

The Impact of Social Participation on Mental Health in Old Age: Evidence from CHARLS

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Abstract

China is becoming a moderately aging society, and in the post-pandemic era, older adults are less willing to engage in social activities, which is affecting their mental health. Improving the well-being of the elderly and promoting active aging have become urgent priorities. This paper analyzes the impact of social participation on older adults' mental health using data from the China Health and Retirement Longitudinal Study (CHARLS) from 2011, 2018, and 2020. By using instrumental variables to tackle endogeneity issues, the study provides recommendations for government policies to support active aging. Key findings show that first, there is a positive link between social participation and mental health among the elderly, and the use of instrumental variables suggests that previous estimates may have underestimated this effect. Second, older women, those with partners, and individuals with lower education levels benefit more from social engagement. The paper calls for government initiatives to encourage social participation, develop livable environments, and ensure comprehensive health protection for older adults.

Keywords: Active aging; Mental health of the elderly; Social participation

1 Introduction

In recent years, the aging process of China's population has accelerated. According to data from the National Bureau of Statistics, by the end of 2023, the number of individuals over 60 years old in China will reach 297 million, accounting for 21.1% of the population, officially marking the transition to a moderately aging society. Wang Haidong, director of the Department of Aging at the National Health

and Health Commission, estimates that during the "14th Five-Year Plan" period, the total number of elderly people aged 60 and above will exceed 300 million, making up over 20% of the total population. By around 2035, this number is expected to surpass 400 million, representing more than 30% of the population and entering the stage of severe aging.

At the same time, the health status of the aging population is concerning. The National Health Commission reports significant declines in cognitive, motor, and sensory functions, alongside nutritional and psychological health issues among the elderly. Over 78% of older adults suffer from at least one chronic disease, and the number of disabled elderly individuals is rising. Zhao Yaohui, a Boya Distinguished Professor at Peking University, emphasized the global challenge of population aging, advocating for "healthy aging" as a viable solution. This concept aims to generate new health potential while reducing healthcare expenditures and care needs. Thus, addressing the worsening situation of population aging and achieving healthy aging are urgent issues for China.

In response to these challenges, the Chinese government has implemented several policies regarding health for the aging population and elderly care services. Since the 18th Party Congress, the government has prioritized the quality of life for older adults, integrating their health into the "Healthy China Construction" initiative, with a clear focus on safeguarding public health. The 14th Five-Year Plan of 2021 outlines a national strategy to actively respond to population aging, incorporating active and healthy aging concepts into economic and social development, thus creating a path tailored to China's unique circumstances.

The global COVID-19 pandemic, which began in December 2019, has further complicated the situation. While the epidemic is somewhat controlled, its impact lingers, ushering in a post-pandemic era characterized by long-term cohabitation with the virus. Elderly individuals, due to their fragile health and the prevalence of chronic illnesses, have heightened fears of infection. Consequently, they have reduced their social participation, with declining physical abilities making staying at home the safest preventive measure. This reduction in social engagement raises concerns about its effects on their mental health.

A review of the literature on social participation and geriatric mental health indicates that active social engagement is associated with better life satisfaction, higher self-esteem, reduced nursing home

admissions, and lower mortality rates among older adults (Glass et al., 1999; Unger et al., 1999; Reitzes et al., 1995). Social participation enhances health by providing a sense of meaning and increasing social support (Kawasaki et al., 2004; Kawachi & Berkman, 2001). For instance, volunteer activities improve mental health by expanding social networks, social prestige, access to resources, and emotional well-being (Moen et al., 1992). Relationships formed through participation fulfill needs for attachment, esteem, social approval, belongingness, social identity, and security (Antonucci & Jackson, 1987; Bandura, 1986). Chinese studies also support these findings, indicating that social participation improves the mental health of older adults. Wei & Wu (2015) argue that social participation fulfills the psychological, spiritual, and physical needs of the elderly, crucial for improving their health. Zhang & Zhang (2016) found that volunteer activities help maintain and enhance the physical and mental health of the elderly, allowing them to realize their life's value. Using instrumental variables, Yang & Wang (2020) and Gao & Wen (2018) established that active social participation significantly improves health outcomes for older adults.

Moreover, some research indicates that the impacts of social participation can vary significantly based on individuals' social characteristics. For example, Kavanagh et al. (2006) explored the influence of neighborhood-level political participation on self-rated health across genders, finding notable improvements in women's self-rated health but no significant effect on men. Similarly, Spanish research among older adults shows that friendships are linked to a protective effect against cognitive decline specifically for women (Zunzunegui et al., 2003). Conversely, some studies suggest potential drawbacks for women with high social participation. In certain contexts, increased engagement can lead to higher psychological distress due to "role strain," where women may feel pressured to provide extensive emotional support to others (Kawachi & Berkman, 2001). Strazdins & Broom (2004) discuss gendered norms related to the expectation of "emotional labor" within social relationships. Morrow-Howell et al. (2003) examined the interaction effects of gender and participation in volunteer activities on health outcomes in the U.S., finding positive effects overall but no statistically significant interaction effects with gender. These findings highlight the complex and multifaceted nature of how social participation impacts health, underscoring the need for further exploration into how specific demographic and social factors shape these relationships.

