2.90) was significantly higher than male (3.29 ± 2.33). Apart from the sleep duration (component 3), the mean scores of other components in females were significantly higher than males. In particular, the score in sleep disturbance was the highest, while the score in use of sleep medication was the lowest (Table 2). The global PSQI scores ranged from 2.78 (1.82) to 4.10 (2.89) across age groups. Age has an inverse relationship with the sleep quality, and there was a sharp worsening of sleep quality in age group of 40–50 years for both genders. The global mean score in females were higher than in males across all age groups (Fig. 1).

The mean sleep latency among participants was 0.46 (0.54) hour, and 13828 (50.42%) of the subjects could not fall asleep within 15 min. The sleep latency in females was significantly higher than in males ($P < 0.001$). The mean sleep duration among the participants was 7.71 (1.27) hour, and 6936 (25.29%) of the participants showed having less than 7 h of sleep per night. There was no significant difference about the mean sleep duration between males and females ($P = 0.820$) (Table S1).

3.3. Prevalence of poor sleep quality

In this study, the overall crude and age-standardized prevalence of poor sleep quality were 21.62% (21.13%–22.11%) and 15.80% (15.37%–16.23%), respectively. The crude prevalence of poor sleep quality in females was 25.73% (25.06%–26.39%) which was significantly higher than in males 15.38% (14.70%–16.05%) ($P < 0.001$). The age-standardized prevalence of poor sleep quality in males was 12.46% (11.84%–13.08%) and in females was 17.99% (17.40%–18.58%). Apart from the age groups of 18~ and 30~, the prevalence of poor sleep quality in females were higher than males in the remaining age groups ($P < 0.001$). Similarly, the prevalence in females were significantly higher than males in all demographic characteristics and life styles. In those participants with chronic diseases, the prevalence in females was also significantly higher than males. As for BMI, the prevalence of female was significantly higher than males in normal weight, overweight and obese groups, excluding the low weight group.

Among females, participants with older age, unmarried/divorced/widowed, lower education level, lower income level, current drinking, no high fat diet, hypertension, diabetes, dyslipidemia and depression were predisposed to poor sleep quality. For males, participants with older age, unmarried/divorced/widowed, lower education level, lower income level, no drinking, and depression showed higher prevalence of poor sleep quality (Table 3). The age-standardized prevalence of poor sleep quality among male and female were also increased with age groups (Fig. 2).

3.4. Risk factors for poor sleep quality

The results of multivariate logistic regression showed that subjects who were much older, were female, were unmarried/divorced/widowed, had low education level or low average monthly individual income and suffered from depression experienced poor sleep quality. In addition, males who were current smoking were 1.12 times more likely to suffer from poor sleep quality than non-smokers, whereas females who were current drinkers or suffered dyslipidemia had a higher risk of poor sleep quality. Moreover, females who were obese were 0.90 times less likely to suffer from poor sleep quality (Table 4).

3.5. Meta-analysis

A total of 14 studies were selected according to the inclusion and exclusion criteria. The prevalence of poor sleep quality about total sample could be extracted in 14 studies [17,20–32]. However, the corresponding data about males and females could be obtained only from six studies [17,28–32]. The details were showed in (Table S2 and Fig. S1). The pooled prevalence of poor sleep quality in the total sample was 25.0% (18.8%–31.2%). The pooled prevalence of males and females were 31.7% (24.9%–38.5%) and 38.2% (29.7%–46.7%), respectively (Fig. 3). Obvious heterogeneity existed (I^2 >50%). Publication bias was not detected by Begg's and Egger's tests ($P > 0.05$).

Table 1
Characteristics of the participants by gender.

