

# Factors associated with depressive symptoms among the elderly in China: structural equation model

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## ABSTRACT

**Objectives:** To establish a structural equation model for exploring the direct and indirect relationships of depressive symptoms and their associated factors among the Chinese elderly population.

**Design:** A cross-sectional research. The 2015 data from the China Health and Retirement Longitudinal Study (CHARLS) were adopted.

**Setting:** CHARLS is an ongoing longitudinal study assessing the social, economic, and health status of nationally representative samples of middle-aged and elderly Chinese residents.

**Participants:** A total of 5791 participants aged 60 years and above were included.

**Measurements:** Depressive symptoms were used as the study outcome. Sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration were used as predictors. Confirmatory factor analysis was first conducted to test the latent variables. Structural equation model was then utilized to examine the associations among latent variables and depressive symptoms.

**Results:** The mean age of the participants was  $68.82 \pm 6.86$  years, with 55.53% being males. The total prevalence of depressive symptoms was 37.52%. The model paths indicated that sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration were directly associated with depressive symptoms, and the effects were 0.281, 0.509,  $-0.067$ , and  $-0.162$ , respectively. Sociodemographic characteristics, unhealthy habits, and sleep duration were indirectly associated with depressive symptoms, mediating by poor health status. Their effects on poor health status were  $-0.093$ , 0.180, and  $-0.279$ , respectively. All paths of the model were significant ( $P < 0.001$ ). The model could explain 40.9% of the variance in the depressive symptoms of the Chinese elderly population.

**Conclusions:** Depressive symptoms were significantly associated with sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration among Chinese elderly population. The dominant predictor of depressive symptoms was poor health status. Targeting these results might be helpful in rationally allocating health resources during screening or other mental health promotion activities for the elderly.

**Key words:** aged, Chinese, depression, mental health

## Introduction

China is experiencing a rapid and intense aging process and has the largest aging population in the world. By the end of 2018, its population with elderly aged 60 years or above (locally defined age cutoff for the elderly) reached 249.49 million, accounting for

17.9% of the total population (National Bureau of Statistics, 2019). The expansion of the elderly population, especially older seniors, likely causes a substantial increase in nonproductive consumption expenditures, such as medical treatment, nursing, and old age security. Therefore, healthy aging is crucial to sustainable development.

Depression (major depressive disorders) is a major public health issue affecting the health of the elderly population in China. According to a nationwide survey, China Health and Retirement Longitudinal Study (CHARLS), about 40%

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of older adults reported depressive symptoms (CHARLS Research Team, 2013). In addition, the proportion of “empty-nesters,” i.e. those who were not living with their children, has increased remarkably, and the number is still rising (Gao *et al.*, 2017). This group is more likely to suffer from mental health problems (Su *et al.*, 2018). In contrast to depression in the younger population, depression in late life is associated with decreased physical, cognitive, and social functioning and increased self-neglect (Ni *et al.*, 2017). Moreover, depression in late life can lead to chronic disease course, poor response to antidepressants, and high relapse rate, which are associated with increased mortality (Van Orden *et al.*, 2015; Haigh *et al.*, 2018). Consequently, the issue of depression among Chinese elderly population should be settled urgently.

Some sociodemographic factors, such as gender, age, marital status, place of residence, employment status, and educational level, have been reported to be associated with depression in the elderly population (Chin *et al.*, 2016; Yang *et al.*, 2017; Cao *et al.*, 2016). Negative life events, multiple chronic health conditions, major physical diseases, and poor self-rated general health in older people can also increase the risk of depression (Alexandrino-Silva *et al.*, 2011). However, studies have yet to adopt a structural equation model (SEM) for exploring the relationships between factors and depressive symptoms, which are the major manifestations of depressive disorders. SEM is a multivariate analysis technique used to ascertain relationships among variables and provide a comprehensive and flexible approach for data analysis (Crowley and Fan, 1997). It enables the simultaneous estimation of structural relationships among multiple independent and dependent variables while controlling measurement errors; it can also identify direct, indirect, and total effects among variables (Pentz and Chou, 1994). Given these advantages, this study aimed to establish an SEM to analyze the structural relationships of depressive symptoms and associated factors among the elderly population in China.