Despite the consensus that social participation enhances mental health in older adults, the extent of its impact across different demographic characteristics remains inconclusive. Additionally, factors like personality, family culture, and community-level institutional factors, along with potential reverse causality between mental health and social participation, complicate the findings. While instrumental variables have been employed to address these issues, the net effect of social participation on the health of older adults is still debated.

This paper empirically explores the impact of social participation on the mental health of older adults using CHARLS data from 2020, 2018, and 2011. OLS regression analysis indicates that participation in social activities improves mental health. To address potential omitted variables and reverse causality, the paper uses the presence of senior centers or community boardrooms as instrumental variables. The two-stage regression results show a stronger positive impact than OLS, suggesting an underestimation of the effect of social participation on mental health among the elderly. Additionally, the benefits of social participation vary by gender, marital status, and education level, with women, those with partners or spouses, and individuals with less than a bachelor's degree deriving greater mental health benefits.

The contributions of this paper include (1) utilizing specific instrumental variables to validate previous study results, (2) conducting sub-sample regressions to test the generalizability of findings across different demographics, and (3) providing policy recommendations. In the post-epidemic era, promoting social participation among the elderly is crucial for maintaining their health. Policies should encourage active engagement, create supportive community environments, and promote active aging.

The structure of this paper is as follows: the second part explores the effect of social participation on elderly mental health using OLS regression; the third part addresses endogeneity with instrumental variables; the fourth part presents robustness tests; and the fifth part concludes.

2 Data Description

All the data used in this study come from CHARLS, a large-scale, representative tracking survey of individuals aged 45 and older in mainland China. CHARLS aims to establish a high-quality public micro-database that collects comprehensive information across various dimensions, including socio-

economic and health status. To ensure the best international data collection methods and comparability, CHARLS has modeled its survey design on several prominent international aging research studies, including the Health and Retirement Study (HRS) in the United States.

The national baseline survey was conducted from 2011 to 2012, followed by four rounds of follow-up surveys in 2013, 2015, 2018, and 2020. Additionally, the Chinese Middle-aged and Elderly Life Course Survey was completed in 2014. The baseline survey covered 150 county-level units and 450 village-level units nationwide, involving 17,708 individuals across 10,257 households, thus reflecting the overall situation of China's middle-aged and elderly population. The outbreak of the COVID-19 pandemic in late 2019 and early 2020 necessitated a pause midway through the fifth round of the 2020 survey, which was subsequently extended from 2021 to 2023 (Zhao et al., 2023).

For our analysis, we selected the CHARLS databases from 2020, 2018, and 2011, with the 2020 dataset serving as the primary source. Instrumental variables were drawn from the 2011 database, while key independent and dependent variables were sourced from the 2020 dataset. Control variables were present in the 2011, 2018, and 2020 databases. According to the World Health Organization's (WHO) criteria, individuals aged 60-74 years are classified as "young elderly," those aged 75 years and above as "elderly," and those aged 90 years and above as "long-lived elderly." Due to significant declines in cognitive, motor, and sensory functions, as well as other health problems among those aged 90 and above, this group was excluded from the study. Consequently, only individuals aged 60 to 90 years were retained. After combining the datasets from 2011, 2018, and 2020 and eliminating samples with missing values and outliers, 7,581 valid samples were obtained.

Table 1 presents the distribution of the variables used in the OLS regression. Social participation is the core independent variable, with data sourced from the CHARLS 2020 questionnaire on health status and functioning, specifically item DA038: "Do you have the following social activities in the past month?" (multiple choice). The nine options are: 1) Visit people and socialize with friends; 2) Play mahjong, chess, cards, or visit the community activity room; 3) Help relatives, friends, or neighbors who do not live with you; 4) Dance, engage in fitness, practice Qigong, etc.; 5) Participate in community organization activities; 6) Engage in volunteer or charity activities, or care for patients or disabled individuals who do not live with you; 7) Attend school or training courses; 8) Other social activities; 9) None of the above. If option 9 is selected, social participation is assigned a value of 0;

otherwise, it is assigned a value of 1. From the table, it is evident that nearly half of older individuals have engaged in social participation in the past month, indicating that social participation among older adults in 2020 remains at a low level.

