

Risk factors of geriatric depression in rural China based on a generalized estimating equation

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ABSTRACT

Background: The number of elderly individuals living in China is increasing rapidly. The aim of this study was to examine the potential risk factors of geriatric depression in rural areas.

Methods: A repeated cross-sectional study was conducted between January 2015 and October 2016 in rural China. Nine hundred forty-five elderly individuals were included in both investigations. A generalized estimating equation (GEE) was used to examine the relationships between geriatric depression and socio-demographics, the number of chronic diseases, ADL (*Activity of Daily Living*) disability, cognitive impairment, and anxiety.

Results: Among the participants, the majority was female (61.4%) and illiterate (81.5%) and had a general economic status (63.0%) and more than two kinds of chronic diseases (62.9%). The bivariate analysis indicated that geriatric depression was associated with social support, education level, economic status, ADL disability, anxiety disorders, and cognitive impairment at both survey time points. The GEE results showed that poor economic status (OR = 8.294, $p < 0.001$), the presence of more than two chronic diseases (OR = 1.681, $p = 0.048$), ADL disability (OR = 2.184, $p < 0.001$), cognitive impairment (OR = 1.921, $p < 0.001$), and anxiety (OR = 5.434, $p < 0.001$) were risk factors for geriatric depression in rural China; better social support (OR = 0.924, 95% CI = 0.899–0.949, $p < 0.001$) was found to be a protective factor.

Conclusions: Geriatric depression in rural China was associated with several socio-demographic, physical, and mental factors. Targeted interventions are essential to improve the psychological health of aged individuals in rural China.

Key words: geriatric depression, rural area, activity of daily life, anxiety, social support

Introduction

Societies with older ages are growing around the globe, especially in low- and middle-income countries (United Nations, 2014). It is expected that the proportion of people over the age of 60 years will reach 22% worldwide by 2050, totaling a startling 2 billion people (WHO Ageing and Life Course, 2015). In China, there were

222 million people who were 60 years of age or older at the end of 2015 (China National Bureau of Statistics, 2015). In addition, 60% of the elderly are scattered in rural areas (Xie *et al.*, 2010). Disparities between the inhabitants of rural and urban areas of China in terms of lifestyle, tradition, health awareness, economic factors, health services, and social and infrastructural support most assuredly exist (Wang, 2004). Elderly individuals living in rural areas without retirement allowances usually receive poorer quality health services and social support (Akhtar *et al.*, 2013). Therefore, the mental and physical conditions of the elderly living in rural areas of China are important issues that cannot be overlooked.

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The elderly are especially vulnerable to psychological disorders. Among the typical psychiatric problems ailing the elderly, depression is generally the most common one (Moss *et al.*, 2012). Depression is characterized by loss of interest, fatigue, and feelings of worthlessness and guilt and was reported to be ranked first in the global disease burden in terms of disability-adjusted life years (DALYs) by 2030 (World Health Organization, 2012). The prevalence of depressive symptoms among the elderly is high: 23.3% in southern Brazil (Goes *et al.*, 2017), 36.7% in Iran (Taheri Tanjanai *et al.*, 2017), and 11.4% in India (Behera *et al.*, 2016). Data drawn from the second wave of the China Health and Retirement Longitudinal Study (CHARLS) showed that more than 32.55% of the elderly in China had depression (Xu *et al.*, 2016). Depressive disorder is also a first-line cause of mortality (Kuehner, 2003) and disability in the aged population (Blazer *et al.*, 2001). Hypertensive patients with depressive disorder have a higher risk of sudden cardiac death (Ma *et al.*, 2015). Late-life depression could increase the risk of dementia (Jorm, 2000). Patients with depression in the senior age group were found to be more likely to commit suicide than depressed patients in other age groups (Xu *et al.*, 2000). A burgeoning aging population, together with a high prevalence of geriatric depression, will inevitably lead to a tremendous burden not only on individuals and families, but also on governments and societies. Monitoring and taking command of geriatric depression are essential.