## Methods

### Sample

The publicly available data of CHARLS collected in 2015 were used. CHARLS is an ongoing longitudinal study assessing the social, economic, and health status of nationally representative samples of middle-aged and elderly Chinese residents. In CHARLS, a multi-stage stratified probability-proportional-to-size (PPS) sampling method is adopted, and the software package CHARLS-GIS is created to make village sampling frames. Data were

collected through face-to-face interviews by trained investigators. The response rate was over 85% (CHARLS, 2018). After participants younger than 60 years and participants with missing values on the main outcome variables were removed from the study, a total of 5791 samples were retained.

### Study variables

Based on the content of “CHARLS Followup Questionnaire 2015” (CHARLS, 2018) and our literature review, 16 observational variables were included in this study, and we hypothesized that four latent variables could be extracted and used to collectively reflect the sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration of the participants. The hypothetical latent variables and the corresponding observational variables are presented in Supplementary Table 1. For the sociodemographic characteristic factor, household consumption expenditure in the previous year rather than household income was used to reflect the economic status of the participants because it was a better representation of the permanent income of the retired and the elderly (Islam and Smyth, 2015). For the poor health status factor, the activity of daily living scale, which was recommended by the World Health Organization for assessing the health status of the elderly population, was used to assess the participants’ ability to perform daily living activities (Katz *et al.*, 1963).

### Assessment of depressive symptoms

Depressive symptoms were quantified using the 10-item version of the Center for Epidemiologic Studies Depression Scale (CES-D-10), which accurately predicts depressive symptoms (Andresen *et al.*, 1994). The Chinese version of this scale has good reliability and validity among the elderly population in China, and Cronbach’s alpha was 0.813 (Huang *et al.*, 2015).

The 10 items were as follows: item 1, “I was bothered by things that do not usually bother me;” item 2, “I had trouble keeping my mind on what I was doing;” item 3, “I felt depressed;” item 4, “I felt everything I did was an effort;” item 5, “I felt hopeful about the future;” item 6, “I felt fearful;” item 7, “My sleep was restless;” item 8, “I was happy;” item 9, “I felt lonely;” and item 10, “I could not get going.” Each item was rated on a 3-point Likert scale with answers varying from “rarely or none of the time (<1 day)” to “most or all of the time (5–7 days).” Thus, the total score of the CES-D-10 scale ranged from 0 to 30. A score of 10 or higher indicated the presence of significant depressive symptoms.

### Statistical analysis

*Stata/SE* version 15.1 was used for preliminary data processing and descriptive statistics of the

demographic variables and depressive symptoms. SEM was created by using *Mplus* version 7.4 to test the hypothetical associations among the variables. Confirmatory factor analysis (CFA) was first conducted to test whether the latent variables could be well reflected by the involved observational variables. Based on the measurement model, SEM was then utilized to examine the associations among latent variables and depressive symptoms.

All continuous variables were converted to categorical variables before they were analyzed. The correlation matrix of the study variables was examined using *Pearson's* correlation coefficients. Weighted least squares with the mean and variance (WLSMV)-adjusted method were used for the parameter estimation of CFA and SEM. All the effects were quantified with standardization, and two-sided  $P < 0.05$  was regarded as statistically significant. Four goodness-of-fit indices: maximum likelihood chi-square ( $\chi^2$ ) and degrees of freedom ( $df$ ), comparative fit index (CFI), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA) were adopted to check whether the hypothesized model was well fitted to the data. The value of  $\chi^2$  is susceptible to sample size, and it is statistically significant for models with large sample size (Bollen and Long, 1993). The value of CFI or TLI for a good fitting model should be 0.90 or greater (Hu and Bentler, 1999). And a model is considered excellent fit when RMSEA value is less than 0.05 (Bollen and Long, 1993).