Variables	Total (n = 27424)	Male (n = 10881)	Female (n = 16543)	*P*-value
Age (years), mean (SD)	55.85 (12.22)	57.02 (12.16)	55.08 (12.20)	<0.001
Marital status, n (%)				0.806
Married/cohabiting	24644 (89.86)	9784 (89.92)	14860 (89.83)	
Unmarried/divorced/widowed	2780 (10.14)	1097 (10.08)	1683 (10.17)	
Education, n (%)				<0.001
Elementary school or below	12502 (45.59)	3737 (34.34)	8765 (52.98)	
Junior high school	10514 (38.34)	4904 (45.07)	5610 (33.91)	
High school or above	4408 (16.07)	2240 (20.59)	2168 (13.11)	
Average monthly individual income, n (%)				0.004
<500RMB	10125 (36.92)	4121 (37.87)	6004 (36.29)	
500 ~ RMB	8659 (31.57)	3321 (30.52)	5338 (32.27)	
1000 ~ RMB	8640 (31.51)	3439 (31.61)	5201 (31.44)	
Smoking, n (%)				<0.001
No smoking	22081 (80.52)	5584 (51.32)	16497 (99.72)	
Current smoking	5343 (19.48)	5297 (48.68)	46 (0.28)	
Drinking, n (%)				<0.001
No drinking	22815 (83.19)	6589 (60.56)	16226 (98.08)	
Current drinking	4609 (16.81)	4292 (39.44)	317 (1.92)	
Physical activity, n (%)				<0.001
Low	8601 (31.36)	3728 (34.26)	4873 (29.46)	
Moderate	10117 (36.89)	3026 (27.81)	7091 (42.86)	
High	8706 (31.75)	4127 (37.93)	4579 (27.68)	
High fat diet, n (%)	4924 (17.96)	2556 (23.49)	2368 (14.31)	<0.001
More vegetables and fruit intake, n (%)	13284 (48.44)	5306 (48.77)	7978 (48.23)	0.379
BMI, mean (SD)	24.74 (3.56)	24.47 (3.44)	24.91 (3.63)	<0.001
Hypertension, n (%)	8873 (32.38)	3514 (32.32)	5359 (32.42)	0.872
Diabetes, n (%)	2456 (8.97)	939 (8.65)	1517 (9.19)	0.128
Depression, n (%)	1600 (5.83)	510 (4.69)	1090 (6.59)	<0.001
Dyslipidemia, n (%)	10620 (38.73)	4364 (40.11)	6256 (37.82)	<0.001

BMI, body mass index; SD, standard deviation.
Values are means and standard deviation for continuous variables, and numbers and percentages for categorical variables.

Table 2
The mean score of PSQI components.

PSQI component	Total (n = 27424)	Male (n = 10881)	Female (n = 16543)	*P*-value
Subjective sleep quality, M (SD)	0.79 (0.80)	0.66 (0.73)	0.88 (0.83)	<0.001
Sleep latency, M (SD)	1.02 (1.12)	0.82 (1.02)	1.15 (1.16)	<0.001
Sleep duration, M (SD)	0.34 (0.66)	0.36 (0.67)	0.33 (0.65)	0.003
Habitual sleep efficiency, M (SD)	0.10 (0.40)	0.06 (0.30)	0.13 (0.46)	<0.001
Sleep disturbance, M (SD)	1.15 (0.53)	1.08 (0.50)	1.19 (0.56)	<0.001
Use of sleep medication, M (SD)	0.06 (0.38)	0.04 (0.30)	0.08 (0.43)	<0.001
Daytime dysfunction, M (SD)	0.32 (0.60)	0.27 (0.56)	0.34 (0.63)	<0.001
Global score	3.78 (2.72)	3.29 (2.33)	4.10 (2.90)	<0.001

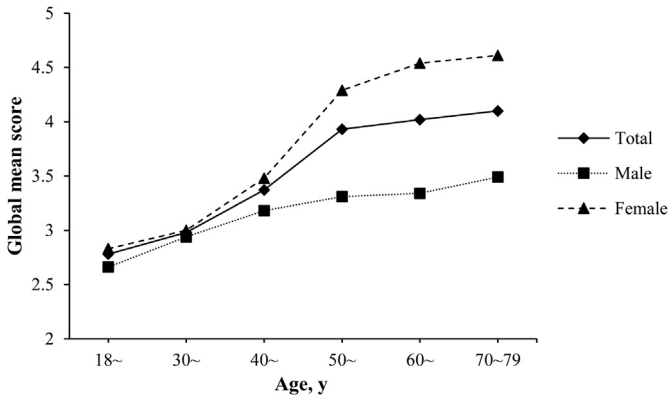

Fig. 1. The global mean scores between different age groups for males and females.

4. Discussion

The present study is the first large-scale survey of sleep quality about the general population in the rural area combined with meta-analysis. The overall crude prevalence of poor sleep quality in the rural population was 21.62% (21.13%–22.11%) and the age-standardized prevalence of total sample was 15.80% (15.37%–16.23%). Differences in the prevalence of total sample (21.62% vs. 25.0%), males (15.38% *vs*. 31.7%) and females (25.73% *vs*. 38.2%) were found between the present study and meta-analysis. In addition, A study conducted in Guangdong urban population reported the prevalence of poor sleep among middle-aged and older adults was 20.67%, and the PSQI total mean score was 3.84 (2.81) which was comparable to the present study [14]. Furthermore, the prevalence of poor sleep quality in general population of Hong Kong was 39.4% (37.8%–41.0%) [9]. The rates of poor sleep reported in previous studies about Spain general population were 38.2% [33]. However, with the same sleep evaluation standard and the cut-off (PSQI > 5), our study indicated the prevalence of rural Henan population was lower than the aforementioned studies apart from the Guangdong

Table 3
The prevalence and 95% confidence intervals of poor sleep quality among males and females.

