



# OPEN Prevalence and related influencing factors of depression symptoms among empty-nest elderly in China

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With the rapid aging of China's population, the number of empty-nest elderly who have no children or whose children have left home is increasing, and empty nests are gradually becoming a family life pattern for the elderly population. This change has implications for their mental health. The research data were sourced from the 2020 China health and retirement longitudinal study. The center for epidemiologic studies depression scale was used to assess the prevalence of depression among this population. Logistic regression was employed to analyze the influencing factors of depressive symptoms. The overall prevalence of depression symptoms among empty-nest elderly is 40.2%. Multivariate logistic regression results show that higher education, having a spouse, living in an urban area, self-rated good health, frequent contact with children, high life satisfaction, and having a pension are protective factors against depressive symptoms among empty-nest elderly. Conversely, being female, having difficulties with activities of daily living, chronic diseases, physical pain, short sleep duration, frequent drinking, and living in impoverished households are risk factors in this population. It is crucial to prioritize the prevention and treatment of depression in empty-nest elderly, particularly among groups such as female elderly, those in rural areas, and those with poorer economic conditions.

**Keywords** Empty-nest elderly, Mental health, Depression symptoms, Influencing factors, Prevention and intervention

Among the various social issues arising from the aging population trend, the mental health of the elderly is likely the most prominent. This concern is particularly pressing in China, given the country's rapid aging process. By the end of 2023, the population aged 60 and above in China had reached 297 million, accounting for 21.1% of the total population<sup>1</sup>. Meanwhile, due to China's former one-child policy<sup>2</sup> and the rapid urbanization process<sup>3</sup>, there have been significant changes in family structures, with empty-nest living becoming a predominant family lifestyle for the elderly. In the past, due to traditional filial piety norms, elderly people in many East Asian countries, including China, often lived with their children<sup>4</sup>. However, recent years have seen a growing trend where more young people are choosing to move out, no longer living with their parents, and instead opting for independent living<sup>5,6</sup>. This move away from family life can be driven by various factors, including the pursuit of employment or education, marriage, or simply the desire to gain independence from parents as a symbol of adulthood<sup>7</sup>.

Empty-nest elderly refers to older adults who live alone or with a spouse, without children or whose children have already left home<sup>8,9</sup>. According to data from the China National Committee on Aging, the number of empty-nest elderly in China reached 118 million in 2020, and it is expected that by 2030, the proportion of empty-nest families will reach 90%, with over 200 million empty-nest elderly<sup>10</sup>. Empty-nest elderly have lower levels of general health, role physical, role emotional, and vitality<sup>11</sup>. As a vulnerable group<sup>12</sup>, they not only undergo a personal life cycle transition from middle age to old age but also a family cycle shift from a nuclear or extended family to an empty-nest family<sup>13</sup>. This dual transition makes them more susceptible to various adverse conditions and age-related issues, particularly mental health problems such as depression symptoms<sup>14,15</sup>. Therefore, it is crucial to prioritize the mental health of this population.

Among the various mental health issues affecting the elderly, depression symptoms are a common psychiatric disorder. An increasing number of studies report a high prevalence of depression symptoms in the elderly population<sup>16–18</sup>, making it a significant public health issue<sup>19</sup>. Depression symptoms severely impact the mental health and quality of life of the elderly, imposing a substantial burden on families and society<sup>20,21</sup>, and also

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elevating the risk of suicide among the elderly<sup>22,23</sup>. Additionally, depression symptoms are often associated with an increased risk of other diseases and higher mortality rates in the elderly<sup>24,25</sup>.

Despite the availability of effective treatments for mental disorders, over 75% of individuals in low-income and middle-income countries do not receive treatment<sup>26</sup>. In particular, Asia ranks second among continents in terms of depression prevalence, with many patients potentially not receiving adequate treatment<sup>27</sup>. In China, there is a shortage of mental health professionals and an uneven distribution across regions<sup>28</sup> resulting in limited access to mental health services<sup>29</sup>. For the mental health issues of empty-nest elderly in China, it is crucial to implement early identification and intervention to ensure they are addressed timely and in effective manner.

