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

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Abstract

China had become a moderately aging society by the end of 2023. In the post-pandemic era, older adults are less inclined to participate in social activities, which affects 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 the mental health of older adults using data from the China Health and Retirement Longitudinal Study (CHARLS) in 2011, 2018, and 2020. By employing an instrumental variable to address endogeneity issues, the study finds that: First, social participation can enhance the mental health of the elderly. Secondly, the 2SLS regression result indicates a stronger positive impact than OLS, suggesting an underestimation of the effect of social participation on the mental health of the elderly in the baseline linear regression model. Thirdly, women, those with partners, and those with lower education levels benefit more from social engagement. Finally, 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; 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 Health of the National 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 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, with declining physical abilities, they have reduced their social participation, 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 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[1]; Unger et al., 1999[3]; Reitzes et al., 1995[2]). Social participation enhances health by providing a sense of meaning and increasing social support (Kawachi & Berkman, 2001[4]). For instance, volunteer activities improve mental health by expanding social networks, social prestige, access to resources, and emotional well-being (Moen et al., 1992[5]). Relationships formed through participation fulfill needs for attachment, esteem, social approval, belongingness, social identity, and security (Antonucci & Jackson, 1987[6]; Bandura, 1986[7]). Chinese studies also support these findings, indicating that social participation improves the mental health of older adults. Wei & Wu (2015)[9] argue that social participation fulfills the psychological, spiritual, and physical needs of the elderly, which is crucial for improving their health. Zhang & Zhang (2016)[10] 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)[8] and Gao & Wen (2018)[11] 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)[12]

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[13]). 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[4]). Strazdins & Broom (2004)[14] discuss gendered norms related to the expectation of "emotional labor" within social relationships. Morrow-Howell et al. (2003)[15] 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, emphasizing 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. To address potential omitted variables and reverse causality, the paper uses the presence of senior activity centers or boardrooms in villages or communities as an instrumental variable. The 2SLS regression result shows 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. In the older age group, women, who have partners or spouses, and have a diploma below high school, can benefit more from social participation.

The contributions of this paper include (1) using an instrumental variable to alleviate endogeneity problems in ordinary linear regression models, (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 presents the data. The third part presents the baseline linear regression estimation and 2SLS estimation. The fourth part shows the robustness checks, including bootstrap and heterogeneity analysis. The fifth part is the

paper's conclusion, including the policy recommendation, shortcomings, and future direction.

2   Data

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, the survey design of CHARLS is modeled on several well-known international aging 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. 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 COVID-19 pandemic that broke out in late 2019 and early 2020 led to the suspension of the fifth round of the survey in 2020. Therefore, the fifth round of the survey was extended from 2021 to 2023.(Zhao et al., 2023[16]).

In the empirical analysis, I selected the CHARLS databases of 2020, 2018, and 2011. Since this paper focuses on the relationship between the mental health and social activity participation of the elderly in the post-epidemic era, the 2020 database is the main one. The independent and dependent variables of concern (mental health and social participation), demographic characteristic variables (the highest education level is from the 2018 database), personal behavioral variables, and household characteristics variables are all from the 2020 data. Considering the possible reverse causality problem, I used the instrumental variable method to alleviate it. The instrumental variables used in the analysis ("the construction of senior activity centers or boardrooms in villages or communities in 2010" and "the establishment of dance or exercise teams in villages or communities in 2010"), and Community characteristic variables are all from the 2011 database.

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. Hence, only individuals aged 60 to 90 years were included in the research. After combining the datasets from 2011, 2018, and 2020 and eliminating samples with missing values and outliers in the variables, 7,592 valid samples were obtained.

2.1 Data description

Table 1 shows the distribution of variables used in the empirical analysis. Considering the practices of some scholars (Yang & Wang, 2020[8]; Liu, 2016[17], Fu et al., 2022[18]), social participation is the core binary 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.

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-D-10 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.

The information on two instrument variables comes from the CHARLS 2011 community questionnaire. JB029-1-11 "Whether the village/community has a senior activity center" and JB029-1-5 "Whether the village/community has a chess and card activity room". If the village or community had one of these two activity venues in 2010, IV representing the establishment of a senior activity center or boardroom will be assigned a value of 1, otherwise it is 0. The construction process of the IV representing the construction of a dance or exercise team is the same. Data comes from questionnaire JB029-1-8 "Whether the village/community (V/C) has a dance or exercise team". As can be seen from the table, the number of V/Cs with these recreational facilities in 2010 was smaller, less than half.

