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The mediating role of daily living ability and sleep in depression and cognitive function based on a structural equation model

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Abstract

Background The incidence of depression and cognitive dysfunction is high in the elderly population, which incurs serious social burden. In recent years, an increasing number of studies have found that poor sleep quality and impaired daily activities in the elderly are also closely related to these two diseases.To explore the mediating role of sleep quality and daily activity ability in the elderly's cognition and depression. It extends upon existing research and provides evidence for new areas of intervention that may ameliorate and delay cognitive decline in the elderly.

Methods Data were collected from a representative sample of 5,470 (aged 60 years and above) in Anhui Province from the 2019 Anhui Health and Life Expectancy Survey(AHLS). Cognitive function was assessed by the Mini-Mental State Examination(MMSE), depression symptoms by the Patient Health Questionnaire(PHQ-9), physical function by the Barthel Index for Activities of Daily Living, and sleep quality by the Pittsburgh Sleep Quality Index(PSQI). Descriptive analysis was conducted for the distribution of various covariates and results. Pearson correlation analysis was employed to test the relationship between depression symptoms, cognition, poor sleep quality and daily living ability of the elderly. The structural equation model was used to explore the link between depression and cognition in the older adults, and to test mediating effects of daily activity and sleep disturbance on depression and cognition.

Results Among all participants, the average cognitive score was 21.51 ($SD = 6.10$), and the incidence of depression symptoms was 31.6%. Depression symptoms had a significant direct impact on cognition (β= -0.075, 95%CI=-0.099, -0.050). Depression symptoms was related to poor sleep quality and daily living ability ($\beta = 0.420$, 95%$CI = 0.409, 0.447$; β=-0.161, 95%CI=-0.163, -0.113). Cognition was also related to both factors (β=-0.042, 95%CI=-0.070, -0.024; $\beta = 0.143$, 95%$CI = 0.112, 0.173$). The ability of daily living was related to poor sleep quality (β=-0.049, 95%CI=-0.079, -0.027). Poor sleep quality and daily living ability mediated the relationship between depression symptoms and cognition (β=-0.020, 95% CI=-0.025, -0.014; β=-0.020, 95%CI=-0.030, -0.010).

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Conclusions This study found that depression symptoms in the older adults was significantly related to cognitive function. Older adults with depression symptoms are more likely to have cognitive impairment. In addition, poor sleep quality and the ability of daily living can play a mediating role between depression and cognition. In the future, the society should pay attention to the mental health of the elderly to avoid depression. They should also pay attention to the impact of their sleep quality and daily activity ability, so as to better maintain cognitive function.

Keywords Cognitive function, Daily life, Depression, Elderly, Sleep quality

Background

Cognitive impairment and depression are commonly associated with an aging population [1, 2]. Both diseases are closely related to mortality rate, the ability to perform daily living, and the economic burden of social diseases in the older adults [3, 4]. There is evidence that their prevalence and impact on public health will further increase in the future. These diseases deserve comprehensive research to improve the quality of life of the older adults [5, 6]. Anhui Province in China has been aging since 1998 and is one of the earliest provinces in the country to become an aging society. Over the past 5 years, the proportion of people aged ≥ 65 years in Anhui Province has increased annually. In 2023, the province's population of those aged ≥ 60 years was 12.85 million, accounting for 21% of the total population [7]. The degree of aging in Anhui Province has further progressed; the demand for care services for the older adults has continued to increase, as has the burden on social support.

In addition to the decline in physiological and biochemical functions over time, the older adults also experience various negative life events such as unemployment, retirement, widowhood, and social role changes, resulting in different levels of mental and psychological symptoms, of which depression is the most common. Depression is a common mental disorder in old age characterized by low mood, pessimistic negativity, persistent sadness, and a lack of interest or pleasure in previously rewarding or enjoyable activities [8]. It can interfere with sleep and appetite. Moreover, it is a common cause of suicide among the older adults. Emerging studies suggest that depression symptoms, including those in the minimal and mild ranges, are disturbing and prevalent among older individuals [9]. The causes of depression include complex interactions between social, psychological, and biological factors. The World Health Organization estimates that in 2015, more than 264 million people worldwide had depression, equivalent to 4.4% of the world's population; it is more common among females (5.1%) than males (3.6%) [10].

Similarly, cognitive impairment is a serious public health problem, which is prevalent in older adults. The cognitive function of the older adults is an important indicator of their health. Mild cognitive impairment refers to a pathological state in which an individual has memory impairment or other cognitive impairment, but the ability to perform daily activities is not affected. Severe impairment of cognitive function may develop into dementia, which affects the patients' physical and mental health and brings heavy economic and psychological burdens to the family and society. Studies have shown that by 2050, dementia will increase exponentially in the older adults aged ≥ 60 years, accounting for 22% of the world's population [11]. In addition, the global cost of treating dementia is estimated at 818 billion US dollars, it also note that the most recent estimate of the cost of treating dementia has risen to $1.3 trillion US dollars from the WHO website for this information [12]. Currently, there is no effective treatment for dementia; therefore, early prevention is crucial, and mild cognitive impairment is the key stage of intervention.

