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## The prevalence of poor sleep quality and its association with depression symptoms among the elderly in nursing homes in Hunan province,China

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**The prevalence of poor sleep quality and its association with depression symptoms among the elderly in nursing homes in Hunan province,China**

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Word count:4606;Tables:4

## ABSTRACT

**Objectives:** To examine the association between the prevalence of poor sleep quality and depression symptoms among the elderly in the nursing homes of Hunan Province in China.

**Design, Setting and participants:** A Cross-sectional study was conducted among 817 elderly people from 24 nursing homes in China's Hunan Province.

**Main outcome measures:** Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), and poor sleep quality was defined by a PSQI score>5. Depression symptoms were assessed using the Geriatric Depression Scale (GDS). General linear models (GLM) and binary logistic regression models were used to analyse the relationship between the prevalence of poor sleep quality and depression symptoms.

**Results:** The mean PSQI score was 8.5±4.9, and the prevalence of poor sleep quality was 67.3%. Additionally, the mean GDS score was 9.8±7.5, and the prevalence of depression symptoms was 36.0%. Elderly people with poor sleep quality had increased GDS score (mean difference=2.54, 95%CI: 1.66, 3.42) and increased risk of depression symptoms (odds

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ratio [OR]=3.19, 95% CI: 2.04, 4.98) after controlling for other factors.

**Conclusions:** The prevalence of poor sleep quality was relatively high, and this was associated with increased depression symptoms. Therefore, poor sleep quality could be speculated as a marker of current depression symptoms in the elderly.

**Keywords:** depression; sleep quality; elderly; nursing home;risk factors.

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**Article Summary**

**Strengths and limitations of this study**

- This is the first study to examine the impact of sleep quality on depression symptoms among elderly individuals in nursing homes.

- The study provides valueable information on sleep pattern and emotion problems with a nursing home setting.

- The cross-sectional study design makes causal relationships undeterminable.

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**1. Introduction**

Aging is a challenge problem in China and all over the world. As age increases in old age, the risk of problems with sleep also increases, which has emerged as a critical issue. For examples,a cross-sectional investigation conducted among 2,398 community-dwelling older persons in Italy indicated that 74% of men and 79% of women had sleep complaints [1]. Another cross-sectional study on 2,565 elderly Singaporeans showed that 69.4% experienced sleep interruption at night and 48.9% reported having difficulty falling asleep [2]. Moreover, the prevalence of poor sleep quality among older adults was also relatively high. In China, the prevalence of poor sleep quality was 41.5% in urban communities [3] and 49.7% in rural areas among the elderly [4]. However, several studies demonstrated that most sleep problems can be exacerbated by an institutional setting [5-7]. Fetveit and colleagues [6] found that the prevalence of sleep disturbance was approximately 70% among nursing home residents, whereas Hoffman[7]reported that approximately two-thirds of older adults living in long-term care facilities have some degree of sleep disturbance. In summary, sleep problems are very common among the elderly in nursing homes and pose a great challenge for public health.

There is many of evidence to suggesting that poor sleep quality has significant negative effects on physical and mental health, and health-related quality of life [8-10]. The findings of epidemiological studies suggest that poor sleep quality is a strong risk factor for suicidal ideation among the elderly [8 9]. In a large population-based cohort study, long sleepers with poor sleep quality had a 95% higher risk of cardiovascular disease mortality than those who slept for 7 hours [11]. Another large cohort study found that poor sleep quality was associated

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with increased odds of hypertension in a Chinese rural population [12]. However, despite the

significance of poor sleep quality among the elderly population, its prevalence and the

underlying effect on physical and mental function are not entirely understood.

Depression is a common psychiatric disorder among the elderly. It contributes not only

to mild cognitive impairment but also to an increased risk of comorbidity and mortality [13-15].

In addition, many studies indicated that the institutionalized elderly have a higher

prevalence of depression than the community-dwelling elderly. Due to differences in

diagnostic criteria, assessment tools and sample characteristics, the reported prevalence of

depression symptoms in nursing homes varied widely across different localities.

Epidemiological studies indicated that the prevalence of depressive symptoms among the

elderly in nursing homes was 90.2% in Iran [16], 81.8% in Taiwan [17], 29.6% in London [18] and

46.1% in mainland China [19].

The association between sleep quality and depressive symptoms among the elderly is

complex, bidirectional and not entirely understood. On one hand, many studies have

suggested that elderly people with some sleep disturbance are more likely to develop

depressive symptoms than younger people [20 21]. On the other hand, people with depression

symptoms reported a higher prevalence of poor sleep quality [22]. Although many previous

studies have demonstrated that poor sleep quality is positively associated with depression

symptoms among the elderly, the evidence of this relationship among the elderly in nursing

homes was scarce. Therefore, the purpose of this study was to examine the association

between poor sleep quality and depression symptoms among the elderly of nursing homes

in China.

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## 2. Methods

### 2.1 Study population

This cross-sectional study was conducted in Changsha, Hengyang and Yiyang Cities of Hunan Province in China from October 2018 up until December 2018. In order to select a representative sample of elderly people living in nursing homes of Hunan Province, a multistage sampling method was used. Firstly, three cities, Yiyang, Changsha and Hengyang were randomly selected from Northern Hunan, Central Hunan, and Southern Hunan, respectively. Subsequently, three counties, one from each City; and six districts, two from each City were randomly selected and this resulted in the following counties and districts chosen: Changsha County, Kaifu and Yuelu districts from Changsha City; Hengyang County, Yanfeng and Shigu districts from Hengyang City; and Yuanjiang County, Ziyang and Heshan districts from Yiyang City. Furthermore, six townships, two from each county were randomly selected and this resulted in the following townships chosen: Xingsha and Tiaoma from Changsha County; Xidu and Jingtou from Hengyang County; and Qionghu and Caowei from Yuanjiang County. Finally, 24 nursing homes were randomly selected, two from each district and two from each township.

The elderly population in selected nursing homes formed the sampling frame and participants were included in our study if they met the following inclusion criteria: (1) age 60 years and above; (2) has been in the nursing home for more than one year. Participants were excluded if they (1) refused to participate in this study; (2) have a severe hearing impairment or a language barrier. A total of 2,055 older adults residents in the 24 nursing homes, of which 511 were excluded because of less than 60 years or staying in a nursing

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home less than one year. 603 older adults have severe hearing impairment or language barrier and 112 older adults residents who did not agree to participate were also excluded in this study. Of the remaining 829 older adults, 12 were excluded for incomplete data. Finally, in total of 817 elderly were included in data analysis in this study.

## 2.2 Data collection

Trained staff collected data through face-to-face interviews using a set of structured questionnaires, and each interview lasted between 1/2 and 1 hour. General demographic information were collected including gender, age, education level, marital status, monthly personal income, duration of admission, number of living children, history of chronic diseases, history of smoking tobacco and history of alcohol consumption. Marital status was classified as either stable or unstable. Unstable marital status meant either divorce, loss of a partner or has never married. Smoking was defined as averaging at least one cigarette per day in the last year. Alcohol consumption was defined as drinking one glass of wine per day in the last week. Chronic diseases included type 2 diabetes, hypertension, coronary heart disease, chronic obstructive pulmonary disease and other chronic diseases as specified in the medical records of the respondent.

## 2.3 Sleep quality assessment

Sleep quality among the participants was assessed using the Chinese version of the Pittsburgh Sleep Quality Index (PSQI). The PSQI is a self-rated questionnaire that assesses sleep quality in the past month. It contains nineteen items grouped according to seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction[23]. These components

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were defined as follows in this study: subjective sleep quality (good or poor); reduced sleep efficiency (sleep efficiency<85%); increased sleep latency (sleep latency component score >1); sleep duration (<6 h,6-7 h and >7 h); sleep disturbances (any kind of sleep disturbance ≥1 time/week); use of sleep medication (use of sleep medication≥1 time/week); and daytime dysfunction (daytime dysfunction component score > 1). Each component's score ranges from 0 to 3 points so that the global PSQI score ranges from 0 to 21 points. The Chinese version of the PSQI has been shown to have good validity and reliability among older adults [24]. Participants with a global PSQI score greater than 5 were defined as having poor sleep quality [23].

## 2.4 Depression symptoms assessment

Depressive symptoms were assessed using the Chinese version of the Geriatric Depression Scale-30 items (GDS-30). The 30 items of this instrument are true/false questions whose total score ranges from 0 to 30 points. Participants who scored 11 or greater were considered as having depression symptoms in this study. The GDS-30 was developed by Brink and colleagues in 1982 and has been widely used to assess depression symptoms in the elderly worldwide [25]. Several studies have demonstrated that this measurement tool is reliable and valid in multiple settings and have recommended it for use in nursing home populations [26][27].The validity and reliability of the Chinese version of the GDS-30 have also been extensively assessed in China[28][29]. The GDS-30 consists of 30 true/false questions, and the total score ranges from 0 to 30 points. Participants who scored 11 or greater are considered to be depressive in this study[30].

## 2.5 Covariates

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Other information including, social support, activities of daily living (ADL) and negative

life events were collected. Social support among the elderly was assessed using the Social

Support Rating Scale (SSRS), which was developed by Xiao [31]. The scale consists of 10 items

and is divided into three parts: objective support, subjective support and availability of

social support. The total support score ranges from 12 to 66 points, and higher scores

indicate higher social support. An SSRS score greater than 30 points was defined as

indicating high social support in this study. Furthermore, ADL status was assessed using

Lawton and Brody's ADL scale [32]. It includes 16 items, and each item is scored from 1 (can do

it myself) to 4 (cannot do it myself). Participants' possible total scores on this instrument

range between 16 and 64 points. A participant is classified as having Disabled ADL status

when the participant's total score is higher than 14 points. Negative life events were

assessed using the Life Events Scale for the Elderly (LESE). The LESE is a valid and reliable

tool used in the elderly population and is widely used in China [33]. It includes 46 items that

are grouped into three main domains: health-related problems, family-related problems and

social-related problems. Participants were determined to have experienced from negative

life events when any such events occurred nd caused stress.

**2.6 Statistical analysis**

Categorical data were summarised as absolute values and percentages, whereas

continuous data were summarised as mean± standard deviation. The $\chi^2$ test for categorical

data or Student's *t*-test for continuous data was used to compare the differences between the

good sleep quality group and the poor sleep quality group. Additionally, student's *t*-test or

one-way analysis of variance (ANOVA) was used to identify the dependence of the

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differences in the GDS-30 and PSQI scores on different variables. General linear models (GLM) were used to estimate the difference in the mean GDS-30 scores with respect to sleep quality    (poor=1, good=0) using both the univariate (crude) and the multivariate (adjusted) models. Furthermore, the crude and adjusted binary logistic regression models were used to examine the association between sleep quality and depression symptoms; and the association between components of sleep quality and depression symptoms. A $P<0.05$ was considered statistically significant. All data analyses were performed using the Statistical Package for the Social Sciences (SPSS) 20.0 software (SPSS Inc., Chicago, IL, USA).

**2.7 Patient and public involvement**

Neither patients nor the public was directly involved in the development, design or recruitment of the study. Test results were provided to the participants at the point of testing.

**3. Results**

**3.1 Characteristics of the study sample**

The average age was 79.1±8.7 years, and more than half of the participants were female. Furthermore, majority of the participants had medical insurance, at least one kind of chronic disease, and one child. Also, minority of the participants were smokers, were drinkers, and normal ADL scores.

