Title: Association between Social Security and Depression among Older Adults: Evidence from the China Health and Retirement Longitudinal Study 2013

Running Title: Social security and depression in China

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Abstract

Objectives This study aims to examine the association between province level social security factors and depression symptoms among older adults in China.

Methods Respondents aged 65 and older were selected from the 2013 China Health and Retirement Longitudinal Study (CHARLS), Wave two (N=8,950). Based on 14 province level variables from the China Statistical Yearbook 2014, a principal component analysis was used to extract social security factors. A Bayesian random intercepts logistic model was used to measure the association between the three social security factors and depression symptoms while controlling for socio-demographic variables.

Results The principal component analysis identified that economic security, medical resource security, and social service security, together explained 82.6% of the total variance of the 14 province level variables. It was found that increasing economic security (odds ratio, OR = 0.694, 95% credible interval, 95% CI: [0.557, 0.856]) was significantly associated with a lower probability of depression symptoms. Uncertainty existed as to whether having a medical resource (OR = 1.07, 95% CI: [0.885, 1.28]) or social service security (OR = 0.875, 95% CI: [0.752, 1.016]) was associated with depression.

Conclusions Economic security, substantiated by the Chinese government's continuous health spending, is associated with a lower depression probability among older Chinese adults.

Keywords: Social Security, Depression, Aging, CHARLS.

Key Points:

1. Increased economic security is associated with reduced depression symptoms among older adults in China.
2. Being female, having an unmarried marital status, having non-Chinese Communist party membership, living in rural areas, and being under-educated are identified as the risk factors of depression symptoms among older adults in China.
3. Our study provides new insight on how to reduce the increasing rate of mental health disorders that is seen in other developing countries. Increasing governmental funding and guaranteeing economic security can reduce the potential depression symptoms among older minorities in developing countries.

1. Introduction

Depression is a globally significant health issue that is seen in the older population. Approximately 4% to 13% of the general older population have minor depression symptoms, while 1% to 4% have major depression symptoms.[1] Depression, often with other chronic conditions such as cognitive impairment and disability, leads to over 80% of the suicides seen among individuals 75 years or older.[2,3,1] A consensus has been reached that depression interventions as well as prevention can likely improve quality of life and reduce the suicide rates in this population.[4,5] Therefore, understanding the factors associated with depression in this population is needed in order to develop effective prevention approaches and treatment programs.

Although there has been a strict one-child policy that was implemented over 40 years ago, China is still the largest country in the world, with a population of 1.4 billion people and a rapidly growing aging society.[6] In 2016, the government relaxed the policy, allowing citizens to now have two children. Despite this change in policy, no baby boom spike has been observed in the new generation.[7] The size of the current older adults (over 65 years old) population is estimated to be over 400 million by 2050. This is characterized as an aging "tsunami" and will account for over 30% of the Chinese population.[8] Moreover, approximately one-third of the elderly citizens in China experience both severe depressive symptoms and psychological issues.[9] These mental disorders and depression symptoms have been shown to be associated with mortality and suicide rates.[10,11,9]

The government of China is not ignorant of the "ticking aging bomb". The pension scheme and universal medical insurance are two social security policies that have been targeted at the aging population. The pension scheme is based on an employee's wages before retirement as well as employer contributions.[12] Although a large variation exists in the social benefits of the pension schemes between developed Eastern cities and under-developed Western China cities, these savings will be returned to the employees after their retirement.[13,14] Furthermore, there are three medical insurance schemes, which include the rural new cooperative medical scheme (NCMS), the urban resident-based basic medical insurance scheme (URBMI) and urban employee-based basic medical insurance scheme (UEBMI). Medical insurance schemes account for over 90% of the medical service provided to citizens in China.[15] There are also social security schemes that aim to tackle the rapidly aging population structure in China. However, to the best of our knowledge, no prior study has examined the association between province-wide social security factors and depression symptoms among older adults in China. Given the rapidly increasing aging population and the high prevalence of depression among the older population,[8,10] understanding the specific social security factors associated with depression symptoms among this population may help to decrease the prevalence and create significant value in China.

