

The relationship between sleep length and depression level in older adults: the masking effect of education level

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Abstract: Depression is a prevalent mental health issue that affects many people around the world, has a serious impact on global public health, and causes significant economic loss and social burden. There is evidence that sleep length is strongly associated with depression levels, and that sleep length is associated with education levels in different populations. This study found that older adults who lacked sleep length were more depressed, while education level acted as a masking effect between sleep length and depression in older adults. Therefore, it is important to focus on the sleep length of older adults to ensure that they get enough sleep for good health. Further consideration should be given to recommending different specific interventions for older adults with different education levels in order to better reduce the risk of depression in older adults.

1. Introduction

Depression is a widespread mental health issue in the world, with 6% of the global population meeting criteria for depression at any given time. At present, depression is the third largest cause of the global burden of disease, but by 2030 it will be the first^[1]. As a result, depression has a major impact on global health and significantly increases social costs and burdens^[2]. Some studies have shown that there is a significant correlation between short sleep and low sleep quality and depression levels^[3].

Sleep deprivation is an important potential public health problem that is strongly associated with the health of older adults^[4], and more than 80% of older adults with sleep problems have at least one major mental or physical health problem, especially depression^[5]. The overlap between sleep problems and other disorders leads to a tendency to overlook the role of sleep itself. In recent decades, there has been increasing evidence that sleep problems not only coexist with other disorders, but may also be causally related to them^[6]. In addition, sleep length has been shown to vary considerably between populations, and this variation is largely driven by education level, with the less educated being more likely to sleep longer^[7].

Simultaneously, as medical advancements and life expectancy progress, the global ageing trend continues to escalate, with maintaining the wellbeing of older adults becoming a priority global health issue. Therefore, the purpose of this study was to examine the correlation between the sleep length and depression level in older

adults and the mediation effect of education level in this relationship. Based on relevant literature, theories, and our research objectives, we posit the following research hypotheses: 1) Sleep length negatively predicts depression level in older adults, and education level also negatively predicts depression level; 2) Education level has a medication effect in the relationship between sleep length and depression level in older adults.

2. Methods

2.1. Data description

The study data are sourced from the China Family Panel Studies (CFPS), which is a nationwide, large-scale, multi-disciplinary social tracking study program. The CFPS sample covered 25 provinces with a target sample size of 16,000 households and included all family members in the sampled households. The final sample size was 14,960 households with 42,590 individuals. This study used the latest CFPS 2020 data and selected older adults aged 60 years and above as the study population, with a final inclusion sample size of 4667.

2.2. Measures

2.2.1 Sleep length

The independent variable in this study was sleep length (SL). In CFPS, participants answered nap time and night sleep time. Of these, night sleep time is subdivided into

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weekday sleep time and rest day sleep time, and we took the average amount of weekday sleep time and rest day sleep time as the night sleep time, and then added it with the nap time, which ultimately resulted in the total daily sleep time of the participants as the independent variable.

2.2.2 Depression level

The dependent variable in this study was older adults' depression level (DL). The CFPS used the Center of Epidemiologic Studies - Depression (CES-D) scale to measure the depression level of the study participants. CFPS selected 8 out of the 20 questions in the CES-D scale as primary items. Each item has four options: almost never, sometimes, often, and mostly. The four levels receive scores of 0, 1, 2, and 3. Question 4 and 6 are reverse scored, and the total score for the eight items is 24, with higher scores indicating greater levels of depression.

2.2.3 Educational level

The mediator variable in this study was educational level (EL). This study combined it into 6 levels of "no school education," "elementary school and below," "middle school," "high school / technical secondary school," "junior college," "bachelor's degree and above," and scored them from 0 to 5, with higher scores indicating higher education levels.

2.2.4 Covariates

This study also selected a number of demographic characteristics as control covariates, including age, gender, marriage, and residence. Marriage was categorized as unmarried, married, divorced, or widowed, and residence was categorized as urban or rural.

2.3. Statistical analysis

We analyzed data using SPSS 25.0. Demographic characteristics were expressed as frequencies and percentages or mean(SD). We analyzed data using descriptive statistics, Pearson's correlation analysis, and ANOVA. We used SPSS PROCESS V4.2 by Hayes to analyze and test for mediation effects. Differences were considered statistically significant at $P < 0.05$.

