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Depressive Symptom among Older People in Rural China : The Role of Socio-Economic Characteristics and Housing Conditions

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Abstract:

Background: Mental health problems are more frequent in socially disadvantaged groups, but the results vary between different studies, different populations and different measures of mental health. Literature from the developed world suggests that poor housing conditions and housing environments contribute to poor mental health outcomes, although results are mixed. This paper investigated the association between housing conditions, socio-economic status and depressive symptom in older people in rural China.

Methods: The study population included 4585 respondents over the age of 60 who responded to a survey questionnaire in China in 2013. Depressive symptom was measured with the 10-item Center for Epidemiologic Studies Depression Scale(CESD-10), and multivariate logistic regression models were used in statistical analyses, adjusting for Socio-demographic characteristics and health status.

Results: The prevalence of depressive symptom was higher in women than in men ($p<0.001$). Persons with poor housing conditions had a higher risk of depressive symptom than persons with good housing conditions after adjustment for confounders. The Binary logistic regression analysis shows cooking fuel type (OR=1.171, 95%CI=1.029-1.333), toilet type (OR=1.310, 95%CI=1.088-1.578) and the availability of shower/bath facility (OR=1.197, 95%CI=1.047-1.368) were significantly associated with depressive symptoms in those living in rural areas. Economic difficulties had a strong association with psychological distress (OR=1.628, 95% CI=1.289-2.057)) after adjustment for confounders. Adjustment for socio-economic status did not change the impact of housing conditions on the prevalence of depressive symptoms.

Conclusion: We found a strong association between housing conditions, SES and depressive symptoms in this study Our findings underscore the importance of strong political commitment, inter-sectorial coordination and adequate financing are required to improve the housing condition in order to prevent the developing of depressive symptoms among older in rural regions in developing country such as China.

Keywords: housing condition; depressive symptom; older people; rural china; developing country

Strengths and Limitations of this study

- The study is based on the nationally representative data all China contributes to implementation of cross-country comparisons and to collection of much more information about the effect of housing condition on depressive symptom in low-and middle-income and

developing country, just like developed country does.

- Internationally validated questionnaire (10-item Center for Epidemiologic Studies Depression Scale) was used to measure depressive symptoms**.**
- As people with poor housing conditions and SES often have higher rate of depressive symptom.
- The study is based on cross-sectional data which do not allow interpretations of the direction of the observed associations.

1. Introduction

Ageing is one of the most conspicuous phenomena in the contemporary world. One in eight people in the world are aged 60 or over [1]. As long as fertility rates continue to decline and life expectancy continues to rise, older people will rapidly increase as a proportion of the total population. Between 2015 and 2050, the proportion of the world's older adults is estimated to almost double from about 12% to 22%. In absolute terms, this is an expected increase from 900 million to 2 billion people over the age of 60[2]. And while population ageing is a global phenomenon, it is progressing fastest in developing countries, and especially in China. In 2016, the Chinese population aged 60 years and over was over 230 million (the account will further increase to 480 million by 2050) and accounted for 16.7% of the total population, of which the most prominent the population over the age of 65 up to 150 million and reached 10.8% of the total population [3].

Older people face special physical and mental health challenges which need to be recognized. According to “Mental health of older adults”, the WHO report in 2017, Over 20% of adults aged 60 and over are suffering from the mental or neurological disorder (excluding headache disorders) and 6.6% of all disability (disability adjusted life years-DALYs) among people over 60 years is attributed to mental and neurological disorders. These disorders in older people account for 17.4% of Years Lived with Disability (YLDs). Depression, one of the most common mental and neurological disorders in this age group, which affect approximately 7% of the world’s older population and comprise a substantial proportion of the global burden of disease [4].

Based on the previous literatures, there may be multiple influence and risk factors for depression problems at any different periods of life and particularly prominent among the elderly due to their physical, psychological and social characteristics. Various factors, such as socio-economic factors (education, gender, marital status, employment, et al), as well as environmental factors which including public environment and personal housing environment have been shown to increased risks of developing depressive symptoms [5,6]. Researchers initially showed an interest in socio-demographic and socio-economic characteristics believed to affect depressive symptoms among elderly. Nowadays, a growing number of researchers are considering whether the housing environment and the physical facilities surrounding their dwelling place (e.g., condition of neighborhoods and housing materials) affect their depressive symptoms [7,8].

Housing condition (such as house type, house quality, house tenure and housing facility, et al), as an important social determinant of health, it’s association with the process of depressive symptoms developing is well documented in the literature and have been investigated in urban area in several studies [9-11]. Reasons for focusing on urban housing are that the urban population, especially the office workers, spend up to 90% of their lives indoors. In addition, the much more important thing is the house has been an important venue where the most significant contact takes

place with other household members. Studies concerning suggested that residents, especially mothers and their children, living in high-rise buildings contributes to poor mental health. Some previous studies have showed the relationship between mental health and in terms of different aspects of urban housing quality such as house structure, indoor temperature, availability of amenities, dampness and housing facility [12-14]. Some of which have shown significant relationships between poor public housing quality and worse mental health outcomes. Moreover, some other articles have investigated the relationship between housing affordability, accessibility and mental health [15-17].

From another perspective, however, research on housing condition and depression among rural population is remarkably underdeveloped. Few studies have discussed in more detail about the impact of rural housing hardware on depressive symptoms among the elderly, especially in China. In rural areas of China, many older houses which built decades and above, especially in remote poverty-stricken areas, are still made from wood and adobe and short of basic housing facility. The poor housing condition may lead to a greater possibility of resulting in depressive symptoms. With the development and Urbanization in rural areas, it is necessary to further focus on the relationship between rural housing conditions and the mental health especially depressive symptoms of the elderly, which has significant effect on the construction of the age-friendly environments, a concept and program proposed by WHO, among rural area, and further reducing the health inequality between urban and rural population [18].

Given that the poor housing condition in rural areas may influence the prevalence of depression in older population, further study of this relationship in elderly Chinese rural population in contemporary society is warranted. In order to address the issue of rural housing conditions for elderly's mental health, this study will examine whether the depressive symptoms of rural older differ by their various housing conditions and characteristics. We hypothesize that rural elderly with poorer housing conditions (regarding material, structure, facility, et al) will result in more serious depressive symptoms. We believe our study will improve understanding of the complex nature of the relationship between housing conditions and the development of depressive symptoms among rural elderly population in developing country like China.

2. Materials and Methods

2.1. Design and Study Population

This study is based on the nationally representative China Health and Retirement Longitudinal Study (CHARLS) conducted by the China Centre for Economic Research of Peking University, which was designed after the Health and Retirement Study (HRS) in the US as a broad purposed social science and health survey of the elderly in China. Face-to face interviews in respondents' homes collected detailed information on their demographic characteristics, socioeconomic status, health-related behaviors and lifestyles, health status including health conditions, health insurance and health services use [19]. More details on the CHARLS survey design are available from Zhao et al. Our analysis uses data from the third wave in 2015. Ethics approval for the baseline data collection was obtained from the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015). Ethics approval for the use of CHARLS data was obtained from the University of Newcastle HREC (H-2015-0290) [20].

2.2. Assessment and Measurements

Depressive symptoms. The 10-item Center for Epidemiologic Studies Depression Scale (CES-D) short form was used to measure depressive symptoms. The time frame for the CES-D questions refers to the week prior to the interview. Each item was rated on a 4-point Likert scale with answers varying from 'rarely or none of the time (0-1 day)' to 'most or all of the time (5-7 days)', The total of score ranges from 0 to 30, with a lower score indicating a lower level of depressive symptoms. CES-D has shown good validity and reliability in the Chinese population (Boey, 1999; Cheng and Chan, 2005). A previous validation study in elderly Chinese found a cut-off point of 10 provides the optimal threshold to identify clinically significant depression (Andresen et al., 1994). Hence, a cut-off point of 10 was used in this study to generate the binary depressive symptom variable. Those participants with total scores of less than 11 were categorized as non-depressed. The CESD-10 has been described in detail elsewhere (Boey, 1999; Chen and Mui, 2014) [21,23].

Housing condition. We used five variables to measure housing condition: years of house building (≤10, 10-20, 20-30, ≥30); Housing structure (One-story building, Multi-story building); housing materials were dichotomized as "improved material" (Concrete and steel/Bricks and wood) and "unimproved material" (Adobe, Wood, Cave dwelling, Mongolian yurt/ Woolen felt, Stone); Number of bedroom (0-1, 2, ≥3); Cooking fuel was categorized as Clean fuel(2= Natural gas, 3= Marsh gas, 4=Liquefied Petroleum Gas, 5=Electric), Polluting fuel(1=Coal, 6=Crop residue/ Wood burning), and others(7=Other). Housing facility was assessed by the availability of toilet, running water, shower or bath facility, heating system, telephone connection and Internet connection. These facilities were all categorized as "0= yes" (available) and "1= no" (not available) while toilet which was categorized to "0=Toilet with seat" and "1=Toilet without seat" [23-26].