Studies have shown that depression often co-occurs with dementia in old age [13]. Regarding the correlation between depression and cognitive function in the older adults, a study has found that depression in later life is a risk factor for cognitive deterioration and is associated with a two-fold increase in the incidence of dementia [14]. Another study found that older adult patients with depression may be at a higher risk of cognitive decline and brain atrophy. Relieving depression symptoms can help delay cognitive decline [15]. Mackin et al. found that depression is common in patients with mild cognitive impairment [16]. A study has reported a dose-response relationship between depression and the risk of dementia [17].

A large number of studies have found that the daily activity ability and poor sleep quality of the elderly are closely related to depression and cognitive dysfunction. Studies have shown that there is a positive correlation between physical activity and cognitive ability, which has been confirmed in the elderly population [18]. Another study found that sleep is an important lifestyle that affects the cognitive function of the elderly [19]. It was reported that sleep concerns are prevalent in older adults, and individuals with cognitive impairment may experience severer sleep disturbances than cognitively intact older adults [20]. Catherine Duclos et al. found that lack of sleep has a direct effect on cognition, and indirectly affects cognition by weakening the ability of daily living [21]. The literature has confirmed that ADL, depression and poor sleep quality of the elderly are related to each other [22].

Existing studies have verified the relationship between depression, daily living ability, sleep quality and cognitive function, but the interaction between the four and the mediating effect of daily activity ability and sleep quality on depression and cognitive ability in the elderly have not been reported. Structural equation modeling is a statistical method based on covariance matrix analysis to examine the relationships between variables. It allows for the simultaneous investigation of the interactions among multiple variables, including both direct and indirect effects. Therefore, with the help of large sample data, this study uses structural equation modeling to explore the relationship between depression and cognitive function in the elderly and its possible mechanism, and explore whether daily activity ability and poor sleep quality play an intermediary role between them. The results will provide a reference for delaying cognitive function decline in the elderly and formulating health promotion measures and related policies for the elderly.

Methods

Sampling and data collection

This survey was part of the Anhui Health and Longevity Survey (AHLS) that assessed the health conditions of older adult people living in Anhui, China, adopting the multi-stage method [23]. In the first stage, according to geographical location, a city was determined to be in one of the four regions of eastern, western, southern, and northern Anhui Province. In the second stage, three to five urban communities were randomly selected from all urban communities in each sample city; the three to five rural communities were selected in each sample city according to the same principle. In the third stage, in the selected communities, face-to-face questionnaire surveys of 750 samples in each of the urban and rural areas were completed. Data were collected from July to August 2019. The investigators consisted of selected students from Anhui Medical University. Under the supervision of the community medical staff, the investigators entered the house of the elderly to explain the purpose of the survey. The elderly volunteered to participate in the survey, and the elderly who participated in the survey was given a small gift worth $1.

Participants

Participants aged ≥ 60 years were recruited for this study. The inclusion and exclusion criteria were based on the study by Albert et al. [24]. Criteria for subject inclusion were seniors who: (a) maintain good communication skills; and (b) agreed to participate in the study and was able to cooperate actively. The exclusion criteria were presence of dementia, a history of other psychiatric problems, cerebrovascular accident, Parkinson's disease, brain injury. People who had thyroid disease, who were on sleeping and stress medicines, and those who had hearing impairment or language communication impairment were also excluded. In this study, a total of 6211 elderly people were investigated, and 741 elderly people who were missing information on important variables were excluded. The valid sample totaled 5470 people.

Measurement

Exposure

The Patient Health Questionnaire (PHQ-9) is a simple and easy self-assessment tool [25]. It is often widely used for the screening of mental disorders in primary medical units, and is used to assess the depression symptoms of the older adults in this study. The PHQ-9 contains nine items, the scores of which range from 0 to 27. Scores of ≤ 4 indicate that the subjects have no symptoms of depression, and scores greater than or equal to 5 indicate that the subjects have depression symptoms. PHQ-9 scores of 5, 10, 15, and 20 represented mild, moderate, moderately severe, and severe depression, respectively [26].

Outcomes

The cognition of older adults people was tested using the Mini-Mental State Examination (MMSE) [27]. The MMSE briefly assesses several cognitive domains (time and space orientation, memory, calculation, and language), and scores range from 0 to 30. Based on the research by Zhang et al. [28], we used different cut-off points according to the education level of the respondents: 17 for those with no formal education, 20 for those who received 6 years of education or less (elementary), and 24 for those who had more than 6 years of education (middle or high school). Older adult people with MMSE scores lower than this cut-off point were judged to have cognitive impairment.

Mediating variables

The Barthel Index for Activities of Daily Living was used to assess the ability of the older adults to conduct daily activities (functional independence) [29]. It consists of 10 items, including eating, bathing, grooming, dressing, stool control, urination control, toileting, bed and chair transfer, walking on flat ground, and climbing up and down stairs. The answer to each item was divided into two to four categories or options and points were assigned according to the degree of help the research subjects need to complete each activity item. The total score ranged from 0 to 100 points. A score < 100 is defined as an impaired ability of daily living [30].