## Results

### Participants and depressive symptoms

Of the 5791 participants, 55.53% were males ( $n = 3216$ ), and their mean age was 68.82 years (standard deviation, 6.86; range, 60–102). Nearly two-thirds of the participants were living with their spouses, and the remaining participants were married but were temporarily not living with their spouses, separated, divorced, widowed, or never married. Most of the participants resided in a village. Nearly half of the participants' educational levels were elementary school or below, followed by illiterate. More than half of the participants reported that their household consumption expenditure per capita was within 2,000 RMB. The detailed sociodemographic characteristics and corresponding prevalence of the depressive symptoms of the participants are summarized in Table 1. As shown in Table 1, the total prevalence of depressive symptoms was 37.52%. The participants with different genders, marital status, residence, and educational levels showed a significant difference in the prevalence of depressive symptoms ( $P < 0.001$ ).

### Measurement model construction

All hypothetical latent variables, namely, sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration, were specified in the measurement model. Observational variables with insignificant paths or low factor loadings were deleted from the initial measurement model to determine the most parsimonious model. After preliminary data analysis, 11 observational variables were retained, and their assignment is illustrated in Supplementary Table 2. The correlation matrix of the study variables is presented in Table 2. Many of the variables showed significant correlations.

Figure 1 shows the final measurement model. Sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration were assigned three, four, two, and two observational variables, and the factor loadings ranged 0.457–0.687, 0.491–0.863, 0.575–0.747, and 0.224–0.695, respectively. All these factor loadings were significant ( $P < 0.001$ ). The four latent variables were significantly inter-correlated. Among them, sociodemographic characteristics displayed the strongest association with unhealthy habits ( $r = 0.516$ ); however, it was correlated with poor health status with a minimum correlation coefficient ( $r = 0.046$ ). All the correlation paths were significant ( $P < 0.01$ ).

The measurement model was well fitted to the data. The goodness-of-fit indices were as follows:  $\chi^2 = 374.765$ ,  $df = 38$ ,  $P < 0.001$ , CFI = 0.960, TLI = 0.942, and RMSEA = 0.039 (95% confidence intervals [CI] = 0.036–0.043).

### SEM

Figure 2 displays the SEM designed on the basis of the measurement model. Sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration had direct paths to depressive symptoms, and their regression coefficients were 0.281, 0.509,  $-0.067$ , and  $-0.162$ , respectively. Sociodemographic characteristics, unhealthy habits, and sleep duration also had direct paths to poor health status, and these variables were correlated with one another. All the parameters were significant ( $P < 0.01$ ). The model was also well fitted to the data:  $\chi^2 = 513.471$ ,  $df = 45$ ,  $P < 0.001$ , CFI = 0.957, TLI = 0.937, and RMSEA = 0.042 (95% CI = 0.039–0.046).

Table 3 illustrates the direct and indirect associations of all latent variables with depressive symptoms. Among the four latent variables, poor health status had the strongest direct and total associations with depressive symptoms. According to the SEM, the identified variables explained 40.9% of the variance in depressive symptoms.