However, a very few longitudinal studies have focused on geriatric depressive symptoms in rural areas of China. Moreover, there is a high proportion of illiterate individuals in rural China. Against this background and based on our research group's large-sample, cross-sectional study on the elderly (Zhao *et al.*, 2017), this longitudinal study was carried out to determine the effects of different factors (including social-demographics, activities of daily living, social support, cognitive function, and anxiety) related to depression among the aged population in rural China.

Methods

Participants

A repeated cross-sectional study survey was performed in the rural region of Ma'anshan City, Anhui Province. The participants were recruited using a cluster sampling method. A total of 3,182 older adults were successfully interviewed at the baseline. Both the recruitment of the baseline participants and the study design were described

extensively in our research group's previous study (Zhao *et al.*, 2017). We conducted the second investigation using the same design and data collection procedures. A total of 3,048 older adults were successfully interviewed the second time. Because of the new administrative district division, ultimately, a total of 945 elderly people completed both records. This study was approved by the Ethics Committee of Anhui Medical University, Hefei, China.

Procedure

Informed consent was obtained from all the included participants. At baseline, a house-to-house and face-to-face investigation was performed by public health postgraduate and undergraduate students. They were all coached by professional investigators before the interview. The participants were asked to provide information regarding their socio-demographic characteristics, social support, chronic diseases, activities of daily living, cognitive function, anxiety, and depression disorder. For illiterate individuals, some of these terminologies may have been difficult to understand. Thus, we transformed these self-reported questions to ask them neutral, straightforward questions in the local dialect. One year later, the participants were invited to complete the same questionnaires again at the second assessment.

Instruments

SOCIAL DEMOGRAPHIC QUESTIONNAIRE

A self-compiled demographic data questionnaire, including questions on gender (male, female), age (years), educational level (illiteracy, primary school, secondary school, high school or above), self-perceived economic status (good, middle, poor), and the number of chronic diseases (0, 1, ≥ 2), was administered to the participants.

GERIATRIC DEPRESSION SCALE-15 (GDS-15)

The GDS-15 scale (Sheikh and Yesavage, 1986), extracted from the GDS-30, contains 15 items. A systematic review suggested that the GDS has good validity within the Chinese population: Cronbach's α for the GDS was higher than 0.85, and the test-retest reliability was higher than 0.73 (Sun *et al.*, 2017). Moreover, a high correlation exists between the two scales ($r = 0.66$, $p < 0.001$) (Chan, 1996). This scale is frequently used as a special instrument for screening elderly patients with depression. The older adults were asked to express their feelings from the prior week using the GDS-15. Every item included two answers, namely, yes and no. The scores varied from zero to fifteen. Generally, a GDS-15 score of 0–7 is

considered normal and a GDS-15 score of 8–15 is considered depression, with higher scores indicating more severe depression.

SOCIAL SUPPORT RATING SCALE (SSRS)

The SSRS (Xiao, 1993) contains ten items and explores possible situations related to the following three subscales: (1) objective support (scores ranging from 1 to 22); (2) subjective support (scores from 8 to 32); and (3) support utilization (from 3 to 12). The item scores of the SSRS were simply added up (ranging from 12 to 66). Higher scores represented greater social support. This instrument had an internal consistency ranging from $\alpha = 0.89$ to 0.94 in the Chinese population.

ACTIVITY OF DAILY LIVING (ADL) SCALE

The ADL scale (Lawton and Brody, 1969) consists of the following two sections, with a total of 14 items: the physical self-maintenance scale, which included six items, and the instrumental activities of daily living scale, which included eight items. Each activity is evaluated by a scoring system ranging from 1 (independent execution of activities) to 4 (full dependence) points. The scale range is 14–56 points; scores <15 are considered to be in the normal range, and scores ≥ 15 indicate different degrees of ADL functional decline.

ZUNG SELF-RATING ANXIETY SCALE (SAS)

The SAS (Zung, 1971) was used to assess the levels of anxiety of the participants. This scale includes 20 questions, with each response using a 4-point scale ranging from “none” to “most of the time,” the standardized score of which is equal to the raw score times 1.25 (range 0–100). A total point score less than 50 represented no anxiety, whereas anything above 50 represented mean anxiety disorder. The internal reliability (α) of the Chinese version of the SAS is 0.93, and the validity (correlation with the Global Assessment Scale) is 0.71 (Li *et al.*, 2012).

