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Research Article

Does Social Participation Modify the Association between Depression and Cognitive Functioning among Older Adults in China? A Secondary Analysis based on CHARLS

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Abstract

Background: Cognitive impairment and depression significantly affect the mental health of older Chinese adults. While previous studies highlighted the positive impact of social participation on cognitive functioning and depression, research on its specific types and their influence on the depression-cognitive relationship is limited. This study investigated which social activities mitigate cognitive impairment and if they moderate depression's effect on cognitive functioning in older Chinese adults.

Methods: The study conducted hierarchical regression analysis on the China Health and Retirement Longitudinal Study (CHARLS) dataset of 5,056 older adults. The Mini-Mental State Examination (MMSE) was employed to measure the cognitive performance of the subjects, and the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10) was utilized to evaluate depressive symptoms. Hierarchical regression analysis tested the fit of stepwise models: Model 1 examined the main effect of depression on cognitive functioning; Model 2 & 3 assessed the main and interactive effects of formal and informal social participation; and Model 4 & 5

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evaluated the effects of specific social participation categories and their interactions with depression on cognitive functioning.

Results: Regression results indicated that depression significantly impacted older Chinese adults' cognitive functioning in all models. Engaging in both formal and informal social activities reduced cognitive decline among these adults. Specific activities like "playing mahjong, chess, or cards," "attending clubs or community organizations" and "stock investing" positively correlated with the MMSE scores. No interaction was observed between any form of social participation and depression.

Conclusion: The study highlighted the positive impact of social participation, especially informal activities, on the mental health of older Chinese adults. Its findings have implications for public policy and health, suggesting the need for social venues and activities for older adults. This could enhance their life satisfaction and ease the load on China's health system.

Keywords: Cognitive functioning; Depression; Older adults in China; Social activity; Social participation

Background

Population aging has become one of the most pressing social issues in modern China since the aging population in China is increasing at an unprecedented rate [1]. According to the National Bureau of Statistics of China [2], the proportion of older adults in China reached 18.7% in 2020, which were more than 260 million people [2]. The proportion of older adults in China has been rapidly increasing due to declining fertility rates and increasing life expectancy [3]. This demographic shift has significant implications for health and social care systems, particularly in relation to cognitive impairment and depression among older adults [3,4].

Cognitive impairment is a prevalent problem among older Chinese adults. According to Xue's research, the incidence of cognitive impairment among older adults in China is about 14.61% in nonclinical samples [4]. This is a major public health concern since cognitive impairment can result in disability, decreased quality of life, and increased healthcare expenses [1]. Cognitive maintenance has important implications in sustaining the life quality and well-being of older adults [5]. Moreover, impairment in cognitive ability carries risks for severe loss of cognitive functioning such as dementia and Alzheimer's disease [6-8]. Studies have shown that demographic factors contributing to cognitive functioning include gender, age, education, living style and many other aspects [8-14]. Supported by previous studies, Zhang and colleagues [9] found that higher odds for cognitive impairment is significantly associated with female, older age, lower education level, living alone with no spousal support, less income, worse psychological well-being, less fresh fruit and vegetable intake, lower social engagement, and more activities of daily living limitations [15-17].

Depression is another widespread ailment among older adults in China [18]. A study in 2022 showed that an estimated 33% and above of older adults in China demonstrated depressive symptoms

[19]. Depression can have a substantial impact on older adults' quality of life, resulting in diminished independence, social isolation and functioning in everyday tasks [18,20,21]. Zhou and colleagues [22] discovered a negative correlation between depressive symptoms and cognitive functioning among older Chinese adults using The China Health and Retirement Longitudinal Study (CHRLS). Older adults who scored higher on the 10-item Center for Epidemiological Studies Depression Scale (CESD-10) were more likely to exhibit suboptimal cognitive functioning, scoring lower in the Mini-Mental State Examination (MMSE) in aspects such as orientation, memory, and attention and computation.

Social participation requires older adults to engage in several important mental processes. Previous studies [23] showed that social activities such as playing mahjong or card games reinforce short-term episodic memory. It indicates that enhancing mental processes may help bolster cognitive functioning among older adults. Moreover, social participation may influence depressive symptoms [24-26]. Participating in social activities could reduce depressive symptoms in older adults by providing social support, a sense of purpose and increased physical activity [27]. According to previous studies, depression has been linked to cognitive impairments such as memory problems and slower processing speed [28,29]. Furthermore, prior studies demonstrated that social participation could be a protective factor against cognitive decline by reducing the risk of developing depression [30,31]. Based on those findings, it is reasonable to speculate that it may mitigate the negative effects of depression on cognitive functioning.