Research on depressive symptoms among empty-nest elderly in China has largely been confined to specific regions or to either urban or rural settings. Reported prevalence varies substantially across locations, ranging from 47% in coastal cities of Zhejiang Province<sup>30</sup>, 64.2% in Shanxi Province<sup>31</sup>, to 79.7% in rural Yongzhou, Hunan Province<sup>32</sup>. In Xi'an City, Shaanxi Province, depressive symptoms were reported in 28.4% of urban and 36.2% of rural empty-nest elderly<sup>33</sup>. Given China's vast geographic diversity and regional disparities in socio-economic development and policy contexts, these findings are not readily generalizable to the national level. Therefore, the present study draws on a nationally representative sample to examine depressive symptoms among this population.

To develop effective interventions for depression symptoms among empty-nest elderly, it is essential to understand their influencing factors. Existing research has primarily focused on sociodemographic and health-related factors, including gender, age, and education level<sup>34</sup>; marital status, chronic diseases, economic status, relationships with children, and social support<sup>35</sup>; as well as sleep duration, activities of daily living, self-rated health, and place of residence<sup>36</sup>. Other factors such as social security<sup>37</sup>, life satisfaction<sup>38</sup>, and physical pain<sup>39</sup> have also been linked to depressive symptoms. Importantly, depression cannot be explained by individual factors alone, as welfare systems, cultural contexts, and socioeconomic conditions also play a significant role<sup>40</sup>. Accordingly, our study incorporates a comprehensive set of variables to assess the risk of depression symptoms in this unique population.

The main contributions of this study are: (1) assessing the prevalence of depression symptoms among empty-nest elderly; (2) examining the within-group correlates of depression; (3) further enriching the understanding of mental health issues in this specific population, and providing insights to inform effective intervention and prevention strategies, ultimately promoting their mental health and supporting healthy aging.

## Data and methods

### Data source

The data used in this study comes from the fifth wave (2020) of CHARLS, which was released by the National School of Development at Peking University in 2023. CHARLS was designed with reference to a series of international aging studies, including the Health and Retirement Study, the English Longitudinal Study of Ageing, and the Survey of Health, Ageing and Retirement in Europe, employing a multi-stage stratified Probability Proportional to Size (PPS) sampling method.

PPS sampling is a method in which the probability of selecting a sampling unit is proportional to its size, such as population or household count. The CHARLS baseline survey used stratification by region, urban/rural status, and per capita GDP. In the first stage, 150 counties and districts across eight regions were randomly selected with probability proportional to population size. In the second stage, three villages or communities per selected county/district were similarly chosen. The resulting sample covered 28 provinces, 150 counties/districts, and 450 villages/communities, ensuring national and regional representativeness. The CHARLS official dataset used in this study has already been processed to account for sampling weights and the complex survey design. Therefore, no additional survey weights, strata, or clustering were applied in our analyses.