Table 1: Descriptive statistics of variables

	Mean	Std. Dev.	Min	p50	Max
Social participation	0.465	0.499	0	0	1
CES-D-10 scores	9.293	6.544	0	8	30
Instrument variables					
=1 if V/C had boardroom or senior activity center in 2010	0.448	0.497	0	0	1
=1 if V/C had dance or exercise team in 2010	0.341	0.474	0	0	1
Demographic characteristic variables					
Age	67.906	5.949	60	67	90
=1 if residence is in the village	0.664	0.472	0	1	1
=1 if female	0.497	0.500	0	0	1
=1 if has spouse/partner	0.798	0.402	0	1	1
=1 if with a high school diploma or above	0.101	0.302	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 2020	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 in the past month	0.236	0.425	0	0	1
=1 if has nonfarm work	0.145	0.352	0	0	1
Household characteristics variables					
=1 if poor household	0.163	0.370	0	0	1
Number of children alive	2.806	1.345	0	3	10
Community characteristic variables					
=1 if V/C was once expropriated in 2010	0.338	0.473	0	0	1
=1 if V/C had public restrooms in 2010	0.357	0.479	0	0	1
=1 if the power supply was in good condition in 2010	0.764	0.424	0	1	1
=1 if main terrain of V/C was plain in 2010	0.416	0.493	0	0	1
Observations	7592				

Control variables are categorized into four types: demographic characteristics, personal behaviors, household characteristics, and community characteristics variables. In terms of demographic characteristics, the mean age of respondents is about 68, 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 low.

Personal behavioral variables and household characteristics variables may significantly impact both their participation in social activities and their mental health; thus, these factors are included in the regression analysis. From the distribution of personal behavioral variables, it can be seen that in the elderly population, the popularity of social medical insurance is quite high, the proportion of hospitalizations in the past year is relatively small, the situation of living alone is also relatively small, and the proportion of non-agricultural jobs is also very small, and the popularity of the Internet is relatively low. From the distribution of household characteristics variables, the proportion of poor families such as low-income households, uninsured households, and extremely poor households is very low, and the vast majority of the elderly have living children.

The community characteristic variables are derived from the CHARLS data of 2011. The purpose of control is to enhance the exclusion restriction hypothesis of the instrumental variables

Table 2: Mean differences in variables (grouped by social participation)

	With social participation		No social participation		Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Diff.	P-value
CES-D-10 scores	8.912	6.404	9.623	6.646	0.711	0.000
Instrument variables						
=1 if V/C had boardroom or senior activity center in 2010	0.494	0.500	0.408	0.492	-0.086	0.000
=1 if V/C had dance or exercise team in 2010	0.381	0.486	0.306	0.461	-0.075	0.000
Demographic characteristic variables						
Age	67.671	5.754	68.110	6.108	0.439	0.001
=1 if residence is in the village	0.623	0.485	0.700	0.458	0.077	0.000
=1 if female	0.509	0.500	0.487	0.500	-0.022	0.058
=1 if has spouse/partner	0.793	0.405	0.802	0.399	0.008	0.371
=1 if with a high school diploma or above	0.127	0.334	0.079	0.269	-0.049	0.000
Personal behavioral variables						
=1 if has social medical insurance	0.960	0.197	0.945	0.228	-0.014	0.003
=1 if lived alone in the first half of 2020	0.221	0.415	0.197	0.398	-0.024	0.010
=1 if hospitalized in the past year	0.230	0.421	0.227	0.419	-0.003	0.762
=1 if used the Internet in the past month	0.313	0.464	0.169	0.375	-0.144	0.000
=1 if has nonfarm work	0.137	0.343	0.152	0.359	0.016	0.053
Household characteristics variables						
=1 if poor household	0.142	0.350	0.181	0.385	0.039	0.000
Number of children alive	2.731	1.312	2.872	1.370	0.142	0.000
Community characteristic variables						
=1 if V/C was once expropriated in 2010	0.338	0.473	0	0	1	0.832
=1 if V/C had public restrooms in 2010	0.357	0.479	0	0	1	0.000
=1 if the power supply was in good condition in 2010	0.764	0.424	0	1	1	0.002
=1 if main terrain of V/C was plain in 2010	0.416	0.493	0	0	1	0.000
Observations	3531		4061		7592	