The activities involved in social participation can be divided into formal and informal categories, depending on the degree of intimacy and intensity [32]. According to a study conducted based on the Korean Longitudinal Study of Aging (KLoSA), informal activities involve interaction with family, friends, and neighbors, while formal activities involve participating in formal organizations such as alumni societies [33]. Researchers found that both formal and informal activities can reduce depression and improve cognitive functioning in older adults [33,34]. However, participating in which types of social activities can protect cognitive functioning from depression remains unclear.

Several studies in the past examined the relationship between social participation, depression, and cognitive functioning [35,36]. Some researchers have suggested that certain types of activities, such as physical exercise, may have a greater impact on cognitive functioning and depression [22,35,37]. Despite the promising implications of social participation, few studies have explored the influence of specific types of social activities. Thus, this study aims to examine 1) whether social participation serves as a preventative measure and mitigates the negative impacts on cognitive functioning in the older Chinese adult population; 2) which type(s) of social activities (i.e., formal or informal) could benefit older Chinese adults' cognitive functioning; 3) whether the interaction between social participation and depression influences cognitive functioning.

Methods

Sample selection

Database

The dataset used is the China Health and Retirement Longitudinal Study (CHARLS), which collected data from socioeconomic status to health conditions for a nationally representative sample of Chinese residents aged 45 and older. However, individuals over the age of 45 comprise a wide range of age groups, from middle-aged (48 to 64 years) to oldest-old (≥85 years) categories [38,39]. Besides, the Law of the People's Republic of China on the Protection of the Rights and Interests of the Elderly, promulgated in 1996, defines a senior as 60 years and above [40]. The study population in this study was therefore restricted to over-60-year-olds.

The CHARLS utilized a probability-proportional-to-size sampling method [41]. The sample comprised all country-level units (excluding Tibet) and was stratified based on regional, county-level (urban/rural) and per-capita GDP characteristics. Participants were followed up every 2 or 3 years over four waves since 2008 [41]. In this study, we chose to use the most recent wave (Wave 4) which was conducted between July 2018 and March 2019 [40]. We obtained the data of Wave 4 on November 25 after submitting our application to the CHARLS database on November 17, 2022 [42].

Inclusion criteria

There are 19,816 respondents in the current dataset. Our study included older adults based on three criteria: 1) their age was 60 years and above; 2) they completed basic demographic information including age, gender, education level, marital status, and location of residential address; 3) they answered all questions in both the Mini-Mental State Examination (MMSE) and the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10). Finally, a total of 5,056 older adults were included.

Variable selection

Outcome variable

Cognitive Functioning: The Mini-Mental State Examination (MMSE) is an 11-item, 30-point questionnaire first developed by Folstein to measure cognitive performance [43,44]. It is now widely used as a measure to assess older adults' cognitive functioning in research environments and performed in a systematic and routine manner as a screening tool in clinical and community settings to identify cognitive impairment in older, community-dwelling, hospitalized, and institutionalized adults [45]. The CHARLS dataset used the Chinese version of the MMSE, which shows good validity and reliability (Cronbach's α=0.86) [46-48]. In this study, Cronbach's α coefficient was .75.

These items consist of eight cognitive domain functions: orientation [e.g., "What is the year?" "What is the season of the year?"], registration [e.g., "I am going to name three objects. After I have said them, I want you to repeat them. Remember what they are because I am going to ask you to name them again in a few minutes. Ball, flag, tree. Please repeat the names for me."], attention and calculation [e.g., "Please calculate 100 minus 7, and keep minus 7 continuously, tell me each answer you get from minus 7, until I say stop."], recall and delayed recall [e.g., "What were the three objects I asked you to remember?"], naming [e.g., Showing the respondent the watch picture on the screen and asking, "What is this called?"], repetition [e.g., "I would like you to repeat a phrase after me. The phrase is: 'No if's and's or but's'"], verbal and written comprehension [e.g., "Write any complete sentence on that piece of paper for me."], and visuospatial capability [e.g., "I am going to give you a piece of paper. When I do, take the paper in your right hand, fold the paper in half with both hands, and put the paper down on your left lap."] [48]. Each correct answer scores 1 point for the respondent. The normal level is a score of 24 or higher (out of 30). Scores of 23 or lower suggest a cognitive

impairment that is either severe (9 points), moderate (10–18 points), or mild (19–23 points).