According to the cut-off value of the PSQI in terms of sleep quality, 550 (67.3%) participants had poor sleep quality. Moreover, 18.6% of the participants had a sleep duration between 6 and 7 hours, 30.4% reported sleep disturbances, 49.9% reported daytime dysfunction, and 10.3% had taken sleep medication more than once a week. Based

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on the $\chi^2$ test, the good sleep quality group and the poor sleep quality group had statistically significant differences with respect to education level, marital status, monthly personal income, history of chronic disease, negative life events, social support and ADL status. Additionally, participants with poor sleep quality were those who had an unstable marital status, a monthly personal income below 3,000 RMB, a history of chronic disease, the experience of negative life events, low social support and disabled ADL status. The results are shown in Table 1.

Table 1 Characteristics of the elderly people in the nursing homes

| Characteristic | Total (n=817) | Sleep quality | | P-value |
| --- | --- | --- | --- | --- |
| | | Poor (n=550) | Good(n=267) | |
| Age | 79.1±8.7 | 79.4±8.3 | 78.6±9.5 | 0.228 |
| Gender | | | | |
| Male | 376(46.0) | 251(45.6) | 125(46.8) | 0.751 |
| Female | 441(54.0) | 299(54.4) | 142(53.2) | |
| Education | | | | |
| Primary school andbelow | 364(44.6) | 263(47.8) | 101(37.8) | 0.004 |
| Junior high school | 203(24.8) | 138(25.1) | 65(24.3) | |
| Senior high school and above | 250(30.6) | 149(27.1) | 101(37.8) | |
| Marital status | | | | |
| Stable | 302(37.0) | 186(33.8) | 116(43.4) | 0.007 |
| Unstable | 515(63.0) | 364(66.2) | 151(56.6) | |
| Medical insurance | | | | |

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|---|---|---|---|---|
| Yes | 766(93.8) | 517(94.0) | 249(93.3) | 0.681 |
| No | 51(6.2) | 33(6.0) | 18(6.7) | |
| **Monthly personal income** | | | | |
| ≤3,000 RMB | 568(69.5) | 404(73.5) | 164(61.4) | <0.001 |
| >3,000 RMB | 249(30.5) | 146(26.5) | 103(38.6) | |
| **Duration of admission** | | | | |
| 1-3 years | 566(69.3) | 370(67.3) | 196(73.4) | 0.075 |
| >3 years | 251(30.7) | 180(32.7) | 71(26.6) | |
| **History of chronic disease** | | | | |
| Yes | 620(75.9) | 454(82.5) | 166(62.2) | <0.001 |
| No | 197(24.1) | 96(17.5) | 101(37.8) | |
| **Smoking** | | | | |
| Yes | 132(16.2) | 82(14.9) | 50(18.7) | 0.164 |
| No | 685(83.8) | 468(85.1) | 217(81.3) | |
| **Alcohol drinking** | | | | |
| Yes | 96(11.8) | 60(10.9) | 36(13.5) | 0.284 |
| No | 721(88.2) | 490(89.1) | 231(76.5) | |
| **Have a child or more** | | | | |
| Yes | 746(91.3) | 496(90.2) | 250(93.6) | 0.100 |
| No | 71(8.7) | 54(9.8) | 17(6.4) | |
| **Negative life events** | | | | |
| Yes | 725(88.7) | 515(93.6) | 210(78.7) | <0.001 |

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|---|---|---|---|---|
| No | 92(11.3) | 35(6.4) | 57(21.3) | |
| **Social support** | | | | |
| High | 382(46.8) | 213(38.7) | 169(63.3) | <0.001 |
| Low | 435(53.2) | 337(61.3) | 98(36.7) | |
| **ADL status** | | | | |
| Normal | 268(32.8) | 152(27.6) | 116(43.4) | <0.001 |
| Disabled | 549(67.2) | 398(72.4) | 151(56.6) | |
| **Subjective sleep quality** | | | | |
| Good | 483(59.1) | 220(40.0) | 263(98.5) | <0.001 |
| Poor | 334(40.9) | 330(60.0) | 4(1.5) | |
| **Increased sleep latency** | | | | |
| Yes | 433(53.0) | 421(76.5) | 12(4.5) | <0.001 |
| No | 384(47.0) | 129(23.5) | 255(95.5) | |
| **Sleep duration** | | | | |
| <6 h | 388(47.5) | 373(67.8) | 15(5.6) | <0.001 |
| 6-7 h | 152(18.6) | 98(17.8) | 54(20.2) | |
| >7 h | 277(33.9) | 79(14.4) | 198(74.2) | |
| **Reduced sleep efficiency** | | | | |
| Yes | 499(61.1) | 457(83.1) | 84(31.5) | <0.001 |
| No | 309(38.9) | 42(16.9) | 225(68.5) | |
| **Sleep disturbances** | | | | |
| Yes | 248(30.4) | 231(42.0) | 17(6.4) | <0.001 |

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|---|---|---|---|---|
| No | 569(69.6) | 319(58.0) | 250(93.6) | |
| Use of sleep medication | | | | |
| Yes | 84(10.3) | 83(15.1) | 1(0.4) | <0.001 |
| No | 733(89.7) | 467(84.9) | 266(99.6) | |
| Daytime dysfunction | | | | |
| Yes | 408(49.9) | 366(66.5) | 42(15.7) | <0.001 |
| No | 409(50.1) | 184(33.5) | 225(84.3) | |

Values are n (%) or mean±SD; ADL, activities of daily living

### 3.2 PSQI and GDS scores

The average GDS score was 9.8±7.5 points, and 294 (36.0%) participants were determined to have depressive symptoms. Participants with a primary school education or less, an unstable marital status, a monthly personal income ≤3,000 RMB, a duration of admission >3 years, a chronic disease, smoking status, drinking status, no children, low social support, experience of negative life events, and disabled ADL status appeared to have higher GDS scores (all $P$<0.001).

The average PSQI score was 8.5±4.9 points. The distribution of PSQI scores was statistically different across the categories of age, education level, marital status, monthly personal income, duration of admission, negative life events, social support and ADL status. Participants who had older age, primary school education or less, an unstable marital status, a monthly income ≤ 3,000 RMB, admission >3 years, low social support, experience of negative life events and disabled ADL status were more likely to have higher PSQI scores (all $P$<0.05). The results are presented in Table 2.

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Table 2 Distribution of the GDS-30 and PSQI scores across categories of the categorical

variables among the elderly in the nursing homes

| Variables | GDS-30 score | | PSQI score | |
|---|---|---|---|---|
| | Mean±SD | *P*-value[†] | Mean±SD | *P*-value[†] |
| Age | | | | |
| ≤70 years | 10.8±7.9 | 0.079 | 7.8±4.9 | 0.048 |
| >70 years | 9.6±7.4 | | 8.7±4.9 | |
| Gender | | | | |
| Male | 10.0±7.6 | 0.558 | 8.3±4.8 | 0.293 |
| Female | 9.7±7.5 | | 8.7±5.0 | |
| Education | | | | |
| Primary school andbelow | 11.2±7.9 | <0.001 | 9.1±5.0 | <0.001 |
| Junior high school | 10.1±7.4 | | 8.7±5.0 | |
| Senior high school and above | 7.7±6.6 | | 7.4±4.6 | |
| Marital status | | | | |
| Stable | 8.6±7.1 | <0.001 | 7.7±4.9 | <0.001 |
| Unstable | 10.6±7.7 | | 10.0± 4.9 | |
| Medical insurance | | | | |
| Yes | 9.8±7.5 | 0.351 | 8.5±4.9 | 0.892 |
| No | 10.8±7.7 | | 8.6±5.0 | |
| Monthly personal income | | | | |
| ≤3,000 RMB | 11.1±7.8 | <0.001 | 9.1±4.9 | <0.001 |

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|---|---|---|---|---|
| >3,000 RMB | 6.8±5.8 | | 7.1±4.7 | |
| **Duration of admission** | | | | |
| 1-3 years | 8.7±6.6 | <0.001 | 8.1±4.8 | 0.001 |
| >3 years | 12.5±8.7 | | 9.4±5.1 | |
| **Have chronic disease** | | | | |
| Yes | 10.4±7.7 | <0.001 | 9.1±4.8 | <0.001 |
| No | 8.0±6.9 | | 6.6±4.7 | |
| **Smoking** | | | | |
| Yes | 12.3± 8.8 | <0.001 | 8.3±4.9 | 0.619 |
| No | 9.4±7.2 | | 8.5±4.9 | |
| **Alcohol drinking** | | | | |
| Yes | 14.1±9.1 | <0.001 | 8.9±5.6 | 0.410 |
| No | 9.3±7.1 | | 8.5±4.8 | |
| **Have a child or more** | | | | |
| Yes | 9.5±7.4 | <0.001 | 8.4±4.9 | 0.269 |
| No | 13.3±7.9 | | 9.1±4.6 | |
| **Negative life events** | | | | |
| Yes | 10.1±7.6 | <0.001 | 8.9±4.9 | <0.001 |
| No | 7.4±6.6 | | 5.3±4.0 | |
| **Social support** | | | | |
| High | 6.4±5.2 | <0.001 | 6.9±4.5 | <0.001 |
| Low | 12.8±8.0 | | 9.9±4.8 | |

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| ADL status | | | | |
|---|---|---|---|---|
| Normal | 6.9±6.2 | <0.001 | 7.2±4.7 | <0.001 |
| Disabled | 11.3±7.7 | | 9.2±4.9 | |

† *P*-value was determined by student t-test or one-way analysis of variance (ANOVA);

SD, standard deviation; GDS, geriatric depression scale; PSQI, pittsburgh sleep quality index;

ADL, activities of daily living.

**3.3 Association between sleep quality and depression symptoms**

Based on the results of the general linear models, the differences in the mean GDS-30

scores, between the poor sleep quality and the good sleep quality groups, were examined. In

the crude model, a linear independent pairwise comparison showed that participants with

poor sleep quality had significantly higher GDS-30 scores than those with good sleep quality

($M_{diff}$ =5.19, 95% CI: 4.15, 6.24). After adjusting for age, gender, educational level, marital

status, medical insurance status, monthly personal income, duration of admission, number

of living children, smoking status, drinking alcohol status, history of chronic disease, SSRS

status, ADL status, negative life events and GAD, results also shown that participants with

poor sleep quality had higher GDS-30 scores ($M_{diff}$=2.54, 95% CI: 1.66, 3.42). The results are

shown in Table 3.

Table 3 Association between sleep quality and GDS score among the elderly in the nursing

homes

| | Poor sleep quality | | Good sleep quality | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | $M_{diff}$(95%CI) | P-value |
| Crude model | 11.53 | 0.31 | 6.33 | 0.45 | 5.19(4.15,6.24) | <0.001 |

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|---|---|---|---|---|---|---|
| Adjusted model | | | | | | |
| Model 1 | 11.31 | 0.29 | 6.79 | 0.42 | 4.52(3.51,5.53) | <0.001 |
| Model 2 | 11.01 | 0.27 | 7.40 | 0.40 | 3.50(2.54,4.47) | <0.001 |
| Model 3 | 10.67 | 0.24 | 8.09 | 0.36 | 2.54(1.66,3.42) | <0.001 |

SE, standard error; $M_{diff}$, mean difference

Model 1: adjusted for age and gender,

Model 2: adjusted for all covariates as in Model 1 plus education level, marital status, medical insurance status, monthly personal income, duration of admission and number of living children.