to the greatest extent possible. The construction of senior activity centers or boardrooms in 2010 might be related to the topography, environment, and culture of the villages or communities where they were located. These factors do not change easily over time and thus may influence the environment of the communities or villages in 2020, further affecting the lives of the elderly. It should be noticed that whether the power supply was in good condition in 2010 depends on whether the days with electricity ecceeds the average value annually. Overall, the environmental conditions of V/Cs are relatively good.

Table 2 shows the differences in depression level, IVs, and other control variables between the elderly who participate in some social activities and those who don't join any activities at all. Among them, except for the insignificant differences in whether the elderly have a partner, hospitalization status, and whether the community they live in had ever been expropriated by 2010, the mean differences in other variables between the two groups are significant, indicating that there are many characteristic differences between elderly groups with different social participation situations. Although the differences in depression levels were not substantial, this finding can to some extent illustrate that for the elderly who actively participate in social activities, their mental health status is better. Therefore, there is a certain correlation between social participation and mental health, and whether there is a causal relationship still requires further rigorous empirical analysis.

3 Social participation and mental health

3.1 Baseline linear regression estimation

To explore the relation between social participation and mental health, the baseline linear regression model is for the equation

$$Depre_{ihc} = \beta Social_{ihc} + X_{ihc}\gamma + \epsilon_{ihc} \tag{1}$$

Where i represents an elderly person, h represents a household where the elderly belongs, and c represents a community where the elderly lives, $Depre_{ihc}$ is the individual's depression level, obtained from the CES-D-10 scores on a scale of 0-30, representing the mental health status. $Social_{ihc}$ is the social participation. If the individual has participated in the mentioned social activities, this value is 1, otherwise, it is 0. X_{ihc} is a vector of other covariates, including individual, household, and community characteristics, and ϵ_{ihc} is an error term. The coefficient of interest throughout the paper is β, the effect of social participation on mental health.

Table 3 reports the OLS estimates from the regression model of Eq.1. From the regression results from column (1) to column (4), it can be seen that after gradually controlling for demographic, individual behavior, household, and community characteristic variables, The estimate of β remains significantly negative but decreases in magnitude. Such a phenomenon may lead to an inaccurate inference: the impact of social participation on mental health is extremely small. This further underestimates the role of social participation in promoting mental health. The main reason for this phenomenon is the endogeneity problem. An individual's mental health can be affected by many factors, including unobservable and observable but difficult-to-measure variable characteristics, and these factors can also affect an individual's social participation behavior. If the endogeneity problem is not properly handled, it may lead to the problem of underestimated 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[19]; Kim et al., 2009[20]). 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. In addition, the estimation of the coefficient may also be disturbed by reverse causality, that is, the mental health level of the elderly group will, in turn, affect the individual's social participation behavior (Chen et al., 2022[21]; Phillips, 1967[22]). Therefore, if we want to obtain the causal effect of social participation on the mental health of the elderly, it is necessary to solve the problems of omitted variable bias and reverse causality simultaneously.

Table 3: Baseline linear regression estimation: Social participation and mental health in old age

	(1) Depression level	(2) Depression level	(3) Depression level	(4) Depression level
Social participation	-0.531***	-0.446***	-0.391***	-0.367**
	(0.145)	(0.145)	(0.144)	(0.144)
Age	-0.001	-0.042***	-0.057***	-0.047***
	(0.013)	(0.013)	(0.014)	(0.014)
Residence	2.030***	1.737***	1.420***	1.024***
	(0.153)	(0.155)	(0.159)	(0.170)
Gender	2.217***	2.116***	2.139***	2.179***
	(0.148)	(0.149)	(0.149)	(0.149)
Partner	-1.450***	-1.038***	-0.890***	-0.919***
	(0.203)	(0.224)	(0.224)	(0.223)
Education level	-1.730***	-1.460***	-1.327***	-1.270***
	(0.225)	(0.227)	(0.227)	(0.227)
Health insurance		-0.691**	-0.698**	-0.766**
		(0.336)	(0.334)	(0.335)
Live alone		0.746***	0.760***	0.683***
		(0.207)	(0.206)	(0.206)
Hospitalization		2.226***	2.073***	2.060***
		(0.181)	(0.181)	(0.180)
Internet use		-1.131***	-1.029***	-0.999***
		(0.183)	(0.182)	(0.181)
Non-farm work		-0.939***	-0.862***	-0.750***
		(0.196)	(0.195)	(0.195)
Poor household			1.859***	1.739***
			(0.207)	(0.208)
Children			0.225***	0.163***
			(0.060)	(0.061)
Expropriation				-0.028
				(0.151)
Public restroom				-0.862***
				(0.158)
Power supply				-0.016
				(0.175)
Terrain				-0.719***
				(0.149)
N	7592	7592	7592	7592
R^2	0.081	0.111	0.123	0.130