The Pittsburgh Sleep Quality Index (PSQI) was used to assess the subjective sleep quality of the older adults in the past month. It was compiled by Buysee and translated into Chinese in 1996 [31]. The scale includes seven

dimensions, including time to fall asleep, sleep time, sleep efficiency, sleep quality, sleep disorders, hypnotic drugs, and daytime dysfunction, with each dimension scoring 0–3 points. The total PSQI score ranges from 0 to 21, with higher scores indicating poorer sleep. When the total score was > 7, it indicated that the individual experienced poor sleep quality [32].

Covariates

To control for potential confounding variables, age (years), hukou (household registration) status, marriage status, and income (Yuan/per year) were examined as adjustment variables. Hukou includes two options: agricultural and non-agricultural. Marital status includes married and others (unmarried, divorced, widowed, etc.). Income is assessed by asking the respondents, "What is the average annual economic income?" The answers are divided into four levels: <6,500, 6,500–15,000, 15,000–24,000, > 24,000.

Table 1 Characteristics of the participants

Variables	Number($n = 5470$)	Percentage(%)
Age		
60–70	2913	53.3
71–80	1928	35.2
>80	629	11.5
Gender		
Male	2497	45.6
Female	2973	54.4
Marriage		
Married	3987	72.9
Others	1483	27.1
Hukou		
Agricultural	3761	68.8
Non-agricultural	1709	31.2
Income		
<6500	3297	60.3
6500–15,000	814	14.9
15,000–24,000	446	8.2
>24,000	913	16.7
Cognition		
Normal	3681	67.3
Impairment	1789	32.7
Depression symptoms		
No	3740	68.4
Yes	1730	31.6
The ability of daily living		
Normal	2317	42.4
Disability	3153	57.6
Poor sleep quality		
No	3627	66.3
Yes	1843	33.7

Statistical analyses

Data were double-entered into a database using EpiData V.3.1, and then analyzed using SPSS (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp) and MPLUS Version 7.4 (Los Angeles, CA: Muthén & Muthén). Data analyses comprised of descriptive estimations, correlation analysis and structural equation modelling. Descriptive estimations were used to summarize the distribution of participant characteristics, frequency of occurrence of categorical variables (percentage), and mean of continuous variables (standard deviation, SD). Statistical significance was set at $p < 0.05$. Pearson correlation analysis was used to test the relationship between depression symptoms, cognition, poor sleep quality and daily living ability of the elderly.

The structural equation model was used to explore the relationship and specific pathways of depression symptoms, cognition, poor sleep quality, and the ability of daily living in the older adults. Maximum likelihood (ML) was used to estimate the model parameters. The model fit was approximated by the following criteria: (a) ratio of the chi-square value to degrees of freedom (χ^2/df) ≤ 3; (b) comparative fit index (CFI) ≥ 0.90; (c) Tucker-Lewis Index (TLI) ≥ 0.95; (d) standardized root mean square residual (SRMR) < 0.05; (e) root mean square error of approximation (RMSEA) < 0.05 [33]. In the model, depression symptoms, cognition, poor sleep quality, the ability of daily living, hukou status, and marriage status are all two-category variables, income is treated as a four-category variable, and age is a numerical variable.

Results

General information

For all 5470 respondents, the mean age was (71.03 ± 7.11) years. Of these, 2,497 were men and 3,987 were married. There were 3,761 people with agricultural hukou. The annual income of 3297 participants was < 6,500 Yuan, 814 participants had an annual income between 6,500 and 15,000 Yuan, and only 913 participants had an annual income > 24,000 Yuan.

Among all participants, the mean cognitive score was (21.51 ± 6.10) (out of a total score of 30). The average score for depression was (3.68 ± 4.29) (out of a total score of 27), and there were 1730 patients with depression symptoms, accounting for 31.6% of the sample. The average score for the ability of daily living was (94.81 ± 7.51) (out of a total score of 100). The average score for sleep was (6.50 ± 3.68) (out of a total score of 21). There were 1,843 older adults with poor sleep quality. See Table 1 for details.

Table 2 Correlation analysis of depression symptoms, the ability of daily living, poor sleep quality, and cognition

Variables	Depression symptoms	Cognition	The ability of daily living	Poor sleep quality
Depression symptoms	1.000			
Cognition	-0.232**	1.000		
The ability of daily living	-0.115**	0.095**	1.000	
Poor sleep quality	0.471**	-0.124**	-0.066**	1.000

**$p < 0.01$

Table 3 Model fit indices

Model Fit	Home
χ^2/df	5.587/2
CFI/TLI	0.999/0.988
SRMR	0.004
RMSEA	0.018(0.000, 0.037)

The correlation between depression symptoms, the ability of daily living, poor sleep quality and cognition

Pearson correlation analysis showed that depression symptoms was negatively correlated with cognition (r=-0.232, $p < 0.001$) and the ability of daily living (r=-0.115, $p < 0.001$), and positively correlated with poor sleep quality ($r = 0.471$, $p < 0.001$). See Table 2 for details.

Structural equation modelling

Structural equation models were built to estimate the relationships between depression symptoms, cognition, poor sleep quality, and the ability of daily living. After adjusting for age, hukou, marriage, and income, the model fit indices, the standardized direct effects among the four variables, and the indirect effects of the two mediation variables are shown in Tables 3 and 4. The model fit indices were as follows: $\chi^2/df = 2.794$, CFI = 0.999, TLI = 0.988, SRMR = 0.004, and RMSEA = 0.018, indicating that the model has a good fit.