Health status. In this paper, we assessed health status of responses by "number of chronic diseases", "disability status" and "activities of daily living (ADL) limitations". Number of Non-communicable diseases (NCD_S) was assessed as the cumulative number of diagnosed Chronic conditions (hypertension, dyslipidemia, diabetes, cancer, chronic lung diseases, liver or gallbladder disease, heart disease, stroke, kidney disease, stomach or other digestive disease, emotional, nervous, or psychiatric problems, memory-related disease, rheumatism/arthritis, asthma) on three scales: 0, 1-2, 3 and above [22].

Disabilities status was measured by asking "Do you have one of the following disabilities". Responders were categorized as "Yes" when they had any disability of physical disabilities, brain damage/mental retardation, vision problem, hearing problem and speech impediment.

ADL limitations indicate any self-reported difficulty in any of the following six activities of daily living: eating, dressing, getting into or out of bed, using toilet, bathing/showering, or controlling urination and defecation. The four response options were: 1= "I don't have any difficulty", 2 = "I have difficulty but can still do it", 3 = "I have difficulty and need help", 4 = "I cannot do it". It was dichotomously coded (Dependent vs Independent). "ADL dependent" was defined as "have difficulty and need help" or "cannot do it" in any ADL item [27,28].

The health effect of individual characteristics such as Socio-demographic characteristics and socio-economic status(SES) has been well established in the literature.

Socio-economic status. Educational attainment and Personal annual income were used to determine SES. Education levels were classified as "Primary school and below" and "High school and above". Personal annual income was categorized to "≤10000", "10000-20000" and "≥20000".

Socio-demographic characteristics. Age (65–74, 75 and over) was measured by a single question asking date of birth and gender (male or female) were included as covariates. Marital

status was categorized to "married" (1= married with spouse, 2= married but not living with spouse temporarily, 3= separated) and "unmarried" (4= divorced, 5= widowed, 6= never married and 7= cohabitated) [22].

2.3 Patient and public involvement

The study did not involve patients. The results of the survey are disseminated to the public through websites of the public county councils.

2.3 Statistical Analysis

Descriptive statistics were performed to analyze the counts and percentages of the baseline characteristics. Pearson chi-squared tests were conducted to compare whether there were significant differences between housing condition, health status, socio-demographic characteristics and socio-economic status in different domains of depressive symptoms (Table 1). Binary logistic regression analysis was also used to identify the potential risk factors for the different domains of depressive symptoms (Table 2). We evaluated multicollinearity among covariates by using correlation analyses based on the variance inflation factor and tolerance tests; no significant collinearity was detected between any covariates. All statistical tests were conducted using the Statistical Package for the Social Sciences software v. 22.0 for Windows (SPSS, Inc., Chicago, IL, USA) [22,29].

3. Results

Among the participants in this article, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in the rural areas of China.

Participant characteristics, including health status (number of NCD_S, disabilities status, ADL limitations), socio-demographic and socio-economic status as well as the prevalence of different depressive symptoms, are shown in Table 1. 52.79% female and 70.32% older who aged 60-74 reported depressed respectively. Compared to those without depression symptom, participants with depression symptom tended to have lower education level and personal annual income, to have a worse health status (57.61% older had 1-2 NCDs and 55.58% had disabilities) except for ADL limitation which only 19.90% were dependent. The percentage of married participants who experience depression was significantly higher than that of those unmarried. Chi-square tests revealed that age, gender, marital status, education level, number of NCD_S, disabilities status and ADL limitations all had significantly difference among different depressive symptoms.

Table 1 Bivariate associations between depressive symptoms and socio-demographic characteristics, SES and health status

Variable	Totally n (%)	Depressive symptoms		*p*
		Not depressed n (%)	Depressed n (%)	
Totally	4585	2469(53.85)	2116(46.15)	
Age (years)				
60-74	3396(74.07)	1908(77.28)	1488(70.32)	0.000

≥75	1189(25.93)	561(22.72)	628(29.68)	
Gender				
Male	2529(55.16)	1530(61.97)	999(47.21)	0.000
Female	2056(44.84)	939(38.03)	1117(52.79)	
Marital status				
Married	3008(65.61)	1735(70.27)	1273(60.16)	0.000
Unmarried	1577(34.39)	734(29.73)	843(39.84)	
Education				
Primary school and below	4333(94.50)	2309(93.52)	2024(95.65)	0.002
High school and above	252(5.50)	160(6.48)	92(4.35)	
Personal annual income				
≤10000	3643(79.45)	1871(75.78)	1772(83.74)	0.000
10000-20000	556(12.13)	334(13.53)	222(10.49)	
≥20000	386(8.42)	264(10.69)	122(5.77)	
Number of NCDs				
0	698(15.22)	458(18.55)	240(11.34)	0.000
1-2	2615(57.03)	1396(56.54)	1219(57.61)	
≥3	1272(27.74)	615(24.91)	657(31.05)	
Disability				
Yes	2175(47.44)	999(40.46)	1176(55.58)	0.000
No	2410(52.56)	1470(59.54)	940(44.42)	
ADL				
Unimpaired	3828(83.49)	2133(86.39)	1695(80.10)	0.000
Impaired	757(16.51)	336(13.61)	421(19.90)	

Table 2 lists the frequency distributions of the housing condition variables across the outcome variable (depressive symptoms). It is particularly striking that 59.40% and 88.99% responders, who were depressed, reported using polluting cooking fuel and toilet without seat respectively. In addition, the percentage of no telephone connection among participants, who were depressed, was up to 77.50%. Chi-square tests revealed that housing materials, cooking fuel, type of toilet, running water, shower or bath facility had significant differences in depressive symptoms. In addition, other housing condition variables like the years of house, housing structure, indoor temperature, number of bedrooms and heating system were also concluding in Table 1. We haven't shown it just for these variables all had no significantly difference among different depressive symptoms.

Table 2. percentage distribution and the prevalence of depressive symptoms according to housing conditions

Variable	Totally n (%)	Depressive symptoms		*p*
		Not depressed n (%)	Depressed n (%)	
Totally	4585	2469	2116	
Housing materials				
Improved	3567(77.80)	1958(79.30)	1609(76.04)	0.008

Unimproved	1018(22.20)	511(20.70)	507(23.96)	
Cooking fuel				
Clean fuel	1993(43.47)	1156(46.82)	837(39.56)	0.000
Polluting fuel	2544(55.50)	1287(52.13)	1257(59.40)	
others	48(1.05)	26(1.05)	22(1.04)	
Type of toilet				
Toilet with seat	603(13.15)	370(14.99)	233(11.01)	0.000
Toilet without seat	3982(86.85)	2099(85.01)	1883(88.99)	
Running water				
Yes	3128(68.22)	1729(70.03)	1399(66.12)	0.005
No	1457(31.78)	740(29.97)	717(33.88)	
Shower or bath facility				
Yes	1916(41.79)	1128(45.69)	788(37.24)	0.000
No	2669(58.21)	1341(54.31)	1328(62.76)	

The results of the binary logistic regression analysis of the associations between housing condition and depressive symptoms are shown in Table 3. Model 1 included only controlled variables, including socio-demographic (age, gender and marital status) and health status factors (number of NCD_S, disabilities status, ADL limitations), as a baseline model. In Models 2, SES variables (marital status, education and income) were added to model 1 to explore the impact of the odds association between SES and depressive symptoms separately. In Models 3, housing conditions variables were added to Models 1 to explore the impact of housing conditions on depressive symptoms separately. Model 4 added housing conditions and SES variables to Models 1 to explain the impact of housing conditions on depressive symptoms after controlling SES variables.

Models 2 shows that elderly rural residents earned lower annual per capita income had a higher likelihood of having depressive symptoms than those more than 20000 (OR=1.359, 95%CI=1.026-1.800 for those earned 10000-20000; OR=1.759, 95%CI=1.396-2.217 for those less than 10000). Meanwhile, educational attainment was not significant at the $p<0.05$ level in all Model 2 and 4.

In Models 3, elderly rural residents, who used polluting cooking fuel and toilet without seat had a higher likelihood of having depressive symptoms than those used clean fuel (OR=1.171, 95%CI=1.029-1.333) and toilet with seat (OR=1.310, 95%CI=1.088-1.578). So did the availability of Shower/ bath facility (OR = 1.197, 95% CI = 1.047-1.368, Model 3). However, housing materials and the availability of running water were not significant at the $p<0.05$ level in all Model 3 and 4.

The odds of the association between cooking fuel and depressive symptoms was decreased when SES variables were adjusted in Model 4 (OR = 1.159, 95% CI = 1.018-1.320, Model 4). So did the toilet type (OR = 1.275, 95% CI = 1.058-1.537, Model 4) and availability of Shower/ bath facility (OR = 1.169, 95% CI = 1.022-1.337, Model 4).