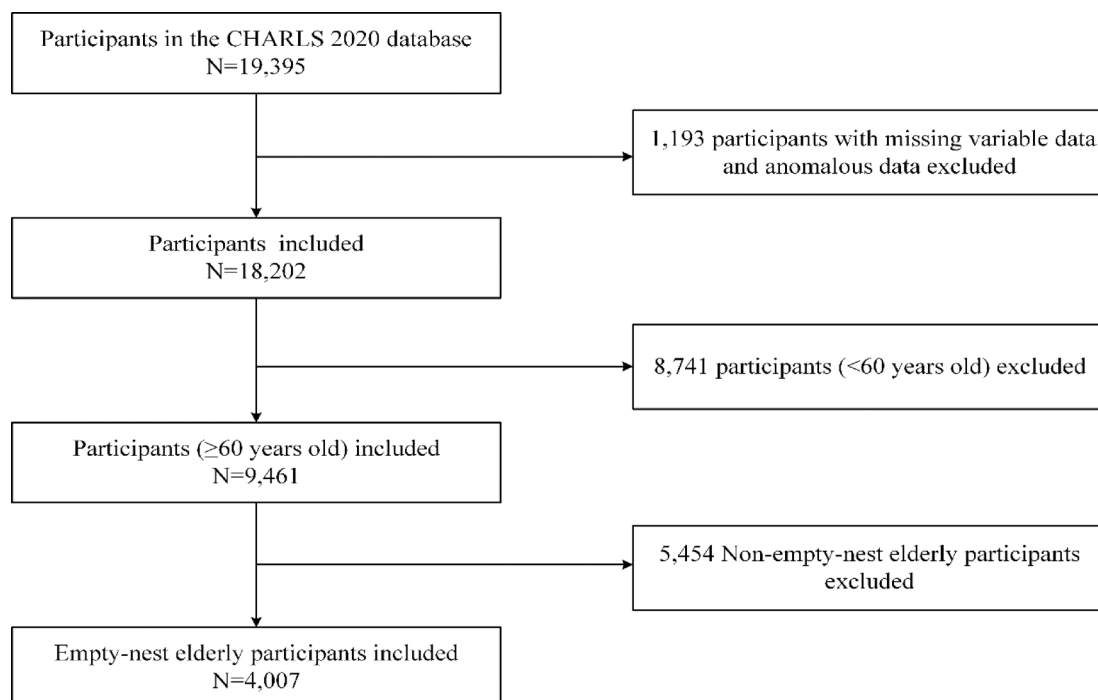
The CHARLS questionnaire collects detailed information on family, health, work, retirement, and pensions among China's middle-aged and elderly population<sup>41</sup>, providing a reliable micro-level data source for this study. The survey was approved by the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015), and all participants provided written informed consent before completing the interviews.

Based on the research requirements, we selected empty-nest elderly aged 60 and above as the study subjects. After variable screening and data cleaning, a total of 4,007 empty-nest elderly were included in the final data sample, with 2,062 males and 1,945 females. The sample selection process of this study is shown below (Fig. 1).

### Variable description

The dependent variable is measured by the presence of depression symptoms. The depression symptom scale used in this study is the simplified version of the Center for Epidemiological Studies Depression Scale<sup>42</sup>. This scale has been validated for use with older respondents in China using CHARLS data<sup>43</sup> and demonstrates high reliability and validity. According to the guidelines for the Chinese version of CES-D10, the scale is rated on a 4-point scale with options “<1 day,” “1–2 days,” “3–4 days,” and “5–7 days,” which are coded as 0, 1, 2, and 3, respectively. Items “I feel hopeful about the future” and “I feel cheerful” are scored in reverse. The total score ranges from 0 to 30, with higher scores indicating more severe depression symptoms. Based on existing research standards for depression assessment<sup>44,45</sup>, a CES-D10 score of  $\geq 10$  is defined as having depression symptoms. In our study, the Cronbach's alpha for the depression scale is 0.7940.

Based on previous studies<sup>46–48</sup>, this study included individual, health-related, child-related, and other related variables. Individual characteristics comprised gender, age, education level, marital status, and place of residence. Health-related variables included self-rated health status, activities of daily living (ADL), chronic diseases, physical pain, sleep duration, drinking, and smoking. Child-related variables included frequency of contact with children and satisfaction with children. Other variables included life satisfaction, social activities,



**Fig. 1.** Selection of study participants.

Variables	Variables description
Gender	Male = 0, Female = 1
Age	60–69 years old = 1, 70–79 years old = 2, 80 years old and above = 3
Education level	Illiterate = 1, Junior high school or below = 2, High school or above = 3
Marital status	Without spouse = 0, With spouse = 1
Place of residence	Rural = 0, Urban = 1
Self-rated health status	Unhealthy = 1, Fair = 2, Healthy = 3
Frequency of contact with children	Low = 1, Moderate = 2, High = 3
Satisfaction with children	Dissatisfied = 1, Fair = 2, Satisfied = 3
Satisfaction with life	Dissatisfied = 1, Fair = 2, Satisfied = 3
Social activities	No = 0, Yes = 1
ADL	Independent = 0, Dependent = 1
Chronic diseases	No = 0, Yes = 1
Physical pain	No = 0, Yes = 1
Sleep duration	7 h or more = 0, Less than 7 h = 1
Drinking	Drinks infrequently = 0, Drinks frequently = 1
Smoking	Never = 1, Current = 2, Former = 3
Exercise	No = 0, Yes = 1
Household economic status	Non-impovertised household = 0, Impoverished household = 1
Medical insurance	No = 0, Yes = 1
Pension	No = 0, Yes = 1

**Table 1.** Definition of variables.

exercise, household economic status, medical insurance, and pension insurance. The definitions of the variables are presented in Table 1.