Variables	Total (n = 27424)	Male (n = 10881)	Female (n = 16543)	*P*-value
Age (years), %				
18~	8.75 (6.92–10.59)	8.65 (5.52–11.79)	8.80 (6.53–11.07)	0.939
30~	10.94 (9.55–12.32)	10.24 (7.94–12.53)	11.30 (9.57–13.04)	0.473
40~	16.98 (15.92–18.04)	13.77 (12.16–15.38)	18.85 (17.46–20.24)	<0.001
50~	23.57 (22.62–24.52)	15.75 (14.39–17.10)	28.03 (26.77–29.29)	<0.001
60~	24.73 (23.82–25.65)	16.15 (14.97–17.33)	31.35 (30.04–32.66)	<0.001
70~79	25.40 (23.96–26.84)	18.15 (16.26–20.03)	31.53 (29.44–33.62)	<0.001
18~79	21.62 (21.13–22.11)	15.38 (14.70–16.05)	25.73 (25.06–26.39)	<0.001
P for trend		<0.001	<0.001	
Marital status, %				
Married/cohabiting	21.02 (20.51–21.52)	14.82 (14.12–15.52)	25.09 (24.40–25.79)	<0.001
Unmarried/divorced/widowed	26.98 (25.33–28.63)	20.33 (17.94–22.71)	31.31 (29.10–33.53)	<0.001
P for difference		<0.001	<0.001	
Education, %				
Elementary school or below	26.12 (25.35–26.89)	17.63 (16.41–18.86)	29.74 (28.79–30.70)	<0.001
Junior high school	19.11 (18.36–19.86)	14.72 (13.73–15.71)	22.94 (21.84–24.04)	<0.001
High school or above	14.84 (13.79–15.89)	13.04 (11.64–14.43)	16.70 (15.13–18.27)	0.001
P for trend		<0.001	<0.001	
Average monthly individual income, %				
<500RMB	24.30 (23.46–25.13)	17.35 (16.19–18.51)	29.06 (27.92–30.21)	<0.001
500 ~ RMB	20.86 (20.00–21.71)	15.06 (13.84–16.27)	24.47 (23.31–25.62)	<0.001
1000 ~ RMB	19.25 (18.42–20.08)	13.32 (12.18–14.45)	23.17 (22.02–24.32)	<0.001
P for trend		<0.001	<0.001	
Smoking, %				
No smoking	22.97 (22.42–23.52)	14.88 (13.95–15.82)	25.71 (25.04–26.37)	<0.001
Current smoking	16.04 (15.06–17.02)	15.90 (14.91–16.88)	32.61 (18.53–46.68)	0.002
P for difference		0.143	0.285	
Drinking, %				
No drinking	22.84 (22.30–23.39)	16.03 (15.14–16.91)	25.61 (24.94–26.28)	<0.001
Current drinking	15.58 (14.53–16.63)	14.38 (13.33–15.43)	31.86 (26.70–37.02)	<0.001
P for difference		0.020	0.012	
Physical activity, %				
Low	21.04 (20.18–21.91)	15.88 (14.71–17.05)	24.99 (23.78–26.21)	<0.001
Moderate	23.05 (22.23–23.87)	15.76 (14.46–17.06)	26.16 (25.14–27.18)	<0.001
High	20.53 (19.68–21.37)	14.64 (13.56–15.71)	25.84 (24.57–27.10)	<0.001
P for trend		0.122	0.339	
High fat diet, %				
No	22.28 (21.73–22.82)	15.57 (14.79–16.35)	26.22 (25.49–26.94)	<0.001
Yes	18.62 (17.54–19.71)	14.75 (13.37–16.13)	22.80 (21.11–24.50)	<0.001
P for difference		0.316	<0.001	
More vegetabl and fruit intake, %				
No	22.16 (21.47–22.84)	15.90 (14.94–16.86)	26.23 (25.30–27.17)	<0.001
Yes	21.05 (20.35–21.74)	14.83 (13.88–15.79)	25.18 (24.23–26.13)	<0.001
P for difference		0.124	0.122	
BMI, %				
Low weight	23.52 (20.36–26.69)	20.14 (15.52–24.76)	26.00 (21.68–30.32)	0.072
Normal weight	21.50 (20.75–22.26)	15.88 (14.85–16.92)	25.63 (24.57–26.69)	<0.001
Overweight	21.59 (20.81–22.37)	14.78 (13.69–15.86)	25.85 (24.79–26.91)	<0.001
Obese	21.66 (20.47–22.84)	14.51 (12.81–16.21)	25.58 (24.02–27.15)	<0.001
P for trend		0.020	0.987	
Hypertension, %				
No	20.52 (19.94–21.10)	15.06 (14.24–15.88)	24.11 (23.32–24.91)	<0.001
Yes	23.93 (23.04–24.81)	16.05 (14.84–17.26)	29.09 (27.87–30.31)	<0.001
P for difference		0.181	<0.001	
Diabetes, %				
No	21.33 (20.82–21.83)	15.36 (14.65–16.07)	25.27 (24.58–25.97)	<0.001
Yes	24.71 (23.01–26.42)	15.87 (13.53–18.21)	30.19 (27.88–32.50)	<0.001
P for difference		0.679	<0.001	
Depression, %				
No	19.85 (19.36–20.33)	14.03 (13.36–14.70)	23.75 (23.08–24.43)	<0.001
Yes	50.31 (47.86–52.77)	42.94 (38.63–47.25)	53.76 (50.80–56.73)	<0.001
P for difference		<0.001	<0.001	
Dyslipidemia, %				
No	20.69 (20.07–21.30)	15.34 (14.47–16.22)	24.07 (23.24–24.90)	<0.001
Yes	23.10 (22.30–23.90)	15.42 (14.35–16.49)	28.45 (27.33–29.57)	<0.001
P for difference		0.913	<0.001	