Note: Robust standard errors in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01

3.2 IV estimation

Previously, some scholars have used instrumental variables to identify the causal effect of social participation on mental health (Yang & Wang, 2020[8]; Liu, 2016[17]; Zhang & Zhang, 2016[10]). They selected two variables from the 2011 CHARLS community questionnaire data as instrumental variables, namely "Whether there is a senior activity center or boardroom in the community" and "Whether there is a dance or exercise team in the community". Combined with the processing methods of these scholars, I used the establishment of a senior activity center or boardroom in a village or community (V/C) in 2010 as the IV of social participation and used "Whether there is a dance team or exercise team in the community" for over-identification tests. The two-stage least-squares (2SLS) regression equations are set up as follows

$$Social_{ihc} = \alpha_0 + \alpha_1 Center_{ic} + X_{ihc}\eta + v_{ihc} \tag{2}$$

$$Depre_{ihc} = \beta_0 + \beta_1 \hat{Social}_{ihc} + X_{ihc}\Gamma + u_{ihc} \tag{3}$$

The meanings indicated by the subscripts are all consistent with Eq.1. $Center_{ic}$ refers to the construction status of the senior activity center or boardroom in V/C in 2010. If the community where the individual lived had built the senior activity center or boardroom by 2010, this value is 1; otherwise, it is 0. The other variables are all consistent with those in Eq.1. v_{ihc} and u_{ihc} are both error terms. Eq.2 is the first-stage regression, reflecting the effect of entertainment venues built in 2010 on older adult's social participation behavior in 2020. In Eq.3, the second-stage regression, $\hat{Social}_{ihc}$ is the predicted value of the first-stage regression results and β_1 is the coefficients that need to be estimated.

The reasons for selecting this instrument variable are as follows. First, places, where community senior activity centers or boardrooms 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 boardrooms 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 factors, it can be shown to a certain extent that the construction of a senior activity center or boardroom in a village or community in 2010 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. In addition, Some national-level policy documents, such as the "11th Five-Year Plan" for the Development of China's Aging Undertakings, clearly state, "In terms of the construction of elderly service facilities in communities, the differences in the needs of the elderly should be considered, and a batch of welfare service facilities of different types and levels should be constructed to alleviate the serious shortage of welfare service facilities for the elderly in urban blocks and

Table 4: Two IVs for over-identification test

	(1) Social participation	(2) Depression level
Social participation		-7.935**
		(3.104)
Center	0.053***	
	(0.013)	
Dance	0.022	
	(0.014)	
Demographic characteristic variables	Control	Control
Personal behavioral variables	Control	Control
Household characteristics variables	Control	Control
Community characteristic variables	Control	Control
N	7592	7592
Endogeneity test (p-value)	0.0044	
F value	11.0253	
Overidentification test (p-value)	0.2480	

Note: Robust standard errors in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01

rural towns, support home-based elderly care, and provide places for the elderly's activities." This policy orientation indicates that the vast majority of senior activity centers are led and constructed by the government or upper-level organizations. This helps to strengthen the exclusion restriction assumption of the instrumental variable.

Meanwhile, I use $Dance_{ic}$ to construct two IVs, then the over-identification test can be done to detect the validity of the $Center_{ic}$. 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. 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 0.2480, indicating that we cannot reject the null hypothesis that these two instrumental variables are exogenous. Based on this analysis and practical considerations, $Center_{ic}$ can be appropriately utilized as an IV for social participation.