In CHARLS, ADL were assessed using the Katz Index of Activities of Daily Living<sup>49</sup>, which evaluates six basic self-care activities: dressing, bathing, eating, getting in and out of bed, using the toilet, and continence. Participants reporting difficulty in at least one activity were classified as having ADL impairment. For chronic disease, participants were classified as having chronic disease if they reported at least one of the three specified

conditions. Ordinal variables such as life satisfaction and satisfaction with children were measured using five-point Likert scales in CHARLS. Based on previous studies, these variables were recoded into three ordinal categories: dissatisfied, fair, and satisfied, with dissatisfied serving as the reference group.

### Statistical analysis

All statistical analyses were conducted using Stata 18.0. Logistic regression models were employed to explore factors associated with depressive symptoms among empty-nest elderly, with all covariates entered simultaneously into the models. The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs), indicating the risk of experiencing depressive symptoms associated with various characteristics. A *p*-value of less than 0.05 was considered statistically significant.

In addition, model goodness of fit was assessed using the Pearson chi-square goodness-of-fit test following logistic regression. The results showed no evidence of lack of fit ( $\chi^2 = 3714.00$ , *df* = 3750, *p* = 0.6588), indicating that the model appeared to fit the data appropriately.

## Research results

### Basic characteristics of depression symptoms in empty-nest elderly

Table 2 presents the basic characteristics of empty-nest elderly stratified by the presence or absence of depression symptoms. The overall prevalence of depression symptoms among empty-nest elderly is 40.15%, 16.62% of which are males and 23.53% are females. The remaining characteristics and corresponding chi-square test results are shown in the table.

### Influencing factors of depression symptoms in empty-nest elderly

The results of the multivariable logistic regression for depression symptoms among the entire empty-nest elderly sample are shown in Table 3. Compared with male empty-nest elderly, females had a higher likelihood of depressive symptoms (OR = 1.366, 95% CI: 1.090–1.713). Higher educational attainment was associated with a lower likelihood of depressive symptoms; compared with illiterate participants, those with junior high school education or below (OR = 0.793, 95% CI: 0.655–0.960) and those with high school education or above (OR = 0.437, 95% CI: 0.319–0.599) had significantly lower risks. Being married (OR = 0.782, 95% CI: 0.633–0.965) and living in urban areas (OR = 0.644, 95% CI: 0.541–0.767) were also associated with reduced likelihood.

Compared with those reporting poor health, participants with fair (OR = 0.553, 95% CI: 0.461–0.664) or good self-rated health (OR = 0.304, 95% CI: 0.236–0.390) had substantially lower likelihood. More frequent contact with children (OR = 0.734, 95% CI: 0.617–0.874), higher life satisfaction (OR = 0.144, 95% CI: 0.102–0.203), and satisfaction with children (OR = 0.385, 95% CI: 0.253–0.586) were also associated with lower likelihood of depressive symptoms.

In contrast, several health-related and socioeconomic factors increased the likelihood of depressive symptoms, including difficulties in ADL (OR = 1.689, 95% CI: 1.411–2.021), chronic diseases (OR = 2.361, 95% CI: 1.616–3.449), physical pain (OR = 1.830, 95% CI: 1.541–2.174), short sleep duration (OR = 1.542, 95% CI: 1.315–1.808), drinking (OR = 1.275, 95% CI: 1.070–1.520) and living in impoverished households (OR = 1.356, 95% CI: 1.092–1.683). Having a pension was associated with a lower likelihood of depressive symptoms (OR = 0.829, 95% CI: 0.706–0.975), whereas age, social activities, smoking, exercise, and medical insurance showed no significant associations.

## Discussion

### Prevalence of depression symptoms in empty-nest elderly

The study found that the prevalence of depression symptoms among empty-nest elderly in China is 40.15%. This finding differs from the prevalence of depression symptoms reported in recent literature. These results should be interpreted with caution, as they may be influenced by differences in the time period of the data and regional variations in the study populations.