Model 3: adjusted for all covariates as in Model 2 plus smoking status, alcohol drinking status, history of chronic disease, SSRS status, ADL status, and negative life events.

The participants were divided into two groups according to the GDS-30 cut-off value between depression symptoms and no depression symptoms. Binary logistic regression analysis showed that participants with poor sleep quality had an increased risk of depression symptoms in the crude model (odds ratio [OR] = 4.37, 95% confidence interval [CI]: 3.03, 6.31). The relationship between depression symptoms and poor sleep quality remained significant in the binary logistic regression models that were adjusted for other covariates. Participants with poor sleep quality were 3.19-fold more likely to have depressive symptoms than those with good sleep quality (OR=3.19, 95% CI, 2.04-4.98). Similar results were also observed for all the component of sleep quality except for the two components, use of sleep medication and sleep duration between 6 and 7 hours. The OR values, which indicated the association between depression symptoms and sleep quality

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components, ranged from 1.95 to 3.15. The results are shown in Table 4.

Table 4 Association between sleep quality and depression symptoms among the elderly in

the nursing homes

| | Crude model | | | Adjusted model[†] | | |
|---|---|---|---|---|---|---|
| | OR | 95%CI | *P*-value | OR | 95%CI | *P*-value |
| Overall sleep quality | | | | | | |
| Good | 1.00 | | | 1.00 | | |
| Poor | 4.37 | 3.03-6.31 | <0.001 | 3.19 | 2.04-4.98 | <0.001 |
| Subjective sleep quality | | | | | | |
| Good | 1.00 | | | 1.00 | | |
| Poor | 5.05 | 3.71-6.87 | <0.001 | 3.15 | 2.18-4.56 | <0.001 |
| Increased sleep latency | | | | | | |
| Yes | 1.00 | | | 1.00 | | |
| No | 3.81 | 2.79-5.20 | <0.001 | 2.58 | 1.78-3.74 | <0.001 |
| Sleep duration | | | | | | |
| >7 h | 1.00 | | | 1.00 | | |
| 6-7 h | 1.09 | 0.70-1.71 | 0.700 | 1.24 | 0.73-2.11 | 0.431 |
| ≤ 6 h | 2.64 | 1.89-3.70 | <0.001 | 1.95 | 1.29-2.95 | 0.001 |
| Reduced sleep efficiency | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 2.74 | 1.99-3.78 | <0.001 | 1.89 | 1.27-2.80 | 0.002 |
| Sleep distrubances | | | | | | |

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|---|---|---|---|---|---|---|
| No | 1.00 | | | 1.00 | | |
| Yes | 3.49 | 2.56-4.77 | <0.001 | 2.33 | 1.59-3.41 | <0.001 |
| Use of sleep medication | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 1.63 | 1.03-2.56 | 0.037 | 1.30 | 0.72-2.35 | 0.379 |
| Daytime dysfunction | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 3.22 | 2.38-4.36 | <0.001 | 2.21 | 1.53-3.20 | <0.001 |

OR, odds ratio; CI, confidence interval

† adjusted for age, gender, education, marital status, medical insurance, monthly personal income, duration of admission, number of living children, smoking status, alcohol drinking status, history of chronic disease, social support status, ADL status and negative life events.

**4.Discussion**

In this study, we examined the prevalence of poor sleep quality and its relationship with depression symptoms in the elderly in nursing homes in Hunan, China. We found that participants with poor sleep quality had higher GDS-30 scores than those with good sleep quality. Moreover, participants with poor sleep quality had an increased risk of depression symptoms.

Considerable evidence suggests that sleep problems are very common among the elderly, and institutional settings may exacerbate them. Based on a large random sample of the elderly in nursing homes, our study determined that the prevalence of poor sleep quality was 67.3%. This finding is higher than that found in some previous studies on sleep quality

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among the elderly in nursing homes. For instance, Eser and colleagues [34] estimated that the

prevalence of poor sleep quality was 60.9% among 540 elderly people in nursing homes in

Turkey. A similar study in Turkey also found that 60.3% of the elderly in nursing homes

had poor sleep quality [35]. In similar institutions and populations, Stefan and colleagues [36]

found that 54.5% of 894 elderly people of Zagreb had poor sleep quality. Furthermore, Tsai

*et al* [37] reported that the prevalence of poor sleep quality was 46.4% in the elderly in nursing

homes. A reason for this variation in these prevalence estimates may be attributed to

differences between studies with regard to inclusion criteria for participants and differences

in the facilities and medical care used in different nursing homes. In addition, the most

commonly reported components of poor sleep quality were decreased sleep efficiency

(61.1%), increased sleep latency (53.0%) and sleep disturbances (30.4%). This pattern

indicates that these participants had problems with both initiating and maintaining sleep.

These results are consistent with those of previous studies conducted on the elderly in

nursing homes. For example, Fetveit et al. [6] found that 72% of the elderly participants in

nursing homes had a sleep efficiency below 85%, and 77.8% reported a sleep onset latency

of more than 30 minutes. Also, Wilfling et al. [38] found that 23.0% of the elderly in German

nursing homes had sleep disturbances, and Wang et al. [39] found that 27.8% of older Chinese

adults living in nursing homes had sleep disturbances. One of the important factors that may

contribute to the development of a higher prevalence of sleep problems in the elderly in

nursing homes is the environment, particularly with respect to the high levels of night-time

noise and light, the low levels of daytime light, and care routines that do not promote sleep

[40]. However, the use of sleep medication is not widespread in Chinese nursing homes, and

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only 10.3% of residents had taken sleep medication once or more a week.

The prevalence of depression symptoms in this study was associated with sleep quality. For example, participants with poor sleep quality scored 2.54 points higher than those with good sleep quality on the GDS-30 score after adjusting for many important covariates. It have meaningful difference since one point represent one symptom in GDS-30 scale. Moreover, participants with poor sleep quality were 3.19-fold more likely to develop depression symptoms compared to those who had good sleep quality. Furthermore, participants with increased sleep latency, shorter sleep duration, lower sleep efficiency, sleep disturbances and daytime dysfunction had increased risk of depression symptoms. These findings are in accordance with those of several previous similar studies in both nursing homes and communities. In this regard, a cross-sectional study by Orhan et al. [35] demonstrated that the GDS-30 score was positively correlated with the global PSQI score ($r$=0.231) as well as the sleep latency and sleep disturbances scores ($r$=0.261 and 0.380) among seventy-three elderly people living in a nursing home in Turkey. Additionally, Foley and colleagues [22] conducted a study on over 9,000 participants aged at least 65 and found that the sleep complaint score was positively associated with the Center for Epidemiologic Studies Depression Scale score (CESD). Also, Sukegawa et al. [41] found that elderly persons with depression symptoms were more likely to report poor sleep efficiency, sleep disturbances, long sleep latency and poor subjective sleep quality. In agreement with the preceding results, a prospective cohort study by Livingston et al. [42] reported that the best predictor of future depression in elderly people, who were not depressed at baseline, was sleep disturbance at baseline. Moreover, Rodin et al. [43] found that the frequency of

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depressed affect was positively associated with sleep disturbances in the elderly after controlling for adjustment factors. Similarly, Cho et al. [21] suggested that, among the elderly with prior depression, depression recurrence was predicted by sleep disturbance, and this association was independent of other depression symptoms. Furthermore, in a previous cross-sectional study, elderly persons with a GDS score ≥6 were 1.29 times more likely to develop sleep disturbances than those with a GDS score of 0 to 2 [44]. Another cross-sectional study [45] found that depression was independently positively associated with poor sleep quality among the elderly after adjusting for other confounders (OR= 1.21, 95% CI: 1.12-1.52). However, the mechanism underlying the relationship between poor sleep quality and depression symptoms is not thoroughly understood. Certainly, many studies have suggested that sleep problems and depression symptoms can reinforce each other and that the relationship might be bidirectionally reinforced. Although the direction of the association between sleep quality and depression symptoms in this study was not possible to determine as a result of the use of a cross-sectional study design, poor sleep quality was viewed as a prodromal state or even a core symptom of depression symptoms in the elderly.

To our knowledge, this is the first study to focus on the elderly in a nursing home in China and to demonstrate that poor sleep quality was independently associated with depression symptoms. However, there are several limitations in this study. First, the causal relationship between poor sleep quality and depression symptoms could not be assessed due to the use of a cross-sectional study design. Therefore, further longitudinal and prospective studies should be conducted to confirm this relationship in the elderly in nursing homes. Second, all data were obtained from self-reports, which may compromise the

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accuracy of measurements due to recall bias, and there was lack of objective measurement of sleep quality, which might have led to misclassification of some of the measurements. Finally, although the odds ratio was decreased in the adjusted models, the mediating effect of other variables on the association between poor sleep quality and depression symptoms was not analysed and should be investigated in future studies.

**5.Conclusions**

In summary, we observed a high prevalence of poor sleep quality among the elderly living in nursing homes in Hunan in China. In addition, poor sleep quality was associated with increased GDS-30 scores and the development of depression symptoms. Nonetheless, further studies are needed to (1) explore whether the intervention and treatment of poor sleep quality can ameliorate depression symptoms among the elderly in nursing homes, and (2) investigate the mediating effects of other variables on the association between sleep quality and depression symptoms.

**Acknowledgements**

We thank all the participants very much for their collaboration

**Author contributions**

ZH and XZ completed the statistical analyses and drafted the manuscript. Atipatsa CK and YY contribute to manuscript edit. HX checked and revised the manuscript. All the authors read and approved the final manuscript.

**Funding**

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

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**Competing interests**

None declared

**Patient consent**

Obtained.

**Ethical approval**

This study was approved by the Ethical Committee of Xiangya School of Public Health in Central South University (No.XYGW-2018-49).

**Data availability statement**

The data analysed during this study are included in the article. The numerical data used to support the findings of this study are available from the corresponding author upon reasonable request.

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 6 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7,8 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7,8 |
| Bias | 9 | Describe any efforts to address potential sources of bias | *NA* |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | NA |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 9 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | NA |
| | | (*c*) Explain how missing data were addressed | NA |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |

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|---|---|---|---|
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 11,12 |
| | | (b) Give reasons for non-participation at each stage | NA |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 13 |
| | | (b) Indicate number of participants with missing data for each variable of interest | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 15,16,17 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 15,16,17 |
| | | (*b*) Report category boundaries when continuous variables were categorized | NA |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 20,21,22 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 23 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 21,22,23 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 23 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 24 |
| | | | |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

# BMJ Open

## Association between poor sleep quality and depression symptoms among the elderly in nursing homes in Hunan province, China: a cross-sectional study

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|---|---|
| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2019-036401.R1 |
| Article Type: | Original research |
| Date Submitted by the Author: | 01-Apr-2020 |
| Complete List of Authors: | Hu, Zhao; Central South University Xiangya School of Public Health, Zhu, Xidi; Central South University Xiangya School of Public Health, Department of Social Medicine and Health Management Kaminga, Atipatsa; XiangYa School of Public Health, Central South University, Department of Epidemiology and Health Statistics Huilan, Xu; Central South University Xiangya School of Public Health, Department of Social Medicine and Health Management |
| <b>Primary Subject Heading</b>: | Mental health |
| Secondary Subject Heading: | Epidemiology, Mental health, Geriatric medicine |
| Keywords: | Depression & mood disorders < PSYCHIATRY, SLEEP MEDICINE, Epidemiology < THORACIC MEDICINE |
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**Association between poor sleep quality and depression symptoms among the elderly**

**in nursing homes in Hunan province,China:a cross-sectional study**

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Word count: 4052; Tables:3

## ABSTRACT

**Objectives:** To examine the association between the prevalence of poor sleep quality and depression symptoms among the elderly in the nursing homes of Hunan Province in China.