**Table 1.** Sociodemographic characteristics of participants and depressive symptoms

VARIABLES	N (%)	DEPRESSIVE SYMPTOMS (N/PREVALENCE %)	$\chi^2$
<b>Gender</b>			157.471***
Male	3216 (55.53)	977 (30.38)	
Female	2575 (44.47)	1196 (46.45)	
<b>Age (years old)</b>			2.646
60–69	3504 (60.51)	1318 (37.61)	
70–79	1791 (30.93)	685 (38.25)	
≥ 80	496 (8.57)	170 (34.27)	
<b>Marital status</b>			83.448***
Living with spouse present	3788 (65.41)	1262 (33.32)	
Married but not living with spouse temporarily	190 (3.28)	81 (42.63)	
Separated/Divorced/Widowed/Never married	1813 (31.31)	830 (48.78)	
<b>Residence</b>			102.656***
Main city zone	916 (15.82)	226 (24.67)	
Town area	540 (9.32)	167 (30.93)	
Township	255 (4.40)	88 (34.51)	
Village	4080 (70.45)	1692 (41.47)	
<b>Educational level</b>			190.701***
Illiterate	1705 (29.44)	812 (47.62)	
Elementary school or below	2706 (46.73)	1030 (38.06)	
Middle school	851 (14.70)	229 (26.91)	
High school or Vocational school	410 (7.08)	81 (19.76)	
Bachelor's degree/Associate degree or greater	119 (2.05)	21 (17.65)	
<b>Household per capita consumption expenditure (RMB)</b>			3.474
≤ 2,000	3302 (57.02)	1233 (37.34)	
~5,000	1233 (21.29)	487 (39.50)	
~10,000	630 (10.88)	223 (35.40)	
>10,000	626 (10.81)	230 (36.74)	
<b>Total</b>	5791 (100.00)	2173 (37.52)	

\*  $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ 

## Discussion

Depression is one of the most common mental disorders in the elderly, and this condition can affect their physical and mental health, leading to the decline in the quality of life and even death (Doraiswamy *et al.*, 2002). This study is the first to explore the structural relationships of depressive symptoms with the possible associated factors among the elderly population in China. The model indicated that sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration had significant direct relationships with depressive symptoms. Sociodemographic characteristics, unhealthy habits, sleep duration, and depressive symptoms were also indirectly related. The direct and indirect paths suggested that poor health status was a dominant predictor of depressive symptoms.

### Sociodemographic characteristics

The sociodemographic characteristics in the present study included three observed variables: age, marital status, and educational level. In terms of age, the

paths indicated that older participants were prone to depressive symptoms. This result was consistent with a few studies on elderly population (Glaesmer *et al.*, 2011; Urbina Torija *et al.*, 2007; Kaneko *et al.*, 2007). Unlike the young, the prevalence of depressive symptoms generally increases with age among the elderly population. This difference may be mainly attributed to the lower physical and cognitive functions, which are closely related to depressive symptoms among older people (Al-Otaibi *et al.*, 2007). In terms of marital status, our results suggested that older people who were not living with their spouses (separated/divorced/widowed/single) had relatively high odds of depressive symptoms. Similarly, many studies have reported that marital status is a key variable that affects depressive symptoms among the elderly population (Javed, 2014; Xie *et al.*, 2010; Fatima *et al.*, 2019). Kim and McKenry (2002) found that separation, divorce, and death of a spouse have significant effects on exacerbating depressive symptoms. Elderly people have relatively small social support networks, and their spouses are an important channel for them to

**Table 2. Correlation matrix for study variables (N = 5791)**

VARIABLES	1	2	3	4	5	6	7	8	9	10	11
<b>Sociodemographic characteristics</b>											
1. Age (years old)	1.000										
2. Marital status	0.249***	1.000									
3. Educational level	-0.168***	-0.250***	1.000								
<b>Poor health status</b>											
4. Self-reported health status	0.019	0.032*	-0.101***	1.000							
5. Health status change compare to last year	0.012	-0.001	-0.041**	0.382***	1.000						
6. Types of chronic diseases suffered	0.032*	0.021	0.012	0.365***	0.184***	1.000					
7. Health status satisfaction	-0.033*	-0.027*	0.059***	0.463***	0.267***	0.268***	1.000				
<b>Unhealthy habits</b>											
8. Smoking status	0.050***	0.141***	-0.177***	0.040**	-0.017	0.088***	0.010	1.000			
9. Alcoholic beverages last year	0.106***	0.131***	-0.183***	0.118***	0.029*	0.099***	0.050***	0.307***	1.000		
<b>Sleep duration</b>											
10. Average actual sleep hours per night last month	-0.036**	-0.051***	0.037**	-0.142***	-0.077***	-0.120***	-0.124***	-0.059***	-0.023	1.000	
11. Average duration per nap last month	0.009	-0.045**	0.077***	-0.023	-0.018	0.024	-0.028*	-0.086***	-0.060***	0.124***	1.000