3. Results

3.1 Descriptive statistics

Table 1 shows the descriptive statistics of all variables. In this study, The average age of 4667 older adults was 68.00 ± 5.71 years; 2219 (47.5%) were female and 2448 (52.5%) were male; 54 (1.2%) were unmarried, 4003 (85.7%) were married, 60 (1.3%) were divorced, and 550 (11.8%) were widowed; 2301 (49.3%) resided in rural areas, 2,366 (50.7%) in urban areas; SL averaged 8.02 ± 1.79 ; EL averaged 1.02 ± 1.79 ; DL averaged

13.52 ± 4.48 . Moreover, there were significant differences in depression level among the elderly by gender, marriage and residence.

Table 1 Descriptive statistics (sample $n = 4667$)

Variables	Frequency	Percent	DL		Mean(SD)
			Mean(SD)	P	
Age					68.00(5.71)
Gender				<0.01	
Male	2448	52.5	12.91(4.30)		
Female	2219	47.5	14.20(4.57)		
Marriage				<0.01	
Unmarried	54	1.2	15.54(5.62)		
Married	4003	85.7	13.33(4.41)		
Divorced	60	1.3	13.88(4.98)		
Widowed	550	11.8	14.69(4.61)		
Residence				<0.01	
Rural	2301	49.3	14.21(4.63)		
Urban	2366	50.7	12.86(4.22)		
SL					8.02(1.79)
EL					1.19(1.19)
DL					13.52(4.48)

Note: SL represents sleep length, EL represents education level, and DL represents depression level.

3.2 Correlation statistics

Table 2 shows a negative correlation between sleep length and education level and depression level in older adults ($p < 0.05$); education level and depression level were also negatively correlated ($P < 0.05$).

Table 2 Pearson's correlation coefficient results

	SL	EL	DL
SL	1		
EL	-.101**	1	
DL	-.082**	-.171**	1

Note: ** $P < 0.01$. SL represents sleep length, EL represents education level, and DL represents depression level.

3.3 Analysis of mediation effects

In this study, we used a simple mediation model to further test the possible mediating effect of education level between sleep length and depression level in older adults and to verify its significance while controlling for demographic variables. Table 3 showed that sleep length negatively predicted education level ($\beta = -0.054$, $P < 0.01$) and depression level ($\beta = -0.256$, $P < 0.01$); education level negatively predicted depression level ($\beta = -0.463$, $P < 0.01$).

Table 3 Simple mediation model analysis results

	EL			
	β	SE	t	P
Constant	3.484	0.204	17.117	<0.01
Age	-0.035	0.003	-12.121	<0.01

Gender	0.618	0.033	18.924	<0.01
Marriage	-0.046	0.025	-1.806	0.071
Residence	-0.046	0.032	18.032	<0.01
SL	-0.054	0.009	-5.919	<0.01
R^2		0.401		
Adjusted R^2		0.161		
P		<0.01		
		DL		
	β	SE	t	P
Constant	18.303	0.829	22.079	<0.01
Age	-0.030	0.012	-2.587	0.010
Gender	-0.912	0.134	-6.811	<0.01
Marriage	0.434	0.100	4.357	<0.01
Residence	-1.244	0.132	-9.405	<0.01
SL	-0.256	0.036	-7.109	<0.01
EL	-0.463	0.058	-8.007	<0.01
R^2		0.266		
Adjusted R^2		0.071		
P		<0.01		

Note: SL represents sleep length, EL represents education level, and DL represents depression level.

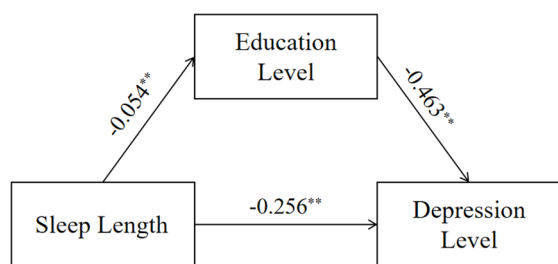
Table 4 shows a statistically significant direct effect of sleep length on depression level in older adults (95% $CI=[-0.326,-0.185]$); and a statistically significant masked effect between sleep length and depression level in older adults with education level (95% $CI=[0.016,0.035]$).

Table 4 Mediation effect bootstrap test

	Path	Estimate	SE	95% CI	percentage
Direct effect	SL→DL	-0.256	0.036	-0.326,-0.185	
Indirect effect	SL→EL→DL	0.025	0.008	0.016,0.035	10.82%
Total effect		-0.231	0.036	-0.301,-0.160	

Note: SL represents sleep length, EL represents education level, and DL represents depression level.

Finally, we get a simple mediation effect model as shown in Figure 1.