**Design, Setting and participants:** This was a cross-sectional study investigating 817 elderly people from 24 nursing homes in China's Hunan Province.

**Main outcome measures:** Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) such that poor sleep quality was defined as PSQI score>5. In addition, depression symptoms were assessed using the Geriatric Depression Scale (GDS).Linear regression models and binary logistic regression models were used to analyse the relationship between the prevalence of poor sleep quality and depression symptoms.

**Results:** The mean PSQI score was 8.5±4.9, and the prevalence of poor sleep quality was 67.3%. Additionally, the mean GDS score was 9.8±7.5, and the prevalence of depression symptoms was 36.0%. Elderly people with poor sleep quality had increased GDS score (mean difference=2.54, 95% CI: 1.66, 3.42) and increased risk of depression symptoms

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(odds ratio [OR]=3.19, 95% CI: 2.04, 4.98) after controlling for demographics, disease history, lifestyle behaviours and social support..

**Conclusions:** The prevalence of poor sleep quality was relatively high, and this was associated with increased depression symptoms. Therefore, poor sleep quality could be speculated as a marker of current depression symptoms in the elderly.

**Keywords:** depression; sleep quality; elderly; nursing home; risk factors.

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**Article Summary**

**Strengths and limitations of this study**

- This is the first study to examine the impact of sleep quality on depression symptoms among the Chinese elderly in nursing homes.

- The study provides valuable information on sleep pattern and emotional problems among the elderly in a nursing home setting.

- The statistical power was satisfied as the study included adequate samples.

- All data were obtained from self-reports, hence recall bias was unavoidable.

- The cross-sectional study design makes causal relationships undeterminable.

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**1. Introduction**

Aging is a challenging problem in China and all over the world. Research has shown that as age increases in old age, the risk of problems with sleep also increases, which is a public health concern for the elderly. For examples, a cross-sectional investigation conducted among 2,398 community-dwelling older persons in Italy indicated that 74% of men and 79% of women had sleep complaints[1]. Another cross-sectional study on 2,565 elderly Singaporeans showed that 69.4% experienced sleep interruption at night and 48.9% reported having difficulty falling asleep [2].

In agreement with the foregoing observations, the prevalence of poor sleep quality among older adults was also relatively high. For instance, in China, the prevalence of poor sleep quality among the elderly was 41.5% in urban communities [3] and 49.7% in rural areas[4]. However, several studies demonstrated that most sleep problems can be exacerbated by an institutional setting [5-7]. In this regard, Fetveit and colleagues [6] found that the prevalence of sleep disturbance was approximately 70% among nursing home residents, whereas Hoffman[7]reported that approximately two-thirds of older adults living in long-term care facilities had some degree of sleep disturbance. In summary, sleep problems are very common among the elderly in nursing homes and pose a great challenge for public health.

Poor sleep quality has significant negative effects on physical and mental health, and health-related quality of life [8-10]. Specifically, epidemiological studies suggested that poor sleep quality is a strong risk factor for suicidal ideation among the elderly [8,9]. Further, in a large population-based cohort study, long sleepers with poor sleep quality had a 95% higher risk of cardiovascular disease mortality than those who slept for 7 hours [11]. Another large

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cohort study found that poor sleep quality was associated with increased odds of hypertension in a Chinese rural population [12]. However, despite the significance of poor sleep quality among the elderly population, its prevalence and the underlying effect on their physical and mental functioning are not entirely understood.

Depression is a common psychiatric disorder among the elderly. It contributes not only to mild cognitive impairment but also to an increased risk of comorbidity and mortality [13-15]. In addition, many studies indicated that the institutionalized elderly have a higher prevalence of depression than the community-dwelling elderly. Notwithstanding, the reported prevalence of depression symptoms in nursing homes varied widely across different localities due to differences in diagnostic criteria, assessment tools and sample characteristics. For example, epidemiological studies indicated that the prevalence of depression symptoms among the elderly in nursing homes was 90.2% in Iran [16], 81.8% in Taiwan [17], 29.6% in London [18] and 46.1% in the Mainland China [19].

The association between sleep quality and depression symptoms among the elderly is complex, bidirectional and not entirely understood. However, many studies have suggested that elderly people with some sleep disturbance are more likely to develop depression symptoms than younger people with some sleep disturbance [20 21]. Conversely, people with depression symptoms reported a higher prevalence of poor sleep quality [22]. Although many previous studies have demonstrated that poor sleep quality is positively associated with depression symptoms among the elderly, the evidence of this relationship among the elderly in nursing homes was scarce. Therefore, the purpose of this study was to examine the association between poor sleep quality and depression symptoms among the elderly of

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nursing homes in China.

## 2. Methods

### 2.1 Study population

This cross-sectional study was conducted among the elderly living in nursing homes in Changsha, Hengyang and Yiyang Cities of Hunan Province in China from October 2018 up until December 2018. A multistage sampling method was used to select a representative sample as follows. Firstly, three cities, Yiyang, Changsha and Hengyang were randomly selected from Northern Hunan, Central Hunan, and Southern Hunan, respectively. Then, three counties, one from each City; and six districts, two from each City were randomly selected and this resulted in the following counties and districts chosen: Changsha County, Kaifu and Yuelu districts from Changsha City; Hengyang County, Yanfeng and Shigu districts from Hengyang City; and Yuanjiang County, Ziyang and Heshan districts from Yiyang City. Furthermore, six townships, two from each county were randomly selected and this resulted in the following townships chosen: Xingsha and Tiaoma from Changsha County; Xidu and Jingtou from Hengyang County; and Qionghu and Caowei from Yuanjiang County. Finally, 24 nursing homes were randomly selected, two from each district and two from each township.

The elderly population in the selected nursing homes formed the sampling frame and participants were included in our study if they met the following inclusion criteria: (1) had age 60 years and above; and (2) had been in the nursing home for more than one year. However, participants were excluded if they (1) refused to participate in this study; (2) had a severe hearing impairment or a language barrier. A total of 2,055 older adults residents in the 24 nursing homes, of which 511 were excluded because of less than 60 years or staying

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in a nursing home less than one year. 603 older adults have severe hearing impairment or

language barrier and 112 older adults residents who did not agree to participate were also

excluded in this study. Of the remaining 829 older adults, 12 were excluded for incomplete

data. Finally, in total of 817 elderly were included in data analysis in this study.

## 2.2 Data collection

Trained staff collected data through face-to-face interviews using a set of structured

questionnaires, and each interview lasted between 1/2 and 1 hour. Demographic

information collected included gender, age, education level, marital status, monthly personal

income, duration of admission, number of living children, a history of chronic diseases, a

history of smoking tobacco and a history of alcohol consumption. Marital status was

classified as either stable or unstable. Unstable marital status meant divorced, widowed or

never married. Smoking was defined as averaging at least one cigarette per day in the last

year. Alcohol consumption was defined as drinking one glass of wine per day in the last

week. Chronic diseases were self-reported by respondents included type 2 diabetes,

hypertension, coronary heart disease, chronic obstructive pulmonary disease and other

chronic diseases as specified in the medical records of the respondent.

## 2.3 Sleep quality assessment

Sleep quality among the participants was assessed using the Chinese version of the

Pittsburgh Sleep Quality Index (PSQI). The PSQI is a self-rated questionnaire that assesses

sleep quality in the past month. It contains nineteen items grouped according to seven

components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep

disturbances, use of sleeping medication, and daytime dysfunction[23]. These components

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were defined as follows in this study: subjective sleep quality (good or poor); sleep efficiency

(reduced sleep efficiency was sleep efficiency <85%); sleep latency (increased sleep latency

was sleep latency component score >1); sleep duration (<7 h, 7-8 h and >8 h); sleep

disturbances (any kind of sleep disturbance ≥1 time/week); use of sleep medication (use of

sleep medication ≥1 time/week); and daytime dysfunction was daytime dysfunction of at

least once a week. Each component's score ranges from 0 to 3 points such that 0 is the most

positive score and 3 the most negative score. Therefore, the global PSQI score ranges from 0

to 21 points. The Chinese version of the PSQI has been shown to have good validity and

reliability among older adults [24]. Participants with a global PSQI score greater than 5 were

defined as having poor sleep quality [23].

**2.4 Depression symptoms assessment**

Depressive symptoms were assessed using the Chinese version of the Geriatric

Depression Scale-30 items (GDS-30). The 30 items of this instrument are true/false

questions whose total score ranges from 0 to 30 points. The GDS-30 was developed by Brink

and colleagues in 1982 and has been widely used to assess depression symptoms in the

elderly worldwide [25]. Several studies have demonstrated that this measurement tool is

reliable and valid in multiple settings and recommended it for use in nursing home

populations [26 27]. The validity and reliability of the Chinese version of the GDS-30 have been

extensively assessed in China[28 29]. Participants who scored 11 or greater were considered as

having   depression symptoms in this study[30].

**2.5 Covariates**

Other information including, social support, activities of daily living (ADL) and negative

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life events were also collected. Social support among the elderly was assessed using the

Social Support Rating Scale (SSRS), which was developed by Xiao [31]. The scale consists of 10

items and is divided into three parts: objective support, subjective support and availability

of social support. For items 1 to 4, and 8 to10, each item's score ranges from 1 to 4 points.

For item 5, the first, second, third, and fourth options represent 1, 2, 3, and 4 points for each

support source, respectively. In addition, for items 6 and 7,each option is 1 point when

selected and zero when not selected.The total social support score ranges from 12 to 66

points, and higher scores indicate higher social support. An SSRS score greater than 30

points was defined as indicating high social support in this study. Furthermore, ADL status

was assessed using Lawton and Brody's ADL scale [32]. It includes 16 items, and each item is

scored from 1 (can do it myself) to 4 (cannot do it myself). Participants' possible total scores

on this instrument range between 16 and 64 points. A participant is classified as having

disabled ADL status when the participant's ADL total score is greater than 14 points.

Negative life events were assessed using the Life Events Scale for the Elderly (LESE). The

LESE is a valid and reliable tool widely used in China for assessing the elderly population[33].

It includes 46 items that are grouped into three main domains: health-related problems,

family-related problems and social-related problems. Participants were determined to have

experienced a negative life event when any such event occurred and caused them to have

stress.

**2.6 Statistical analysis**

Categorical data were summarised as frequency counts and percentages, whereas

continuous data were summarised as mean± standard deviation. The $\chi^2$ test was used to

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compare categorical data between the good sleep quality group and the poor sleep quality group; while the student's *t*-test was used to compare continuous data between the good sleep quality group and the poor sleep quality group. Additionally, the student's *t*-test or one-way analysis of variance (ANOVA) was used to identify the dependence of the differences in the GDS-30 and PSQI scores on different variables. Additionally, linear models were used to estimate the difference in the mean GDS-30 scores with respect to sleep quality (poor=1, good=0) using both the univariate (crude) and the multivariable (adjusted) models. Furthermore, the crude and adjusted binary logistic regression models were used to examine the association between sleep quality and depression symptoms; and the association between components of sleep quality and depression symptoms. A $P<0.05$ was considered statistically significant. All data analyses were performed using the Statistical Package for the Social Sciences (SPSS) 20.0 software (SPSS Inc., Chicago, IL, USA).