Specifically, the CHARLS data used in this study were collected during the COVID-19 pandemic, a period that may have posed additional psychological challenges for empty-nest elderly. Previous research suggests that the pandemic had a negative impact on the mental health of the elderly in China and may have increased the risk of depressive symptoms<sup>50</sup>. Moreover, eastern regions of China generally have higher levels of economic development<sup>51</sup>, and elderly individuals in these areas tend to have better economic conditions, which are associated with better health status and higher life satisfaction, potentially lowering the likelihood of depressive symptoms<sup>30</sup>. In contrast, this study includes urban and rural samples from central and western regions with greater socioeconomic heterogeneity, which may help explain the observed prevalence of depressive symptoms.

There may be differences in the causal mechanisms of depression between the empty-nest elderly population and the general elderly population. Within the empty-nest elderly population, the lack of companionship from children results in reduced daily interaction and emotional support, leading to higher levels of loneliness, which has been identified as a prominent risk factor for the development of depression<sup>52,53</sup>. In contrast, the general elderly population usually benefits from the companionship of their children and receives more stable emotional support, which can buffer psychological stress and thereby attenuate the causal role of loneliness in depression. In addition, individuals in the empty-nest elderly population often need to manage daily activities independently. When functional limitations or declining health occur, the absence of timely assistance from family members may increase feelings of helplessness and psychological stress, consequently elevating the risk of depression. By comparison, the general elderly population is more likely to receive care and support from children or other family members. As a result, the psychological impact of declining functional ability is relatively smaller, leading to a lower risk of depression.

	No depression Symptoms (%)	Depression symptoms (%)	P value
Gender			< 0.001
Male	1396(34.84%)	666(16.62%)	
Female	1002(25.01%)	943(23.53%)	
Age			0.172
60–69	1539(38.41%)	994(24.81%)	
70–79	732(18.27%)	536(13.38%)	
≥ 80	127(3.17%)	79(1.97%)	
Education level			< 0.001
Illiterate	482(12.03%)	521(13.00%)	
Junior high school or below	1534(38.28%)	982(24.51%)	
High school or above	382(9.23%)	106(2.65%)	
Marital status			< 0.001
Without spouse	325(8.11%)	328(8.19%)	
With spouse	2073(51.73%)	1281(31.97%)	
Place of residence			< 0.001
Rural	1398(34.89%)	1177(29.37%)	
Urban	1000(24.96%)	432(10.78%)	
Self-rated health status			< 0.001
Poor	388(9.68%)	716(17.87%)	
Fair	1287(32.12%)	739(18.44%)	
Good	723(18.04%)	154(3.84%)	
Frequency of contact with children			< 0.001
Low	960(23.96%)	803(20.04%)	
Moderate	515(12.85%)	339(8.46%)	
High	923(23.03%)	467(11.65%)	
Life satisfaction			< 0.001
Dissatisfied	55(1.37%)	337(8.41%)	
Fair	1254(31.30%)	873(21.79%)	
Satisfied	1089(27.18%)	399(9.96%)	
Satisfaction with children			< 0.001
Dissatisfied	45(1.12%)	166(4.14%)	
Fair	899(22.44%)	725(18.09%)	
Satisfied	1454(36.29%)	718(17.92%)	
Social activities			0.012
No	1230(30.70%)	890(22.21%)	
Yes	1168(29.15%)	719(17.94%)	
ADL			< 0.001
Dependent	385(9.61%)	675(16.85%)	
Independent	2013(50.24%)	934(23.31%)	
Chronic diseases			< 0.001
Yes	60(1.50%)	108(2.70%)	
No	2338(58.35%)	1501(37.46%)	
Physical pain			< 0.001
Yes	466(11.63%)	766(19.12%)	
No	1932(48.22%)	843(21.04%)	
Sleep duration			< 0.001
<7 h	1366(34.09%)	1162(29.00%)	
≥ 7 h	1032(25.75%)	447(11.16%)	
Drinking			< 0.001
Frequently	1431(35.71%)	1173(29.27%)	
Infrequently	967(24.13%)	436(10.88%)	
Smoking			< 0.001
Never	1254(31.30%)	1027(25.63%)	
Current	687(17.14%)	362(9.03%)	
Former	457(11.41%)	220(5.49%)	
Exercise			< 0.001
Continued			