Table 3. Relative risk (and 95% confidence intervals) for the associations between housing condition and depressive symptom

Variable		Model 1 OR(95%CI)	Model 2 OR(95%CI)	Model 3 OR(95%CI)	Model 4 OR(95%CI)
Age (60-74)	≥75	1.181*(1.023-1.363)	1.170*(1.014-1.351)	1.205*(1.043-1.392)	1.194*(1.033-1.380)
Gender (Male)	Female	1.675***(1.476-1.900)	1.645***(1.449-1.868)	1.686***(1.485-1.914)	1.660***(1.461-1.886)
Marital status (Married)	Unmarried	1.173*(1.022-1.346)	1.146*** (0.998-1.316)	1.146 (0.997-1.316)	1.126 (0.980-1.294)
Number of NCDs (0)	1-2	1.438*** (1.202-1.721)	1.419*** (1.184-1.700)	1.430*** (1.194-1.713)	1.414*** (1.180-1.695)
	≥3	1.738*** (1.427-2.118)	1.722*** (1.412-2.100)	1.739*** (1.426-2.120)	1.726*** (1.414-2.106)
Disability (No)	Yes	1.638*** (1.449-1.852)	1.603*** (1.416-1.813)	1.584*** (1.400-1.793)	1.559*** (1.377-1.766)
ADL (Unimpaired)	Impaired	1.428*** (1.214-1.680)	1.431*** (1.216-1.684)	1.418*** (1.204-1.670)	1.421*** (1.206-1.674)
Education (High school and above)	Primary school and below		0.914(0.694-1.203)		0.929(0.705-1.223)
Personal annual income (≥20000)	10000-20000		1.359*(1.026-1.800)		1.296(0.977-1.720)
	≤10000		1.759*** (1.396-2.217)		1.628*** (1.289-2.057)
Cooking fuel (Clean fuel)	Polluting fuel			1.171*(1.029-1.333)	1.159*(1.018-1.320)
	others			1.023(0.563-1.859)	1.062(0.584-1.933)
Type of toilet (Toilet with seat)	Toilet without seat			1.310**(1.088-1.578)	1.275*(1.058-1.537)
Shower or bath facility (Yes)	No			1.197**(1.047-1.368)	1.169*(1.022-1.337)
Running water (Yes)	No			1.073(0.939-1.227)	1.072(0.938-1.225)
Housing materials(Improved)	Unimproved			1.013(0.872-1.178)	1.000(0.861-1.163)
Chi-square		265.547***	294.982***	303.041***	324.473***
-2 Log likelihood		6063.408	6033.974	6025.914	6004.482
Cox & Snell R Square		0.056	0.062	0.064	0.068
Nagelkerke R Square		0.075	0.083	0.085	0.091

Model 1: the reference model including only housing conditions;

Model 2: adjusting for socio-demographic characteristics (age and gender); socio-economic status and health status;

Model 3: adjusting for socio-demographic characteristics and socio-economic status (marital status, education and income);

Model 4: adjusting for socio-demographic characteristics, socio-economic status and health status (number of NCDs, disability and ADL)

*: $p<0.05$

**: $p<0.01$

***: $p<0.001$

4. Discussion

4.1. Key Findings

Improving housing conditions to promote elderly health status and well-being has received increasing interest from academics and governments. To date, however, there has been very little research examining housing condition in relation to elder health outcomes, especially mental health, in rural China. Our study examined the association between housing condition and depressive symptom among rural-dwelling older Chinese. We found that, controlling for socio-demographic, health status and SES, older Chinese living in rural region with poor housing condition were more likely to be depressed than those living with better housing condition. It shows that elderly rural residents using polluting cooking fuel, using toilet without seat and reporting shower/bath facility is not available of poor housing conditions were associated with greater odds of depressive symptom.

Multiple mechanisms may be responsible for the association between housing condition and depressive symptoms among older living in rural China. Poor housing conditions of rural residents may suggest that their subjective well-being(SWB) and life satisfaction may inferior than those living in better housing condition, especially in urban. Additionally, poor housing conditions may undermine depressive symptoms of older residents by increasing the risk of negative health outcomes, for example, may lead to some chronic diseases and even negative mental states.

In the article, there are 2544(55.50%) older people using polluting cooking fuel in rural China in 2015. Controlling other variables, compared with older using clean cooking fuel, the odds of being depressed among older using polluting cooking fuel are 15.9% higher. Indoor air pollution (IAP), one of the major public health concerns in low- and middle-income or developing countries, mainly caused by the use of polluting cooking fuels such as coal, charcoal, crop residue and wood burning. Globally, nearly 3 billion (40%) of the world's population, according to WHO report in 2016, relies on solid fuels, including coal and biomass for domestic cooking [30-33]. Evidence shows that IAP is associated with poor physical health. Prior researchers have identified IAP as the most important environmental risk factor globally associated with adverse health effects ranging from respiratory infections to chronic illness such as tuberculosis, chronic obstructive pulmonary disease, and cancer [34-36]. According to WHO report, globally almost 4.3 million deaths annually have been attributed to IAP resulting from cooking fuel in low- and middle-income countries in 2016. However, there is little empirical evidence on the relationship between IAP and psychological or mental health such as anxiety and depression based on nationally representative and longitudinal data, especially in developing country like China [37,38]. Existing studies have speculated that the relationship between IAP and depression may be derived from the substances containing carbon monoxide, sulfur dioxide, poly-cyclic aromatic hydrocarbon and metals like lead, copper, mercury, manganese, and the pathogenesis of depressive symptom involves the mechanism of neuro inflammation [39,40]. Other studies have linked the

existence or deterioration of chronic diseases which were motivated by high concentration particles, to acute or long-term psychological effects, and even increase the risk of suicide [41,42]. Generally speaking, however, the negative effects of polluting cooking fuel on depressive symptoms have not been given enough attention, especially in the older population which primarily because of the effect of indoor air pollution on depression largely dependent upon the social vulnerability and mental resilience among different population group.

Our research shows that 3982 older still using toilet without seat in rural China which accounted for 86.85%. The odds of being depressed among older using toilet without seat are 27.5% higher than those using toilet with seat after controlling all confounding variables. Very little research has explored the relationship between toilet type and depressive symptom. Researches on health, especially on microbiological pollution have demonstrated that the species of microbes on the squat pans are roughly same as the toilet, while the numbers alone is much more [43,44]. As a result, the possibility of transmitting the virus through the air is greater. Some other previous investigations have suggested that the using of squat pans over time can cause anal fissure to a certain extent, raise the risk of dizziness due mainly to the lack of oxygen to the brain which result from resuming blood circulation and flow to lower limb artery after long time using of squat pans, even lead to fall, the cardio-cerebral vascular accident such as cerebral hemorrhage and angina pectoris, especially among constipation patients [45,46]. Maybe we can deduce from these existing researches that the existence or deterioration of chronic diseases resulting from using toilet without seat may lead to a greater possibility of depression among older, especially those with high blood pressure, heart disease, chronic bronchitis and other senile diseases.

Finally, in terms of the relationship between shower/bath facility and depressive symptom, there are 2669(58.21%) older reported that the shower/bath facility is not available among respondents in 2015. The odds of being depressed among older without shower/bath facility are 16.9% higher than those using shower/bath facility after controlling all confounding variables. We found only a few articles, in the previous literature study, involved the relationship between bath facilities and health outcome. A randomized clinical pilot trial conducted in Germany showed that hyperthermic baths(HTB) do have generalized efficacy in depressed patients. Resulting from a non-controlled HTB study aimed at 20 depressive patients, conducted also in Germany, showed an improvement after fine baths [47,48]. Furthermore, HTB, especially before bedtime, improved sleep quality in healthy, insomniac people and elderly patients with depression and vascular dementia. Whole body hyperthermia, according to a further non-controlled study, showed a significant reduction in the CES-D among 16 depressive patients. Trials, conducted by researchers in Japan, showed that warm water bath have a positive effect on physiological parameters and subjective sensation among older. Our research also further corroborated the previous research. These prior researches suggest that HTB have antidepressant effects which mediated through changes in circadian functioning and temperature physiology changes in circadian functioning and temperature physiology, although the underlying mechanisms remain unclear [49,50].

4.2. Strengths and Limitations

Our research adds to the existing knowledge highlighting the role of housing condition factors in exploring the developing of depressive symptom in rural areas. Furthermore, the use of nationally representative data all China contributes to implementation of cross-country comparisons and to collection of much more information about the effect of housing condition on depressive symptom in low-and middle-income and developing country, just like developed

country does.

First limitation of our research concern lies in the absence of time series research, we just use the cross-sectional data to explore it. Additionally, the research subjects, drawn from rural areas in China, have not compared with the urban residents. Furthermore, the content of the study has not covered the cultural environment of housing condition.

5. Conclusions

The older, especially in rural areas, is the most vulnerable group facing multiple serious health inequity. Non-access to complete housing condition along with low income and considerable prevalence of chronic diseases are the underlying causes which are considered depressed. Overall, our findings revealed that living in poor housing conditions may promote them developing depressive symptoms, and main influencing factors of the impact of housing conditions, especially cooking fuel type, toilet type and the availability of shower/bath facility, on depressive symptoms in older resident in rural China. Our findings underscore the importance of strong political commitment, inter-sectorial coordination and adequate financing are required in order to prevent the developing of depressive symptoms among older in rural China.

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The Role of Socio-Economic Status and Housing Conditions in Geriatric Depression in Rural China: a cross-sectional study

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Abstract:

Objectives: The primary aim of this study was to describe SES, housing conditions and depression of the elderly in rural China as well as to examine the associations between depression and SES, housing conditions using China Health and Retirement Longitudinal Study (CHARLS).

Design: cross-sectional study.

Setting: A nationally representative sample of elderly in rural China.

Participants: 4585 elderly adults in 2015 in rural China.

Outcome measures: Prevalence, risk factors of depression among rural elderly.