Relationships among the variables

In the structural model, depression symptoms was observed to have a significant, but weak, direct effect on cognition (β=-0.075, 95%CI=-0.099, -0.050); participants with depression symptoms were more likely to report lower cognition scores. Depression symptoms was also significantly associated with the two mediating variables. Participants with depression symptoms were more likely to have poor sleep quality than those without depression symptoms ($\beta = 0.420$, 95%$CI = 0.409$, 0.447). As for the ability of daily living, older people with depression symptoms often had poorer abilities in daily living (β=-0.161,95%CI=-0.163, -0.113). The direct effect of depression symptoms on cognition was less than that of depression symptoms on daily living ability.

Significant correlations were also found between cognition and the two mediating variables. Participants with poor sleep quality were more likely to have lower cognition scores (β=-0.042, 95%CI=-0.070, -0.024). Cognition was also significantly influenced by the ability of daily living ($\beta = 0.143$, 95%$CI = 0.112$, 0.173), and participants with poor abilities in daily living had lower cognition

Table 4 Standardized direct and indirect effect

Variables	Standardized coefficient(95%CI)
Direct effects	
Depression symptoms	
Cognition	-0.075(-0.099, -0.050) **
Poor sleep quality	0.420(0.409, 0.447) **
Ability of daily living	-0.161(-0.163, -0.113) **
Poor sleep quality	
Ability of daily living	-0.049(-0.079, -0.027) **
Cognition	-0.042(-0.070, -0.024) **
Ability of daily living	
Cognition	0.143(0.112, 0.173) **
Indirect effects	
Depression symptoms →Ability of daily living →Cognition	-0.020(-0.030, -0.010) **
Depression symptoms →Poor sleep quality →Cognition	-0.020(-0.025, -0.014) *
Depression symptoms →Poor sleep quality →Ability of daily living →Cognition	-0.003(-0.005, 0.001) *
Total Indirect	-0.043(-0.054, -0.032) **
Total	-0.117(-0.139, -0.096) **

**$p < 0.01$, *$p < 0.05$; Adjusted for age, hukou, marriage and income

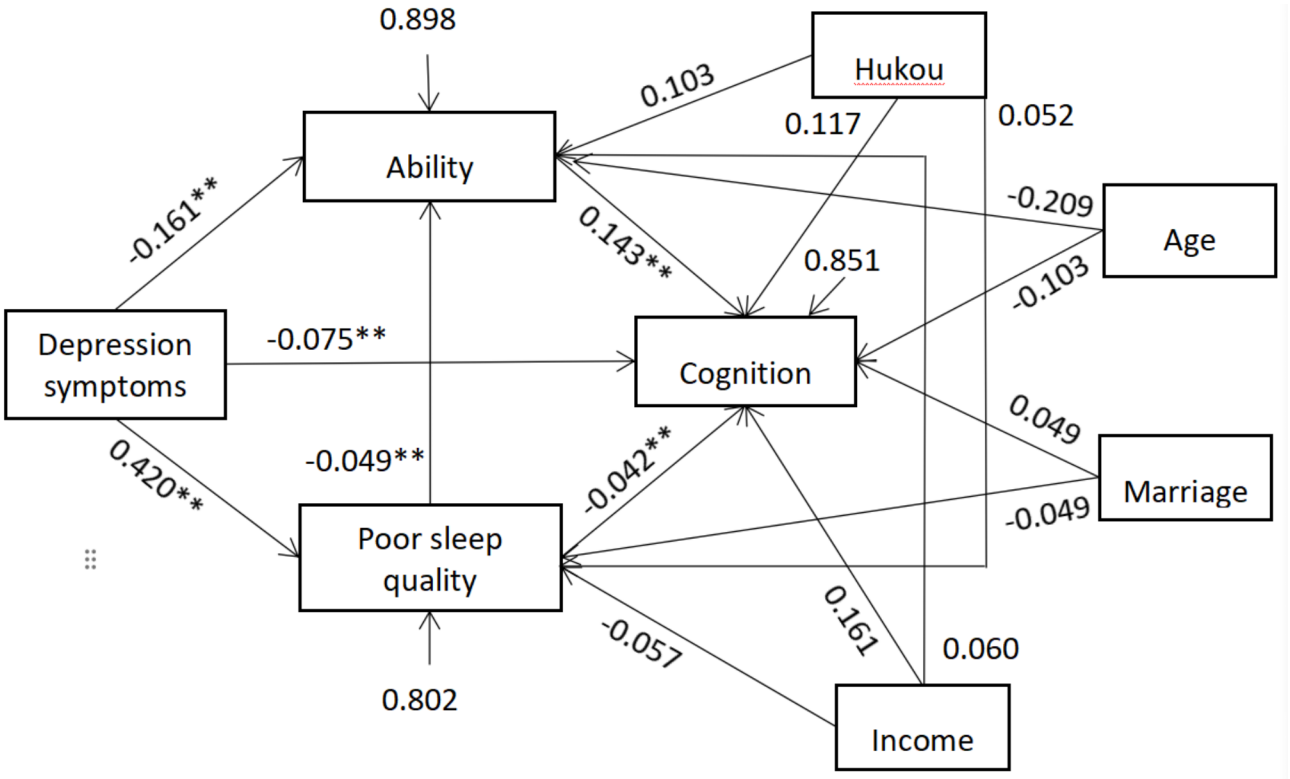

Fig. 1 Results of the structural equation model.**p<0.01,*p<0.05; Adjusted for age, hukou, marriage and income

scores. The direct effect of daily living ability on cognition was greater than that of depression symptoms and poor sleep quality on cognition.