Explanatory variables

Depressive Symptoms: Depressive symptoms were measured with the Chinese version of the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10). Andresen and his colleagues invented CESD-10 in 1994, a now widely used measure to screen for depression in primary care settings [49]. It is a Likert scale survey assessing depressive symptoms in the past week, which shows good internal consistency (Cronbach's α = 0.96) [50]. The Cronbach's α coefficient for this study was .80, showing good consistency.

CESD-10 consists of 10 items, which include three items on depressed affect [i.e., 1-"I was bothered by things that usually don't bother me"; 3-" I felt depressed"; 4-" I felt that everything I did was an effort"], five on somatic symptoms [i.e., 2 -" I had trouble keeping my mind on what I was doing"; 6-" I felt fearful"; 7-"My sleep was restless"; 9-" I felt lonely"; 10- I could not "get going"], and two on positive affect [i.e., 5- "I felt hopeful about the future"; 8-"I was happy"]. Options for each item range from "rarely or none of the time" (score of 0) to "all of the time" (score of 3). For example, older adults were asked to rate the frequency with which they experienced this feeling during the past week. The total score ranges between 0 and 30 with a higher score implying more severe symptoms.

Social Participation: Specific types of social participation were measured respectively as separate categorical variables. Participants indicated whether or not they participated in each following social activity during the past month with 10 items from the CHARLS questionnaire: (1) interacting with friends, (2) playing mahjong, chess, or cards or going to a community club, (3) providing help to family, friends, or neighbors who do not live with you, (4) went to a sport, social or other kinds of the club, (5) took part in a community-related organization, (6) did voluntary or charity work, (7) cared for a sick or disabled adult who does not live with you, (8) attended an educational or training course, (9) stock investment, (10) used the Internet [41]. Based on the Korean Longitudinal Study of Aging (KLoSA), we classified item 5, item 6, and item 8 into the category of formal activities [33]. The remaining seven were categorized as informal activities.

Control variables

We controlled for variables that have been shown to affect cognition in addition to depressive symptoms and social participation, including age, gender, education level, marital status, and location of residential address [9-14].

Statistical analysis

We first performed descriptive statistical analyses on controlled variables, including age, gender, education level, marital status and location of residential address. For deeper analysis, we performed the hierarchical regression model to test the hypothesis. The control variables were placed in the first block of the hierarchical model in Model 0. Following the linearity test, we established the linear relationship between depressive symptoms and cognitive functioning in Model 1. Model 2 allowed us to examine the effect of formal and informal social activities on cognitive functioning. In Model 3, we added interactions between two kinds of social activity and depressive symptoms. To test the effect of each specific social activity, we investigated the effect of ten social activities in Model 4. Similarly, we added interaction between each activity and depressive symptoms in Model 5.

In order to test the impact of social participation and depression on the cognitive functioning of older adults in China, the following hierarchical regression model was established:

$$MMSE_i = \alpha_1 + \beta_1 CESD_i + \mu_m X_i + \varepsilon_i \quad (1)$$

where i refers to the individuals in the survey, $MMSE_i$ denotes the score each individual obtained on the cognitive assessment tool in this baseline model. For the control variables X_i, we set single illiterate female participants who lived in the special zone as the reference group. ϵ_i is the error term. $CESD_i$ denotes the score obtained on the depressive assessment tool. β_1 represents the effect of depressive symptoms (CESD-10) on cognitive functioning (MMSE), controlling for X_i while μ_m represents the effects of control variables on MMSE, holding $CESD_i$ constant.