MINI-MENTAL STATE EXAMINATION (MMSE)

Cognitive function was measured using the Chinese version of the MMSE (Katzman *et al.*, 1988). Participants' orientation, memory, attention, calculation, language, and written and visual construction abilities were assessed using the MMSE. This scale consists of 30 items, with scores ranging from 0 to 30. Cognitive decline was defined as a decline in the MMSE score ≥ 3 points at follow-up (Llewellyn *et al.*, 2010). The widely accepted cut-off score of cognitive impairment in China is education-specific, namely, 17 for illiteracy, 20 for primary school, and 24 for at least middle school.

Statistical analysis

The obtained results were analyzed with SPSS (version 11.0). First, descriptive analyses were performed to determine the distribution of the demographic factors at baseline. The means (SD) were reported for continuous variables, and the number (percentage) was presented for categorical variables. To compare the elderly who had depression with those without depression at baseline, we performed χ^2 tests and *t*-tests. According to this research design, second, generalized estimation equation (GEE) models with log links having robust variances were used to examine the association of the selected variables with geriatric depression. This approach accounts for the correlation between the repeated measures within a person. The GEE parameter estimates were expressed as the coefficients (β) and the 95% confidence intervals (95% CIs). A *p*-value <0.05 was considered to indicate statistical significance.

Results

Demographic characteristics

At the first survey (S1), the gender distribution was 38.6% male and 61.4% female. The age range was from 60 to 95 years, with a mean age of 72 years. Illiteracy was the most frequent education status (81.5%). Regarding self-reported economic status, 63.0% of the participants were at a general level (31.1% were poor, only 5.9% were good). More than half of the participants (62.9%) had at least two kinds of chronic diseases. Detailed characteristics of the participants are presented in Table 1.

Change in geriatric depression

During the two assessments, 45 (4.8%) individuals had consistent geriatric depression, and 682 (72.2%) study participants did not have depressive symptoms at the baseline survey (S1) nor at the second survey (S2) period. One hundred thirty-three (14.1%) individuals exhibited depression at the first survey but then no longer met the diagnostic criteria for depression at the final survey. In contrast, 85 (9.0%) elderly people without depression at S1 were diagnosed as having depression at S2. The characteristics of the participants with different depression statuses are shown in Table 2.

Characteristics of the participants with different depression statuses

The mean age of the no depression group was the lowest (70.7 ± 6.3 years), while that of