In addition, there was a significant association between the two mediating variables, with a higher ability of daily living being associated with better sleep quality (β=-0.049,95%CI=-0.079, -0.027). Before and after adding covariates, the direct and indirect effects of each variable in the model were significant. See Table 4; Fig. 1 for further details.

Mediation of poor sleep quality and the ability of daily living

The results showed that poor sleep quality play a mediating role between depression symptoms and cognition (β=-0.020, 95%CI=-0.025, -0.014). The ability to perform daily living also showed a significant mediating effect between depression symptoms and cognitive function (β=-0.020, 95%CI=-0.030, -0.010). In addition, the indirect relationship between depression symptoms and cognition through poor sleep quality and the ability to perform daily living was also significant. In general, the three indirect associations between depression symptoms and cognition were smaller than the direct associations, and the mediating effects of poor sleep quality and ability of daily living were approximately the same.

Discussion

In this study, a structural equation model was employed to examine the effects of depression symptoms, daily living ability and poor sleep quality on cognition function and the mechanism in the elderly, as well as to explore the mediating roles of daily activity ability and poor sleep quality in the relationship between depression symptoms and cognition. The findings revealed that depression symptoms and poor sleep quality had a negative effect on cognition, whereas daily living ability had a positive impact. Additionally, both daily living ability and poor sleep quality had mediating effects in the association between depression symptoms and cognition, but the mediating effects were weaker than the direct effect of depression symptoms on cognition. This study contributes to the existing literature by enhancing our understanding of the complex interplay among depression symptoms, daily living ability, poor sleep quality and cognition. Furthermore, it provides valuable insights for future research to further explore the relationship among these factors and the development of specific intervention strategies.

Depression symptoms and cognitive status of the elderly in Anhui

The survey found that the average score of cognitive function of the older adults in Anhui Province is 21.51, which

is slightly lower than the results of a study on the older adults in Sao Paulo, Brazil [34], and the detection rate of cognitive dysfunction was 32.7%, which is at a high level. This is higher than the result of a previous study in China (14.71%) [35], and also higher than the range of mild cognitive impairment incidence in the 60–84 years age group, according to the new version of the clinical guidelines for mild cognitive impairment issued by the American Academy of Neurology (AAN) in 2018 (6.7–25.2%) [36]. This discrepancy may be due to different survey tools used or differences in the characteristics of the survey target population; in addition, the detection rate of depression symptoms was 31.6%, which is similar to the results of Tsolaki et al. on the prevalence of depression in the older adults in Greece [37], but higher than that of Li et al. on the prevalence of depression in the older adults in China [38]. The reasons for the different results may be related to the measurement tools adopted by the research institutes, the survey populations they investigated, and the different determination criteria determined.

Relationship between depression symptoms and cognitive function

Previous studies have observed a correlation between depression and cognitive function [39, 40]. Although these studies differ in specific details, they all found negative effects of depression on cognitive function in terms of results [41], which also confirmed our findings. Notably, the study results revealed a relatively weak correlation between depression symptoms and cognitive function, which may be attributed to potential interference from anxiety and other psychological factors that can diminish the direct relationship between depression and cognition [42]. Although the association between depression symptoms and cognitive function was weak, this finding suggests that further studies may be needed to explore the mechanism of this relationship and the underlying influencing factors.

The mediating role of daily living ability and sleep in depression and cognitive function

This study found that depression symptoms is related to impaired ability of daily living and indirectly affects cognitive function by affecting the ability of daily living, which is consistent with related research results [43]. Depression easily triggers social barriers in the older adults, reducing their frequency of participation in social activities and going out, thereby affecting their ability to perform daily living and their physical health. The poorer the ability of the older adults in daily living, the less they go out, and the less opportunity they have to receive external information stimulation, which may aggravate the impairment of cognitive function, thus forming a vicious circle [38].

This study also found that depression symptoms in the older adults is significantly related to sleep quality, which is consistent with the results of Akie Ichimori et al. on the sleep quality and psychological status of older adults Japanese people [44]. At the same time, poor sleep quality also mediates the impairment of depression on cognitive function. A possible reason is that depression can cause the older adults to have some negative emotions, thinking wildly all day, and worrying too much, which can cause insomnia or dreaminess, and affect the quality of sleep. Long-term poor sleep quality can induce cardiovascular and cerebrovascular diseases, physical diseases, and mental disorders in the older adults, which in turn affect cognitive ability.

Studies have also found that poor sleep quality can easily lead to insufficient effective sleep time in the older adults. On the one hand, lack of sleep causes the older adults to lose attention and feel dull, which affects their memory and recall ability [45]; on the other hand, poor sleep quality can lead to excessive daytime sleep in some elderly individuals, which not only affects the health of their physiological functions but also leads to limited social activities, reduced thinking activities, and cognitive decline [46].