Table 1: Descriptive Statistics for Variables in OLS

	Mean	sd	Min	p50	Max
Social participation	0.465	0.499	0	0	1
Depression level	9.293	6.545	0	8	30
Demographic characteristic variables:					
Age	67.903	5.947	60	67	90
=1 if living in the village	0.665	0.472	0	1	1
=1 if female	0.497	0.500	0	0	1
=1 if with spouse/partner	0.798	0.402	0	1	1
=1 if has bachelor's degree and above	0.006	0.077	0	0	1
Personal behavioral variables:					
=1 if has social medical insurance	0.952	0.214	0	1	1
=1 if lived alone in the first half of this year	0.209	0.406	0	0	1
=1 if hospitalized in the past year	0.228	0.420	0	0	1
=1 if used the internet last month	0.236	0.425	0	0	1
=1 if employed	0.562	0.496	0	1	1
Household characteristic variables:					
=1 if poor household	0.163	0.370	0	0	1
Number of living children	2.806	1.345	0	3	10
Observations	7581				

The focus of this study is on the level of depression, which serves as an indicator of the mental health status of older adults. This measure is derived from respondents' answers to the short form of the Center for Epidemiologic Studies Depression Scale (CES-D10) included in the CHARLS 2020 questionnaire on health status and functioning. Of the ten items on the Depression Scale, eight are negatively worded statements and two are positively worded. Respondents were asked to select from four ratings that best reflected their feelings and behaviors over the past week. The four ratings are: rarely or not at all (<1 day); not too much (1-2 days); sometimes or half the time (3-4 days); and most of the time (5-7 days). For negative statements, the corresponding score assignments are as follows: 0, 1, 2, and 3 points. Conversely, for positive statements, the assigned scores are 3, 2, 1, and 0, respectively. The theoretical range of the final CES-D10 score is between 0 and 30, with higher scores indicating higher levels of depression and poorer mental health. The median depression score among the sample is approximately

9, suggesting that the overall mental health status of the older population is relatively low but still shows potential for improvement.

Control variables are categorized into three types: demographic characteristics, personal behaviors, and household characteristics. In terms of demographic characteristics, the mean age of respondents is 67, indicating that the sample primarily comprises relatively young older adults. Most participants reside in rural areas, have a spouse or partner, and the gender ratio is approximately equal. However, educational attainment is generally low¹, reflecting the historical context in which many older adults grew up—an era when college education was less accessible and emphasized, with more job opportunities available that did not require a degree.

Individuals' behaviors and their family environment significantly impact both their participation in social activities and their mental health; thus, these factors are included in the regression analysis. Except for lower internet usage, other covariates suggest better conditions for older age groups.

To assess the feasibility of our regression analysis, the sample was categorized based on social participation status.² Table 2 presents the results, highlighting the differences in depression levels and other control variables between the socially engaged and non-engaged populations. Although the differences in depression levels were not substantial, they were statistically significant. This finding suggests that social participation among older adults may indeed have a modest yet meaningful impact on their mental health.

¹ Information on highest level of education is from 2018 CHARLS data, and the remaining control variables are from 2020 CHARLS data.

² Complete descriptive statistics information on the variables can be found in the Appendix Table A. 2.

Table 2: Partial Descriptive Statistics by Social Participation

	(1)		(2)		(3)	
	With social participation	Mean	No social participation	sd	Difference	t-value
Depression level	8.913	6.405	9.624	6.648	0.710	4.719
Demographic characteristic variables						
Age	67.668	5.752	68.107	6.105	0.440	3.215
=1 if living in the village	0.624	0.484	0.700	0.458	0.076	7.047
=1 if female	0.509	0.500	0.487	0.500	-0.022	-1.908
=1 if with spouse/partner	0.793	0.405	0.802	0.399	0.009	0.955
=1 if has bachelor's degree and above	0.008	0.089	0.004	0.065	-0.004	-2.121
Personal behavioral variables						
=1 if has social medical insurance	0.960	0.197	0.945	0.228	-0.015	-2.983
=1 if lived alone in the first half of this year	0.222	0.415	0.197	0.398	-0.024	-2.574
=1 if hospitalized in the past year	0.230	0.421	0.227	0.419	-0.002	-0.226
=1 if used the internet last month	0.313	0.464	0.169	0.375	-0.143	-14.890
=1 if employed	0.553	0.497	0.570	0.495	0.017	1.473
Household characteristic variables						
=1 if poor household	0.143	0.350	0.181	0.385	0.039	4.558
Number of living children	2.731	1.312	2.871	1.370	0.139	4.509
Observations	3525		4056		7581	

3 Social Participation and Mental Health

3.1 OLS Regressions

Table 3 reports ordinary least-squares (OLS) regressions of depression level on the social participation variable. The linear regression is for the equation

$$Depre_{ih} = \alpha + \beta Social_i + X'_{ih}\gamma + \varepsilon_{ih} \quad (1)$$

Where i represents an individual, h represents a household, $Depre_{ih}$ is individual i 's depression level, representing the mental health status, $Social_i$ is the social participation, which is a dummy variable, X'_{ih} is a vector of other covariates, including individual characteristics and household

characteristics, and ε_{ih} is an error term. The coefficient of interest throughout the paper is β , the effect of social participation on mental health.