	No depression Symptoms (%)	Depression symptoms (%)	P value
No	228(5.69%)	218(5.44%)	
Yes	2170(54.16%)	1391(34.71%)	
Household economic status			< 0.001
Impoverished	250(6.24%)	313(7.81%)	
Non-impovertished	2148(53.61%)	1296(32.34%)	
Medical insurance			0.002
No	81(2.02%)	87(2.17%)	
Yes	2317(57.82%)	1522(37.98%)	
Pension			< 0.001
No	723(18.04%)	642(16.02%)	
Yes	1675(41.80%)	967(24.13%)	

**Table 2.** Basic characteristics of empty-nest elderly with depression Symptoms.

Analysis of influencing factors

Female empty-nest elderly have a higher likelihood of experiencing depressive symptoms compared to their male counterparts, which aligns with previous research findings<sup>31,46</sup>. This gender disparity in depression symptoms may be linked to distinct physiological and psychological factors in women<sup>54</sup>. Higher education, having a spouse, and living in urban areas are each independently associated with a lower prevalence of depressive symptoms among empty-nest elderly. More educated elderly generally have better socioeconomic status, greater knowledge, and more active cognitive skills, which help them cope with life’s challenges and manage stress effectively<sup>55</sup>. According to marital resource theory, spouses provide economic support, emotional companionship, and daily assistance, and their loss, known as the “widowhood effect,” significantly increases depression risk, especially in China, where elderly largely rely on pensions and support from children<sup>56,57</sup>. In empty-nest families, a spouse plays a critical role in providing daily care and emotional support. Urban residents benefit from higher economic development, better infrastructure, more social support, and easier access to healthcare, whereas rural elderly face underdeveloped infrastructure, limited healthcare access, lower social support, and poorer quality of life, all of which elevate depression risk<sup>58,59</sup>.

A higher frequency of contact with children, greater satisfaction with children, and higher life satisfaction are all associated with a lower likelihood of depressive symptoms among empty-nest elderly. Studies have shown that infrequent contact with children is linked to a gradual deterioration in mental health, largely due to increased feelings of loneliness following the transition to an empty-nest status<sup>15</sup>. Loneliness may adversely affect mental health to some extent, whereas increasing contact with children can strengthen family support, reduce loneliness, and thereby lower the likelihood of depressive symptoms<sup>60</sup>. In Confucian culture-oriented countries such as China and Korea, family factors play a central role in both life satisfaction and depression among the elderly<sup>61</sup>. The family, as the most important social bond, provides a sense of belonging, security, and support. Strong family support and financial or emotional assistance from children can enhance satisfaction and life satisfaction among empty-nest elderly, thereby protecting against depressive symptoms<sup>62,63</sup>. Conversely, difficulty in establishing close and reciprocal parent–child relationships, lack of family support, or dysfunctional family dynamics can intensify loneliness, reduce life satisfaction, and increase vulnerability to depressive symptoms.

Among health-related factors, self-rated good health is associated with a lower likelihood of depressive symptoms among empty-nest elderly, whereas difficulties in ADL, chronic diseases, physical pain, short sleep duration, and drinking are each independently associated with a higher likelihood of depressive symptoms. Self-reported health status is a key indicator of overall health<sup>64</sup> and reflects the psychological well-being of older adults to some extent. Those who report better health tend to have greater confidence in their health and are more likely to adopt a positive attitude towards life<sup>65</sup>, which can serve as a protective factor against depression. However, this relationship may be bidirectional, as depression can lead individuals to perceive their health more negatively, further impacting their mental well-being.

Limitations in ADL are significantly associated with depressive symptoms and show a cumulative effect<sup>66</sup>. Basic self-care abilities help maintain mental health and support social integration, while partial or severe dependency may cause social and psychological strain, worsening mood and increasing vulnerability to depression<sup>67,68</sup>. Inability to participate in social activities or fulfill social roles can further heighten feelings of social disconnection, adversely affecting mental health<sup>69</sup>. Among empty-nest elderly, these relationships are likely bidirectional, as depression may impair motivation, energy, and cognitive functioning, which in turn affects ADL performance and further contributes to declines, particularly given their limited social support.