In this study, it was found that the mediating effect of daily living ability and poor sleep quality in the association between depression symptoms and cognition was smaller than the direct effect of depression symptoms on cognition. This indicated that such mediating effect was relatively weak, and more attention should be paid to the direct influence of depression symptoms on cognition. In order to further understand this phenomenon, future research can be carried out to further explore other possible mediating variables or new paths.

The control variables of this study

This study included four control variables: household registration, age, income, and marital status. Relevant studies have shown that age is negatively correlated with cognition, and marital status and income are positively correlated with cognition, which is consistent with the results of this study [47, 48]. In this study, household registration was related to both the outcome variable and the intermediary variable, which has rarely been reported in previous studies. This may be because the social support of the elderly with agricultural household registration is generally less, the social network is monotonous, and it is prone to depression and cognitive decline [49, 50].

Suggestions on delaying cognitive decline in the elderly

Based on the results of this study, the following suggestions are put forward to delay the cognitive decline of the elderly. First of all, the community or government should pay attention to the social behavior of the older adults,

and actively take measures to encourage them to go out to participate in social activities frequently, strengthen their connection with society, actively receive external information, maintain good living ability, and delay the decline of their cognitive ability. Secondly, family members should regularly communicate with the elderly, understand their needs and confusion, and give them emotional support and care. Through regular companionship, family members can help the elderly maintain a good state of mind and reduce depression symptoms. Finally, caregivers of the elderly should pay attention to the sleep status of the elderly, optimize the sleep environment, help them develop good sleep habits, improve sleep quality, reduce fatigue, and prevent cognitive decline.

Innovation and deficiency of the research

In this study, structural equation model was used to reveal the mechanism of depression, daily activity ability and poor sleep quality on cognitive function. It was found that daily living ability and poor sleep quality played an intermediary role between depression and cognitive function, as well as the path and size of each variable. Previous studies have mainly focused on the role of a single mediating variable. This study provides a more comprehensive perspective for understanding the mechanism of depression on cognitive function in the elderly by exploring the dual mediating effects of daily living ability and poor sleep quality. Improving daily living ability and sleep quality will help to reduce the impact of depression on cognitive function.

This study should not be viewed without limitations. Firstly, this study is a cross-sectional study, and the causality cannot be determined. In addition, the cognitive ability of the older adults could be affected by various factors. However, this study only controlled for some confounding factors, which may require more in-depth research in future studies, such as the control of chronic diseases, exercise, diet and other variables.

Conclusion

This study found that depression symptoms in the older adults was significantly related to cognitive function. Older adults with depression symptoms are more likely to have cognitive impairment. In addition, poor sleep quality and daily activity ability can play a mediating role between depression symptoms and cognitive function. Our findings are conducive to a clearer understanding of the interaction between depression symptoms and cognitive function in the older adults, as well as the regulatory role of mediating variables, and clarify the path of action for remediation. These findings may provide a reference for the government or society to formulate measures to delay the decline of cognitive function in the older adults. In the future, society and/or families should not only pay attention to the mental health of the older adults to avoid the generation of depression but also consider the impact of their sleep quality and daily activity ability, so as to better maintain cognitive function.

Abbreviations

AAN	American Academy of Neurology
CFI	Comparative Fit Index
RMSEA	Root Mean Square Error of Approximation
ML	Maximum Likelihood
MMSE	Mini-Mental State Examination
PHQ	Patient Health Questionnaire
PSQI	Pittsburgh Sleep Quality Index
SD	Standard Deviation
WHO	World Health Organization

Author contributions

All authors have made substantial contributions to the manuscript. Liu Huijun and Zhang Xiange: Conceptualization, Methodology, Interpretation of data, Writing of original draft. Yang Ming and Sun Jiayi: Data analysis and Writing–review. Peng Juanjuan: Investigation, Data collection, collation and analysis. Xu Wangquan: Data collection, collation and analysis. Song Yueli: Investigation and Data collection. Fang Guixia: Conceptualization, Methodology, Writing–review & editing, Supervision, Project administration, Funding acquisition.

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Data availability

All data supporting the conclusions of this article are included within the article. Further inquiries can be directed to the corresponding author.

Declarations

Ethics approval and consent to participate

This study was approved by Biomedical Ethics Committee of Anhui Medical University (No. 2020H011). The study was conducted in strict accordance with the ethical principles of the Declaration of Helsinki. All subjects gave their informed consent before participating in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Hu T, Zhao X, Wu M, et al. Prevalence of depression in older adults: a systematic review and meta-analysis. Psychiatry Res. 2022;311:114511. https://doi.org/10.1016/j.psychres.2022.114511.
2. Mental health of older adults. https://www.who.int/news-room/fact-sheets/detail/mental-health-of-older-adults (accessed 3 November 2024).