Results: Among the participants in this article, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in rural China. The results revealed significant associations between higher scores on CES-D 10 (indicating more symptoms of depression) and lowest personal annual income [OR = 1.63, 95% CI (1.290-2.060)], polluting cooking fuel [OR = 1.16, 95% CI (1.018-1.321)], toilet without seat [OR = 1.273, 95% CI (1.056-1.535)] as well as not having bath facility [OR = 1.172, 95% CI (1.025-1.341)] after adjustment for confounders.

Conclusion: Elderly in rural china experienced severe depressive symptoms. Lowest personal annual income, polluting cooking fuel, toilet without seat and not having bath facility were significantly associated with more depressive symptoms. Although caution needs to be taken in generalizing the findings of this study to the rest of the population in China since it is a highly selected sample.

Keywords: SES, housing condition; depressive symptoms; older people; rural china

Strengths and Limitations of this study

- The study is based on the nationally representative data all China contributes to implementation of cross-country comparisons and to collection of much more information about the effect of SES and housing condition on depressive symptoms.
- The main limitations are a cross-sectional study design and its use of self-reports.
- There was no further clinical diagnosis and treatments for the participants who met the screening criteria according to CES-D, in the original research.

1. Introduction

Ageing is one of the most conspicuous phenomena in the contemporary world [1]. Between 2015 and 2050, the proportion of the world's older adults is estimated to almost double from about 12% to 22%. In absolute terms, this is an expected increase from 900 million to 2 billion people over the age of 60[2]. While population ageing is a global phenomenon but the progress is fastest in developing countries, especially in China. In 2016, the Chinese population aged above 60 years old was over 230 million, which will further increase to 480 million by 2050 [3].

Older adults face special physical and mental health challenges that need to be recognized. According to a World Health Organization report published in 2017, over 20% of the older adults suffered from the mental or neurological disorder (excluding headache disorders), and 6.6% of all disability among people over 60 years was attributed to mental and neurological disorders (WHO, 2017). Depression, one of the most common mental and neurological disorders, affects approximately 7% of the world's older population and comprises a substantial proportion of the global burden of disease (WHO, 2017). Depression of the Chinese older population first captured the research attention in the 1980s and emerged as a growing field since the 1990s [4].

Depression in the elderly is often a function of many contributing factors, which include biological, psychosocial, or environmental characteristics. Reflecting the impact of social structures on an individual's mental health, socioeconomic status (SES) has consistently been found to be associated with depression in elderly populations. The theoretical framework of Gallo and Matthews explains that low SES reduces individuals' capacity to manage stress, and thereby increase one's vulnerability to negative emotions and cognitions [5-7].

Housing condition, as an important social determinant of health, it's association with the process of depressive symptoms developing is well documented in the literatures [8-10]. Housing conditions may encompass tangible and observable attributes such as physical structure, design, housing facility, et al. The association between housing conditions has been investigated in several studies, particularly in urban areas [11]. Some previous studies have showed the relationship between mental health and in terms of different aspects of urban housing conditions [12-14]. From another perspective, however, research on housing conditions and depression among rural population is remarkably underdeveloped. Few studies have discussed in more detail about the impact of rural housing conditions on depressive symptoms among the elderly, especially in China [15, 16]. In rural China, the poor physical housing conditions may lead to a greater possibility of resulting in depressive symptoms. With the development and Urbanization, it is necessary to further focus on the relationship between rural housing conditions and mental health, which has significant effect on the construction of the age-friendly environments and further reducing the health inequality between urban and rural population.

It is important to identify factors associated with depression in rural population. Therefore, the primary aim of this study was to describe SES, housing conditions and depression in this population, as well as to examine the associations between depression and SES, housing conditions. We believe our study will improve understanding of the complex nature of the relationship between SES, housing conditions and the development of depressive symptoms among rural elderly population in developing country.

2. Materials and Methods

2.1. Study Design

A cross-sectional design was used. The data were based on the third wave of nationally representative China Health and Retirement Longitudinal Study (CHARLS) that was carried out in 2015.

2.2 Setting and Participants

CHARLS used a multi-stage stratified probability-proportional-to-size sampling (PPS) technique to select participants. Face-to face interviews were conducted to collect detailed information on participants. 21,095 respondents of 150 counties/districts and 450 villages/resident committees, participated during the third wave in 2015. More detailed CHARLS survey design has been described elsewhere [17-19].

The sample only included adults aged 60 and above who lived in rural China. The inclusion criteria were: (1) age ≥60, (2) living at the survey site for at least 6 months, (3) being at home during the investigation period, and (4) able to participate in the study. Subjects with mental retardation and severe cognitive impairment had been excluded from original research by using a short screening form, only to respondents who had little or no help with answering questions in the preceding of the survey. Thus, the number of respondents eligible for our analysis dropped to 4585 rural elderly.

2.2. Assessment and Measurements

Depressive symptoms

Depressive symptoms were screened by the 10-item Center for Epidemiologic Studies Depression Scale (CES-D) short form. The time frame for the CES-D questions refers to the week prior to the interview. Each item was rated on a 4-point Likert scale with answers varying from 'rarely or none of the time (0-1 day)' to 'most or all of the time (5-7 days)', the total of score ranges from 0 to 30, with a lower score indicating a lower level of depressive symptoms. CES-D has shown good validity and reliability in the Chinese population [20]. A previous validation study in elderly Chinese found a cut-off point of 10 provides the optimal threshold to identify clinically significant depression. Hence, a cut-off point of 10 was used in this study to generate the binary depressive symptoms variable. Those participants with total scores of less than 11 were categorized as not-depressed. The CESD-10 has been described in detail elsewhere [21].

Housing condition

Five variables were used to measure housing condition: years of house building; Housing structure; Housing materials were dichotomized as "improved material" (Concrete and steel/Bricks and wood) and "unimproved material" (Adobe, Wood, Cave dwelling, Mongolian yurt/ Woolen felt, Stone); Number of bedrooms; Cooking fuel (clean fuel/ polluting fuel/ others); Housing facility (availability of toilet, running water, shower or bath facility, heating system, telephone connection and Internet connection). These facilities were all categorized as "0= yes" (available) and "1= no" (unavailable) while toilet was categorized to "0=Toilet with seat" and "1=Toilet without seat".

Number of Non-communicable diseases (NCD_S)

NCDS was assessed as the cumulative number of diagnosed Chronic conditions (hypertension, dyslipidemia, diabetes, cancer, chronic lung diseases, liver or gallbladder disease, heart disease, stroke, kidney disease, stomach or other digestive disease, emotional, nervous, or psychiatric problems, memory-related disease, rheumatism/arthritis, asthma) on three scales: 0, 1-2, 3 and above [21].

Disabilities status

It was measured by asking "Do you have one of the following disabilities". Responders were categorized as "Yes" when they had any disability of physical disabilities, brain damage/mental retardation, vision problem, hearing problem and speech impediment.

ADL

ADL limitations indicate any self-reported difficulty in any of the following six activities of daily living: eating, dressing, getting into or out of bed, using toilet, bathing/showering, or controlling urination and defecation. The four response options were: 1= "I don't have any difficulty", 2 = "I have difficulty but can still do it", 3 = "I have difficulty and need help", 4 = "I cannot do it". It was dichotomously coded (Dependent vs Independent). "ADL dependent" was defined as "have difficulty and need help" or "cannot do it" in any ADL item.

SES

Educational attainment and Personal annual income were used to determine SES. Education levels were classified as "Primary school and below" and "High school and above". Personal annual income was categorized to "≤10000", "10000-20000" and "≥20000" [21].

Socio-demographic characteristics

The socio-demographic variables considered in the analysis were age(60-69, 70-79, 80-89, ≥90 years); gender (male/female); marital status (married, unmarried).

2.3 Patient and public involvement

The study did not involve patients. The results of the survey are disseminated to the public through websites of the public county councils.

2.3 Statistical Analysis

All statistical analyses were conducted with SPSS (Statistical Package for the Social Science) V.22 for Windows. Data are presented with percentages and proportions for categorical values. The Pearson chi-squared test was applied for categorical data to access statistical differences between groups. Binary logistic regression analysis was also used to identify the potential risk factors for the different domains of depressive symptoms. Ordered logistic regression was used to examine the relationship between SES, housing conditions and depression. Then the adjusted covariates including age, gender, marital status, number of NCDs, disability and ADL were added. Finally, four ordered logistic regression models were established.

3. Results

Demographic characteristics

Of the 4585 rural participants (2529 men and 2056 women), 3008(65.61%) were married and 1577 (34.39%) were unmarried elderly. The participants ranged in age from 60 to 102 years (mean 69.46±7.34), with 59.15% between the ages 60 and 69. More than 4333 (90%) were primary school and below, nearly four-fifth (79.45%) had lowest personal annual income, nearly three-fifth (2615) had two kinds of chronic diseases. Among the participants in this article, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in rural China (Table 1).

Demographic factors associated with depression: Univariate findings

A univariable analysis revealed that 8 demographic variables are associated with depression using $\chi 2$ tests at a significance level of 0.05 (Table 1). Compared to those without depressive symptoms,

participants with depression symptoms had lower education level and personal annual income, had a worse health status (57.61% older had 1-2 NCDs and 55.58% had disabilities) except for ADL limitation which only 19.90% were dependent. The percentage of married participants who experience depression was significantly higher than that of those unmarried. Chi-square tests revealed that age, gender, marital status, education level, number of NCD_S, disabilities status and ADL limitations all had significantly association among different depressive symptoms.