$$MMSE_i = \alpha_2 + \beta_2 CESD_i + \gamma_2 SP\_formal_i + \gamma^3 SP\_informal_i + \delta_1 CESD\_SP\_informal_i + \delta_2 CESD\_SP\_formal_i + \mu_m X_i + \varepsilon_i \quad (2)$$

where SP_formal represents whether the individual i participated in the formal activities while SP_informal represents whether the individual i participated in the informal activities. γ_2 represents the difference in $MMSE_i$ between older adults who participated in formal social activities versus those who did not participate in any social activities, controlling for other variables including CESD-10. γ_3 represents the differences in $MMSE_i$ between older adults who participated in informal social activities versus those who did not participate in any social activities, controlling for other variables including CESD-10. CESD_SP_informal represents the interaction between CESD-10 and participating in informal activities, and δ_1 represents the effect of interaction between CESD-10 and participating in informal activities, controlling for all other variables. CESD_SP_formal represents the interaction between CESD-10 and participating in formal activities, and δ_2 represents the effect of interactions between CESD-10 and participating in formal activities, controlling for all other variables.

$$MMSE_i = \alpha_3 + \beta_3 CESD_i + \gamma_n SP\_n_i + \delta_i CESD\_SP\_n_i + \mu_m X_i + \varepsilon_i \quad (3)$$

where SP_n_i represents whether the individual i participated in the corresponding 10 social activities mentioned in the survey (e.g., SP_1 refers to "interacted with friends"; when SP_n equals to 1 indicating the individual participated in the activities in the past month, SP_n equals to 0 indicating s/he did not) and γ_i represents the difference in $MMSE_i$ between older adults who participated in the particular social activity versus those who did not, controlling for other variables including CESD-10 and the participation of other social activities besides the control variables. $CESD\_SP\_n_i$ represents the interaction between CESD-10 and the specific social participation (e.g., CESD_SP_1 refers to the interaction between CESD-10 and "interacted with friends"), and δ_i represents the effect of interaction between CESD-10 and the specific social participation, controlling for all other variables.

Results

Demographic statistics

The study included 3,284 participants who were selected for analysis. Of these, 2488 (49.20%) were male and 2568 (50.80%) were female. Demographic information can be found in table 1. Older Chinese adults in the CHARLS database demonstrated varying degrees of cognitive impairment (M = 20.96, SD = 5.62), given that an MMSE score of 23 or lower indicates dementia. The subjects also manifested "minimal" to "moderate-severe" depression (M = 8.78, SD = 6.67) with a CESD-10 cut-off score of 10 implying cases of depression.

Descriptive statistics for CESD-10 and MMSE scores are presented in table 2. The mean score for the MMSE was 20.96, with a standard deviation of 5.62, while the mean score for the CESD-10 was 8.78, with a standard deviation of 6.67. With a cut-off MMSE score of 23, participants exhibited mixed degrees of cognitive functioning, with some showing mild dementia [51]. A suggested CESD-10 cut-off score of 10 indicated that participants had varying levels of depressive symptoms, with some meeting the score of cases of depression [52].

Variables	
Age (y), M±SD	69.14±7.15
Gender, n (%)	
Male	2488 (49.20%)
Female	2568 (50.80%)
Education, n (%)	
Illiterate[a]	1497 (29.60%)
1 to 6 years of education	2232 (44.10%)
More than 7 years of education	1327 (26.20%)
Marital status, n (%)	
Married	3989 (78.90%)
Divorced	40 (0.80%)
Widowed	995 (19.70%)
Never Married[a]	32 (0.60%)
Location of residential address, n (%)	
Central of city/town	1050 (20.80%)
Urban-rural integration zone	348 (6.90%)
Rural areas	3644 (72.10%)
Special zone[a]	14 (0.30%)

Table 1: The demographic information of selected subjects (n = 5056).

Variables	
MMSE, M±SD	20.9 ±5.62
CESD-10, M±SD	8.78±6.67
SP: have at least one social participation, n (%)	2743 (54.3%)
SP_informal: have at least one informal social participation, n (%)	217 (4.30%)
SP_formal: have at least one formal social participation, n (%)	2720 (53.80%)
SP_1: interacting with friends, n (%)	1773 (35.10%)
SP_2: playing mahjong, chess, or cards or going to a club, n (%)	887 (17.50%)
SP_3: providing help to family, friends not living with you, n (%)	723 (14.30%)
SP_4: went to a sport, social or other kinds of the club, n (%)	340 (6.70%)
SP_5: took part in a community-related organization, n (%)	136 (2.70%)
SP_6: did voluntary or charity work, n (%)	87 (1.70%)
SP_7: caring for a sick or disabled adult not living with you, n (%)	160 (3.20%)
SP_8: attended an educational or training course, n (%)	43 (0.90%)
SP_9: stock investment, n (%)	41 (0.80%)
SP_10: used the Internet, n (%)	659 (13.00%)

Table 2: The descriptive statistics of MMSE scores, CESD-10 scores, and social participation.