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001

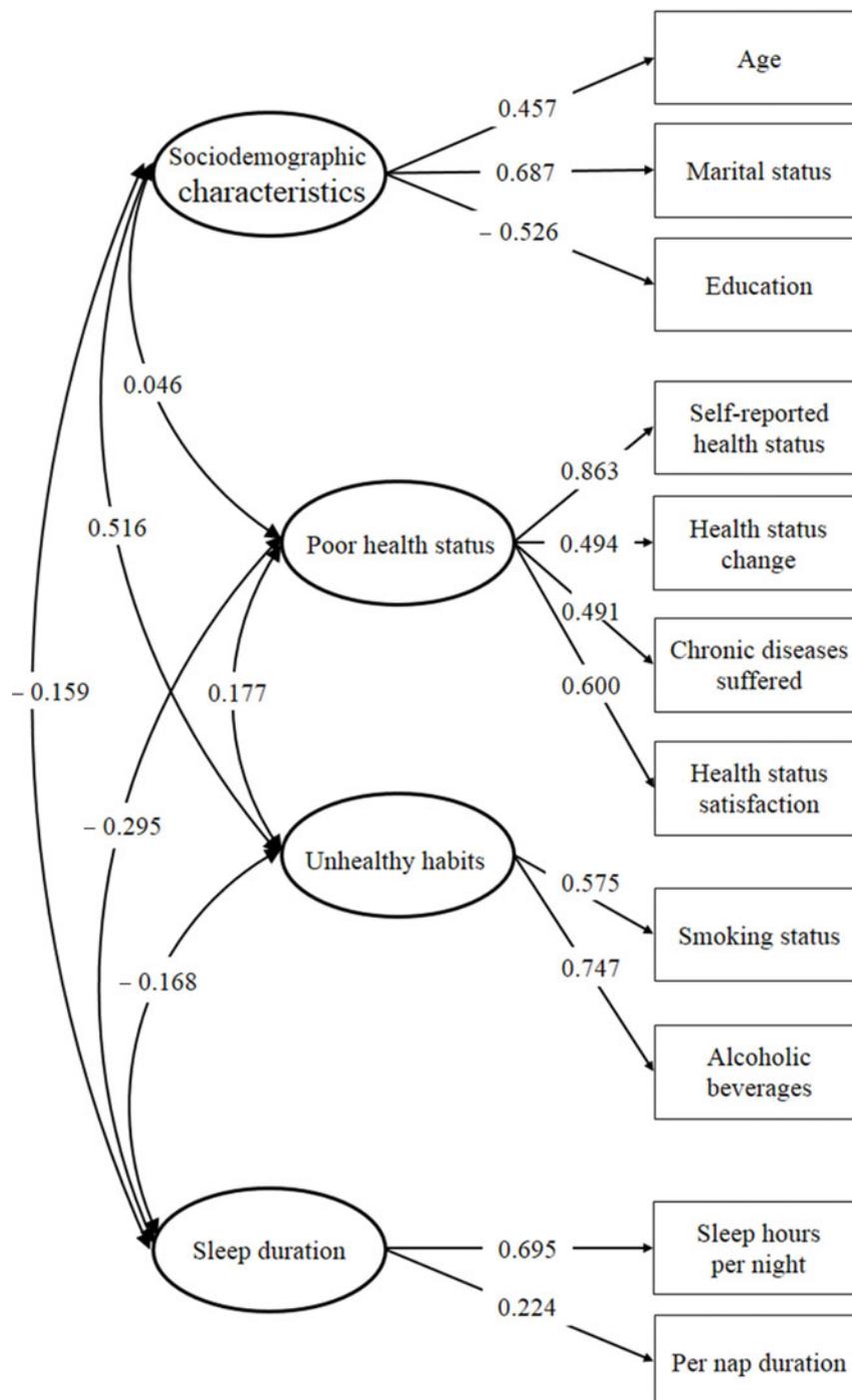
gain support and eliminate negative emotions. Therefore, elderly people not living with their spouses are more likely to feel lonely and be affected by adverse events. In terms of educational level, the results indicated that educational level could clearly predict depressive symptoms among the elderly population, and this observation was consistent with previous findings (Gibson *et al.*, 2013; Zhang *et al.*, 2019; de la Torre-Luque *et al.*, 2019). This may be due to the relatively low social and economic status of poorly educated elderly; therefore, they were more likely to have low self-evaluation and negative emotions. Moreover, highly educated elderly people tended to have more knowledge and an active mind, which enabled them to better channel negative emotions and pressure.