This study attempts to address one the of main gaps in the literature on the association between social security and depression among older adults. Using the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative sample,[16] and social security data from the China Statistical Yearbook 2014,[17] this paper aims to examine the association between social security factors and depression among older adults in China.

2. Method

2.1. Data

To investigate both individual level and province level factors associated with depression, the authors merged two databases: the CHARLS Wave two in 2013[16] and China Statistical Yearbook 2014.[17] Designed using the Health and Retirement Study in the United States as a guide, the CHARLS is a nationally representative individual survey that is used to understand the social-economic status, health and community activities of Chinese citizens over 45 years old.[11,18] We included all respondents who were age 65 and older from 28 provinces in China, and the total sample size ended up at 8,950 (48.6% of the CHARLS Wave two survey data in 2013). In addition, the China Statistical Yearbook 2014 provided the province level social security variables for senior citizens.[17] The individual data from the CHARLS and the province level social security data from China Statistical Yearbook were merged according to a unique province identity number.

2.2. Measurements

2.2.1. Depression

The outcome variable is depression, which is a dichotomous variable based on the depression scores computed in the CHARLS data. There were ten depression questions in the Center for Epidemiologic Studies-Depression scale (CES-D) in CHARLS, including two positive questions and eight negative questions. The answers for the CES-D 10 questions were on a four-scale metric: rarely, some days (1-2 days), occasionally (3-4 days), and most of the time (5-7 days). The depression score was the sum of scores for these questions using the zero to three metric suggested by two previous studies.[18,19] We used a cutoff point of 12 (out of 30 as the maximum), as suggested by Cheng and Chan,[20] to dichotomize the depression outcome variable. It was recoded as one if the depression score of the respondent was above 12 and zero if it was not.

2.2.2. Social security variables

The authors used 14 province level social security variables from the China Statistical Yearbook 2014.[17] There were five variables with the unit of per person per month: funding levels for medical insurance, urban and rural standards for the minimum living guarantee, concentrated and scattered support levels for five-guarantee older individuals; there were nine variables with the unit of per 10,000 older population: governmental social welfare expenditure, the number of schools, associations, recreation rooms, legal aid centers, public service institutions, hospitals, medical workers and hospital beds, for senior citizens respectively.

Based on the variance inflation factor analysis, we found that these 14 province level social security variables were highly correlated. Adding them all in the same statistical models would have caused multicollinearity, making the results invalid. Therefore, we used the principal component analysis (PCA) to extract three linearly uncorrelated principal components from the 14 social security variables and then merge these principal components back to the CHARLS individual data.

2.2.3. Covariates

We also included covariates that may have biased the association between depression and social security principal components in the regression model. We kept age as a continuous variable since the study sample included only respondents over 65 years old and can not be categorized into young, middle-aged and older groups. Gender was a binary variable with the female as the reference group. Marital status was coded as married or unmarried (reference). Registered residency status, also known as hukou, was divided into rural or urban residence (reference). The political party categories included Communist or non-Communist (reference). Education was categorized as illiterate (reference), home or private education, elementary school, middle school, and high school or above. The respondents' self-rated living standard in their residency area was categorized as feeling worse (reference), about the same, and feeling better. Medical insurance and pension were dichotomous variables with "No" as the reference. Alcohol consumption was categorized as never (reference), less than once a month, and more than once a month.

2.3. Statistical Models

In our sample, less than 50 respondents were recruited in some provinces or cities (Shanghai, Xinjiang, Tianjin, and Beijing), so the traditional frequentist methods that rely on maximum likelihood or restricted maximum likelihood estimates are not adequate for the sparse data we used. In addition, these two estimation methods may not have been able to identify the desired model and produce valid estimates due to the sparse data that was available in our sample.[21] Bayesian regression model was a better analysis approach because it has prior information that can outweigh maximum likelihood estimation. Another important consideration was that the independent observation assumption was not met in our data, due to not only variation from province to province but also similarities within one province in terms of economic development, social policy, reimbursement level, and culture in China.[22,23,24] Therefore, instead of pooling individual data from different provinces or constructing 28 different models, a hierarchical logistic regression that partially pools individual respondents information and province level data was more appropriate for the data used in this study.[25,26,27]