3. Chen YM, Wang JY, Han HJ, et al. Long-term economic burden evaluation for cognitive impairment and depression co-existing based on Markov model. Chin J Health Stat. 2018;35:834-7,842.
4. Gallagher D, Kiss A, Lanctot KL, et al. Toward prevention of mild cognitive impairment in older adults with depression: an observational study of potentially modifiable risk factors. J Clin Psychiatry. 2019;80:18m12331. https://doi.org/10.4088/JCP.18m12331.
5. Damian J, Pastor-Barriuso R, Valderrama-Gama E, et al. Association of detected depression and undetected depressive symptoms with long-term mortality in a cohort of institutionalised older people. Epidemiol Psychiatr Sci. 2017;26:189–98. https://doi.org/10.1017/S2045796015001171.
6. Doi T, Shimada H, Park H, et al. Cognitive function and falling among older adults with mild cognitive impairment and slow gait. Geriatr Gerontol Int. 2015;15:1073–8. https://doi.org/10.1111/ggi.12407.
7. Bulletin of Main Data of Anhui Province Sample Survey on Population Changes. in 2023. https://tjj.ah.gov.cn/ssah/qwfbjd/qwfb/149224301.html(accessed 3 November 2024).
8. Alexapoulos GS. Depression in the elderly. Lancet. 2005;365:1961–70. https://doi.org/10.1016/S0140-6736(05)66665-2.
9. Laborde LP, Gabalawy ER, Kinley J, et al. Subsyndromal depression among older adults in the USA: prevalence, comorbidity, and risk for new-onset psychiatric disorders in late life. Int J Geriatr Psychiatry. 2015;30:677–85.
10. Depression and other common mental disorders. https://www.who.int/publications/i/item/depression-global-health-estimates (accessed 3 November 2024).
11. Jakovljevic MB, Milovanovic O. Growing burden of non-communicable diseases in the emerging health markets: the case of BRICS. Front Public Health. 2015;3:65.
12. Global action plan on the public. health response to dementia 2017–2025. https://www.who.int/publications/i/item/9789241513487 (accessed 3 November 2024).
13. Enache D, Winblad B, Aarsland D. Depression in dementia: epidemiology, mechanisms, and treatment. Curr Opin Psychiatr. 2011;24:461–72. https://doi.org/10.1097/YCO.0b013e32834bb9d4.
14. Diniz BS, Butters MA, Albert SM, et al. Late-life depression and risk of vascular dementia and Alzheimer's disease: systematic review and meta-analysis of community-based cohort studies. Br J Psychiatry. 2013;202:329–35. https://doi.org/10.1192/bjp.bp.112.118307.
15. Zhang Z, Wei F, Shen XN, et al. Associations of subsyndromal symptomatic depression with cognitive decline and brain atrophy in elderly individuals without dementia: a longitudinal study. J Affect Disord. 2020;274:262–8. https://doi.org/10.1016/j.jad.2020.05.097.
16. Mackin RS, Insel P, Aisen PS, et al. Longitudinal stability of subsyndromal symptoms of depression in individuals with mild cognitive impairment: relationship to conversion to dementia after 3 years. Int J Geriatr Psychiatr. 2012;27:355–63. https://doi.org/10.1002/gps.2713.
17. Wu JJ, Wang HX, Yao W, et al. Late-life depression and the risk of dementia in 14 countries: a 10-year follow-up study from the survey of health, ageing and retirement in Europe. J Affect Disord. 2020;274:671–7. https://doi.org/10.1016/j.jad.2020.05.059.
18. Chu CH, Chen AG, Hung TM, et al. Exercise and fitness modulate cognitive function in older adults. Psychol Aging. 2015;30:842–8. https://doi.org/10.1037/pag0000047.
19. Dzierzewski JM, Dautovich N, Ravyts S. Sleep and cognition in older adults. Sleep Med Clin. 2018;13:93–106. https://doi.org/10.1016/j.jsmc.2017.09.009.
20. Cochen V, Arbus C, Soto ME, et al. Sleep disorders and their impacts on healthy, dependent, and frail older adults. J Nutr Health Aging. 2009;13:322–9. https://doi.org/10.1007/s12603-009-0030-0.
21. Catherine D, Marie-Pascale B, Carolina B, et al. The impact of poor sleep on cognition and activities of daily living after traumatic brain injury: a review. Aust Occup Ther J. 2015;62:2–12.
22. Altiok M, Yilmaz M, Onal P, et al. Relationship between activities of daily living, sleep and depression among the aged living at home. Pak J Med Sci. 2012;28:162–6.
23. Zhang Y, Hou F, Cheng J, et al. The association between leftover food consumption and depression among older adults: findings from a cross-sectional study. J Affect Disord. 2022;307:157–62. https://doi.org/10.1016/j.jad.2022.03.074.
24. Albert MS, DeKosky ST, Dickson D, et al. The diagnosis of mild cognitive impairment due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimer's Dement. 2011;7:270–9. https://doi.org/10.1016/j.jalz.2011.03.008.
25. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary care evaluation of mental disorders. Patient Health Questionnaire JAMA. 1999;282:1737–44. https://doi.org/10.1001/jama.282.18.1737.
26. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16:606–13. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.