**2.7 Patient and public involvement**

Neither patients nor the public was directly involved in the development, design or recruitment of the study. Test results were provided to the participants at the point of testing.

**3. Results**

**3.1 Characteristics of the study sample**

The average age was 79.1±8.7 years, and more than half of the participants were female. Furthermore, about 90% of the participants had medical insurance and one child. Besides, about 70% of the participants had at least one kind of chronic disease. Also, more than 10% of the participants were smokers, and alcohol consumers, whereas about a third of the

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participants had normal ADL status.

In addition, 550 (67.3%) participants had poor sleep quality, 35.9% had a sleep duration between 7 and 8 hours, 30.4% reported sleep disturbances, 49.9% reported daytime dysfunction, and 10.3% had taken sleep medication more than once a week. Based on the $\chi^2$ test, the good sleep quality group and the poor sleep quality group had statistically significant differences with respect to education level, marital status, monthly personal income, a history of chronic disease, negative life events, social support and ADL status. Additionally, participants with poor sleep quality were those who had an unstable marital status, a monthly personal income below 3,000 RMB, a history of chronic disease, an experience of negative life events, low social support and disabled ADL status. The results are shown in Table 1.

Table 1 Characteristics of the elderly people in the nursing homes

| Characteristic | Total (n=817) | Sleep quality | | P-value |
| --- | --- | --- | --- | --- |
| | | Poor (n=550) | Good(n=267) | |
| Age | 79.1±8.7 | 79.4±8.3 | 78.6±9.5 | 0.228 |
| Gender male | 376(46.0) | 251(45.6) | 125(46.8) | 0.751 |
| Education | | | | |
|    Primary school and below | 364(44.6) | 263(47.8) | 101(37.8) | 0.004 |
|    Junior high school | 203(24.8) | 138(25.1) | 65(24.3) | |
|    Senior high school and above | 250(30.6) | 149(27.1) | 101(37.8) | |
| Stable marital status | 302(37.0) | 186(33.8) | 116(43.4) | 0.007 |
| Medical insurance | 766(93.8) | 517(94.0) | 249(93.3) | 0.681 |

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| | | | | |
|---|---|---|---|---|
| Monthly personal income ≤3,000 RMB | 568(69.5) | 404(73.5) | 164(61.4) | <0.001 |
| Duration of admission >3 years | 251(30.7) | 180(32.7) | 71(26.6) | 0.075 |
| History of chronic disease | 620(75.9) | 454(82.5) | 166(62.2) | <0.001 |
| Smoking | 132(16.2) | 82(14.9) | 50(18.7) | 0.164 |
| Alcohol drinking | 96(11.8) | 60(10.9) | 36(13.5) | 0.284 |
| Have a child or more | 746(91.3) | 496(90.2) | 250(93.6) | 0.100 |
| Negative life events | 725(88.7) | 515(93.6) | 210(78.7) | <0.001 |
| High social support | 382(46.8) | 213(38.7) | 169(63.3) | <0.001 |
| Normal ADL status | 268(32.8) | 152(27.6) | 116(43.4) | <0.001 |
| Good subjective sleep quality | 483(59.1) | 220(40.0) | 263(98.5) | <0.001 |
| Increased sleep latency | 433(53.0) | 421(76.5) | 12(4.5) | <0.001 |
| Sleep duration | | | | |
| <7 h | 388(47.5) | 373(67.8) | 15(5.6) | <0.001 |
| 7-8 h | 293(35.9) | 140(25.5) | 153(57.3) | |
| >8 h | 136(16.6) | 37(6.7) | 99(37.1) | |
| Reduced sleep efficiency | 499(61.1) | 457(83.1) | 84(31.5) | <0.001 |
| Sleep disturbances | 248(30.4) | 231(42.0) | 17(6.4) | <0.001 |
| Use of sleep medication | 84(10.3) | 83(15.1) | 1(0.4) | <0.001 |
| Daytime dysfunction | 408(49.9) | 366(66.5) | 42(15.7) | <0.001 |

Values are n (%) or mean±SD; ADL, activities of daily living

### 3.2 Association between sleep quality and depression symptoms

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Based on the results of the linear models, the differences in the mean GDS-30 scores, between the poor sleep quality and the good sleep quality groups, were examined. In the crude model, a linear independent pairwise comparison showed that participants with poor sleep quality had significantly higher GDS-30 scores than those with good sleep quality ($M_{diff}$ =5.19, 95% CI: 4.15, 6.24). After adjusting for age, gender, educational level, marital status, medical insurance status, monthly personal income, duration of admission, number of living children, smoking status, drinking alcohol status, a history of chronic disease, SSRS status, ADL status, negative life events and GAD, results still indicated that participants with poor sleep quality had higher GDS-30 scores ($M_{diff}$=2.54, 95% CI: 1.66, 3.42). The results are shown in Table 2.

Table 2 Association between sleep quality and GDS-30 scores among the elderly in the nursing homes

| | Poor sleep quality | | Good sleep quality | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | $M_{diff}$(95%CI) | P-value |
| Crude model | 11.53 | 0.31 | 6.33 | 0.45 | 5.19(4.15,6.24) | <0.001 |
| Adjusted Model 1($R^2$=0.11,$F$=33.54,$P$<0.001) | | | | | | |
| | 11.31 | 0.29 | 6.79 | 0.42 | 4.52(3.51,5.53) | <0.001 |
| Adjusted Model 2($R^2$=0.24,$F$=27.42,$P$<0.001) | | | | | | |
| | 11.01 | 0.27 | 7.40 | 0.40 | 3.50(2.54,4.47) | <0.001 |
| Adjusted Model 3($R^2$=0.40,$F$=30.78,$P$<0.001) | | | | | | |
| | 10.67 | 0.24 | 8.09 | 0.36 | 2.54(1.66,3.42) | <0.001 |

SE, standard error; $M_{diff}$, mean difference

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Model 1: adjusted for age and gender,

Model 2: adjusted for all covariates as in Model 1 plus education level, marital status, medical insurance status, monthly personal income, duration of admission and number of living children.

Model 3: adjusted for all covariates as in Model 2 plus smoking status, alcohol drinking status, a history of chronic disease, SSRS status, ADL status, and negative life events.

Furthermore, participants were divided into two groups according to the GDS-30 cut-off value between depression symptoms and no depression symptoms. Therefore, binary logistic regression analysis showed that participants with poor sleep quality had an increased risk of depression symptoms in the crude model (odds ratio [OR] = 4.37, 95% confidence interval [CI]: 3.03, 6.31). This relationship remained significant after adjusting for other covariates. In this regard, participants with poor sleep quality were 3.19-fold more likely to have depressive symptoms than those with good sleep quality (OR=3.19, 95% CI, 2.04-4.98). Similar results were observed for all but two components of sleep quality, namely use of sleep medication and sleep duration between 6 and 7 hours. The OR values, which indicated an association between depression symptoms and sleep quality components, ranged from 1.95 to 3.15. The results are shown in Table 3.

Table 3 Association between sleep quality and depression symptoms among the elderly in the nursing homes

|  | Crude model | | | Adjusted model[†] | | |
|---|---|---|---|---|---|---|
|  | OR | 95%CI | *P*-value | OR | 95%CI | *P*-value |
| Overall sleep quality | | | | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Good | 1.00 | | | 1.00 | | |
| Poor | 4.37 | 3.03-6.31 | <0.001 | 3.19 | 2.04-4.98 | <0.001 |
| **Subjective sleep quality** | | | | | | |
| Good | 1.00 | | | 1.00 | | |
| Poor | 5.05 | 3.71-6.87 | <0.001 | 3.15 | 2.18-4.56 | <0.001 |
| **Increased sleep latency** | | | | | | |
| Yes | 1.00 | | | 1.00 | | |
| No | 3.81 | 2.79-5.20 | <0.001 | 2.58 | 1.78-3.74 | <0.001 |
| **Sleep duration** | | | | | | |
| >8h | 1.00 | | | 1.00 | | |
| 7-8h | 1.09 | 0.70-1.71 | 0.700 | 1.24 | 0.73-2.11 | 0.431 |
| <7 h | 2.64 | 1.89-3.70 | <0.001 | 1.95 | 1.29-2.95 | 0.001 |
| **Reduced sleep efficiency** | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 2.74 | 1.99-3.78 | <0.001 | 1.89 | 1.27-2.80 | 0.002 |
| **Sleep distrubances** | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 3.49 | 2.56-4.77 | <0.001 | 2.33 | 1.59-3.41 | <0.001 |
| **Use of sleep medication** | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 1.63 | 1.03-2.56 | 0.037 | 1.30 | 0.72-2.35 | 0.379 |
| **Daytime dysfunction** | | | | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| No | 1.00 | | | 1.00 | | |
| Yes | 3.22 | 2.38-4.36 | <0.001 | 2.21 | 1.53-3.20 | <0.001 |

OR, odds ratio; CI, confidence interval

† adjusted for age, gender, education, marital status, medical insurance, monthly personal income, duration of admission, number of living children, smoking status, alcohol drinking status, a history of chronic disease, social support status, ADL status and negative life events.

**4.Discussion**

This study examined the prevalence of poor sleep quality and its relationship with depression symptoms among the elderly in nursing homes in Hunan, China. Accordingly, the prevalence of poor sleep quality was 67.3%, which was associated with higher GDS-30 scores than good sleep quality. Moreover, participants with poor sleep quality had an increased risk of depression symptoms.

Considerable evidence suggested that sleep problems are very common among the elderly, and institutional settings may exacerbate them. The prevalence of poor sleep quality in this study is higher than that found in some previous studies among the elderly in nursing homes. For instance, Eser and colleagues [34] estimated that the prevalence of poor sleep quality was 60.9% among 540 elderly people in Turkey, and a similar study in the same country found that 60.3% of the elderly had poor sleep quality [35]. Lower prevalence was also observed in Zagreb (54.5%) among 894 elderly people[36], and in Taiwan (46.4%) [37]. A reason for this variation in these prevalence estimates may be attributed to differences in study designs with regard to inclusion criteria for participants, and differences in the facilities and medical care used in different nursing homes. In addition, the most commonly reported

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components of poor sleep quality were decreased sleep efficiency (61.1%), increased sleep latency (53.0%) and sleep disturbances (30.4%). This pattern indicates that these participants had problems with both initiating and maintaining sleep. Similarly, Fetveit et al. [6] found that 72% of the elderly participants in nursing homes had a sleep efficiency below 85%, while 77.8% reported a sleep onset latency of more than 30 minutes. Also, Wilfling et al. [38] found that 23.0% of the elderly in German nursing homes had sleep disturbances and, in the same way, Wang et al. [39] found that 27.8% of older Chinese adults living in nursing homes had sleep disturbances. One of the important factors that may contribute to the development of a higher prevalence of sleep problems among the elderly in nursing homes is the environment, particularly with respect to the high levels of night-time noise and light, the low levels of daytime light, and care routines that do not promote sleep [40]. However, the use of sleep medication is not popular among the elderly in the Chinese nursing homes and this could be the reason why only 10.3% of residents in this study had taken sleep medication.

Moreover, among the participants that had taken sleep medication, majority of them had poor sleep quality. Nevertheless, due to the cross-sectional study design, a causal relationship between sleep quality and taking sleep medication could not be established. Therefore, from this result, it can be assumed that participants with poor sleep quality are more likely to take sleep medication, but this proportion is lower in the Chinese nursing homes.