Table 3: The Effect of Social Participation on Mental Health in Old Age (OLS)

	(1)	(2)	(3)	(4)
Social participation	-0.710*** (0.150)	-0.596*** (0.146)	-0.445*** (0.145)	-0.388*** (0.145)
Age		0.005 (0.013)	-0.032** (0.013)	-0.050*** (0.014)
=1 if living in the village		2.262*** (0.151)	1.934*** (0.167)	1.600*** (0.170)
=1 if female		2.345*** (0.148)	2.300*** (0.148)	2.301*** (0.148)
=1 if with spouse/partner		-1.485*** (0.204)	-1.094*** (0.226)	-0.936*** (0.225)
=1 if has bachelor's degree and above		-1.062 (0.815)	-0.654 (0.767)	-0.358 (0.766)
=1 if has social medical insurance			-0.724** (0.338)	-0.724** (0.337)
=1 if lived alone in the first half of this year			0.671*** (0.208)	0.692*** (0.207)
=1 if hospitalized in the past year			2.256*** (0.181)	2.090*** (0.181)
=1 if used the internet last month			-1.403*** (0.179)	-1.279*** (0.178)
=1 if employed			-0.072 (0.164)	-0.113 (0.162)
=1 if poor household				1.921*** (0.208)
Number of living children				0.246*** (0.060)
Observations	7581	7581	7581	7581
R ²	0.0029	0.0755	0.1049	0.1180

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Column (1) illustrates a strong correlation between social participation and the mental health of older adults. As control variables for individual and household characteristics are gradually added, the coefficients remain significantly negative but decrease in magnitude. This reduction reflects the multifaceted nature of mental health, influenced by various factors. Including control variables that

affect both social participation and mental health alters the size of the estimated coefficients. For instance, elderly individuals living alone are at a heightened risk for depression and anxiety due to isolation, loneliness, and lack of social support (Wu et al., 2022; Kim et al., 2009). Such individuals may also be less inclined to engage in social activities because they lack daily opportunities for social interaction. Omitting this factor could result in a downward bias, underestimating the effect of social participation on depression levels.

The R^2 value demonstrates this need for control variables, initially close to 0 and increasing to 0.12, indicating that a sufficient number of control variables enhances the model's fit regarding the relationship between social participation and depression. Column (4) presents the regression results, where the R^2 indicates that 12 percent of the variation in the mental health index is explained by variations in social participation. The estimated coefficient of -0.388 suggests that, after controlling for various individual and family characteristics, older adults who participate in social activities experience a reduction in depression levels by 0.388 compared to those who do not. This finding implies that participation in social activities can improve the mental health of older adults to a meaningful extent

Overall, the results in Table 3 indicate a strong correlation between social participation and mental health. However, several important factors prevent us from interpreting this relationship as causal. First, older adults with better mental health are more likely to engage in social activities, suggesting a potential issue of reverse causality. Additionally, numerous omitted determinants of mental health variations may be correlated with social participation. To address these concerns, an appropriate instrument for social participation is essential. Such an instrument must significantly account for the observed variation in an individual's social participation while having no direct effect on their mental health.

3.2 The selection of Instrumental Variable

By drawing on the research of previous scholars (Yang & Wang, 2020; Liu, 2016) and combining my own understanding and realistic basis, this study finally selected the construction of senior activity center or boardroom (Entertainment venues for short) in villages or communities in 2011 as an

instrumental variable for the social participation of senior groups in 2020. This instrumental variable is represented by $Activecard_c$. The two-stage least-squares (2SLS) regression equations are set up as follows:

$$Social_{ihc} = \theta_0 + \theta_1 Activecard_c + Comu'_c \rho + X'_{ih} \eta + v_{ihc} \quad (2)$$

$$Depre_{ihc} = \beta_0 + \beta_1 \widehat{Social}_{ihc} + Comu'_c \varphi + X'_{ih} \Gamma + \varepsilon_{ihc} \quad (3)$$

Where c represents a community, $Activecard_c$ is the construction of senior activity center or boardroom in 2011 in community c , $Comu'_c$ is a vector of community characteristic variables, v_{ihc} and ε_{ihc} are error terms. Equation (2) is the first-stage regression, reflecting the effect of entertainment venues built in 2011 on older adult's social participation behavior in 2020. Both $Social_{ihc}$ and $Depre_{ihc}$ display the same meaning in equation (1). \widehat{Social}_{ihc} is the predicted value of the first-stage regression results and β_1 is the focus. In addition to a vector of individual and household characteristic variables X'_{ih} , community characteristic factors $Comu'_c$ are included in the 2SLS regression, information on which is obtained from CHARLS 2011 community questionnaire.³

The information of $Activecard_c$ comes from CHARLS 2011 community questionnaire, JB029 "Whether the village/community has a senior activity center" and "Whether the village/community has a chess and card activity room in the senior activity center". If the village or community c had one of these two activity venues in 2011, $Activecard_c$ will be assigned a value of 1, otherwise it is 0. The reasons for selecting this instrument variable are as follows. First, places where community senior activity centers or chess and card activity rooms were built in the past may still exist or be rebuilt today. These facilities promote socialization among older people. Those who have visited senior activity centers or chess and card activity rooms are more likely to participate in various types and forms of social activities, thus influencing their social participation behavior in 2020. Based on this, instrumental relevance is satisfied to some extent. Second, by controlling for some community characteristic factors⁴, it can be shown to a certain extent that the construction of a senior activity

³ See Appendix Table A. 1 for detailed information on community characteristics and instrumental variables.