Table 1 Bivariate association between depressive symptoms and socio-demographic characteristics, SES and health status

Variable	Total n (%)	Depressive symptoms		*p*
		Not depressed n (%)	Depressed n (%)	
Age (years)				
60-69	2712(59.15)	1539(62.33)	1173(55.43)	< 0.001
70-79	1350(29.44)	711(28.80)	639(30.20)	
80-89	476(10.38)	205(8.30)	271(12.81)	
≥90	47(1.03)	14(0.57)	33(1.56)	
Gender				
Male	2529(55.16)	1530(61.97)	999(47.21)	< 0.001
Female	2056(44.84)	939(38.03)	1117(52.79)	
Marital status				
Married	3008(65.61)	1735(70.27)	1273(60.16)	< 0.001
Unmarried	1577(34.39)	734(29.73)	843(39.84)	
Education				
Primary school and below	4333(94.50)	2309(93.52)	2024(95.65)	0.002
High school and above	252(5.50)	160(6.48)	92(4.35)	
Personal annual income				
≤10000	3643(79.45)	1871(75.78)	1772(83.74)	< 0.001
10000-20000	556(12.13)	334(13.53)	222(10.49)	
≥20000	386(8.42)	264(10.69)	122(5.77)	
Number of NCDs				
0	698(15.22)	458(18.55)	240(11.34)	< 0.001
1-2	2615(57.03)	1396(56.54)	1219(57.61)	
≥3	1272(27.74)	615(24.91)	657(31.05)	
Disability				
Yes	2175(47.44)	999(40.46)	1176(55.58)	< 0.001
No	2410(52.56)	1470(59.54)	940(44.42)	
ADL				

Unimpaired	3828(83.49)	2133(86.39)	1695(80.10)	< 0.001
Impaired	757(16.51)	336(13.61)	421(19.90)	

Housing conditions associated with depression: Univariate findings

Table 2 lists the frequency distributions of the housing condition variables across the outcome variable (depressive symptoms). It is particularly striking that 59.40% and 88.99% responders, who were depressed, reported using polluting cooking fuel and toilet without seat respectively. Chi-square tests revealed that housing materials, cooking fuel, type of toilet, running water, shower or bath facility had significant differences in depressive symptoms. In addition, other housing condition variables, such as the years of house, housing structure, indoor temperature, number of bedrooms and heating system were also analyzed while these variables all had no significantly difference among different depressive symptoms.

Table 2. Percentage distribution and the prevalence of depressive symptoms and housing conditions

Variable	Total n (%)	Depressive symptoms		*p*
		Not depressed n (%)	Depressed n (%)	
Housing materials				
Improved	3567(77.80)	1958(79.30)	1609(76.04)	0.008
Unimproved	1018(22.20)	511(20.70)	507(23.96)	
Cooking fuel				
Clean fuel	1993(43.47)	1156(46.82)	837(39.56)	< 0.001
Polluting fuel	2544(55.50)	1287(52.13)	1257(59.40)	
others	48(1.05)	26(1.05)	22(1.04)	
Type of toilet				
Toilet with seat	603(13.15)	370(14.99)	233(11.01)	< 0.001
Toilet without seat	3982(86.85)	2099(85.01)	1883(88.99)	
Running water				
Yes	3128(68.22)	1729(70.03)	1399(66.12)	0.005
No	1457(31.78)	740(29.97)	717(33.88)	
Shower or bath facility				
Yes	1916(41.79)	1128(45.69)	788(37.24)	< 0.001
No	2669(58.21)	1341(54.31)	1328(62.76)	

Binary logistic regression analysis of depressive symptoms: odds ratio (95% CI)

The results of the binary logistic regression analysis of the associations between SES, housing condition and depressive symptoms are shown in table 3. Model 1 included only controlled variables, including socio-demographic and health status factors, as a baseline model. In model 2, SES variables (marital status, education and income) were added to model 1 to explore association between SES and depressive symptoms separately. In model 3, housing conditions variables were added to model 1 to explore the impact of housing conditions on depressive symptoms separately.

Model 4 added housing conditions and SES variables to model 1 to explain the impact of SES, housing conditions on depressive symptoms after controlling other variables.

The final regression model (model 4) showed that personal annual income, cooking fuel, type of toilet and bath facility were significantly and independently associated with depression. However, depression had no significant association with education and other housing condition variables. Elderly participants with lowest personal annual income (≤10000) were 1.6 times more likely to have depression compared to participants with highest personal annual income (≥20000) [OR = 1.63, 95% CI (1.290-2.060)]. Older individuals used polluting cooking fuel were nearly 1.2 times more likely to have depression than those used clean cooking fuel [OR = 1.16, 95% CI (1.018-1.321)]. Older individuals used toilet without seat and not had bath facility, were almost 1.3 and 1.2 times separately, more likely to have depression than those used toilet with seat [OR = 1.273, 95% CI (1.056-1.535)] and had bath facility [OR = 1.172, 95% CI (1.025-1.341)] (Table 3).

Table 3. Relative risk (and 95% confidence intervals) for the associations between housing condition and depressive symptoms

Variable		Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
Age (60-69)	70-79	1.080(0.940-1.240)	1.055(0.918 -1.212)	1.062 (0.924 -1.220)	1.043(0.907-1.199)
	80-89	1.334**(1.079-1650)	1.322**(1.069-1.636)	1.356**(1.095-1.679)	1.343**(1.085-1.664)
	≥90	2.160*(1.127-4.141)	2.161*(1.125-4.149)	2.242*(1.165-4.314)	2.231*(1.159-4.295)
Gender (Male)	Female	1.668***(1.470-1.893)	1.638***(1.442-1.860)	1.678***(1.477-1.905)	1.650***(1.452-1.876)
Marital status (Married)	Unmarried	1.146(0.997-1.317)	1.121(0.975-1.289)	1.122 (0.976-1.291)	1.104 (0.960-1.271)
Number of NCDs (0)	1-2	1.428*** (1.193-1.710)	1.412*** (1.178-1.692)	1.422*** (1.187-1.704)	1.408*** (1.175-1.689)
	≥3	1.757*** (1.442-2.142)	1.741*** (1.427-2.124)	1.757*** (1.440-2.143)	1.743*** (1.428-2.128)
Disability (No)	Yes	1.621*** (1.433-1.834)	1.588*** (1.403-1.797)	1.571*** (1.388-1.778)	1.547*** (1.366-1.753)
ADL (Unimpaired)	Impaired	1.431*** (1.216-1.683)	1.432*** (1.217-1.686)	1.420*** (1.206-1.673)	1.422*** (1.207-1.676)
Education (High school and above)	Primary school and below		0.919(0.698-1.209)		0.933(0.709-1.229)
Personal annual income (≥20000)	10000-20000		1.354*(1.022-1.794)		1.290(0.972-1.713)
	≤10000		1.760*** (1.396-2.219)		1.630*** (1.290-2.060)
Cooking fuel (Clean fuel)	Polluting fuel			1.171*(1.029-1.334)	1.160*(1.018-1.321)
	others			1.005(0.552-1.827)	1.041(0.571-1.898)
Type of toilet (Toilet with seat)	Toilet without seat			1.308**(1.086-1.575)	1.273*(1.056-1.535)
Shower or bath facility (Yes)	No			1.200**(1.050-1.372)	1.172*(1.025-1.341)
Running water (Yes)	No			1.067(0.933-1.219)	1.065(0.932-1.218)
Housing materials (Improved)	Unimproved			1.018(0.876-1.183)	1.005(0.864-1.168)

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

4. Discussion

4.1. Key Findings

Our study examined the association between SES, housing condition and depressive symptoms in rural China. Among the participants in this article, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in rural China, which was consistent with previous population-based surveys in China that found up to 44.2% of rural-dwelling older adults to have depression and depressive symptoms [20, 21].

SES and depression

Using education and personal annual income as measures of SES, we found that education level was not associated with depressive symptoms as other studies have found [21]. Personal annual income was found to be a stronger factor in this study, elderly participants with lowest personal annual income (≤10000) were 1.6 times more likely to have depression compared to participants with highest personal annual income (≥20000). Depressive symptoms among the elderly in China are negatively related to better SES, in particular personal annual income. This result is consistent with what other studies in China have found for depression, but now replicated on a national sample and for the elderly population [21]. Further, it has been suggested that lower income may be related to poor access to health and mental health services, which can influence the diagnosis and treatment of depression, as patients are unlikely to have their health care needs attended to on a regular basis, and are even more unlikely to be screened for depressive disorders. How to approach these problems is outside the scope of this paper, but our findings highlight the importance of SES on the development of depressive symptoms in rural China.

Housing conditions and depression

Poor housing conditions (using polluting cooking fuel, toilet without seat and having no bath facility) was another factor that was found to be associated with depressive symptoms. Older individuals used polluting cooking fuel was nearly 1.2 times more likely to have depression than those used clean cooking fuel. Older individuals used toilet without seat and bath facility were almost 1.3 and 1.2 times more likely to have depression than those used toilet with seat and without bath facility.