Additionally, the prevalence of depression symptoms in this study was associated with sleep quality. For example, participants with poor sleep quality scored 2.54 points higher

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than those with good sleep quality on the GDS-30 score after adjusting for many important

covariates. Moreover, participants with poor sleep quality were 3.19-fold more likely to

develop depression symptoms than those who had good sleep quality. Furthermore,

participants with increased sleep latency, shorter sleep duration, lower sleep efficiency,

sleep disturbances and daytime dysfunction had increased risk of depression symptoms.

These findings are in accordance with those of several previous similar studies in both

nursing homes and communities[35 41 42]. In this regard, a cross-sectional study by Orhan et al.

[35] demonstrated that the GDS-30 score was positively correlated with the global PSQI score

($r$=0.231) as well as the sleep latency and sleep disturbances scores ($r$=0.261 and 0.380,

respectively) among seventy-three elderly people living in a nursing home in Turkey.

Additionally, Foley and colleagues [22] conducted a study on over 9,000 participants aged at

least 65 and found that the sleep complaint score was positively associated with the Center

for Epidemiologic Studies Depression Scale score (CESD). Also, Sukegawa et al. [43] found that

elderly persons with depression symptoms were more likely to report poor sleep efficiency,

sleep disturbances, long sleep latency and poor subjective sleep quality. In agreement with

the preceding results, a prospective cohort study by Livingston et al. [41] reported that the best

predictor of future depression in the elderly people, who were not depressed at baseline,

was sleep disturbance at baseline. Moreover, Rodin et al. [42] found that the frequency of

depressed affect was positively associated with sleep disturbances in the elderly after

controlling for adjustment factors. Similarly, Cho et al. [21] suggested that, among the elderly

with prior depression, depression recurrence was predicted by sleep disturbance, and this

association was independent of other depression symptoms. Furthermore, in a previous

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cross-sectional study, elderly persons with a GDS-30 score ≥6 were 1.29 times more likely to develop sleep disturbances than those with a GDS-30 score of 0 to 2 [44]. Another cross-sectional study [45] found that depression was independently positively associated with poor sleep quality among the elderly after adjusting for other confounders (OR= 1.21, 95% CI: 1.12-1.52). However, the mechanism underlying the relationship between poor sleep quality and depression symptoms is not thoroughly understood. Certainly, many studies have suggested that sleep problems and depression symptoms can reinforce each other and this relationship might be bidirectional. Although the direction of the association between sleep quality and depression symptoms in this study was not possible to determine as a result of the use of a cross-sectional study design, poor sleep quality was viewed as a prodromal state or even a core symptom of depression symptoms in the elderly.

To our knowledge, this is the first study to focus on the elderly in a nursing home in China and demonstrate that poor sleep quality was independently associated with depression symptoms. However, there are several limitations in this study. First, the causal relationship between poor sleep quality and depression symptoms could not be assessed due to the use of a cross-sectional study design. Therefore, further longitudinal and prospective studies should be conducted to confirm this relationship in the elderly in nursing homes. Second, all data were obtained from self-reports, which may compromise the accuracy of measurements due to recall bias; and there was lack of objective measurement of sleep quality, which might have led to misclassification of some of the components of sleep quality. Third, stratification by city or county, as well as cluster effect within a nursing homes, were not considered in this study which may lead to biased findings. Fourth, the

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findings of this study cannot be generalized to patients with dementia and hearing or

cognition impairment as these were excluded from this study. Finally, although the odds

ratio was decreased in the adjusted models, the mediating effect of other variables on the

association between poor sleep quality and depression symptoms was not analysed and

should be investigated in future studies.

**5.Conclusions**

In summary, a high prevalence of poor sleep quality among the elderly living in

nursing homes in Hunan in China was observed. In addition, poor sleep quality was

associated with increased GDS-30 scores and the development of depression symptoms.

Nonetheless, further studies are needed to (1) explore whether the intervention and

treatment of poor sleep quality can ameliorate depression symptoms among the elderly in

nursing homes; and (2) investigate the mediating effects of other variables on the

association between sleep quality and depression symptoms.

**Acknowledgements**

We thank all the participants very much for their collaboration

**Author contributions**

ZH and XZ completed the statistical analyses and drafted the manuscript. Atipatsa CK

contributed to the manuscript editing. HX checked and revised the manuscript. All the

authors read and approved the final manuscript.

**Funding**

This research received no specific grant from any funding agency in the public, commercial

or not-for-profit sectors

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**Competing interests**

None declared

**Patient consent**

Written informed consent was obtained from all participants.

**Ethical approval**

This study was approved by the Ethical Committee of Xiangya School of Public Health in

Central South University (No.XYGW-2018-49).

**Data availability statement**

The data analysed during this study are included in the article. The numerical data used to

support the findings of this study are available from the corresponding author upon

reasonable request.

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 6 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7,8 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7,8 |
| Bias | 9 | Describe any efforts to address potential sources of bias | *NA* |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | NA |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 9 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | NA |
| | | (*c*) Explain how missing data were addressed | NA |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |

| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 11,12 |
| | | (b) Give reasons for non-participation at each stage | NA |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 13 |
| | | (b) Indicate number of participants with missing data for each variable of interest | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 15,16,17 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 15,16,17 |
| | | (*b*) Report category boundaries when continuous variables were categorized | NA |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 20,21,22 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 23 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 21,22,23 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 23 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 24 |
| | | | |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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## Association between poor sleep quality and depression symptoms among the elderly in nursing homes in Hunan province, China: a cross-sectional study

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**Association between poor sleep quality and depression symptoms among the elderly in nursing homes in Hunan province,China:a cross-sectional study**

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Word count: 4052; Tables:3

## ABSTRACT

**Objectives:** To examine the association between the prevalence of poor sleep quality and depression symptoms among the elderly in the nursing homes of Hunan Province in China.

**Design, Setting and participants:** This was a cross-sectional study investigating 817 elderly people from 24 nursing homes in China's Hunan Province.

**Main outcome measures:** Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) such that poor sleep quality was defined as PSQI score>5. In addition, depression symptoms were assessed using the Geriatric Depression Scale (GDS). Linear regression models and binary logistic regression models were used to analyse the relationship between the prevalence of poor sleep quality and depression symptoms.

**Results:** The mean PSQI score was 8.5±4.9, and the prevalence of poor sleep quality was 67.3%. Additionally, the mean GDS score was 9.8±7.5, and the prevalence of depression symptoms was 36.0%. Elderly people with poor sleep quality had increased GDS score

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(mean difference=2.54, 95% CI: 1.66, 3.42) and increased risk of depression symptoms (odds ratio [OR]=3.19, 95% CI: 2.04, 4.98) after controlling for demographics, chronic disease history, lifestyle behaviors, social support, activities of daily living (ADL) and negative life events.

**Conclusions:** The prevalence of poor sleep quality was relatively high, and this was associated with increased depression symptoms. Therefore, poor sleep quality could be speculated as a marker of current depression symptoms in the elderly.

**Keywords:** depression; sleep quality; elderly; nursing home; risk factors.

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**Article Summary**

**Strengths and limitations of this study**

- This is the first study to examine the impact of sleep quality on depression symptoms among the Chinese elderly in nursing homes.

- The study provides valuable information on sleep pattern and emotional problems among the elderly in a nursing home setting.

- The statistical power was satisfied as the study included adequate samples.

- All data were obtained from self-reports, hence recall bias was unavoidable.

- The cross-sectional study design makes causal relationships undeterminable.

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## 1. Introduction

Aging is a challenging problem in China and all over the world. Research has shown that as age increases in old age, the risk of problems with sleep also increases, which is a public health concern for the elderly. For examples, a cross-sectional investigation conducted among 2,398 community-dwelling older persons in Italy indicated that 74% of men and 79% of women had sleep complaints[1]. Another cross-sectional study on 2,565 elderly Singaporeans showed that 69.4% experienced sleep interruption at night and 48.9% reported having difficulty falling asleep [2].

In agreement with the foregoing observations, the prevalence of poor sleep quality among older adults was also relatively high. For instance, in China, the prevalence of poor sleep quality among the elderly was 41.5% in urban communities [3] and 49.7% in rural areas[4]. However, several studies demonstrated that most sleep problems can be exacerbated by an institutional setting [5-7]. In this regard, Fetveit and colleagues [6] found that the prevalence of sleep disturbance was approximately 70% among nursing home residents, whereas Hoffman[7]reported that approximately two-thirds of older adults living in long-term care facilities had some degree of sleep disturbance. In summary, sleep problems are very common among the elderly in nursing homes and pose a great challenge for public health.

Poor sleep quality has significant negative effects on physical and mental health, and health-related quality of life [8-10]. Specifically, epidemiological studies suggested that poor sleep quality is a strong risk factor for suicidal ideation among the elderly [8 9]. Further, in a large population-based cohort study, long sleepers with poor sleep quality had a 95% higher risk of cardiovascular disease mortality than those who slept for 7 hours [11]. Another large

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cohort study found that poor sleep quality was associated with increased odds of hypertension in a Chinese rural population [12]. However, despite the significance of poor sleep quality among the elderly population, its prevalence and the underlying effect on their physical and mental functioning are not entirely understood.

Depression is a common psychiatric disorder among the elderly. It contributes not only to mild cognitive impairment but also to an increased risk of comorbidity and mortality [13-15]. In addition, many studies indicated that the institutionalized elderly have a higher prevalence of depression than the community-dwelling elderly. Notwithstanding, the reported prevalence of depression symptoms in nursing homes varied widely across different localities due to differences in diagnostic criteria, assessment tools and sample characteristics. For example, epidemiological studies indicated that the prevalence of depression symptoms among the elderly in nursing homes was 90.2% in Iran [16], 81.8% in Taiwan [17], 29.6% in London [18] and 46.1% in the Mainland China [19].

The association between sleep quality and depression symptoms among the elderly is complex, bidirectional and not entirely understood. However, many studies have suggested that elderly people with some sleep disturbance are more likely to develop depression symptoms than younger people with some sleep disturbance [20 21]. Conversely, people with depression symptoms reported a higher prevalence of poor sleep quality [22]. Although many previous studies have demonstrated that poor sleep quality is positively associated with depression symptoms among the elderly, the evidence of this relationship among the elderly in nursing homes was scarce. Therefore, the purpose of this study was to examine the association between poor sleep quality and depression symptoms among the elderly of

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nursing homes in China.

## 2. Methods

### 2.1 Sample size

To examine the impact of sleep quality on depression symptoms among the elderly of nursing homes, a sample size was calculated using the formula as follows:

$$n = 4\{(\mu_\alpha + \mu_\beta)/ln[(1 + \rho)/(1 - \rho)]\}^2 + 3$$

Where, $\mu_\alpha$=1.96 when $\alpha$=0.05; $\mu_\beta$=0.84 when $\beta$=0.80; and $\rho$ is the correlation coefficient between sleep quality and depression symptoms in the elderly in nursing homes. Thus, $\rho$ was taken as 0.231, according to a previous study[23], when calculating the sample size. Therefore, using the formula, the theoretical sample size was 145 and, after including an extra 10% of 145, to make up for subjects who may be withdrawn during the study, the total sample size was 160.