urban population. Geographic setting, socioeconomic level and lifestyle might partly contribute to this phenomenon [34,35].

A higher prevalence of poor sleep quality among females than males has been observed [9], and similar results were found in the present study. In line with previous research [8], females were two times more inclined to suffer from poor sleep quality than male after controlling for sociodemographic, lifestyle factors as well as chronic disease and depression. Especially in older age in females, the rates increased more which might be due to menopause status [36]. In agreement with the studies conducted in rural and urban

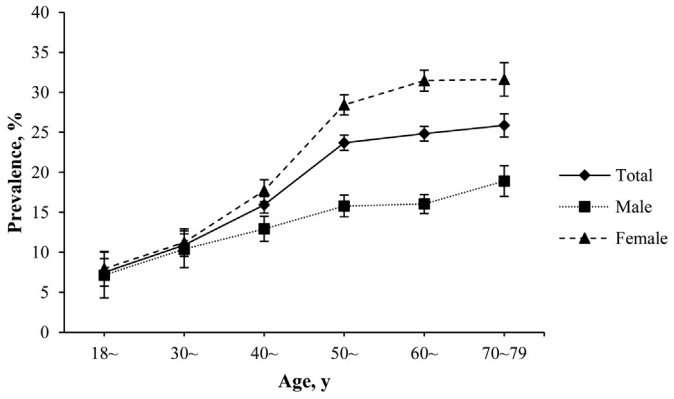

Fig. 2. The age-standardized prevalence of poor sleep quality between different age groups for males and females. I bar indicate 95% confidence intervals.

region of Beijing [37], the current study also showed the rates of sleep complaints rose with age in both genders. Additionally, our research demonstrated that unmarried/divorced/widowed status could increase the odds of poor sleep quality in multivariable-adjusted analysis [17]. Marital status was beneficial to individuals and people who were married reported greater satisfaction with life [38]. The association between education level, income and sleep quality were also been found consistent with previous research [34]. High education level and income might indicate higher socioeconomic status which demonstrated lower probability of poor sleep quality [39]. Furthermore, the present study demonstrated the significant association between sleep quality and depression similar to previous studies [35].

A previous study found that females were more vulnerable to adverse effect of alcohol consumption [40]. The present study showed that current alcohol intake could increase the risk of poor sleep quality in females while the significant association was not found in male.