⁴ Considering that the construction of a senior center or boardroom will be related to the topography, environment, and culture of the village or community in which it is located, and that these factors do not easily shift over time, they are controlled to enhance the

center or chess room in a village or community in 2011 can only influence the elderly's behavior of participating in social activities in 2020 by cultivating their awareness of social participation, which will ultimately affect their mental health level in 2020.

Meanwhile, this paper also uses the information of JB029 "whether there is a dancing team or other exercise team in the village/community", denoted by $dance_c$, in the CHARLS 2011 community questionnaire to construct two instrumental variables, which can be used to conduct an over-identification test to detect the effect of the instrumental variable $Activecard_c$. The validity of the instrumental variable $dance_c$ is based on the assumption that the culture of a community where there used to be a senior dance team or other exercise team is largely retained by the general elderly population, which in turn has a long-lasting impact on the social participation behavior of the elderly population.

The regression results for the two instrumental variables (IVs) are presented in Table 4. First, the endogeneity test reveals a p-value significantly less than 5%, indicating that IV regression is preferable to OLS. In column (1), the first-stage regression results demonstrate that the estimated coefficients for both IVs are significantly positive. This supports the notion that the establishment of activity centers or boardrooms for the elderly, as well as the presence of dance or exercise teams, effectively encourages greater social participation among older adults.

credibility of the tool's exogenous hypothesis. These community factors include previous expropriation of land, supply of electricity, construction of public restrooms, and main terrain.

Table 4: Regression Results for the Two IVs

	(1)	(2)
	Social participation	Depression level
=1 if V/C has senior center or boardroom in 2011	0.052*** (0.014)	
=1 if V/C has dance or workout team in 2011	0.028* (0.014)	
Social participation		-9.082*** (3.128)
=1 if community was once expropriated	0.011 (0.012)	0.162 (0.190)
=1 if days with electricity supply one year are over its mean	-0.003 (0.014)	-0.014 (0.217)
=1 if has public restroom in 2011	-0.017 (0.014)	-0.820*** (0.194)
Main terrain of the community in 2011	-0.010* (0.006)	0.227** (0.092)
Demographic_characteristics	Control	Control
Personal_behavior	Control	Control
Household_characteristics	Control	Control
Observations	7581	7581
F value	11.8660	
Endogeneity test (p-value)	0.0007	
Overidentification test (p-value)	0.1720	

Robust standard errors in parentheses

 $* p < 0.1, ** p < 0.05, *** p < 0.01$

Furthermore, the first-stage F-value exceeds 10, suggesting that the instruments are not weak. Additionally, the p-value for the over-identification test in the second stage is 0.1720, indicating that we cannot reject the null hypothesis that these two instrumental variables are exogenous. Based on this analysis and practical considerations, the construction of senior centers or boardrooms can be appropriately utilized as instrumental variables for social participation.

3.3 Comparison Between OLS and IV Results

Table 5 presents the OLS and IV regression results after controlling for demographic characteristics, personal behavior, household characteristics, and community characteristics. In column (1), the OLS results indicate that the estimated effect of social participation on the depression levels of the elderly

is -0.369, with an R-squared of approximately 0.12, reflecting modest explanatory power. Columns (2) and (3) display the IV results, where the endogeneity test confirms that social participation is indeed endogenous, necessitating the use of instrumental variables to achieve unbiased and consistent coefficient estimates. The first-stage F-value is around 20, suggesting that our instrumental variables, $Activecard_c$, are strong and credible predictors of social participation.

Table 5: Comparison Between OLS and IV Results

	(1)	(2)	(3)
	OLS	IV	
	Depression level	Social participation	Depression level
=1 if V/C has senior center or boardroom in 2011		0.059*** (0.013)	
Social participation	-0.369** (0.144)		-7.269** (3.186)
Demographic_characteristics	Control	Control	Control
Personal_behavior	Control	Control	Control
Household_characteristics	Control	Control	Control
Community_characteristics	Control	Control	Control
Observations	7581	7581	7581
R ²	0.1243		
F value		20.1142	
Endogeneity test (p-value)		0.0131	

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

From column (3), it is evident that older adults residing in neighborhoods or villages with senior centers or boardrooms experience a significant enhancement in their mental health through social participation, with an average reduction in depression levels by 7.269. This underscores the substantial impact of social participation on improving the well-being of the elderly.

The discrepancy between the IV and OLS estimates may stem from several factors contributing to potential bias. First, OLS regression may be affected by omitted variable bias, where unobserved factors—such as personality traits, health status, or the strength of social support networks—simultaneously influence both social participation and depression levels. By employing instrumental variables that correlate with the endogenous explanatory variables but remain uncorrelated with the error term, this approach can yield larger estimates if the OLS bias is negative.

Second, measurement error in the OLS estimation of social participation can lead to attenuation bias, where the estimated effect is biased toward zero. IV methods can correct for such measurement errors, resulting in larger and less biased estimates compared to OLS.