Table 1. Characteristics of participants with and without depression

VARIABLES	ALL OF SAMPLE 945	GERIATRIC DEPRESSION AT S1				GERIATRIC DEPRESSION AT S2			
		YES (N = 178)	NO (N = 767)	<i>t/χ</i> ²	<i>p</i>	YES (N = 130)	NO (N = 815)	<i>t/χ</i> ²	<i>p</i>
Age, mean(SD)	71.1(6.3)	72.8(6.3)	70.7(6.3)	-3.92*	<0.001	73.4(6.4)	72.3(6.4)	-1.75	0.080
Gender, %				2.78	0.096			2.29	0.130
Male	365(38.6)	59(33.1)	306(39.9)			42(32.3)	320(39.3)		
Female	580(61.4)	119(66.9)	461(60.1)			88(67.7)	495(60.7)		
Education, %				9.76	0.008			7.39	0.025
Illiteracy	770(81.5)	158(88.8)	612(79.8)			107(82.3)	593(72.8)		
Primary	129(13.7)	18(10.1)	111(14.5)			21(16.2)	168(20.6)		
At least middle school	46(4.9)	2(1.1)	44(5.7)			2(1.5)	54(6.6)		
Economic status,%				89.40	<0.001			73.76	<0.001
Poor	294(31.1)	107(60.1)	187(24.4)			99(76.2)	297(36.4)		
General	595(63.0)	70(39.3)	525(68.4)			28(21.5)	406(49.8)		
Good	56(5.9)	1(.6)	55(7.2)			3(2.3)	112(13.7)		
Chronic diseases, %				12.15	0.002			5.92	0.052
No	112(11.9)	16(8.9)	96(12.5)			10(7.7)	124(15.2)		
1	239(25.3)	30(16.9)	209(27.3)			42(32.3)	269(33.0)		
≥2	594(62.9)	132(74.2)	462(60.2)			78(60.0)	422(51.8)		
ADL disabilities, %				37.35	<0.001			22.45	<0.001
No	323(34.2)	26(14.6)	297(38.7)			21(16.2)	305(37.4)		
Yes	622(65.8)	152(85.4)	470(61.3)			109(83.8)	510(62.6)		
Anxiety, %				144.05	<0.001			40.40	<0.001
No	770(81.5)	89(50.0)	681(88.8)			96(73.8)	751(92.1)		
Yes	175(18.5)	89(50.0)	86(11.2)			34(26.2)	64(7.9)		
Cognitive impairment, %				16.94	<0.001			43.28	<0.001
No	549(58.1)	79(44.4)	470(61.3)			64(49.2)	626(76.8)		
Yes	396(41.9)	99(55.6)	297(38.7)			66(50.8)	189(23.2)		
Social support, mean(SD)	31.6(5.4)	29.4(5.8)	32.1(5.2)	5.7*	<0.001	28.8(6.3)	33.1(5.9)	7.76	<0.001

**t*-test, the others are χ^2 test.

the always depression group was the highest (73.9 ± 6.4 years). The elderly who presented with depression throughout the study period had higher percentages of females (68.9%), illiteracy (88.9%), poor economic status (62.2%), ADL disability (93.3%) and cognitive impairment (62.2%), and lower social support scores (28.4 ± 6.4).

Factors associated with geriatric depression: bivariate analysis

Table 1 also shows the characteristics of the 945 participants at the two assessments according to the presence or absence of geriatric depressive symptoms. The elderly with depression were of older ages and had more chronic diseases at S1. In both surveys, older individuals with geriatric depression had lower scores on social support, poorer education, and worse economic status and reported a greater proportion of ADL disability, anxiety disorders, and cognitive impairment.

Factors associated with geriatric depression: multivariate GEE analysis

The GEE suggested that geriatric depression was associated with economic status (poor: OR = 8.294, 95% CI = 3.124–22.023, *p* < 0.001; general: OR = 2.791, 95% CI = 1.057–7.372, *p* = 0.038), the number of chronic diseases (≥2: OR = 1.681, 95% CI = 1.004–2.814, *p* = 0.048), ADL dysfunction (OR = 2.184, 95% CI = 1.490–3.199, *p* < 0.001), anxiety (OR = 5.434, 95% CI = 3.866–7.640, *p* < 0.001), cognitive impairment (OR = 1.921, 95% CI = 1.447–2.549, *p* < 0.001), and social support (OR = 0.924, 95% CI = 0.899–0.949, *p* < 0.001). The results of the GEE are shown in Table 3.

Discussion

In our study, the prevalence of geriatric depression in rural China was 18.8% at baseline and 13.8% at the second assessment. This was much higher

Table 2. Characteristics of participants in different depression status at baseline