### 2.2 Study population

This cross-sectional study was conducted among the elderly living in nursing homes in Changsha, Hengyang and Yiyang Cities of Hunan Province in China from October 2018 up until December 2018. A multistage sampling method was used to select a representative sample as follows. Firstly, three cities, Yiyang, Changsha and Hengyang were randomly selected from Northern Hunan, Central Hunan, and Southern Hunan, respectively. Then, three counties, one from each City; and six districts, two from each City were randomly selected and this resulted in the following counties and districts chosen: Changsha County, Kaifu and Yuelu districts from Changsha City; Hengyang County, Yanfeng and Shigu districts from Hengyang City; and Yuanjiang County, Ziyang and Heshan districts from Yiyang City.

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Furthermore, six townships, two from each county were randomly selected and this resulted

in the following townships chosen: Xingsha and Tiaoma from Changsha County; Xidu and

Jingtou from Hengyang County; and Qionghu and Caowei from Yuanjiang County. Finally, 24

nursing homes were randomly selected, two from each district and two from each township.

The elderly population in the selected nursing homes formed the sampling frame and

participants were included in our study if they met the following inclusion criteria: (1) had

age 60 years and above; and (2) had been in the nursing home for more than one year.

However, participants were excluded if they (1) refused to participate in this study; (2) had

a severe hearing impairment or a language barrier. A total of 2,055 older adults residents in

the 24 nursing homes, of which 511 were excluded because of less than 60 years or staying

in a nursing home less than one year. 603 older adults have severe hearing impairment or

language barrier and 112 older adults, who did not agree to participate, were also excluded

in this study. Of the remaining 829 older adults, 12 were excluded for incomplete data.

Finally, a total of 817 subjects were included in the data analysis of this study.

**2.3 Data collection**

Trained staff collected data through face-to-face interviews using a set of structured

questionnaires, and each interview lasted between 1/2 and 1 hour. Demographic

information collected included gender, age, education level, marital status, monthly personal

income, duration of admission, number of living children, a history of chronic diseases, a

history of smoking tobacco and a history of alcohol consumption. Marital status was

classified as either stable or unstable. Unstable marital status meant divorced, widowed or

never married. Smoking was defined as averaging at least one cigarette per day in the last

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year. Alcohol consumption was defined as drinking one glass of wine per day in the last

week.

## 2.4 Sleep quality assessment

Sleep quality among the participants was assessed using the Chinese version of the

Pittsburgh Sleep Quality Index (PSQI). The PSQI is a self-rated questionnaire that assesses

sleep quality in the past month. It contains nineteen items grouped according to seven

components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep

disturbances, use of sleeping medication, and daytime dysfunction[24]. These components

were defined as follows in this study: subjective sleep quality (good or poor); sleep efficiency

(reduced sleep efficiency was sleep efficiency <85%); sleep latency (increased sleep latency

was sleep latency component score >1); sleep duration (<7 h, 7-8 h and >8 h); sleep

disturbances (any kind of sleep disturbance ≥1 time/week); use of sleep medication (use of

sleep medication ≥1 time/week); and daytime dysfunction was daytime dysfunction of at

least once a week. Each component's score ranges from 0 to 3 points such that 0 is the most

positive score and 3 the most negative score. Therefore, the global PSQI score ranges from 0

to 21 points. The Chinese version of the PSQI has been shown to have good validity and

reliability among older adults [25]. Participants with a global PSQI score greater than 5 were

defined as having poor sleep quality [24].

## 2.5 Depression symptoms assessment

Depressive symptoms were assessed using the Chinese version of the Geriatric

Depression Scale-30 items (GDS-30). The 30 items of this instrument are true/false

questions whose total score ranges from 0 to 30 points. The GDS-30 was developed by Brink

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and colleagues in 1982 and has been widely used to assess depression symptoms in the elderly worldwide [26]. Several studies have demonstrated that this measurement tool is reliable and valid in multiple settings and recommended it for use in nursing home populations [27 28]. The validity and reliability of the Chinese version of the GDS-30 have been extensively assessed in China[29 30]. Participants who scored 11 or greater were considered as having    depression symptoms in this study[31].

**2.6 Covariates**

Other information including, social support, activities of daily living (ADL) and negative life events were also collected. Social support among the elderly was assessed using the Social Support Rating Scale (SSRS), which was developed by Xiao [32]. The scale consists of 10 items and is divided into three parts: objective support, subjective support and availability of social support. For items 1 to 4, and 8 to10, each item's score ranges from 1 to 4 points. For item 5, the first, second, third, and fourth options represent 1, 2, 3, and 4 points for each support source, respectively. In addition, for items 6 and 7, each option is 1 point when selected and zero when not selected.The total social support score ranges from 12 to 66 points, and higher scores indicate higher social support. An SSRS score greater than 30 points was defined as indicating high social support in this study. Furthermore, ADL status was assessed using Lawton and Brody's ADL scale [33]. It includes 16 items, and each item is scored from 1 (can do it myself) to 4 (cannot do it myself). Participants' possible total scores on this instrument range between 16 and 64 points. A participant is classified as having disabled ADL status when the participant's ADL total score is greater than 14 points. Negative life events were assessed using the Life Events Scale for the Elderly (LESE). The

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LESE is a valid and reliable tool widely used in China for assessing the elderly population[34]. It includes 46 items that are grouped into three main domains: health-related problems, family-related problems and social-related problems. Participants were determined to have experienced a negative life event when any such event occurred and caused them to have stress.

**2.7 Statistical analysis**

Categorical data were summarised as frequency counts and percentages, whereas continuous data were summarised as mean± standard deviation. The $\chi^2$ test was used to compare categorical data between the good sleep quality group and the poor sleep quality group; while the student's *t*-test was used to compare continuous data between the good sleep quality group and the poor sleep quality group. Linear regression models were used to estimate the difference in the mean GDS-30 scores with respect to sleep quality (poor=1, good=0) using both the univariate (crude) and the multivariable (adjusted) models. Furthermore, the crude and adjusted binary logistic regression models were used to examine the association between sleep quality and depression symptoms; and the association between components of sleep quality and depression symptoms. A $P<0.05$ was considered statistically significant. All data analyses were performed using the Statistical Package for the Social Sciences (SPSS) 20.0 software (SPSS Inc., Chicago, IL, USA).

**2.8 Patient and public involvement**

Neither patients nor the public was directly involved in the development, design or recruitment of the study. Test results were provided to the participants at the point of testing.

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## 3. Results

### 3.1 Characteristics of the study sample

The average age was 79.1±8.7 years, and more than half of the participants were female. Furthermore, about 90% of the participants had medical insurance and one child. Besides, about 70% of the participants had at least one kind of chronic disease. Also, more than 10% of the participants were smokers, and alcohol consumers, whereas about a third of the participants had normal ADL status.

In addition, 550 (67.3%) participants had poor sleep quality, 35.9% had a sleep duration between 7 and 8 hours, 30.4% reported sleep disturbances, 49.9% reported daytime dysfunction, and 10.3% had taken sleep medication more than once a week. Based on the $\chi^2$ test, the good sleep quality group and the poor sleep quality group had statistically significant differences with respect to education level, marital status, monthly personal income, a history of chronic disease, negative life events, social support and ADL status. Additionally, participants with poor sleep quality were those who had an unstable marital status, a monthly personal income below 3,000 RMB, a history of chronic disease, an experience of negative life events, low social support and disabled ADL status. The results are shown in Table 1.

Table 1 Characteristics of the elderly people in the nursing homes

| Characteristic | Total (n=817) | Sleep quality | | P-value |
| --- | --- | --- | --- | --- |
| | | Poor (n=550) | Good(n=267) | |
| Age | 79.1±8.7 | 79.4±8.3 | 78.6±9.5 | 0.228 |
| Gender male | 376(46.0) | 251(45.6) | 125(46.8) | 0.751 |

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|---|---|---|---|---|
| Education | | | | |
| Primary school and below | 364(44.6) | 263(47.8) | 101(37.8) | 0.004 |
| Junior high school | 203(24.8) | 138(25.1) | 65(24.3) | |
| Senior high school and above | 250(30.6) | 149(27.1) | 101(37.8) | |
| Stable marital status | 302(37.0) | 186(33.8) | 116(43.4) | 0.007 |
| Medical insurance | 766(93.8) | 517(94.0) | 249(93.3) | 0.681 |
| Monthly personal income ≤3,000 RMB | 568(69.5) | 404(73.5) | 164(61.4) | <0.001 |
| Duration of admission >3 years | 251(30.7) | 180(32.7) | 71(26.6) | 0.075 |
| History of chronic disease | 620(75.9) | 454(82.5) | 166(62.2) | <0.001 |
| Smoking | 132(16.2) | 82(14.9) | 50(18.7) | 0.164 |
| Alcohol drinking | 96(11.8) | 60(10.9) | 36(13.5) | 0.284 |
| Have a child or more | 746(91.3) | 496(90.2) | 250(93.6) | 0.100 |
| Negative life events | 725(88.7) | 515(93.6) | 210(78.7) | <0.001 |
| High social support | 382(46.8) | 213(38.7) | 169(63.3) | <0.001 |
| Normal ADL status | 268(32.8) | 152(27.6) | 116(43.4) | <0.001 |
| Good subjective sleep quality | 483(59.1) | 220(40.0) | 263(98.5) | <0.001 |
| Increased sleep latency | 433(53.0) | 421(76.5) | 12(4.5) | <0.001 |
| Sleep duration | | | | |
| <7 h | 388(47.5) | 373(67.8) | 15(5.6) | <0.001 |
| 7-8 h | 293(35.9) | 140(25.5) | 153(57.3) | |
| >8 h | 136(16.6) | 37(6.7) | 99(37.1) | |

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|---|---|---|---|---|
| Reduced sleep efficiency | 499(61.1) | 457(83.1) | 42 (15.7) | <0.001 |
| Sleep disturbances | 248(30.4) | 231(42.0) | 17(6.4) | <0.001 |
| Use of sleep medication | 84(10.3) | 83(15.1) | 1(0.4) | <0.001 |
| Daytime dysfunction | 408(49.9) | 366(66.5) | 42(15.7) | <0.001 |

Values are n (%) or mean±SD; ADL, activities of daily living

### 3.2 Association between sleep quality and depression symptoms

Based on the results of the linear models, the differences in the mean GDS-30 scores, between the poor sleep quality and the good sleep quality groups, were examined. In the crude model, a linear independent pairwise comparison showed that participants with poor sleep quality had significantly higher GDS-30 scores than those with good sleep quality ($M_{diff}$ =5.19, 95% CI: 4.15, 6.24). After adjusting for age, gender, educational level, marital status, medical insurance status, monthly personal income, duration of admission, number of living children, smoking status, drinking alcohol status, a history of chronic disease, SSRS status, ADL status, negative life events and GAD, results still indicated that participants with poor sleep quality had higher GDS-30 scores ($M_{diff}$=2.54, 95% CI: 1.66, 3.42). The results are shown in Table 2.

Table 2 Association between sleep quality and GDS-30 scores among the elderly in the nursing homes

| | Poor sleep quality | | Good sleep quality | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | $M_{diff}$(95%CI) | P-value |
| Crude model | 11.53 | 0.31 | 6.33 | 0.45 | 5.19(4.15,6.24) | <0.001 |
| Adjusted Model 1($R^2$=0.11,$F$=33.54,$P$<0.001) | | | | | | |

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|---|---|---|---|---|---|
| 11.31 | 0.29 | 6.79 | 0.42 | 4.52(3.51,5.53) | <0.001 |

Adjusted Model 2($R^2$=0.24,$F$=27.42,$P$<0.001)

| | | | | | |
|---|---|---|---|---|---|
| 11.01 | 0.27 | 7.40 | 0.40 | 3.50(2.54,4.47) | <0.001 |

Adjusted Model 3($R^2$=0.40,$F$=30.78,$P$<0.001)

| | | | | | |
|---|---|---|---|---|---|
| 10.67 | 0.24 | 8.09 | 0.36 | 2.54(1.66,3.42) | <0.001 |

SE, standard error; $M_{diff}$, mean difference

Model 1: adjusted for age and gender,

Model 2: adjusted for all covariates as in Model 1 plus education level, marital status, medical insurance status, monthly personal income, duration of admission and number of living children.