Likewise, we fit a hierarchical (two-level) Bayesian random intercept logistic regression to explore the association between social security and depression in China. The random intercepts accounted for the similarities of economic level, social policy, and other factors shared within each province. In addition, with weakly informative priors, Bayesian methods can produce valid estimates in situations such as perfect separation or sparse data.[28,21] Bayesian inference also helps with clear result interpretations, simple and intuitive model checking, and complex model flexibility, all of which are becoming more propagated in the social sciences.[27,26]

For each respondent i in province P_i, $P_i = 1, 2, \ldots, 28.$, Y_i denotes the dichotomous binary depression variable, data matrix $\mathbf{X}$ denotes the three social security principal components, and all other covariates and β were the parameter vectors of interest. We modeled the depression outcome as random draws from a hierarchical logistic regression parameterized

as follows:

$$\begin{aligned} Y_i &\sim \text{Bernoulli}(p_i) \\ \text{Logit}(p_i) &= \beta_{0,P(i)} + \mathbf{X}'\beta \\ \beta_{0,P(i)} &\sim N(\mu, \sigma^2) \\ \mu &\sim N(0, 5^2) \\ \sigma &\sim \text{Gamma}(1, 1) \end{aligned} \tag{1}$$

$\beta_{0,P(i)}$ are the province level random intercepts. μ and σ are province level location and scale hyperparameters. We assigned weakly informative priors to these parameters to prevent potential issues with complete separation and the sparse data problem in the hierarchical logistic regression,[28] namely, $\beta, \mu \sim N(0, 5^2)$, $\sigma \sim$ Exponential(1). For the parameters of other covariates, we assigned relatively weak priors $N(0, 10^2)$. To ensure the convergence of Markov Chain Monte Carlo algorithm, we set 2,000 warm-up (burn-in) steps, 5,000 iteration steps, and four chains. We used the Gelman-Rubin statistics,[29] posterior trace plots, and the number of effective sample size to check the convergence of the Markov Chains.[30] The Bayesian inference in this study was performed using the R package `rstanarm`, which is based on a probabilistic programming language `Stan`.[31,30] Data cleaning and merging were conducted in Stata 13.0,[32] while statistical modeling and data visualization were performed in R 3.5.1.[33]

3. Results

Table 1 demonstrates the characteristics of our study population stratified by gender. Females (30.6%) had significantly higher depression rates than males (18.0%) in our study sample. The female group was more likely to be with rural registered residency (75% versus 87.7%), less likely to be a Chinese Communist party member (5.4% versus 20.9%) or married (75% versus 87.7%), less educated (51.6% illiterate versus 17.8%), and consumed more alcohol (85.9% consumed alcohol more than once a month versus 48.9%). Despite the statistical significance that potentially resulted from a relatively large sample size, there was not much economic significance in the difference between female and male groups in terms of age, living standard, medical insurance, and pension.

Figure 1 shows the percentage of total variance of the 14 province level social security variables explained by each principal component (PC). PC1 (39.5%), PC2 (28.6%), and PC3 (14.6%) together explained 82.6% of the total variance in the province level social security data, compared to PC4 to PC14 that accounted for less of the total variance compared to the previous three components, as seen in Figure 1. Therefore, we included PC1 to PC3 in our Bayesian hierarchical logistic regression model.

Table 2 shows the matrix of variable loading in PCA, which can be interpreted as the correlation between the original variables and the principal components. The factor loading of PC1 was primarily associated with funding levels for medical insurance, urban and rural standard for the minimum living guarantee, concentrated support levels for five-guarantee older individuals, and scattered support levels for five-guarantee senior citizens. Therefore,

PC1 can be considered as "Economic security" for senior citizens. Similarly, PC2 can be considered as "medical resource security" for senior citizens since it was primarily associated with the number of hospitals, medical workers, and hospital beds per 10,000 senior citizens. PC3 was named "social service security" for senior citizens since it was highly correlated with the numbers of schools, associations, recreation rooms, and legal aid centers per 10,000 senior citizens in China.