Research shows that those with one chronic condition have a 13% higher likelihood of experiencing depressive symptoms, while those with two or more chronic conditions have a 20% higher likelihood<sup>70</sup>. The duration of chronic disease also increases the risk of depressive symptoms<sup>71</sup>. Chronic diseases often limit social interactions, preventing individuals from alleviating loneliness and fear of illness, which can eventually lead to depressive feelings<sup>72</sup>. Conversely, depression may negatively affect disease management and immune function, exacerbating chronic disease symptoms and creating a mutually reinforcing negative cycle.

There is a bidirectional longitudinal association between pain and depressive symptoms, with individuals experiencing physical pain at an increased risk of developing depression, while depression may also amplify pain perception or increase pain sensitivity<sup>73</sup>. From a pathological perspective, this may be related to the key



Influencing factors	OR (95% CI)	P value
Gender		
Male	Ref.	
Female	1.366 (1.090–1.713)	0.007
Age		
60–69	Ref.	
70–79	0.978 (0.828–1.157)	0.799
≥ 80	1.078 (0.762–1.525)	0.673
Education level		
Illiterate	Ref.	
Junior high school or below	0.793 (0.655–0.960)	0.017
High school or above	0.437 (0.319–0.599)	< 0.001
Marital status		
Without spouse	Ref.	
With spouse	0.782 (0.633–0.965)	0.022
Place of residence		
Rural	Ref.	
Urban	0.644 (0.541–0.767)	< 0.001
Self-rated health status		
Poor	Ref.	
Fair	0.553 (0.461–0.664)	< 0.001
Good	0.304 (0.236–0.390)	< 0.001
Frequency of contact with children		
Low	Ref.	
Moderate	0.889 (0.730–1.082)	0.241
High	0.734 (0.617–0.874)	0.001
Life satisfaction		
Dissatisfied	Ref.	
Fair	0.232 (0.167–0.323)	< 0.001
Satisfied	0.144 (0.102–0.203)	< 0.001
Satisfaction with children		
Dissatisfied	Ref.	
Fair	0.541 (0.356–0.823)	0.004
Satisfied	0.385 (0.253–0.586)	< 0.001
Social activities		
No	Ref.	
Yes	0.976 (0.838–1.137)	0.755
ADL		
Independent	Ref.	
Dependent	1.689 (1.411–2.021)	< 0.001
Chronic diseases		
No	Ref.	
Yes	2.361 (1.616–3.449)	< 0.001
Physical pain		
No	Ref.	
Yes	1.830 (1.541–2.174)	< 0.001
Sleep duration		
≥ 7 h	Ref.	
< 7 h	1.542 (1.315–1.808)	< 0.001
Drinking		
Infrequently	Ref.	
Frequently	1.275 (1.070–1.520)	0.007
Smoking		
Never	Ref.	
Current	0.956 (0.758–1.204)	0.701
Former	0.827 (0.637–1.073)	0.153
Exercise		
Continued		

Influencing factors	OR (95% CI)	P value
No	Ref.	
Yes	0.901 (0.709–1.145)	0.395
Household economic status		
Non-impoveryshed	Ref.	
Impoveryshed	1.356 (1.092–1.683)	0.006
Medical insurance		
No	Ref.	
Yes	0.908 (0.622–1.324)	0.615
Pension		
No	Ref.	
Yes	0.829 (0.706–0.975)	0.023

**Table 3.** Logistic regression analysis of influencing factors on depression symptoms in empty-nest elderly.

role of neuroinflammation in the development of both depression and chronic pain<sup>74</sup>. Additionally, physical pain can substantially impair daily living activities in older adults, heightening negative emotions and potentially triggering further depressive symptoms<sup>75</sup>. For empty-nest elderly, the impact of physical pain is further intensified by the lack of daily caregiving from children, worsening the situation.