**Poor health status**

Our results suggested that poor health status was a strong predictor of depressive symptoms among the elderly people in China. A prior study in Taiwan (Hsiao and Chen, 2018) indicated that the number of chronic diseases and the self-assessed health status are the factors significantly associated with depressive symptoms among the elderly residents of care settings Tanaka *et al.* (2011) also reported that having a chronic disease increases the risk of depressive symptoms in the elderly. In fact, some common physical disorders are risk factors of depressive symptoms in the elderly population (Weinger and Lee, 2006; Hackett *et al.*, 2005). These disorders could cause indisposition and decline of physical function, which could seriously affect the quality of life of the elderly and cause or exacerbate depressive symptoms to some extent. The economic and psychological burden brought by this disease could simultaneously cause depressive symptoms. Consequently, the elderly who had a poor physical health status needed more attention.

**Unhealthy habits**

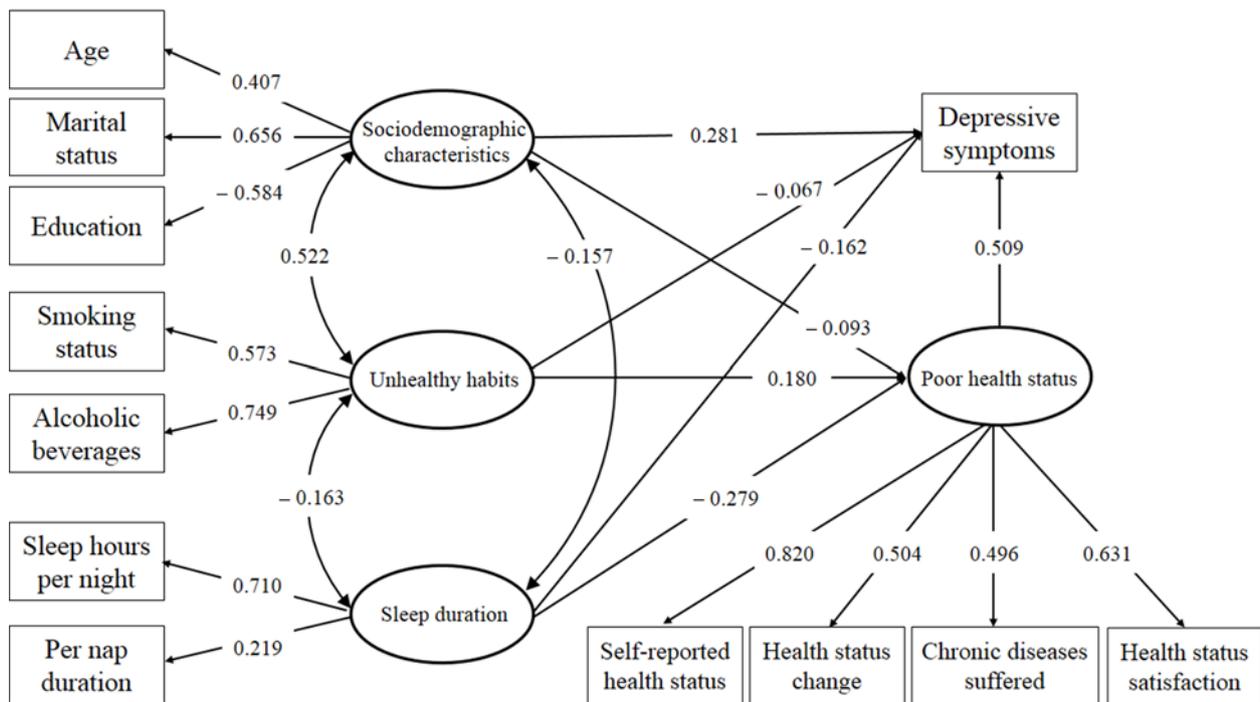
For unhealthy habits, the direct association between smoking and depressive symptoms should be interpreted with caution. Previous population-based studies reported inconsistent findings: two cross-sectional studies on the depressive symptoms of the elderly population in Brazil (Gazalle *et al.*, 2004) and Iran. Taheri Tanjanai *et al.* (2017) found that the odds of having depressive symptoms in smokers are statistically higher than those in nonsmokers. A large population-based longitudinal study (Luijendijk *et al.*, 2008) also found that current smoking status is independently associated with depressive symptoms. However, a cohort study on the associations of lifestyle factors with depressive symptoms in old Taiwanese people (Tsai *et al.*, 2013) indicated that smoking