Third, while reverse causation—where individuals with lower depression levels are more likely to engage in social activities—might inflate OLS estimates, it is also plausible that seniors experiencing mild depression actively seek social interaction to improve their psychological well-being (Ding et al., 2022; Ruijsbroek et al., 2016), which could introduce downward bias.

Lastly, IV estimates typically represent a Local Average Treatment Effect (LATE), as opposed to the average treatment effect (ATE) captured by OLS. In this context, LATE reflects the impact of social participation on the mental health of elderly individuals residing in communities with senior centers or boardrooms. This effect may be larger if the subpopulation is more responsive to the treatment than the general population.

4 Robustness

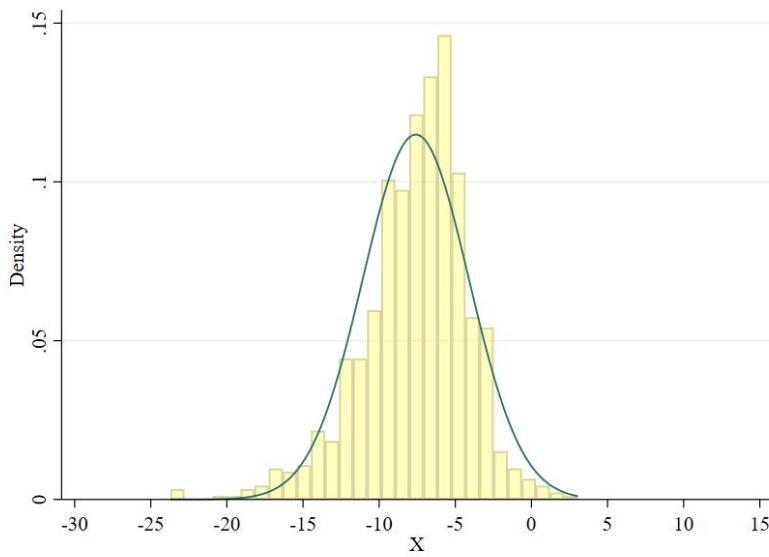
4.1 *Bootstrap Analysis*

A preferred method for regressing a dummy variable on another dummy variable is through logit or probit regression, as is widely acknowledged. However, in the first stage of my 2SLS regression, where both social participation and the presence of a senior center or boardroom are dummy variables, using OLS may pose certain challenges. To ensure the reliability and stability of the IV results, I employed bootstrap methods. Bootstrapping is a resampling technique that assesses the robustness of estimated coefficients by repeatedly sampling from the data with replacement. This approach is particularly valuable when the underlying distribution is unknown or when the assumptions of traditional parametric methods are uncertain. It helps mitigate potential biases and provides a more comprehensive evaluation of the instrument's validity in my regression analysis.

To assess the stability of the coefficient estimates, I conducted a bootstrap analysis with 1,000 replications. By sampling the data 1,000 times with replacement, I obtained 1,000 coefficients for the effect of social participation on depression levels and plotted a density histogram of these estimated

coefficients. Figure 1 illustrates the results, showing that the majority of estimated coefficients cluster around -7.6, with a standard deviation of approximately 3.47. This consistency closely mirrors the original regression results, indicating that the model's coefficients are stable and reliable. This finding enhances our confidence in the results and underscores the validity of our model in explaining the impact of social participation on depression levels.

Figure 1: Estimated Coefficient of Social Participation from Bootstrap Method



4.2 Variable Substitution

To further validate the consistency of the IV results, we estimated the impact of social participation on mental health using an IV Probit model with a dummy variable for depression levels. The dummy variable was defined based on the mean value of the depression level variable, which is approximately 10 in our dataset. If an individual's depression level exceeds this mean, the dummy variable is assigned a value of 1; otherwise, it is assigned 0. Table 6 shows that individuals who participate in social activities are less likely to experience higher levels of depression, which aligns with the conclusions drawn from our previous IV regression.

Table 6: IV Probit Regression Results

	(1)	(2)
	Social participation	Depression level (Dummy)
=1 if V/C has senior center or boardroom in 2011	0.059*** (0.013)	
Social participation		-1.389*** (0.291)
Demographic_characteristics	Control	Control
Personal_behavior	Control	Control
Household_characteristics	Control	Control
Community_characteristics	Control	Control
Observations	7581	7581
Endogeneity test (p-value)	0.0020	

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

To enhance the measurement of elderly social participation, a "social activeness" indicator for the elderly was constructed. The indicator is computed as:

$$Sociactice_i = \sum_{i=1}^{N=8} (A_i * F_i) \quad (4)$$

Where $Sociactice_i$ represents social participation activation of individual i , A_i indicates social activity items, based on a total of eight specific items of social activities listed in DA038 of the 2020 Health Status and Functioning Questionnaire. Each activity is coded as 1 (performed) or 0 (not performed). F_i Indicates the frequency of each socialization activity from DA039, "In the past month, how often did you do these activities just described?" The answer settings in this section assign three frequencies, almost daily, almost weekly, and infrequently, in that order, as 3, 2, and 1.