In this article, there are 2544(55.50%) older people using polluting cooking fuel in rural China in 2015. Indoor air pollution (IAP), one of the major public health concerns in low- and middle-income or developing countries, mainly caused by the use of polluting cooking fuels such as coal, charcoal, crop residue and wood burning [22-24]. Globally, nearly 3 billion (40%) of the world's population, according to WHO report in 2016, relies on solid fuels, including coal and biomass for domestic cooking. Evidence shows that IAP is associated with poor physical health [25-28]. Prior researchers have identified IAP as the most important environmental risk factor globally associated with adverse health effects ranging from respiratory infections to chronic illness such as tuberculosis, chronic obstructive pulmonary disease, and cancer [29-31]. According to WHO report, globally almost 4.3 million deaths annually have been attributed to IAP resulting from cooking fuel in low- and middle-income countries in 2016. However, there is little empirical evidence on the relationship between IAP and psychological or mental health such as anxiety and depression based on nationally representative and longitudinal data, especially in developing country [32-34]. Generally speaking, however, the negative effects of polluting cooking fuel on depressive symptoms have not been given enough attention, especially in the older population which primarily because of the effect of indoor air pollution on depression largely dependent upon the social vulnerability and mental resilience

among different population group.

Our research shows that 3982 older still using toilet without seat in rural China which accounted for 86.85%. Very little research has explored the relationship between toilet type and depressive symptoms. Researches on health, especially on microbiological pollution have demonstrated that the species of microbes on the squat pans are roughly same as the toilet, while the numbers alone is much more [35, 36]. As a result, the possibility of transmitting the virus through the air is greater. Some other previous investigations have suggested that the using of squat pans over time can cause anal fissure to a certain extent, raise the risk of dizziness due mainly to the lack of oxygen to the brain which result from resuming blood circulation and flow to lower limb artery after long time using of squat pans, even lead to fall, the cardio-cerebral vascular accident such as cerebral hemorrhage and angina pectoris, especially among constipation patients [37, 38]. Maybe we can deduce from these existing researches that the existence or deterioration of chronic diseases resulting from using toilet without seat may lead to a greater possibility of depression among older, especially those with high blood pressure, heart disease, chronic bronchitis and other senile diseases.

Finally, in terms of the relationship between shower/bath facility and depressive symptoms, there are 2669(58.21%) older reported that the shower/bath facility is not available among respondents in 2015. We found few articles involved the relationship between the available of bath facilities and health outcome [39]. Our findings underscore the importance of the available of bath facilities on depressive symptoms among elderly in rural China.

4.2. Limitations

The main limitations of this study were a cross sectional study design and its use of self-reports data. This study cannot use the Geriatric Depression Scale (GDS) to assess the screen for depression in the elderly according to original data. Finally, we used screening instruments of depression only while no diagnostic instrument was used to further confirm depression.

5. Conclusions

Using a large nationally representative sample of elderly in rural China, we concluded that elderly in rural china experienced severe depressive symptoms. The study identified lowest personal annual income, polluting cooking fuel, toilet without seat and not having bath facility were significantly associated with more depressive symptoms. Older adult living in rural areas are the vulnerable group which facing multiple serious health inequity. Therefore, this study emphasize that SES and housing conditions are important for this vulnerable group and should at least be part of the current governmental intervention to improve depressive symptoms. In addition, further studies should investigate the rural-urban differences of elderly adults using a prospective design.

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

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 2: Paragraph 1-4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 2: The last Paragraph 5
Methods			
Study design	4	Present key elements of study design early in the paper	Page 3: The first paragraph in page 3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 3: Paragraph 2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 3: Paragraph 2-3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 3-4: In the section' Assessment and Measurements'
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 3-4
Bias	9	Describe any efforts to address potential sources of bias	Page 3 Paragraph 3
Study size	10	Explain how the study size was arrived at	Page 3 In the section: Setting and Participants
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 4 In the section: Statistical Analysis
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			Page 4-7
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included	Page 4

		in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 4
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	Page 4-6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 4-7
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 4-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 9

*Give information separately for exposed and unexposed groups.

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

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The Role of Socio-Economic Status and Housing Conditions in Geriatric Depression in Rural China: a cross-sectional study

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The Role of Socio-Economic Status and Housing Conditions in Geriatric Depression in Rural China: a cross-sectional study

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Abstract:

Objectives: The primary aim of this study was to describe SES, housing conditions and depression of the elderly in rural China as well as to examine the associations between depression and SES and housing conditions using China Health and Retirement Longitudinal Study (CHARLS).

Design: cross-sectional study.

Setting: A nationally representative sample of elderly in rural China.

Participants: 4585 elderly adults in 2015 in rural China.

Outcome measures: Prevalence, risk factors of depression among rural elderly.

Results: Among the participants in this study, approximately 46.15% (2,116/4,585) reported depressive symptoms (CESD-10 score >10) in rural China. The results revealed significant associations between higher scores on CES-D 10 (indicating more symptoms of depression) and lowest personal annual income [OR = 1.63, 95% CI (1.290-2.060)], polluting cooking fuel [OR = 1.16, 95% CI (1.018-1.321)], toilet without seat [OR = 1.273, 95% CI (1.056-1.535)] as well as having no bath facility [OR = 1.172, 95% CI (1.025-1.341)] after adjustment for confounders.

Conclusion: Elderly in rural china experienced severe depressive symptoms. Lowest personal annual income, polluting cooking fuel, toilet without seat and having no bath facility were significantly associated with more depressive symptoms. Caution need to be taken in generalizing the findings of this study to the rest of the population in China since its highly selected sample.

Keywords: SES, housing conditions; depressive symptoms; older people; rural china

Strengths and Limitations of this study

- The study is based on the nationally representative data all China contributes to implementation of cross-country comparisons and to collection of much more information about the effect of SES and housing conditions on depressive symptoms.
- The main limitations are a cross-sectional study design and its use of self-reports.
- There was no further clinical diagnosis and treatments for the participants who met the screening criteria according to CES-D, in the original research.

1. Introduction

Ageing is one of the most conspicuous phenomena in the contemporary world [1]. Between 2015 and 2050, the proportion of the world's older adults is estimated to almost double from about 12% to 22%. In absolute terms, this is an expected increase from 900 million to 2 billion people over the age of 60[2]. While population ageing is a global phenomenon that the progress is fastest in developing countries, especially in China. In 2016, the Chinese population aged above 60 years old was over 230 million, which will further increase to 480 million by 2050 [3].

Older adults face special physical and mental health challenges that need to be recognized. According to a World Health Organization report published in 2017, over 20% of the older adults suffered from the mental or neurological disorder (excluding headache disorders), and 6.6% of all disability among people over 60 years was attributed to mental and neurological disorders. Depression, one of the most common mental and neurological disorders, affects approximately 7% of the world's older population and comprises a substantial proportion of the global burden of disease. Depression of the Chinese older population first captured the research attention in the 1980s and emerged as a growing concern since the 1990s [4].

Depression in the elderly is often a function of many contributing factors, which include biological, psychosocial or environmental characteristics. Socioeconomic status (SES), an important indicator of social structures, has consistently been found to be associated with geriatric depression. Some previous studies have showed poor SES is related to the decrease in ability to manage stress, and further reduces the ability to deal with negative emotions and cognitions [5-8].

Housing conditions, as an important social determinant of health, its association with the process of depressive symptoms developing is well documented in the literature [9-11]. Housing conditions may encompass tangible and observable attributes such as physical structure, design and housing facility. The association between housing conditions has been investigated in several studies, particularly in urban areas [12]. Some previous studies have showed the relationship between mental health and different aspects of urban housing conditions [13-15]. However, research on housing conditions and depression among rural population is remarkably underdeveloped. Few studies have discussed in more detail about the impact of rural housing conditions on depressive symptoms among the elderly, especially in China [16, 17]. In rural China, the poor physical housing conditions may lead to a greater possibility of depressive symptoms. With development and urbanization, it is necessary to further focus on the relationship between rural housing conditions and mental health, which have significant effect on the construction of the age-friendly environments and further reducing the health inequality between urban and rural population.

It is important to identify factors associated with depression in rural population. Therefore, the primary aim of this study was to describe SES, housing conditions and depression in this population, as well as to examine the associations between depression and SES and housing conditions. We believe our study will improve understanding of the complex nature of the relationship between SES, housing conditions and the developing of depressive symptoms among rural elderly population in developing country.

2. Materials and Methods

2.1. Study Design

A cross-sectional design was used. The data were based on the third wave of nationally representative China Health and Retirement Longitudinal Study (CHARLS) in 2015.

2.2 Setting and Participants

CHARLS used a multi-stage stratified probability-proportional-to-size sampling (PPS) technique to select participants. Face-to face interviews were conducted to collect detailed information on participants. 21,095 respondents of 150 counties/districts and 450 villages/resident committees, participated during the third wave in 2015. More detailed CHARLS survey design has been described elsewhere [18-20].

The sample only included adults aged 60 and above who lived in rural China. The inclusion criteria were: (1) age ≥60, (2) living at the survey site for at least 6 months, (3) being at home during the investigation period, and (4) able to participate in the study. Subjects with mental retardation and severe cognitive impairment had been excluded from original research by using a short screening form. Thus, the number of respondents eligible for our analysis dropped to 4585 rural elderly.