	NO DEPRESSION	ALWAYS DEPRESSION	DEPRESSION ONLY BASELINE	DEPRESSION ONLY FOLLOW-UP
<i>n</i>	682	45	133	85
Age, mean(SD)	70.7(6.3)	73.9(6.4)	72.4(6.3)	70.8(6.1)
Gender, %				
Male	277(40.6)	14(31.1)	45(33.8)	29(34.1)
Female	405(59.4)	31(68.9)	88(66.2)	56(65.9)
Education, %				
Illiteracy	541(79.3)	40(88.9)	118(88.7)	71(83.5)
Primary	99(14.5)	5(11.1)	13(9.8)	12(14.1)
At least middle school	42(6.2)	0(0)	2(1.5)	2(2.4)
Economic status, %				
Poor	156(22.9)	28(62.2)	79(59.4)	31(36.5)
General	471(69.1)	17(37.8)	53(39.8)	54(63.5)
Good	55(8.1)	0(0)	1(0.8)	0(0)
Chronic diseases, %				
No	93(13.6)	7(15.6)	9(6.8)	3(3.5)
1	187(27.4)	5(11.1)	25(18.8)	22(25.9)
≥2	402(58.9)	33(73.3)	99(74.4)	60(70.6)
ADL disabilities, %				
No	271(39.7)	3(6.7)	23(17.3)	26(30.6)
Yes	411(60.3)	42(93.3)	110(82.7)	59(69.4)
Anxiety, %				
No	608(89.1)	30(66.7)	59(44.4)	73(85.9)
Yes	74(10.9)	15(33.3)	74(55.6)	12(14.1)
Cognitive impairment, %				
No	419(61.4)	17(37.8)	62(46.6)	51(60.0)
Yes	263(38.6)	28(62.2)	71(53.4)	34(40.0)
Social support, mean(SD)	32.2(5.2)	28.4(6.4)	29.8(5.5)	31.5(5.4)

than the prevalence of 6.0% that was reported in Chen's study in Yingshang County, Anhui Province (Chen *et al.*, 2005), and slightly higher than the prevalence of 10.61% that was reported in Feng's study conducted in Xinjiang (Feng *et al.*, 2014). However, it was lower than the prevalence of 36.94% that was found in a recent study conducted in Lengshuijiang City, Hunan Province (He *et al.*, 2016). Overall, a decline in the prevalence of depression was found in our study. Several explanations give rise to this prevalence change. First, a previous study indicated that elderly individuals living in rural areas were more likely to have poor-quality healthcare services, increased suffering from chronic diseases, and finally depression (Alexopoulos, 2005). Similarly, we found that the elderly individuals with more than two chronic diseases were more likely to have depression. In recent years, the perpetually sophisticated basic medical facilities and convenient transportation have brought to individuals more convenient and better medical treatment. Thus, aged individuals should have a better physical status and a lower risk of depression. Second, previous studies have suggested that depressive symptoms

are more concentrated among aged individuals who live in disadvantaged economic situations (Yusuf *et al.*, 2013; Xu *et al.*, 2016). This notion is consistent with our finding that poor economic status may increase the risk of depression. With the development of industrialization, some elderly individuals have part-time jobs at nearby factories. In addition, poor elderly individuals can benefit from the anti-poverty project. A better income might lead to fewer psychosocial disorders. Third, we found that social support, similarly to an antecedent study (Chao, 2011), was highly associated with depressive symptoms. Increasing income support and greater concerns for weak, ill, and disabled aged individuals are buffers against depression in later life. Different measures of depressive symptoms were used, and thus direct comparisons should be made with caution. The improved conditions mentioned above may partly account for the difference. In addition, 4.8% of the individuals had consistent geriatric depression. This value is lower than that of Steinert's report, which reported that a percentage of 10–17% has a chronic course of depression in the general population (Steinert *et al.*, 2014).

Table 3. Multivariate analysis for associations between depression and covariates, performed by generalized estimating equations (GEE)

	OR	95% CI		WALD χ^2	<i>p</i> -VALUE
		LOWER	UPPER		
Age	0.99	0.963	1.019	0.462	0.497
Gender					
Female	0.94	0.651	1.358	0.108	0.743
Male	Ref				
Education					
Literacy	Ref				
Primary	1.123	0.711	1.774	0.247	0.619
At least middle school	0.484	0.159	1.48	1.617	0.204
Economic status					
Poor	8.294	3.124	22.023	18.029	<0.001
General	2.791	1.057	7.372	4.291	0.038
Good	Ref				
Chronic diseases					
No	Ref				
1	1.328	0.769	2.294	1.036	0.309
≥ 2	1.681	1.004	2.814	3.895	0.048
ADL disabilities					
No	Ref				
Yes	2.184	1.49	3.199	16.059	<0.001
Anxiety					
No	Ref				
Yes	5.434	3.866	7.64	94.851	<0.001
Cognitive impairment					
No	Ref				
Yes	1.921	1.447	2.549	20.419	<0.001
Social support	0.924	0.899	0.949	33.513	<0.001