From equation (4), we can get the theoretical range of $Sociactice_i$ is 0-24, but the actual range is 0-14, with mean value approximately 2. In order to avoid the violation of asymptotic normality, I create a dummy variable for social participation activation, if the value is greater than 2, this dummy variable will be assigned 1, otherwise 0. The results are shown in Table 7. With an F-value exceeding 10, we affirm the IV's robustness. Column (2) affirms that elderly individuals who are more socially engaged and active tend to exhibit better mental health, aligning consistently with findings from the baseline IV regression models.

Table 7: Alternative to Social Participation

	(1)	(2)
	Social participation activation	Depression level
=1 if V/C has senior center or boardroom in 2011	0.061*** (0.012)	
Social participation activation		-7.050** (3.002)
Demographic_characteristics	Control	Control
Personal_behavior	Control	Control
Household_characteristics	Control	Control
Community_characteristics	Control	Control
Observations	7581	7581
F value	23.7111	
Endogeneity test (p-value)	0.0166	

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3 Heterogeneity Analysis

Table 8 presents the results of the second stage regression of the sub-sample 2SLS for gender. Column (1) demonstrates that the instrumental variable is valid, showing a significant positive effect of social engagement on the mental health of females. However, the IV does not explain the effect of social engagement in the male group. Several explanations may account for this disparity. Firstly, women often cultivate different types of social networks compared to men, which may be more supportive and emotionally enriching, thereby positively influencing their mental health. They may also engage in more meaningful, emotionally supportive interactions that directly benefit their well-being. Secondly, societal norms and gender roles may encourage women to actively seek and prioritize social support, thereby amplifying the beneficial impact of social engagement on their mental health.

Table 8: Gender Differences in Social Participation for Mental Health Improvement

	(1) Female	(2) Male
Social participation	-8.929** (4.187)	-4.880 (4.855)
Demographic_characteristics	Control	Control
Personal_behavior	Control	Control
Household_characteristics	Control	Control
Community_characteristics	Control	Control
Observations	3767	3814
F value	13.9682	6.7694
Endogeneity test (p-value)	0.0128	0.3370

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9 presents the results of the second stage of the 2SLS regression for older adults with different marital status. In column (1), it is evident that the instrumental variables are valid, showing a significant positive effect of social participation on the mental health of older adults with a partner or spouse. However, the IV does not explain the effect of social participation in the group without a partner or spouse.

Table 9: Differences in the Effects of Social Participation on Mental Health across Marital Statuses

	(1) With spouse/partner	(2) No spouse/partner
Social participation	-8.753** (3.966)	-1.979 (5.251)
Demographic_characteristics	Control	Control
Personal_behavior	Control	Control
Household_characteristics	Control	Control
Community_characteristics	Control	Control
Observations	6049	1532
F value	14.1299	6.4304
Endogeneity test (p-value)	0.0096	0.7919

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Several potential explanations can be considered. Firstly, having a partner or spouse may provide a stable source of emotional support, amplifying the positive effects of social participation. Social activities may be more enjoyable and emotionally fulfilling when shared with a partner. Additionally,

older adults with partners often have access to broader social networks, engaging not only with their own friends but also with their partner's social circle, which can lead to richer interactions and greater mental health benefits. Secondly, older adults with partners may experience better financial stability, facilitating greater participation in social activities and thus improving mental health. Conversely, financial constraints among those without partners may limit their ability to engage in social activities, reducing the potential benefits derived from social participation.

Table 10 presents the results of the second stage of the 2SLS regression for older adults with different levels of education. In column (2), it is evident that the instrumental variables are valid, showing a significant positive effect of social engagement on the mental health of older adults with the highest level of education below a bachelor's degree. However, the IV does not explain the effect of social engagement in the group with a bachelor's degree and above. One potential explanation could be that higher education is often associated with better economic stability, providing access to a broader array of mental health resources such as professional counseling and recreational activities. These additional resources may mitigate the relative impact of social engagement on mental health compared to those with lower educational attainment.

Table 10: Differences in education levels in the impact of social participation on mental health status

	(1) Bachelor's degree and above	(2) Below bachelor's degree
Social participation	-3.862 (3.624)	-7.209** (3.216)
Demographic_characteristics	Control	Control
Personal_behavior	Control	Control
Household_characteristics	Control	Control
Community_characteristics	Control	Control
Observations	45	7536
F value	7.6982	19.6994
Endogeneity test (p-value)	0.9724	0.0147

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusion

Population aging is a significant demographic shift that will shape Chinese society throughout the 21st century, impacting not only the elderly but also families and the broader socio-economic landscape. In the post-pandemic era, a decline in motivation among older adults to engage in social activities has raised concerns about their mental health. Consequently, enhancing the mental well-being of this demographic and promoting active aging has become an urgent priority.

This study utilizes data from CHARLS surveys conducted in 2020, 2018, and 2011 to investigate the impact of social participation on the mental health of older adults. By employing instrumental variables to address endogeneity issues, the research provides insights for policymaking aimed at improving elderly mental health and fostering active aging.