2.2. Assessment and Measurements

Depressive symptoms

Depressive symptoms were screened by the 10-item Center for Epidemiologic Studies Depression Scale (CES-D) short form. The time frame for the CES-D questions refers to the week prior to the interview. Each item was rated on a 4-point Likert scale with answers varying from 'rarely or none of the time (0-1 day)' to 'most or all of the time (5-7 days)', the total of score ranges from 0 to 30, with a lower score indicating a lower level of depressive symptoms. CES-D has shown good validity and reliability in the Chinese population [21]. A previous validation study found a cut-off point of 10 had reasonable levels of sensitivity and specificity in Chinese older adults. Hence, a cut-off point of 10 was used in this study to generate the binary depressive symptoms variable. Those participants with total scores of more than 10 were categorized as depressed. The CESD-10 has been described in detail elsewhere [22].

Housing conditions

Five variables were used to measure housing conditions: years of house building; housing structure; housing materials were dichotomized as "improved material" (Concrete and steel/Bricks and wood) and "unimproved material" (Adobe, Wood, Cave dwelling, Mongolian yurt/ Woolen felt, Stone); number of bedrooms; cooking fuel (clean fuel/ polluting fuel/ others); housing facility (availability of toilet, running water, shower or bath facility, heating system, telephone connection and Internet connection). These facilities were all categorized as "0= yes" (available) and "1= no" (unavailable) while toilet was categorized to "0=Toilet with seat" and "1=Toilet without seat".

Number of Non-communicable diseases (NCD_S)

NCDs was assessed as the cumulative number of diagnosed chronic conditions (hypertension, dyslipidemia, diabetes, cancer, chronic lung diseases, liver or gallbladder disease, heart disease, stroke, kidney disease, stomach or other digestive disease, emotional, nervous, or psychiatric problems, memory-related disease, rheumatism/arthritis, asthma) that information collected from the clinical records available with the participants. It was categorized to: "0", "1-2" and "3 and above". "0" was defined as participants had no any diagnosed chronic conditions. [22].

Disabilities status

It was measured by asking "Do you have one of the following disabilities". Responders were categorized as "yes" when they had any disability of physical disabilities, brain damage/mental retardation, vision problem, hearing problem and speech impediment.

ADL

ADL limitations indicate any self-reported difficulty in any of the following six activities of daily living: eating, dressing, getting into or out of bed, using toilet, bathing/showering, or controlling urination and defecation. The four response options were: 1= "I don't have any difficulty", 2 = "I have difficulty but can still do it", 3 = "I have difficulty and need help", 4 = "I cannot do it". It was dichotomously coded (dependent vs independent). "ADL dependent" was defined as "have difficulty and need help" or "cannot do it" in any ADL item.

SES

Education level and Personal annual income were used to determine SES. Education level was classified as "Primary school and below" and "High school and above". Personal annual income (RMB) was categorized to "≤10000", "10000-20000" and "≥20000" [22].

Socio-demographic characteristics

The socio-demographic variables considered in the analysis were age(60-69, 70-79, 80-89, ≥90 years); gender (male/female) and marital status (married, unmarried).

2.3 Patient and public involvement

The study did not involve patients. The results of the survey are disseminated to the public through websites of the public county councils.

2.3 Statistical Analysis

All statistical analyses were conducted with SPSS (Statistical Package for the Social Science) V.22 for Windows. Data are presented with percentages and proportions for categorical values. The Pearson chi-square test was applied for categorical data to access statistical differences between groups. Binary logistic regression analysis was used to identify the potential risk factors of depressive symptoms. Ordered logistic regression was used to examine the relationship between SES, housing conditions and depression. Then the adjusted covariates including age, gender, marital status, number of NCDs, disability and ADL were added. Finally, four ordered logistic regression models were established.

3. Results

Demographic characteristics

Of the 4585 rural participants (2529 men and 2056 women), 3008(65.61%) were married and 1577 (34.39%) were unmarried elderly. The participants ranged in age from 60 to 102 years (mean 69.46±7.34), with 59.15% between the ages 60 and 69. More than 4333 (90%) were primary school and below, nearly four-fifth (79.45%) had lowest personal annual income, nearly three-fifth (2615) had 2 kinds of chronic diseases. Among the participants in this study, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in rural China (Table 1).

Demographic factors associated with depression: univariate findings

A univariable analysis revealed that 8 demographic variables are associated with depression using $\chi 2$ tests at a significance level of 0.05 (Table 1). Compared to those without depressive symptoms, participants with depression symptoms had lower education level and personal annual income, had a worse health status (57.61% older had 1-2 NCDs and 55.58% had disabilities) except for ADL limitation which only 19.90% were dependent. The percentage of married participants who experience depression was significantly higher than that of those unmarried. Chi-square tests

revealed that age, gender, marital status, education level, number of NCD_S, disabilities status and ADL limitations all had significantly association with depressive symptoms.

Table 1 Bivariate association between depressive symptoms and socio-demographic characteristics, SES and health status

Variable	Total n (%)	Depressive symptoms		*p*
		Not depressed n (%)	Depressed n (%)	
Age (years)				
60-69	2712(59.15)	1539(62.33)	1173(55.43)	< 0.001
70-79	1350(29.44)	711(28.80)	639(30.20)	
80-89	476(10.38)	205(8.30)	271(12.81)	
≥90	47(1.03)	14(0.57)	33(1.56)	
Gender				
Male	2529(55.16)	1530(61.97)	999(47.21)	< 0.001
Female	2056(44.84)	939(38.03)	1117(52.79)	
Marital status				
Married	3008(65.61)	1735(70.27)	1273(60.16)	< 0.001
Unmarried	1577(34.39)	734(29.73)	843(39.84)	
Education				
Primary school and below	4333(94.50)	2309(93.52)	2024(95.65)	0.002
High school and above	252(5.50)	160(6.48)	92(4.35)	
Personal annual income				
≤10000	3643(79.45)	1871(75.78)	1772(83.74)	< 0.001
10000-20000	556(12.13)	334(13.53)	222(10.49)	
≥20000	386(8.42)	264(10.69)	122(5.77)	
Number of NCDs				
0	698(15.22)	458(18.55)	240(11.34)	< 0.001
1-2	2615(57.03)	1396(56.54)	1219(57.61)	
≥3	1272(27.74)	615(24.91)	657(31.05)	
Disability				
Yes	2175(47.44)	999(40.46)	1176(55.58)	< 0.001
No	2410(52.56)	1470(59.54)	940(44.42)	
ADL				
Unimpaired	3828(83.49)	2133(86.39)	1695(80.10)	< 0.001
Impaired	757(16.51)	336(13.61)	421(19.90)	

Housing conditions associated with depression: univariate findings

Table 2 lists the frequency distributions of the housing conditions variables across the outcome

variable (depressive symptoms). It is particularly striking that 59.40% and 88.99% responders, who were depressed, reported using polluting cooking fuel and toilet without seat respectively. Chi-square tests revealed that housing materials, cooking fuel, type of toilet, running water, shower or bath facility had significant differences in depressive symptoms. In addition, other housing conditions variables, such as the years of house, housing structure, indoor temperature, number of bedrooms and heating system were also analyzed while these variables all had no significantly difference among different depressive symptoms.

Table 2. Percentage distribution and the prevalence of depressive symptoms and housing conditions

Variable	Total n (%)	Depressive symptoms		*p*
		Not depressed n (%)	Depressed n (%)	
Housing materials				
Improved	3567(77.80)	1958(79.30)	1609(76.04)	0.008
Unimproved	1018(22.20)	511(20.70)	507(23.96)	
Cooking fuel				
Clean fuel	1993(43.47)	1156(46.82)	837(39.56)	< 0.001
Polluting fuel	2544(55.50)	1287(52.13)	1257(59.40)	
others	48(1.05)	26(1.05)	22(1.04)	
Type of toilet				
Toilet with seat	603(13.15)	370(14.99)	233(11.01)	< 0.001
Toilet without seat	3982(86.85)	2099(85.01)	1883(88.99)	
Running water				
Yes	3128(68.22)	1729(70.03)	1399(66.12)	0.005
No	1457(31.78)	740(29.97)	717(33.88)	
Shower or bath facility				
Yes	1916(41.79)	1128(45.69)	788(37.24)	< 0.001
No	2669(58.21)	1341(54.31)	1328(62.76)	

Binary logistic regression analysis of depressive symptoms: odds ratio (95% CI)

The results of the binary logistic regression analysis of the associations between SES, housing conditions and depressive symptoms are shown in table 3. Model 1 included only controlled variables, including socio-demographic and health status factors, as a baseline model. In model 2, SES variables (marital status, education and income) were added to model 1 to explore association between SES and depressive symptoms separately. In model 3, housing conditions variables were added to model 1 to explore the impact of housing conditions on depressive symptoms separately. Model 4 added housing conditions and SES variables to model 1 to explain the impact of SES, housing conditions on depressive symptoms after controlling other variables.