Table 3 shows the results of the Bayesian random intercepts hierarchical logistic regression. The Gelman-Rubin statistics[29] were all around one, and the effective sample sizes were all above 1,000 for the parameters that were used, which indicated the Markov chains were converged and parameter posterior estimates were valid.[31,30] The 95% credible interval (95% CI) of PC1 economic security did not include 0 (odds ratio, OR = 0.694, 95% CI: [0.557, 0.856]), which indicated that there was over 95% probability that increasing economic security was associated with lower depression symptoms. PC 2 medical resource security (OR = 1.07, 95% CI: [0.885, 1.28]) and PC3 social service security (OR = 0.875, 95% CI: [0.752, 1.016]) were positively and negatively associated with depression symptoms respectively, although the 95% credible intervals of the odds ratios included one. In terms of depression demographics, the results indicated that respondents who were male (OR = 0.598, 95% CI: [0.515, 0.691]), married (OR = 0.79, 95% CI: [0.674, 0.930]), a Chinese Communist party member (OR = 0.832, 95% CI: [0.668, 1.031]), and highly-educated were less likely to have depression symptoms. On the other hand, rural respondents (OR = 1.92, 95% CI: [1.594, 2.316]) had significantly higher chances of having depression symptoms compared to urban residents. There was a fair amount of uncertainty with the parameters of age, medical insurance, and pension as well as no clear association between these variables and depression symptoms.

4. Discussion

Despite the significant economic development and urbanization in China over the recent 30 years, mental illness has become one of the leading disease burdens among Chinese citizens.[34,22,10] This study explored the association between province level social security variables and depression symptoms in elder population using the nationally representative CHARLS database Wave two in China. We found that there was a high probability that economic security was negatively associated with depression symptoms, while there was much uncertainty in the association between medical resource security, social services, and depression. To the best of our knowledge, this is the first study to evaluate the association between province level social security factors and depression symptoms among senior citizens in China.

Our conclusion that economic security via increasing government funding and expenditure for senior citizens is associated with less depression might appear straight forward. However, it has been widely suspected that fast economic development, which supports the health expenditure of the older Chinese population, induces stressors such as noise and social isolation, leading to mental disorders.[35,36,37,10] An example of this is seen among young immigrants who move from rural to urban areas. They tend to have significantly higher

mental health scores than those who remained in rural areas.[38] As a result of social exclusion, discrimination, stigmatization, and working pressure, the immigrant population is prone to having mental health issues.[39,10] On the other hand, increasing government expenditure for mental health illness can help mitigate and eventually improve the psychological health and overall well-being of people in China.[15] Our analyses support this claim and continuous government health care spending seemed to have produced positive effects on health outcomes.

Although no previous studies have investigated the association between province level social security and depression, other literature have looked at the association between socioeconomic status and depression among senior citizens in China. The parameter estimate directions of socio-demographic variables in our study were consistent with the findings of previous studies. Being a female, a rural resident, under-educated, and unmarried senior citizen are all risk factors for depression symptoms and suicide as identified in previous studies.[20,40,41,42] Interestingly, Chinese Communist party members have a lower risk of having depression symptoms compared to non-Communist party members. Since China has a one-party-dominate system, it is expected that this finding is opposite of what is seen in most countries that have a multi-party political system. Being a Chinese Communist party member generally means having a major civic value and high socioeconomic status,[41] which explains the association that was found between Communist party membership and a lower chance of having depression symptoms.

Since depression and mental health disorders are more prevalent and highly associated with suicides in China,[23,42] our study findings suggest that the Chinese government's consistent investment in mental health prevention and treatment programs will help reduce the prevalence of depression. Although our study was based on the CHARLS database in China, it can still provide insight on ways of reducing mental health disorders for other developing countries as well. Increasing governmental funding and guaranteeing economic security for older minorities in these developing countries could help reduce the chances of having depression symptoms among this population.

This study does have several limitations. First, the depression variable in this study was based on self-reported data. Although the validity and consistency of the CES-D 10 questionnaires have been proven by several previous studies,[19,43,18] self-reported depression symptoms can rarely be independently verified and diagnosed since there are no objective golden standard for diagnosing depression. Second, we used province-level social security variables instead of city or county level variables due to limited publicly available access to this information. Despite the fact that social security policies and benefits tend to be similar within a province, they are subject to minor adjustments based on local fiscal revenue and government budget balance. Third, since the study is based on cross-sectional data from the CHARLS Wave 2 in 2013, we were not able to investigate the time trend and changing patterns of depression symptoms among the respondents. Future studies should link the respondents in different waves of the CHARLS through a common identification number and investigate the trends and changing patterns of factors associated with depression symptoms. Fourth, since the CHARLS is a second-hand database, we were not able to collect other potentially endogenous variables such as family depression history and community

engagement.