Smoking was well known to be related with poor sleep quality [17]. We observed that smoking could significantly increase the odds ratio of poor sleep quality in males, while that was non-significant in females which was affected by the limited number of smoking. Studies have investigated the association between obesity and sleep quality but the results were controversial. A study demonstrated that the poor sleep quality was significantly related with obesity [41], while other studies have reported no significant association between obesity and sleep quality [10,14]. However, a large-scale study found that high sleep quality was associated with high BMI for male in China and India [42]. In the present study, obesity was positively associated with good sleep quality in female after controlling other confounders, while no significant associations between other BMI conditions and sleep quality were found.

Table 4
The odds ratio and 95% confidence intervals of poor sleep quality by gender.

Variables	Total (n = 27424)	Male (n = 10881)	Female (n = 16543)
Age (years)			
18~	1.00	1.00	1.00
30~	1.25 (0.95–1.65)	1.28 (0.79–2.06)	1.26 (0.90–1.77)
40~	2.00 (1.55–2.57)	1.81 (1.17–2.80)	2.10 (1.54–2.86)
50~	3.02 (2.36–3.87)	2.17 (1.42–3.32)	3.49 (2.58–4.73)
60~	3.08 (2.40–3.95)	2.08 (1.36–3.19)	3.72 (2.73–5.06)
70~79	3.03 (2.34–3.93)	2.21 (1.42–3.43)	3.56 (2.58–4.91)
Sex			
Female	2.02 (1.85–2.21)		
Marital status			
Married/cohabiting	1.00	1.00	1.00
Unmarried/divorced/widowed	1.23 (1.11–1.35)	1.37 (1.16–1.62)	1.15 (1.02–1.29)
Education			
Elementary school or below	1.00	1.00	1.00
Junior high school	0.87 (0.81–0.93)	0.91 (0.80–1.03)	0.88 (0.80–0.95)
High school or above	0.78 (0.70–0.86)	0.86 (0.73–1.01)	0.75 (0.65–0.86)
Average monthly individual income			
<500RMB	1.00	1.00	1.00
500 ~ RMB	0.91 (0.84–0.98)	0.92 (0.81–1.05)	0.90 (0.83–0.98)
1000 ~ RMB	0.89 (0.83–0.96)	0.85 (0.74–0.97)	0.90 (0.83–0.99)
Smoking			
No smoking	1.00	1.00	1.00
Current smoking	1.11 (0.99–1.24)	1.12 (1.00–1.25)	0.99 (0.53–1.87)
Drinking			
No drinking	1.00	1.00	1.00
Current drinking	1.10 (0.99–1.22)	0.98 (0.88–1.11)	1.55 (1.21–1.99)
Physical activity			
Low	1.00	1.00	1.00
Moderate	1.09 (1.01–1.17)	1.01 (0.88–1.16)	1.12 (1.02–1.22)
High	1.00 (0.92–1.08)	0.95 (0.84–1.08)	1.02 (0.92–1.12)
High fat diet	1.02 (0.94–1.11)	1.07 (0.94–1.22)	0.98 (0.88–1.09)
More vegetables and fruit intake	0.95 (0.89–1.01)	0.92 (0.82–1.02)	0.97 (0.90–1.04)
BMI			
Normal weight	1.00	1.00	1.00
Low weight	1.11 (0.92–1.35)	1.25 (0.92–1.70)	1.03 (0.81–1.31)
Overweight	0.95 (0.89–1.02)	0.97 (0.85–1.09)	0.94 (0.87–1.02)
Obese	0.93 (0.85–1.02)	0.99 (0.83–1.18)	0.90 (0.81–1.00)
Hypertension	1.03 (0.97–1.11)	1.05 (0.93–1.18)	1.02 (0.94–1.10)
Diabetes	1.02 (0.92–1.13)	0.97 (0.80–1.18)	1.04 (0.92–1.17)
Depression	3.93 (3.54–4.37)	4.54 (3.77–5.48)	3.65 (3.21–4.15)
Dyslipidemia	1.10 (1.04–1.18)	1.06 (0.94–1.19)	1.10 (1.02–1.18)