Model 3: adjusted for all covariates as in Model 2 plus smoking status, alcohol drinking status, a history of chronic disease, SSRS status, ADL status, and negative life events.

Furthermore, participants were divided into two groups according to the GDS-30 cut-off value between depression symptoms and no depression symptoms. Therefore, binary logistic regression analysis showed that participants with poor sleep quality had an increased risk of depression symptoms in the crude model (odds ratio [OR] = 4.37, 95% confidence interval [CI]: 3.03, 6.31). This relationship remained significant after adjusting for other covariates. In this regard, participants with poor sleep quality were 3.19-fold more likely to have depressive symptoms than those with good sleep quality (OR=3.19, 95% CI, 2.04-4.98). Similar results were observed for all but two components of sleep quality, namely use of sleep medication and sleep duration between 6 and 7 hours. The OR values, which indicated an association between depression symptoms and sleep quality

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components, ranged from 1.95 to 3.15. The results are shown in Table 3.

Table 3 Association between sleep quality and depression symptoms among the elderly in

the nursing homes

| | Crude model | | | Adjusted model[†] | | |
|---|---|---|---|---|---|---|
| | OR | 95%CI | *P*-value | OR | 95%CI | *P*-value |
| Overall sleep quality | | | | | | |
| Good | 1.00 | | | 1.00 | | |
| Poor | 4.37 | 3.03-6.31 | <0.001 | 3.19 | 2.04-4.98 | <0.001 |
| Subjective sleep quality | | | | | | |
| Good | 1.00 | | | 1.00 | | |
| Poor | 5.05 | 3.71-6.87 | <0.001 | 3.15 | 2.18-4.56 | <0.001 |
| Increased sleep latency | | | | | | |
| Yes | 1.00 | | | 1.00 | | |
| No | 3.81 | 2.79-5.20 | <0.001 | 2.58 | 1.78-3.74 | <0.001 |
| Sleep duration | | | | | | |
| >8h | 1.00 | | | 1.00 | | |
| 7-8h | 1.09 | 0.70-1.71 | 0.700 | 1.24 | 0.73-2.11 | 0.431 |
| <7 h | 2.64 | 1.89-3.70 | <0.001 | 1.95 | 1.29-2.95 | 0.001 |
| Reduced sleep efficiency | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 2.74 | 1.99-3.78 | <0.001 | 1.89 | 1.27-2.80 | 0.002 |
| Sleep disturbances | | | | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| No | 1.00 | | | 1.00 | | |
| Yes | 3.49 | 2.56-4.77 | <0.001 | 2.33 | 1.59-3.41 | <0.001 |
| Use of sleep medication | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 1.63 | 1.03-2.56 | 0.037 | 1.30 | 0.72-2.35 | 0.379 |
| Daytime dysfunction | | | | | | |
| No | 1.00 | | | 1.00 | | |
| Yes | 3.22 | 2.38-4.36 | <0.001 | 2.21 | 1.53-3.20 | <0.001 |

OR, odds ratio; CI, confidence interval

† adjusted for age, gender, education, marital status, medical insurance, monthly personal

income, duration of admission, number of living children, smoking status, alcohol drinking

status, a history of chronic disease, social support status, ADL status and negative life events.

**4.Discussion**

This study examined the prevalence of poor sleep quality and its relationship with

depression symptoms among the elderly in nursing homes in Hunan, China. Accordingly, the

prevalence of poor sleep quality was 67.3%, which was associated with higher GDS-30

scores than good sleep quality. Moreover, participants with poor sleep quality had an

increased risk of depression symptoms.

Considerable evidence suggested that sleep problems are very common among the

elderly, and institutional settings may exacerbate them. The prevalence of poor sleep quality

in this study is higher than that found in some previous studies among the elderly in nursing

homes. For instance, Eser and colleagues [35] estimated that the prevalence of poor sleep

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quality was 60.9% among 540 elderly people in Turkey, and a similar study in the same country found that 60.3% of the elderly had poor sleep quality [23]. Lower prevalence was also observed in Zagreb (54.5%) among 894 elderly people[36], and in Taiwan (46.4%) [37]. A reason for this variation in these prevalence estimates may be attributed to differences in study designs with regard to inclusion criteria for participants, and differences in the facilities and medical care used in different nursing homes. In addition, the most commonly reported components of poor sleep quality were decreased sleep efficiency (61.1%), increased sleep latency (53.0%) and sleep disturbances (30.4%). This pattern indicates that these participants had problems with both initiating and maintaining sleep. Similarly, Fetveit et al. [6] found that 72% of the elderly participants in nursing homes had a sleep efficiency below 85%, while 77.8% reported a sleep onset latency of more than 30 minutes. Also, Wilfling et al. [38] found that 23.0% of the elderly in German nursing homes had sleep disturbances and, in the same way, Wang et al. [39] found that 27.8% of older Chinese adults living in nursing homes had sleep disturbances. One of the important factors that may contribute to the development of a higher prevalence of sleep problems among the elderly in nursing homes is the environment, particularly with respect to the high levels of night-time noise and light, the low levels of daytime light, and care routines that do not promote sleep [40]. However, the use of sleep medication is not popular among the elderly in the Chinese nursing homes and this could be the reason why only 10.3% of residents in this study had taken sleep medication. Moreover, among the participants that had taken sleep medication, majority of them had poor sleep quality. Nevertheless, due to the cross-sectional study design, a causal relationship between sleep quality and taking sleep medication could not be established.

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Therefore, from this result, it can be assumed that participants with poor sleep quality are

more likely to take sleep medication, but this proportion is lower in the Chinese nursing

homes.

Additionally, the prevalence of depression symptoms in this study was associated with

sleep quality. For example, participants with poor sleep quality scored 2.54 points higher

than those with good sleep quality on the GDS-30 score after adjusting for many important

covariates. Moreover, participants with poor sleep quality were 3.19-fold more likely to

develop depression symptoms than those who had good sleep quality. Furthermore,

participants with increased sleep latency, shorter sleep duration, lower sleep efficiency,

sleep disturbances and daytime dysfunction had increased risk of depression symptoms.

These findings are in accordance with those of several previous similar studies in both

nursing homes and communities[23 41 42]. In this regard, a cross-sectional study by Orhan et al.

[23] demonstrated that the GDS-30 score was positively correlated with the global PSQI score

($r$=0.231) as well as the sleep latency and sleep disturbances scores ($r$=0.261 and 0.380,

respectively) among seventy-three elderly people living in a nursing home in Turkey.

Additionally, Foley and colleagues [22] conducted a study on over 9,000 participants aged at

least 65 and found that the sleep complaint score was positively associated with the Center

for Epidemiologic Studies Depression Scale score (CESD). Also, Sukegawa et al. [43] found that

elderly persons with depression symptoms were more likely to report poor sleep efficiency,

sleep disturbances, long sleep latency and poor subjective sleep quality. In agreement with

the preceding results, a prospective cohort study by Livingston et al. [41] reported that the best

predictor of future depression in the elderly people, who were not depressed at baseline,

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was sleep disturbance at baseline. Moreover, Rodin et al. [42] found that the frequency of depressed affect was positively associated with sleep disturbances in the elderly after controlling for adjustment factors. Similarly, Cho et al. [21] suggested that, among the elderly with prior depression, depression recurrence was predicted by sleep disturbance, and this association was independent of other depression symptoms. Furthermore, in a previous cross-sectional study, elderly persons with a GDS-30 score ≥6 were 1.29 times more likely to develop sleep disturbances than those with a GDS-30 score of 0 to 2 [44]. Another cross-sectional study [45] found that depression was independently positively associated with poor sleep quality among the elderly after adjusting for other confounders (OR= 1.21, 95% CI: 1.12-1.52). However, the mechanism underlying the relationship between poor sleep quality and depression symptoms is not thoroughly understood. Certainly, many studies have suggested that sleep problems and depression symptoms can reinforce each other and this relationship might be bidirectional. Although the direction of the association between sleep quality and depression symptoms in this study was not possible to determine as a result of the use of a cross-sectional study design, poor sleep quality was viewed as a prodromal state or even a core symptom of depression symptoms in the elderly.

To our knowledge, this is the first study to focus on the elderly in a nursing home in China and demonstrate that poor sleep quality was independently associated with depression symptoms. However, there are several limitations in this study. First, the causal relationship between poor sleep quality and depression symptoms could not be assessed due to the use of a cross-sectional study design. Therefore, further longitudinal and prospective studies should be conducted to confirm this relationship in the elderly in

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nursing homes. Second, all data were obtained from self-reports, which may compromise the

accuracy of measurements due to recall bias; and there was lack of objective measurement

of sleep quality, which might have led to misclassification of some of the components of

sleep quality. Third, the findings of this study cannot be generalized to patients with

dementia and hearing or cognition impairment as these were excluded from this study.

Finally, although the mean differences and odds ratio were decreased in the adjusted

models, the mediating effect of other variables on the association between poor sleep quality

and depression symptoms was not analysed and should be investigated in future studies.

## 5.Conclusions

In summary, a high prevalence of poor sleep quality among the elderly living in

nursing homes in Hunan in China was observed. In addition, poor sleep quality was

associated with increased GDS-30 scores and the development of depression symptoms.

Nonetheless, further studies are needed to (1) explore whether the intervention and

treatment of poor sleep quality can ameliorate depression symptoms among the elderly in

nursing homes; and (2) investigate the mediating effects of other variables on the

association between sleep quality and depression symptoms.

## Acknowledgements

## Author contributions

ZH and XDZ completed the statistical analyses and drafted the manuscript. Atipatsa CK

contributed to the manuscript editing. TTZ and YN contributed to the investigation and data

collection. HLX checked and revised the manuscript. All the authors read and approved the

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final manuscript.

**Funding**

This research received no specific grant from any funding agency in the public, commercial

or not-for-profit sectors.

**Competing interests**

None declared

**Patient consent**

Written informed consent was obtained from all participants.

**Ethical approval**

This study was approved by the Ethical Committee of Xiangya School of Public Health in

Central South University (No.XYGW-2018-49).

**Data availability statement**

The data analysed during this study are included in the article. The numerical data used to

support the findings of this study are available from the corresponding author upon

reasonable request.

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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

| Section/Topic | Item # | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4,5 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 6 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 6,7 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7,8,9 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7,8,9 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 10 |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 10 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 10 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 10 |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | no |
| | | (*e*) Describe any sensitivity analyses | 10 |
| **Results** | | | |

| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 11,12 |
|---|---|---|---|
| | | (b) Give reasons for non-participation at each stage | 7 |
| | | (c) Consider use of a flow diagram | no |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 12,13 |
| | | (b) Indicate number of participants with missing data for each variable of interest | 7 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 13,14,15 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 13,14,15 |
| | | (*b*) Report category boundaries when continuous variables were categorized | 13,14 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | no |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 16 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 16,17 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 19,20 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 17,18,19 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 19 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 21 |
| | | | |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.