5. Conclusion

The number of older citizens in China is large and will continue to increase significantly over the next few few decades. Given the high prevalence and incidence rate of depression symptoms among the older population, the rapid increase in older Chinese citizens poses a huge threat on the well-being of the Chinese society. This study fills in the gap in previous literature because there is limited research on the association between province-level social security factors and depression symptoms among the older Chinese population. The findings from this study highlight the significant negative association that exists between economic security and depression symptoms among older adults in China. Our results imply that policy makers should prioritize interventions that are targeted at the economic security of the elderly. Future studies that use longitudinal survey data across multiple years are needed to confirm and quantify this association.

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Table 1: Characteristic of the study population by gender among the older adults in the CHARLS, 2014

	Female (n = 2955)	Male (n = 3178)	P-value
Depression = Yes (%)	905 (30.6)	571 (18.0)	<0.001
Age (mean (sd))	67.49 (6.41)	67.84 (6.34)	0.031
Marrital status = Married (%)	2217 (75.0)	2787 (87.7)	<0.001
Hukou = Rural (%)	2320 (78.5)	2353 (74.0)	<0.001
Political party = Communist (%)	161 (5.4)	664 (20.9)	<0.001
Education (%)			<0.001
Illiterate	1464 (51.6)	505 (17.8)	
Home or private education	578 (20.4)	702 (24.7)	
Elementary school	9 (0.3)	40 (1.4)	
Middle school	524 (18.5)	1020 (35.9)	
High school and above	261 (9.2)	573 (20.2)	
Living standard (%)			0.023
Feeling worse	2117 (71.6)	2204 (69.4)	
about the same	747 (25.3)	839 (26.4)	
Feeling better	91 (3.1)	135 (4.2)	
Medical insurance = Yes (%)	2841 (96.1)	3101 (97.6)	0.002
Pension = Yes (%)	2628 (88.9)	2903 (91.3)	0.002
Alcohol consumption (%)			<0.001
Never	253 (8.6)	1353 (42.6)	
Less than once a month	163 (5.5)	271 (8.5)	
More than once a month	2539 (85.9)	1554 (48.9)	

Table 2: The matrix of variable loadings in the PCA

Variable names	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14
Funding levels for medical insurance per month	0.392	0.042	-0.029	0.157	0.251	-0.067	0.178	-0.430	-0.188	-0.603	0.046	-0.342	0.122	0.051
The urban standard for minimum living guarantee per person per month	0.370	0.162	0.023	-0.067	0.096	0.192	-0.522	-0.276	-0.094	0.263	-0.351	-0.041	-0.400	0.273
The rural standard for minimum living guarantee per person per month	0.401	0.121	0.013	0.001	0.045	0.126	-0.332	-0.002	0.044	-0.056	0.033	0.485	0.472	-0.482
Concentrated support levels for five-guarantee senior citizens per person per month	0.408	-0.037	-0.008	-0.017	-0.041	0.013	-0.067	0.394	0.404	0.185	0.081	-0.651	0.066	-0.197
Scattered support levels for five-guarantee senior citizens per person per month	0.411	-0.013	-0.004	-0.007	-0.056	-0.127	0.014	0.390	0.071	-0.218	0.434	0.360	-0.231	0.485
Governmental social welfare expenditure of per 10,000 senior citizens	0.298	-0.276	-0.197	0.068	0.130	-0.199	0.368	0.304	-0.235	0.137	-0.631	0.147	0.105	0.049
The number of schools for older adults per 10,000 senior citizens	0.135	-0.159	0.494	0.026	-0.625	-0.434	-0.140	-0.104	-0.285	0.037	-0.032	-0.088	0.103	-0.010
The number of associations for older adults per 10,000 senior citizens	-0.016	-0.227	0.501	-0.361	0.585	0.020	-0.029	0.128	-0.334	0.179	0.220	-0.072	0.100	0.011
The number of recreation rooms for older adults per 10,000 senior citizens	0.090	-0.341	0.344	-0.352	-0.204	0.475	0.246	-0.125	0.378	-0.264	-0.242	0.116	-0.072	0.030
The number of hospitals per 10,000 senior citizens	-0.200	-0.347	-0.146	-0.224	0.206	-0.500	-0.461	-0.020	0.360	-0.305	-0.184	0.014	0.048	0.065
The number of medical workers per 10,000 senior citizens	0.221	-0.374	-0.190	-0.040	0.047	-0.228	0.218	-0.419	0.109	0.324	0.303	0.145	-0.379	-0.351
The number of hospital beds per 10,000 senior citizens	0.011	-0.448	-0.236	0.174	-0.086	0.249	-0.114	-0.218	0.007	0.277	0.190	-0.057	0.512	0.453
The number of legal aid centers for older adults per 10,000 senior citizens	-0.079	-0.242	0.388	0.793	0.220	0.074	-0.107	0.077	0.187	-0.037	-0.064	0.085	-0.177	-0.073
The number of public service institutions for older adults per 10,000 senior citizens	-0.061	-0.409	-0.287	-0.004	-0.171	0.322	-0.283	0.259	-0.467	-0.291	0.082	-0.114	-0.262	-0.274