Table 5 presents the baseline linear regression and 2SLS regression results after controlling for demographic characteristic variables, personal behavioral variables, household characteristics variables, and community characteristic variables. The P value of the endogeneity test in the 2SLS regression is 0.0240, indicating that the null hypothesis that $Social_{ihc}$ is an exogenous variable can be rejected, and IV is needed to alleviate the endogeneity problem. In the first-stage regression, the influence of $Center_{ic}$ on $Social_{ich}$ is significantly positive, and the F value is greater than 10. Therefore, $Center_{ic}$ is an effective IV. Comparing columns (1) and (3), the estimation results of IV and OLS are both significantly negative, but the coefficient size estimated by IV is much larger than the estimation result of OLS, which is -6.693. This indicates that older adults residing in neighborhoods or villages with senior activity centers or boardrooms experience a significant enhancement in their mental health through social

Table 5: IV estimation: Social participation and mental health in old age

	OLS	IV	
	(1)	(2)	(3)
	Depression level	Social participation	Depression level
Social participation	-0.367**		-6.693**
	(0.144)		(3.149)
Center		0.058***	
		(0.013)	
Demographic characteristic variables	Control	Control	Control
Personal behavioral variables	Control	Control	Control
Household characteristics variables	Control	Control	Control
Community characteristic variables	Control	Control	Control
N	7592	7592	7592
Endogeneity test (p-value)		0.0240	
F value		19.7422	

Note: Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

participation, with an average reduction in depression levels of 6.693.

The difference between the IV and OLS estimates may stem from several factors. 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 may yield a larger coefficient estimate if the effect is underestimated in the baseline linear regression model. 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[23]; Ruijsbroek et al., 2016[24]), 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 the elderly residing in communities with senior activity centers or boardrooms, so the estimated coefficient may be larger if the subpopulation is more responsive to social participation behavior.

4 Robustness checks

4.1 Bootstrap analysis

To ensure the reliability and stability of the IV results, I employed bootstrap methods. Bootstrapping is a resampling technique that assesses the robustness of the estimated coefficient 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 the 2SLS regression analysis.

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 -7.11, with a standard deviation of approximately 3.78. The result is consistent with the 2SLS regression results -6.693, indicating that the model's coefficient is stable and reliable.
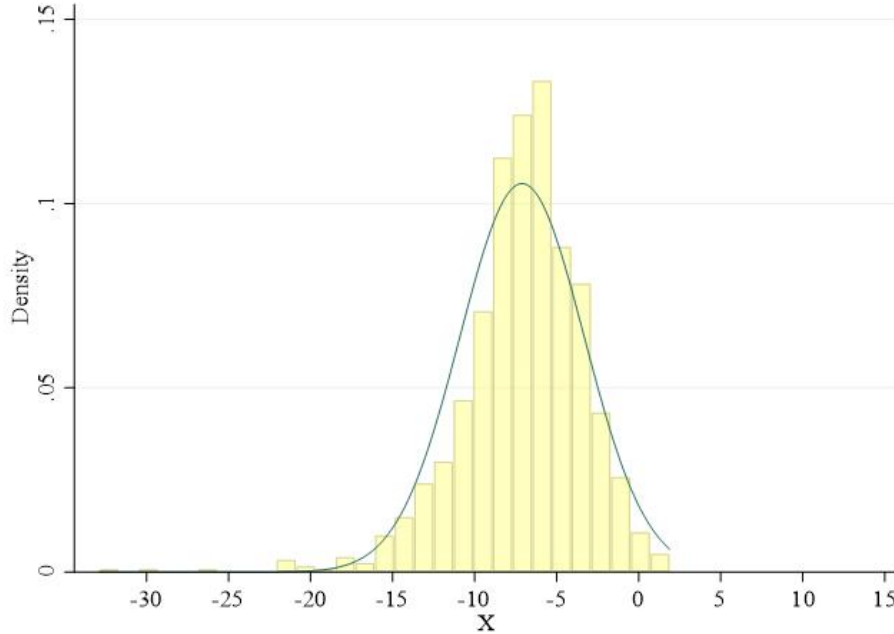

Figure 1: Estimated β_1 by bootstrap method based on the 2SLS model

4.2 Heterogeneity analysis

Table 6 presents the results of the second stage regression of the sub-sample 2SLS for gender. Column (1) demonstrates that IV 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