**Figure 1.** The measurement model of latent variables. Four latent variables and 11 manifest variables are connected by significant paths. The numbers on the straight arrows indicate the path coefficients. Every pair of latent variables is connected by bidirectional arrow curves, and the numbers on the lines indicate the correlation coefficients. The variances are set to 1.000 during the model estimation.

showed no significant associations with concurrent depressive symptoms, but it could increase the development of depressive symptoms. In the present study, smoking was negatively correlated with depressive symptoms, but their direct association was not particularly strong. This result might be due to that the elderly might use smoking to relax, as a form of self-medication or a way of

coping with stress and anxiety (Cassidy *et al.*, 2004). And neuropharmacological effects of nicotine on neurotransmitters could also be associated with improved mood (Kendler *et al.*, 1993). Another possible reason might be the increased pressure experienced by the elderly to stop smoking, especially when they were forced to quit smoking because of chronic disease or other diseases (Hyland *et al.*, 2004). Overall, smoking



**Figure 2.** The structural equation model of sociodemographic characteristics, poor health status, unhealthy habits, sleep duration, and depressive symptoms. The relationships of four latent variables and their corresponding manifest variables and the associations of four latent variables and depressive symptoms are presented. The standardized coefficients are shown on the paths.

was still positively correlated with depressive symptoms because of its positive correlation with the poor health status variable. Thus, elderly population with depressive symptoms was more likely to report smoking.

Frequency of drinking also had a direct negative correlation with depressive symptoms in the present study. This result was similar to a prior study of rural elderly in China that reported alcohol consumption was associated with lower depressive symptoms scores (Gao *et al.*, 2009). It might be explained by the link between moderate alcohol consumption and a more active and sociable lifestyle of the elderly (Hajat *et al.*, 2004). And more social activity participation was considered a protective factor of depressive symptoms among the elderly (Borges *et al.*, 2013; Dai *et al.*, 2019; Yang *et al.*, 2018). However, the direct negative correlation in this study needs to be read cautiously, because it was possible that the characteristics of heavy drinkers would be different. In fact, a few studies have reported that there was a J-shaped or U-shaped association between alcohol consumption and depressive symptoms among the elderly (Bots *et al.*, 2008; Graham *et al.*, 2007; Yun and Kim, 2020), namely, moderate alcohol consumption could lead to decreased levels of depressive symptoms, while heavy alcohol consumption was associated with an elevated risk of depressive symptoms. Thus, detailed quantifying alcohol consumption might be