27. Folstein MF, Folstein SE, McHugh PR. Mini-mental State. A practical method for grading the cognitive State.of patients for the clinician. J Psychiatr Res. 1975;12:189–98. https://doi.org/10.1016/0022-3956(75)90026-6.
28. Katzman R, Zhang M, Ouang-Ya-Qu, et al. A Chinese version of the mini-mental state examination-Impact of illiteracy in a Shanghai dementia survey. J Clin Epidemiol. 1988;41:971–8. https://doi.org/10.1016/0895-4356(88)90034-0.
29. Sainsbury A, Seebass G, Bansal A, et al. Reliability of the Barthel index when used with older people. Age Ageing. 2005;34:228–32. https://doi.org/10.1093/ageing/afi063.
30. Hsieh CL, Hsueh IP. A cross-validation of the comprehensive assessment of activities of daily living after stroke. Scand J Rehabil Med. 1999;31:83–8.
31. Buysse DJ, Reynolds CF 3rd, Monk TH, et al. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28:193–213.
32. Chien TW, Hsu SY, Tai C, et al. Using Rasch analysis to validate the revised PSQI to assess sleep disorders in Taiwan's hi-tech workers. Community Ment Health J. 2008;44:417–25. https://doi.org/10.1007/s10597-008-9144-9.
33. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model. 1999;6:1–55.
34. Soares LM, Cachioni M, da Silva Falcao DV, et al. Determinants of cognitive performance among community dwelling older adults in an impoverished sub-district of Sao Paulo in Brazil. Arch Gerontol Geriatr. 2012;54:E187–92. https://doi.org/10.1016/j.archger.2011.11.014.
35. Xue J, Li J, Liang J, et al. The prevalence of mild cognitive impairment in China: a systematic review. Aging Dis. 2018;9:706–15. https://doi.org/10.14336/AD.2017.0928.
36. Wang G, Cui H. Reader response: practice guideline update summary: mild cognitive impairment: report of the guideline development, dissemination, and implementation subcommittee of the American academy of neurology. Neurology. 2018;91:371–2. https://doi.org/10.1212/WNL.0000000000006041.
37. Tsolaki M, Gkioka M, Verykouki E, et al. Prevalence of dementia, depression, and mild cognitive impairment in a rural area of the Island of Crete, Greece. Am J Alzheimers Dis Other Dement. 2017;32:252–64. https://doi.org/10.1177/1533317517698789.
38. Li N, Chen G, Zeng P, et al. Prevalence and factors associated with mild cognitive impairment among Chinese older adults with depression. Geriatr Gerontol Int. 2018;18:263–8. https://doi.org/10.1111/ggi.13171.
39. Kwan RYC, Leung AYM, Yee A, et al. Cognitive frailty and its association with nutrition and depression in community-dwelling older people. J Nutr Health Aging. 2019;23:943–8. https://doi.org/10.1007/s12603-019-1258-y.
40. Ruan Q, D'Onofrio G, Wu T, et al. Sexual dimorphism of frailty and cognitive impairment: potential underlying mechanisms. Mol Med Rep. 2017;16:3023–33. https://doi.org/10.3892/mmr.2017.6988.
41. Zafar J, Malik NI, Atta M, et al. Loneliness May mediate the relationship between depression and the quality of life among elderly with mild cognitive impairment. Psychogeriatrics. 2021;21:805–12. https://doi.org/10.1111/psyg.12749.
42. Rock PL, Roiser JP, Riedel WJ, et al. Cognitive impairment in depression: a systematic review and meta-analysis. Psychol Med. 2014;44:2029–40. https://doi.org/10.1017/S0033291713002535.
43. Ormel J, Rijsdijk FV, Sullivan M, et al. Temporal and reciprocal relationship between IADL/ADL disability and depressive symptoms in late life. J Gerontol B Psychol Sci Soc Sci. 2002;57:338–47. https://doi.org/10.1093/geronb/57.4.P338.
44. Ichimori A, Tsukasaki K, Koyama E, Illuminance. Subjective sleep quality, and psychosomatic health in elderly individuals requiring care: a survey of Japan's Hokuriku region in winter. J Community Health Nurs. 2015;32:104–14. https://doi.org/10.1080/07370016.2015.1026158.
45. Lo JC, Groeger JA, Cheng GH, et al. Self-reported sleep duration and cognitive performance in older adults: a systematic review and meta-analysis. Sleep Med. 2016;17:87–98. https://doi.org/10.1016/j.sleep.2015.08.021.

46. Tsapanou A, Gu Y, O'Shea DM, et al. Sleep quality and duration in relation to memory in the elderly: initial results from the Hellenic longitudinal investigation of aging and diet. Neurobiol Learn Mem. 2017;141:217–25. https://doi.org/10.1016/j.nlm.2017.04.011.
47. Jaroudi W, Garami J, Garrido S, et al. Factors underlying cognitive decline in old age and Alzheimer's disease: the role of the hippocampus. Rev Neurosci. 2017;28:705–14. https://doi.org/10.1515/revneuro-2016-0086.
48. Cao J, Rammohan A. Social capital and healthy ageing in Indonesia. BMC Public Health. 2016;16:631. https://doi.org/10.1186/s12889-016-3257-9.
49. Zhao F. Urbanization makes life better: household registration changes and residents' life satisfaction. China Rural Observation. 2016;7:56–71, 96.
50. Zhang M, Wang D, Power M, et al. Characteristics of essential social support for the elderly and its relationship with attitudes toward aging. Psychol Sci. 2011;34:441–6. https://doi.org/10.16719/j.cnki.1671-6981.2011.02.045.

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