** $P<0.01$

Figure 1 simple mediation model

4. Conclusions

4.1 Difference analysis

According to the results of the difference analysis, there were significant differences among the depression levels in older adults by gender, marriage, and residence ($P<0.01$).

First, there is a significant difference in depression level in older adults by gender, with female being more depressed than male, which is consistent with the study of Zhao et al. (2020)^[8]. On the one hand, female tend to be more emotional and more prone to reflection and empathy; on the other hand, female experience more internal changes in their physiology, such as pregnancy and gestation, and face more external pressures in their lives, such as family responsibilities and gender discrimination; Second, there is also a significant difference in depression level in older adults by marriage status, with the lowest depression level being married, followed by divorce, widowhood, and the highest level being unmarried. This is similar to the study of Afifi et al. (2006), whose study showed that people who were divorced or separated had a higher risk of depression than those who were married^[9]. Another study found that unmarried people were more depressed than married^[10]. On one hand, spouses can offer emotional support and comfort, while those who are single or widowed lack such support and tend to feel lonely and lost, leading to increased psychological stress. On the other hand, couples can share challenges and stressors, reducing the risk of mental health problems; Finally, the depression level in older adults also differs significantly by residence, with older adults in rural areas having higher depression levels than those in urban areas, which is consistent with the study by Wang et al. (2023) that the depressive level of rural residents in China is significantly higher than that of urban residents^[11]. Economic levels, social welfare, medical services, and infrastructure are all factors that increase the urban-rural gap, and factors such as inequality in the social environment and labor force turnover contribute to the fact that rural older adults are severely affected by mental illness, and rural older adults are more likely to maintain depressive symptoms.

4.2 Direct effect

The study found that sleep length has a direct effect on the depression level in older adults, and short sleep length leads to increased depression, which is basically consistent with the study of Lippman et al. (2017), whose findings showed that sleep length may be a modifiable factor for depressive symptoms in older adults^[12]. On the one hand, the biological clock of the older adults is more sensitive and fragile, their sleep quality is relatively poor, and it is easily disturbed by noise, body temperature discomfort, and other factors, which results in insomnia or sleep disturbances, and long-term sleep deprivation is likely to lead to moodiness and depression in the older adults^[13]. Therefore, sleep disorders are very common in depressed patients^[14]; On the other hand, sleep can repair physiological and psychological damage, and adequate sleep can provide enough rest to help the older adults heal themselves both physically and mentally, relieve fatigue and mental stress, and thus reduce the depression level. Additionally, regular and adequate sleep can also help to stabilize the biological clock of the older adults,

improve the quality of sleep, and reduce the anxiety and depression caused by sleep disorders^[15].

4.3 Masking effect

This study also found that education level had a masking effect between sleep length and depression level in older adults, which is partially consistent with what has been studied^[16-18]. Specifically, sleep length negatively affected education level, which also negatively affected depression level. The indirect effect of education level weakened the direct effect of sleep length on depression level, which weakened the total effect, and belonged to a certain degree of masking effect, where education level masked the effect of sleep length on depression level. We believe there may be several reasons for this: First, older adults with higher education levels typically possess more knowledge and cognitive ability to comprehend and manage sleep disorders and depression better, thus reducing the likelihood of negative effects^[19]; Second, older adults with higher education levels are more likely to adopt healthy lifestyles, such as regular rest and relaxation and appropriate amounts of physical activity, which contribute to improved sleep quality and mental health^[20]; Finally, older adults with higher education levels are more likely to have higher mental health awareness and psychological coping skills, to recognize their own sleep problems and depressive symptoms early, and to take proactive steps to seek help and treatment^[21].

This study constructed and tested a simple mediation effect model using cross-sectional data from the CFPS to explain how sleep length affects depression levels in older adults and how education level mediates this relationship. This study shows the importance of adequate sleep time for the mental health of older adults, and it is important to increase the importance of sleep time for older adults to ensure that they are able to get adequate sleep, which leads to a better health foundation and helps to reduce the risk of depression in older adults.

4.4 Limitations and prospects

In addition, this study has several limitations. First, the data in this study are cross-sectional, which is difficult to establish a clear causal relationship, and more longitudinal studies can be conducted in the future; Second, since the sleep length was collected by self-report of the participants, there may be a measurement error, but the error is within the acceptable range, it can also reliably predict the risk of depression; Finally, the study was limited by the data, and only selected one aspect of sleep, which lacked other sleep-related important information, which may result in a small error between the prediction results and the actual situation.

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