required to fully interpret the direct association between drinking and depressive symptoms among Chinese elderly population. Similar to smoking in present study, our results indicated that poor health status could act as a mediating effect between frequency of drinking and depressive symptoms among the elderly. This might be due to that alcohol problems could contribute to individual biological changes (Boden and Fergusson, 2011), and age-related physiological changes of the elderly could significantly increase the sensitivity and decrease tolerance to alcohol (Rodriguez *et al.*, 2010), resulting in an impact on poor health status. This effect was consistent with the study of Solmi *et al.* that reported physical health-related quality of life could be a bridge node connecting depressive symptoms with alcohol consumption (Solmi *et al.*, 2019). Overall, the frequency of drinking was positively correlated with depressive symptoms because of its harmfulness to health. This result was consistent with the results of studies carried out in Taiwan (Tsai *et al.*, 2013) and Australia (Anstey *et al.*, 2009).

### Sleep duration

The association between sleep and depressive symptoms has been highlighted in other studies. Guimaraes *et al.* (2019) and Zalavadiya *et al.* (2017) reported that depressive symptoms in the elderly are associated with poor sleep quality. Our findings suggested

**Table 3.** Standardized associations of latent variables on depressive symptoms

VARIABLES	ASSOCIATION		
	DIRECT	INDIRECT	TOTAL
Sociodemographic characteristics	0.281	0.134	0.415
Poor health status	0.509	0	0.509
Unhealthy habits	-0.067	0.294	0.227
Sleep duration	-0.162	-0.205	-0.367

that short sleep duration was associated with high rates of depressive symptoms. This result was consistent with the results of Wen *et al.* (2019), who found that elderly people with long sleep duration at night have a lower risk of developing depressive symptoms than those with short sleep duration. Sleep and depressive symptoms have a multifaceted interplay between them. Manber and Chambers (2009) reported that the risk of depressive symptoms in the group of the elderly with sleep disorders is statistically significant higher than that in the group without sleep disorders. In addition, depressive symptoms can cause and exacerbate sleep disorders in the elderly, and it is even the largest risk factor of sleep disorders (Staner, 2010; Ichimori *et al.*, 2015).

### Strengths and limitations

The strength of this study was the use of large-sample data, which were collected through face-to-face interviews. The influencing factors of depressive symptoms were mostly comprehensive, and the corresponding explanation might be incomplete with individual indicators. Therefore, our findings filled in the gap in research on the structural relationships of depressive symptoms and potential latent variables. Our results also simultaneously determined the direct and indirect connections between them.

However, some limitations should be considered in understanding the present results. First, the cross-sectional sample of this study only allowed us to estimate associations between depressive symptoms and observed variables, so it could not establish causal relationships. Second, the result was based on the whole population. Thus, the differences between males and females and between urban and rural areas were not considered in our data analysis. Third, although the final SEM was adequately fitted to the data, more information and variables could be incorporated into the model for an enhanced data fitting and explanation of depressive symptoms. These issues could be addressed by conducting future longitudinal analysis to further understand the relationships of present observations and depressive symptoms. The

inclusion of additional sample information and a more specific analysis should also be considered.

### Conclusion

This study first established an SEM to explore the direct and indirect relationships of depressive symptoms and their associated factors in the Chinese elderly population. The results suggested that sociodemographic characteristics, poor health status, unhealthy habits, and sleep duration could appropriately predict depressive symptoms. Among these variables, poor health status was a major predictor. Sociodemographic characteristics, unhealthy habits, and sleep duration were also indirectly associated with depressive symptoms mediating by poor health status. These results indicated that health resources could be allocated rationally to enhance their utilization efficiency during depression screening and other public health actions.

### Conflict of interest

None.

### Description of authors' roles

Yaofei Xie conducted Mplus analysis of CFA and SEM and was a major contributor in writing the manuscript. Mengdi Ma interpreted the models, completed model fitting, and was a contributor in writing the manuscript. Wenwen Wu performed raw data processing. Yupeng Zhang and Yuting Zhang revised the manuscript. Xiaodong Tan designed and was responsible for the study. All authors read and approved the final manuscript.

### Acknowledgments

The research team of CHARLS is acknowledged for their work.

### Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.1017/S1041610220001398>

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