The final regression model (model 4) showed that personal annual income, cooking fuel, type of toilet and bath facility were significantly and independently associated with depression. However, depression had no significant association with education and other housing conditions variables. Elderly participants with lowest personal annual income (≤10000) were 1.6 times more likely to

have depression compared to participants with highest personal annual income (≥20000) [OR = 1.63, 95% CI (1.290-2.060)]. Older individuals used polluting cooking fuel were nearly 1.2 times more likely to have depression than those used clean cooking fuel [OR = 1.16, 95% CI (1.018-1.321)]. Older individuals used toilet without seat and had no bath facility, were almost 1.3 and 1.2 times separately, more likely to have depression than those used toilet with seat [OR = 1.273, 95% CI (1.056-1.535)] and had bath facility [OR = 1.172, 95% CI (1.025-1.341)] (Table 3).

Table 3. Relative risk (and 95% confidence intervals) for the associations between housing conditions and depressive symptoms

Variable		Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
Age (60-69)	70-79	1.080(0.940-1.240)	1.055(0.918 -1.212)	1.062 (0.924 -1.220)	1.043(0.907-1.199)
	80-89	1.334**(1.079-1650)	1.322**(1.069-1.636)	1.356**(1.095-1.679)	1.343**(1.085-1.664)
	≥90	2.160*(1.127-4.141)	2.161*(1.125-4.149)	2.242*(1.165-4.314)	2.231*(1.159-4.295)
Gender (Male)	Female	1.668***(1.470-1.893)	1.638***(1.442-1.860)	1.678***(1.477-1.905)	1.650***(1.452-1.876)
Marital status (Married)	Unmarried	1.146(0.997-1.317)	1.121(0.975-1.289)	1.122 (0.976-1.291)	1.104 (0.960-1.271)
Number of NCDs (0)	1-2	1.428*** (1.193-1.710)	1.412*** (1.178-1.692)	1.422*** (1.187-1.704)	1.408*** (1.175-1.689)
	≥3	1.757*** (1.442-2.142)	1.741*** (1.427-2.124)	1.757*** (1.440-2.143)	1.743*** (1.428-2.128)
Disability (No)	Yes	1.621*** (1.433-1.834)	1.588*** (1.403-1.797)	1.571*** (1.388-1.778)	1.547*** (1.366-1.753)
ADL (Unimpaired)	Impaired	1.431*** (1.216-1.683)	1.432*** (1.217-1.686)	1.420*** (1.206-1.673)	1.422*** (1.207-1.676)
Education (High school and above)	Primary school and below		0.919(0.698-1.209)		0.933(0.709-1.229)
Personal annual income (≥20000)	10000-20000		1.354*(1.022-1.794)		1.290(0.972-1.713)
	≤10000		1.760*** (1.396-2.219)		1.630*** (1.290-2.060)
Cooking fuel (Clean fuel)	Polluting fuel			1.171*(1.029-1.334)	1.160*(1.018-1.321)
	others			1.005(0.552-1.827)	1.041(0.571-1.898)
Type of toilet (Toilet with seat)	Toilet without seat			1.308**(1.086-1.575)	1.273*(1.056-1.535)
Shower or bath facility (Yes)	No			1.200**(1.050-1.372)	1.172*(1.025-1.341)
Running water (Yes)	No			1.067(0.933-1.219)	1.065(0.932-1.218)
Housing materials (Improved)	Unimproved			1.018(0.876-1.183)	1.005(0.864-1.168)

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

4. Discussion

4.1. Key Findings

This study examined the association between SES, housing conditions and depressive symptoms in rural China. Among the participants in this article, approximately 46.15% (2,116/4,585) reported significant depressed (CESD-10 score >10) in rural China, which was consistent with previous population-based surveys in China that found up to 44.2% of rural-dwelling older adults have depression and depressive symptoms [21, 22].

SES and depression

Using education level and personal annual income as measures of SES, we found that education level was not associated with depressive symptoms as other studies have found [22]. Personal annual income was found to be a stronger factor in this study, elderly participants with lowest personal annual income (≤10000) were 1.6 times more likely to have depression compared to participants with highest personal annual income (≥20000). Depressive symptoms among the elderly in rural China are positively related to better SES, in particular personal annual income. This result is consistent with what other studies in China have found for depression, but now replicated on a national sample and for the elderly population [21]. Further, it has been suggested that poor SES may lead to poor access to mental health services, and further affect the diagnosis and treatment of depression, as it is very difficult for low-income populations to keep regular health care needs and be screened for depressive symptoms [8]. How to approach these problems is outside the scope of this paper, but our findings highlight the importance of SES on the development of depressive symptoms in rural China.

Housing conditions and depression

Poor housing conditions (using polluting cooking fuel, toilet without seat and having no bath facility) was found to be associated with depressive symptoms. Older individuals used polluting cooking fuel was nearly 1.2 times more likely to have depression than those used clean cooking fuel. Older individuals used toilet without seat and had no bath facility were almost 1.3 and 1.2 times more likely to have depression than those used toilet with seat and had bath facility.

In this study, there are 2544(55.50%) older people using polluting cooking fuel in rural China in 2015. Indoor air pollution (IAP), one of the major public health concerns in low- and middle-income countries, mainly caused by the use of polluting cooking fuels such as coal, charcoal, crop residue and wood burning [23, 24]. Globally, nearly 3 billion (40%) of the world's population, according to WHO report in 2016, relies on solid fuels, including coal and biomass for domestic cooking. Evidence shows that IAP is associated with poor physical health [25-28]. Prior researchers have identified IAP as the most important environmental risk factor globally associated with adverse health effects ranging from respiratory infections to chronic illness such as tuberculosis, chronic obstructive pulmonary disease, and cancer [29-31]. According to WHO report, globally almost 4.3 million deaths annually have been attributed to IAP resulting from cooking fuel in low- and middle-income countries in 2016. However, there is little empirical evidence on the relationship between IAP and psychological or mental health such as anxiety and depression based on nationally representative and longitudinal data, especially in developing country [32-34]. Generally speaking, the negative effects of polluting cooking fuel on depressive symptoms have not been given enough attention, especially in the older population which primarily because of the effect of IAP on depression largely dependent upon the social vulnerability and mental resilience among different population group.

Our study shows that 3982 older still using toilet without seat in rural China which accounted for 86.85%. Very little research has explored the relationship between toilet type and depressive symptoms. Researches on health, especially on microbiological pollution have demonstrated that the species of microbes on the squat pans are roughly same as the toilet, while the numbers alone is much more [35,36]. As a result, the possibility of transmitting the virus through the air is greater. Some other previous investigations have suggested that the using of squat pans over time can cause anal fissure to a certain extent, raise the risk of dizziness due mainly to the lack of oxygen to the brain which result from resuming blood circulation and flow to lower limb artery after long time using of squat pans, even lead to fall, the cardio-cerebral vascular accident such as cerebral hemorrhage and angina pectoris, especially among constipation patients [37, 38]. Maybe we can deduce from these existing researches that the existence or deterioration of chronic diseases resulting from using toilet without seat may lead to a greater possibility of depression among older, especially those with high blood pressure, heart disease, chronic bronchitis and other senile diseases.

Finally, in terms of the relationship between shower/bath facility and depressive symptoms, there are 2669(58.21%) older reported that the shower/bath facility is not available among respondents in 2015. We found few articles involved the relationship between the available of bath facilities and health outcome [39]. Our findings underscore the importance of the available of bath facilities on depressive symptoms among elderly in rural China.

4.2. Limitations

The main limitations of this study were a cross sectional study design and its use of self-reports data. This study cannot use the Geriatric Depression Scale (GDS) to assess the screen for depression in the elderly according to original data. Finally, we used screening instruments of depression only while no diagnostic instrument was used to further confirm depression.

5. Conclusions

Using a large nationally representative sample of elderly in rural China, we concluded that elderly in rural china experienced severe depressive symptoms. The study identified lowest personal annual income, polluting cooking fuel, toilet without seat and having no bath facility were significantly associated with more depressive symptoms. Older adults living in rural areas are the vulnerable group which facing multiple serious health inequity. Therefore, this study emphasize that SES and housing conditions are important for this vulnerable group and should at least be part of the current governmental intervention to improve depressive symptoms. In addition, further studies should investigate the rural-urban differences of elderly adults using a prospective design.

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Author Contributions: Xiao Ma conceived and designed the study; Mingwang Fang analyzed and wrote the paper; Gebremeskel Mirutse and Ling Guo were responsible for revising the work.

Patient consent: Not required

Ethics approval: The baseline data collection was obtained from the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015); The use of CHARLS data was obtained

from the University of Newcastle HREC (H-2015-0290).

Competing interests: None declared

Data sharing statement: No additional data are available.

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

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 2: Paragraph 1-4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 2: The last Paragraph 5
Methods			
Study design	4	Present key elements of study design early in the paper	Page 3: The first paragraph in page 3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 3: Paragraph 2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 3: Paragraph 2-3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 3-4: In the section' Assessment and Measurements'
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 3-4
Bias	9	Describe any efforts to address potential sources of bias	Page 3 Paragraph 3
Study size	10	Explain how the study size was arrived at	Page 3 In the section: Setting and Participants
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 4 In the section: Statistical Analysis
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			Page 4-7
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included	Page 4

		in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 4
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	Page 4-6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 4-7
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 4-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 9

*Give information separately for exposed and unexposed groups.

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