Sleep duration has been widely recognized as an important determinant of mental health in later life. The mechanisms underpinning this association can be explained from biological perspectives, including disruption of circadian rhythms, hormonal dysregulation, and elevated levels of chronic inflammation<sup>76</sup>. In addition, shorter sleep duration may further exacerbate depressive symptoms<sup>77</sup>. However, it should also be noted that the relationship is likely bidirectional, as depression can contribute to various sleep problems, such as difficulty initiating or maintaining sleep, early-morning awakening, and poor sleep quality. Therefore, maintaining adequate sleep is crucial for preventing and alleviating depressive symptoms among empty-nest elderly.

Research has identified a U-shaped association between alcohol consumption and depressive symptoms, suggesting that both abstinence and excessive drinking are linked to higher depression risk, whereas moderate drinking may have a protective effect in older adults<sup>78,79</sup>. In this study, most empty-nest elderly report frequent drinking. Prolonged excessive drinking and alcohol dependence can elevate blood alcohol levels and increase the likelihood of adverse health outcomes. Given their reduced tolerance and heightened sensitivity to alcohol, older adults are particularly vulnerable to its negative health effects<sup>80</sup>, which may in turn heighten the risk of depressive symptoms. Conversely, depression may also lead empty-nest elderly to rely on alcohol as a coping mechanism, as a way to manage stress or negative emotions, thereby reinforcing harmful drinking behaviors.

Among other influencing factors, economic conditions significantly affect the risk of depressive symptoms in empty-nest elderly. Those from impoverished households, which in China are defined as families with income below the national poverty line, poor living conditions, and registration to receive government aid, face a higher risk of depression<sup>46</sup>. In addition, elderly individuals living in areas of greater income inequality are more likely to experience depressive symptoms compared to those in lower inequality contexts<sup>81</sup>. Limited financial resources also reduce access to health care, as older adults from low-income families exhibit lower rates of inpatient service utilization<sup>82</sup>, further increasing vulnerability to depression. Conversely, having a pension serves as a protective factor against depressive symptoms<sup>83</sup>, likely due to the financial stability it provides, enabling access to health care and other resources. From a public health perspective, pensions help cover relatively affordable medical services, addressing health care needs<sup>84</sup>. Economically, they provide a stable and reliable income to meet basic living needs, thereby reducing depression risk<sup>85</sup>. Therefore, policies and interventions should prioritize improving the economic conditions of empty-nest elderly to support their physical and mental health.

Conclusion

With the increasing aging population in China, the number of empty-nest elderly experiencing depression symptoms is anticipated to rise, which will put pressure on families and society. It is necessary to prioritize empty-nest elderly in the prevention and treatment of depression symptoms. Considering the factors influencing depression symptoms in empty-nest elderly, we recommend enhancing family support, improving healthcare services, expanding pension coverage, and giving special attention to female, rural, and economically disadvantaged members of this group to lower their risk of developing depressive symptoms.

Limitations and Future Research: First, this study uses cross-sectional data, which only allows for exploring the associations between depressive symptoms in empty-nest elderly and their influencing factors, without establishing causation. Second, the measurement of chronic diseases was limited to three self-reported conditions, which may underestimate the true prevalence and introduce measurement bias. Additionally, with the advancement of information technology and the application of smart healthcare technologies, our study did not examine the potential impact of participation in online social platforms or access to emotional counseling on depressive symptoms among empty-nest elderly. Finally, future research should consider including a control group to enable comparative analyses and examine the differences in depressive symptoms between empty-nest elderly and the general elderly.



## Data availability

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

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## Author contributions

D.L. contributed to writing the original draft, formal analysis, validation, data curation and funding acquisition. Z.L. was responsible for conceptualization, writing review and editing, methodology. All authors have read, approved, and consented to the final version of the manuscript.

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## Declarations

## Competing interests

The authors declare no competing interests.

## Ethics approval and consent to participate

No animal studies are presented in this manuscript. No potentially identifiable human images or data are presented in this study. Ethical approval for all the waves of the China Health and Retirement Longitudinal Study (CHARLS) was granted by the Institutional Review Board at Peking University. The IRB approval number is IRB00001052-11015.

## Additional information

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