PCs denote the principal components.

Table 3: Bayesian posterior distribution estimates of the random intercepts logistic regression model

Parameter	$\hat{R}$	n_eff	mean	sd	se_mean	2.5%	50%	97.5%
(Intercept)	1.000	9000	-0.567	0.447	0.005	-1.438	-0.567	0.305
Gender = Male	1.000	9000	-0.514	0.074	0.001	-0.663	-0.514	-0.370
Age	1.000	9000	-0.007	0.005	0.000	-0.018	-0.007	0.003
Marital status = Married	1.000	9000	-0.235	0.082	0.001	-0.395	-0.236	-0.073
Hukou = Rural	1.000	9000	0.650	0.096	0.001	0.466	0.650	0.840
Political party = Communist	1.000	9000	-0.184	0.111	0.001	-0.404	-0.182	0.031
Education reference = Illiterate								
Home or private education	1.000	9000	0.060	0.086	0.001	-0.109	0.059	0.228
Elementary school	1.000	9000	-0.120	0.091	0.001	-0.299	-0.120	0.059
Middle school	1.000	9000	-0.188	0.120	0.001	-0.426	-0.187	0.049
High school and above	1.000	9000	-0.199	0.177	0.002	-0.553	-0.197	0.145
Living standard Reference = Feeling worse								
about the same	1.000	9000	-0.510	0.079	0.001	-0.668	-0.510	-0.357
Feeling better	1.000	9000	-0.908	0.223	0.002	-1.350	-0.903	-0.482
Medical insurance = Yes	1.000	9000	-0.227	0.173	0.002	-0.560	-0.229	0.123
Pension = Yes	1.000	9000	-0.081	0.105	0.001	-0.282	-0.081	0.127
Alcohol consumption Reference = Never								
Less than once a month	1.000	9000	0.210	0.139	0.001	-0.068	0.211	0.478
More than once a month	1.000	9000	0.301	0.085	0.001	0.138	0.300	0.467
PC1: economic security	1.000	6612	-0.366	0.108	0.001	-0.585	-0.367	-0.156
PC2: medical resource security	1.000	6486	0.069	0.093	0.001	-0.122	0.071	0.244
PC3: social service security	1.000	5175	-0.133	0.075	0.001	-0.285	-0.133	0.016
Sigma	1.001	3205	0.107	0.048	0.001	0.043	0.097	0.225
mean_PPD	1.000	9000	0.241	0.007	0.000	0.226	0.241	0.256
log-posterior	1.001	2562	-3203.302	5.953	0.118	-3215.588	-3203.002	-3192.355

The $\hat{R}$ denotes the Gelman-Rubin statistic, the n_eff is the number of effective sample size, the mean is the posterior mean, sd is the posterior standard deviations, se_mean is the Monte Carlo standard error. The last three columns 2.5%, 50%, and 97.5% are the posterior quantiles at their percents.

Figure 1: Percentage of variance explained by each principal component