Gender was found to be positively associated with depressive symptoms, namely women had a higher risk of suffering from depression (Zhang and Li, 2011). Females are more sensitive to some key factors of depression, such as rejection, separation, and criticism (Martel, 2013). However, the present study reported a non-significant association between gender and depression. In addition, age and education level were not found to be factors influencing vulnerability to depression in later life. This finding is in line with Behera *et al.*'s (2016) study but is not consistent with Weyerer *et al.*'s (2008) paper. Kim *et al.*'s (2014) study also suggested that illiteracy in elderly individuals was associated with a higher rate, and increased severity of depression. A possible explanation of this finding could be that the proportion of illiteracy in our study was too high (81.5%) to identify a relationship. In this study, the risk of later-life depression in a rural area of China was positively influenced by activity of daily living. A prior study (Schoevers *et al.*, 2000) came to the same conclusion: ADL dysfunction was a risk factor of geriatric depression. When

aged individuals are ADL disabled, they are in great need of help and care from others. In the rural area of this study, many young adults leave to earn their living. Nevertheless, there may be some disparities between rural and urban areas, such as a lack of volunteer organizations and community service centers in rural parts of the country. When ADL-disabled elderly feel incapable and hopeless, they are more likely to develop mental illnesses, including anxiety and depression.

Similar to the existing literature (Mirza *et al.*, 2017), we found that cognitive impairment increased the risk of geriatric depression. Several studies came to the opposite conclusion, stating that later-life depression precedes the development of mild cognitive impairment (MCI) and is a potential risk factor of MCI (Spira *et al.*, 2012; Steenland *et al.*, 2012). However, there were also some explanations that could make our finding plausible. Elderly with cognitive impairment are frequently forgetful and cannot perform well in daily life. Some of them fear they will develop dementia. These negative feelings are easy triggers

of psychiatric disorders. Moreover, Mirza *et al.* (2014) reported that later-life depression was a prodrome of dementia during short-term periods but not during long-term periods. This finding hinted that depression may be the intermediate stage between MCI and dementia. Several studies have shown that anxiety symptoms can predict later depressive symptoms across many time scales, ranging from hours to years (Starr and Davila, 2012; Jacobson and Newman, 2014; Starr *et al.*, 2014). In the same way, we found that anxiety was a risk factor of depression among elderly individuals living in rural China. A possible mechanism underlying this association could be that anxiety may lead to interpersonal dysfunction, which in turn elevates the risk of depression.

The results from this analysis may provide important policy implications for mental health among the elderly in rural China. More rigorous studies targeting the risk factors, control, and prevention of geriatric depression are needed. It is, therefore, imperative to develop more appropriate mental healthcare strategies to care for these aged individuals, such as better income support, more complete healthcare facilities, and more physical infrastructure, in rural China.

Several methodological limitations of our study need to be noted. First, elderly individuals with communicative disorders were excluded. Accordingly, this study may have had limited power in determining some of the associations. Second, only two assessments were conducted. It is likely that we will perform more assessments in the future. Finally, some data, such as the chronic disease and economic status information, were based on self-reported information. The vulnerability of self-reported data to information bias should be acknowledged.

Conclusion

In conclusion, the prevalence of depression among the elderly in rural China was high. The GEE results of our study showed that geriatric depression was associated with economic status, the presence of more than two chronic diseases, ADL disability, impaired cognitive function, anxiety, and poor social support. Further studies with larger samples that focus on the mechanism are warranted to verify our findings and to prevent geriatric depression in rural areas.

Conflict of interest

None.

Description of authors' roles

D.D. Zhao and C.Y. Hu were responsible for the data analysis and for writing the paper; J. Chen and Y.J. Huang performed the cluster sampling; B. Dong, Q.Q. Ren, and D.D. Yu performed the data collection; Y.Y. Zhao and J. Li were responsible for the research design; and Y.H. Sun assisted in the critical revisions of the paper.

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