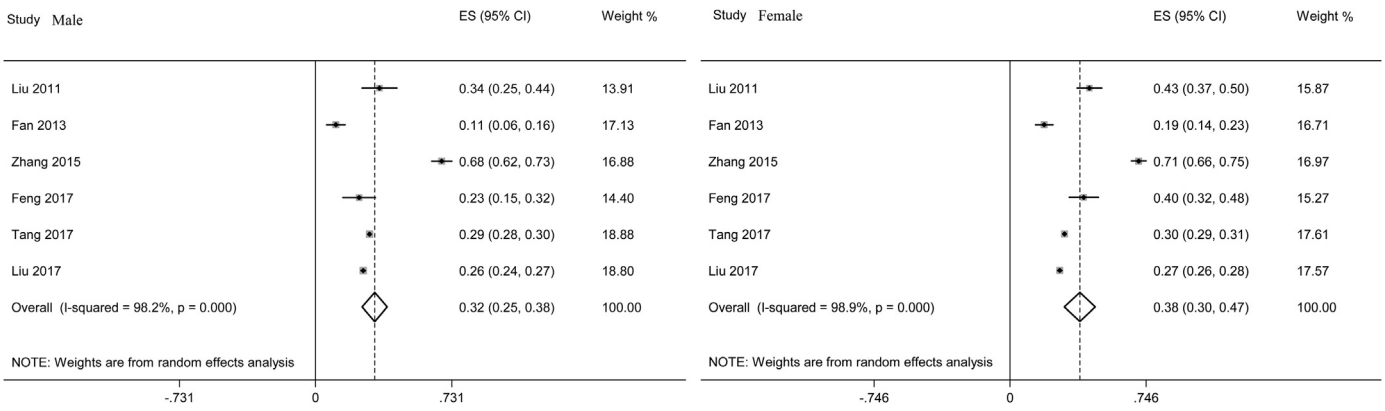

Fig. 3. Forest plot of prevalence of poor sleep quality of included studies.

Ethnicity, age structure and region (rural or urban) might be responsible for the differences [10,14,41,42]. Physical exercise was considered as a positive factor for improving sleep quality [14]. However, the significant association was not observed in our study. Further cohort studies need to be conducted to explicate the mechanisms between drinking, smoking, BMI, physical exercise and sleep quality.

In the present study, we found no significant association between hypertension, diabetes and sleep quality after controlling confounders, which was different with previous researches [43,44], showing that the diseases were harmful to sleep quality. Studies in a meta-analysis reported that the association between poor sleep quality and blood lipids was controversial [45], while the significant association between sleep quality and dyslipidemia in female was found in our research. The relationship between sleep and chronic disease merits a future study.

This was the first study combining epidemiological survey and meta-analysis to comprehensively analyze the prevalence of poor sleep quality and explore related influencing factors in Chinese rural area. In addition, a large range of co-variables were adjusted which helped us to control potential confounders. However, there existed some limitations. First, because the present study was a cross-sectional design, we could not identify the causal relationships between sleep quality and factors. Multi-center and prospective studies need to be done. Second, sleep quality in our study was assessed by PSQI based on self-report of participants, which might be susceptible to the recall bias. However, the validated and structured questionnaire was more desirably incorporated in the large epidemiologic field investigation than objective method. Finally, because the age-standardized prevalence of poor sleep quality in many of the included studies was unavailable, the pooled age-standardized prevalence could not be given in this meta-analysis.

In conclusion, there were more than one fifth of the participants slept poorly in the general population living in rural area of China. Therefore, more attention should be paid to improve the sleep quality in the populations including older, female, unhealthy lifestyle peoples and patients with chronic non-communicable diseases in Chinese rural areas.

Funding

This research was supported by the National Key Research and Development Program of China (Grant NO: 2016YFC0900803), National Natural Science Foundation of China (Grant NO: 81573243, 81602925, U1304821), Henan Provincial Science Fund for Distinguished Young Scholars (Grant NO: 164100510021), Science and Technology Innovation Talents Support Plan of Henan Province Colleges and Universities (Grant NO: 14HASTIT035), High-level Personnel Special Support Project of Zhengzhou University (Grant NO: ZDGD13001). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author contributions

During the research, Yan Wang had full access to all the data in the study. Yan Wang and Yuqian Li analyzed the data and wrote the manuscript. Chongjian Wang designed the study. Yan Wang, Yuqian Li, Ruihua Liu, Xiaotian Liu, Zhenxing Mao, Runqi Tu, Haiqing Zhang, Xia Zhang, Xinling Qian, Jingjing Jiang, Dou Qiao, Zhicheng Luo, Xiaokang Dong, Xue Liu conducted the collection of the data. Xiaotian Liu corrected the manuscript. All authors read and approve this version of the article.

Ethics approval

Ethics approval was obtained from the “Zhengzhou University Life Science Ethics Committee”, and written informed consent was obtained for all participants. Ethic approval code: [2015] MEC (S128).

Acknowledgements

The authors would like to give great gratitude for the participants, all research staff of current study.

Conflict of interest

None.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2018.10.031.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2018.10.031.

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