Key findings include the following: Firstly, OLS regression results indicate a positive relationship between social participation and mental health among older adults. However, two-stage regression results using the instrumental variable "availability of senior center or boardroom in the community," derived from the CHARLS 2011 community questionnaire, show a stronger positive impact than OLS estimates, suggesting that OLS models may underestimate the true effect of social participation on mental health improvement. Secondly, the impact of social participation varies across demographic factors such as gender, marital status, and education level, with women, individuals with partners, and those with lower educational attainment deriving greater mental health benefits from social engagement.

The study recommends several policy measures to enhance elderly participation in social activities. First, government policies should emphasize the health benefits of social engagement among older adults, encouraging interaction and community exploration to improve mental well-being. Second, both national and local governments should prioritize creating age-friendly environments, implementing regulations for accessibility in urban and rural planning. Third, local governments should establish standards to support aging populations, particularly for disabled, economically disadvantaged, and vulnerable elderly groups, through regular support and visits to maintain social engagement. Fourth, increasing awareness of laws protecting elderly rights and promoting public

education can empower older adults to participate in social activities confidently and safely, thereby reducing their vulnerability to exploitation.

Finally, the village or community characteristics controlled for in the regressions may not fully capture actual conditions, such as complex geographic factors. This limitation raises the possibility that the instrumental variables may influence elderly mental health through unobservable channels. Future research should explore randomized and exogenous instrumental variables to better address endogeneity issues and provide robust insights into the relationship between social participation and elderly mental health.

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Appendix

Table A. 1: Descriptive Statistics

	Mean	Std. Dev.	Min	p50	Max
Social participation	0.465	0.499	0	0	1
Social participation activation	0.329	0.470	0	0	1
Depression level	9.293	6.545	0	8	30
IV:					
=1 if V/C has dance or workout team in 2011	0.340	0.474	0	0	1
=1 if V/C has senior center or boardroom in 2011	0.448	0.497	0	0	1
Demographic characteristic variables:					
Age	67.903	5.947	60	67	90
=1 if living in the village	0.665	0.472	0	1	1
=1 if female	0.497	0.500	0	0	1
=1 if with spouse/partner	0.798	0.402	0	1	1
=1 if has bachelor's degree and above	0.006	0.077	0	0	1
Personal behavioral variables:					
=1 if has social medical insurance	0.952	0.214	0	1	1
=1 if lived alone in the first half of this year	0.209	0.406	0	0	1
=1 if hospitalized in the past year	0.228	0.420	0	0	1
=1 if used the internet last month	0.236	0.425	0	0	1
=1 if employed	0.562	0.496	0	1	1
Household characteristic variables:					
=1 if poor household	0.163	0.370	0	0	1
Number of living children	2.806	1.345	0	3	10
Community characteristic variables:					
=1 if community was once expropriated	0.338	0.473	0	0	1
=1 if has public restroom in 2011	0.357	0.479	0	0	1
=1 if days with Electricity Supply One Year over its mean	0.764	0.425	0	1	1
Main terrain of the community in 2011	1.969	1.025	1	2	5
Observations	7581				

Table A. 2: Descriptive Statistics by Social Participation

	(1) With social participation	(2) No social participation		(3) Difference		
	Mean	sd	Mean	sd	Diff.	t-value
Depression level	8.913	6.405	9.624	6.648	0.710	4.719
IV:						
=1 if V/C has dance or workout team in 2011	0.380		0.485	0.306	0.461	-0.074
=1 if V/C has senior center or boardroom in 2011	0.494		0.500	0.408	0.492	-0.086
Demographic characteristic variables:						
Age	67.668		5.752	68.107	6.105	0.440
=1 if living in the village	0.624		0.484	0.700	0.458	0.076
=1 if female	0.509		0.500	0.487	0.500	-0.022
=1 if with spouse/partner	0.793		0.405	0.802	0.399	0.009
=1 if has bachelor's degree and above	0.008		0.089	0.004	0.065	-0.004
Personal behavioral variables:						
=1 if has social medical insurance	0.960		0.197	0.945	0.228	-0.015
=1 if lived alone in the first half of this year	0.222		0.415	0.197	0.398	-0.024
=1 if hospitalized in the past year	0.230		0.421	0.227	0.419	-0.002
=1 if used the internet last month	0.313		0.464	0.169	0.375	-0.143
						14.890
=1 if employed	0.553		0.497	0.570	0.495	0.017
Household characteristic variables:						
=1 if poor household	0.143		0.350	0.181	0.385	0.039
Number of living children	2.731		1.312	2.871	1.370	0.139
=1 if community was once expropriated	0.337		0.473	0.339	0.474	0.002
=1 if has public restroom in 2011	0.378		0.485	0.338	0.473	-0.040
=1 if days with Electricity Supply One Year over its mean	0.780		0.414	0.750	0.433	-0.030
Main terrain of the community in 2011	1.925		1.026	2.007	1.023	0.082
Observations	3525		4056		7581	