Table 6: Gender: Social participation and mental health in old age

	(1) Female	(2) Male
Social participation	-8.494**	-4.248
	(4.242)	(4.696)
N	3775	3817
Endogeneity test (p-value)	0.0214	0.4028
F value	13.1774	6.9726

Note: Demographic characteristic variables, personal behavioral variables, household characteristics variables, and community characteristic variables are all controlled. Robust standard errors in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01

Table 7: Marital status: Social participation and mental health in old age

	(1) With spouse/partner	(2) No spouse/partner
Social participation	-8.450**	-0.791
	(3.918)	(5.410)
N	6056	1536
Endogeneity test (p-value)	0.0124	0.9750
F value	14.1387	5.9700

Note: Demographic characteristic variables, personal behavioral variables, household characteristics variables, and community characteristic variables are all controlled. Robust standard errors in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01

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 7 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 IV is 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. 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 8: Education level: Social participation and mental health in old age

	(1) High school diploma or above	(2) Below high school diploma
Social participation	-23.811	-5.487*
	(25.608)	(3.079)
N	769	6823
Endogeneity test (p-value)	0.0458	0.0661
F value	0.9896	19.5601

Note: Demographic characteristic variables, personal behavioral variables, household characteristics variables, and community characteristic variables are all controlled. Robust standard errors in parentheses. *p< 0.1, **p< 0.05, ***p< 0.01

Table 8 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 IV is valid, showing a significant positive effect of social engagement on the mental health of older adults with the highest level of education below a high school diploma. However, the IV does not explain the effect of social engagement in the group with a high school diploma or above. Some potential explanations may account for the case. For older people with low education levels, they often have fewer economic or material resources. Social participation can provide emotional support and companionship, reducing feelings of isolation and loneliness, which are significant factors contributing to poor mental health. Besides, social activities can offer opportunities to learn about health, finances, or community resources that might otherwise be inaccessible to them, which may increase the probability of having better access to mental health.

5 Conclusion

Society is gradually moving towards a deeply aging state, which is a significant demographic structural change. It will affect Chinese society throughout the 21st century, not only the elderly but also families and the broader socio-economic landscape. In the post-epidemic era, the enthusiasm of the elderly to participate in social activities has declined, which may affect their mental health. Therefore, improving the mental health of this group and promoting active aging have become urgent priorities.

This study uses data from the CHARLS surveys conducted in 2020, 2018, and 2011 to examine how social participation impacts the mental health of older adults. To address endogeneity issues, the study employs an instrumental variable approach. The main findings include: First, baseline linear regression results show a positive relationship between social participation and mental health. Second, two-stage regression analysis using the instrumental variable "availability of senior centers or community boardrooms", from the 2011 CHARLS community questionnaire, indicates a stronger positive effect compared to the baseline model. Lastly, the impact of social participation varies by demographic factors such as gender, marital status, and education level, with greater benefits observed for women, individuals with a partner, and those with lower educational levels.

The study recommends several policy measures to boost elderly participation in social activities. First, government policies should highlight the mental health benefits of social engagement, encouraging older adults to interact and explore their communities. Second, national and local governments should prioritize creating age-friendly environments by ensuring accessibility in urban and rural planning. Third, local governments should establish standards to support aging populations, especially for disabled, economically disadvantaged, and vulnerable elderly groups, through regular visits and social support. Fourth, raising awareness about laws protecting elderly rights and promoting public education will empower older adults to engage in social activities confidently and safely, helping reduce their risk of exploitation.

This paper has several limitations and areas for improvement. First, the village or community characteristics controlled for in the regressions may not fully capture actual conditions, such as complex geographic factors. This limitation suggests that the instrumental variables might influence elderly mental health through unobservable channels. Future research should consider exploring randomized or exogenous instrumental variables to better address endogeneity issues and provide more robust insights into the relationship between social participation and elderly mental health. Second, the paper lacks a detailed exploration of the mechanisms through which social participation impacts elderly mental health. Future studies should delve deeper into the mechanism analysis, review relevant literature in psychology and health behavior, and use a conceptual framework to display these mechanisms intuitively. Additionally, available data should be used to test these mechanisms.

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