Depression and Formal/Informal social participation on cognitive functioning

Table 3 presents the results from the hierarchical regression models for the cognitive functioning of older adults (n = 5,056) when considering depression, formal social participation, and informal participation, controlling for demographic information. Model 1 considered the role of depression on older adults' cognitive functioning. Results showed that depression was negatively associated with older adults' cognitive functioning; in detail, older adults who experienced higher levels of depression showed reduced cognitive functioning ($\beta = -0.195$, $p < 0.001$).

Model 2 involved formal social participation and informal social participation in the model compared with Model 1. Both formal social participation and informal social participation helped better explain the cognitive functioning of older adults ($R^2 = 0.99$, $p < 0.001$). Participating in formal social activities ($\beta = 0.970$, $p < 0.05$) and informal social activities ($\beta = 0.458$, $p < 0.01$) significantly improved older adults' cognitive functioning. Model 3 examined how the interaction of depression and formal social participation and/or the interaction of depression and informal social participation might affect cognitive functioning. The current research did not find significant interactions, that is, formal social activities ($\beta = -0.048$, $p > 0.05$) or informal social activities ($\beta = 0.029$, $p > 0.05$) would not alter the relationship between older adults' depression level and cognitive functioning.

Depression and specific types of social participation on cognitive functioning

In table 3, social participation (i.e., both formal and informal) was broken down into the 10 sub-categories in Model 4 and Model 5 to investigate which specific types of social participation improve cognitive functioning. The interaction effect between each type of social participation and depression was additionally explored in Model 5. In alignment with previous models, the CESD-10 score remained significant across Model 4 ($\beta = -0.189$, $p < 0.001$) and Model 5 ($\beta = -0.200$, $p < 0.001$), indicating a negative main effect of depression on cognitive functioning.

Model 4 showed that three types of informal social participation, "played mahjong, chess, or cards or went to a community club" (SP_2) ($\beta = 0.571$, $p < 0.01$), "went to a sport, social or other kinds of the club" (SP_4) ($\beta = 0.899$, $p < 0.01$), and "stock investment" (SP_9) ($\beta = 1.883$, $p < 0.05$) had a significant positive main effect on the MMSE score of older Chinese adults, while only one type of formal social participation, "took part in a community-related organization" (SP_5) ($\beta = 1.003$, $p < 0.05$), positively affected older adults' cognitive functioning. Particularly, "stock investment" (SP_9) had the greatest positive coefficient, suggesting that older adults who invested in stocks scored 1.883 units higher on MMSE compared to those who did not, controlling for all other variables.

No interaction effects between specific types of social participation and depression on cognitive functioning were found for older Chinese adults in Model 5. Adding the interaction terms did not enhance the explanatory power of the model ($R^2 = 0.109$, $p = 0.518$). While Model 5 failed to detect any moderating effect of social participation on depression's influence on cognitive functioning, the absolute value of the depression coefficient increased by 0.011 units ($\beta = -0.200$, $p < 0.001$), indicating that depression may play a role in negatively affecting social participation's influence on cognitive functioning.

Variable	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	18.914 (1.924)	20.680 (1.873)	20.275 (1.873)	20.332 (1.873)	20.391 (1.868)	20.463 (1.869)
age	0.026* (0.012)	0.023* (0.011)	0.023* (0.011)	0.023* (0.011)	0.022* (0.011)	0.022 (0.011)
Gender_male	-0.439*(0.170)	-0.459**(0.165)	-0.463**(0.165)	-0.463**(0.165)	-0.0480**(0.164)	-0.482**(0.164)
education_1to6	1.048*** (0.195)	0.942*** (0.190)	0.936*** (0.190)	0.932*** (0.190)	0.945*** (0.189)	0.929*** (0.190)
Education_7more	2.135*** (0.241)	1.849*** (0.235)	1.829*** (0.234)	1.824*** (0.234)	1.828*** (0.234)	1.804*** (0.235)
Marital_married	-.954 (0.980)	-1.088 (0.952)	-1.117 (0.951)	-1.091 (0.951)	-1.074 (0.949)	-.964 (0.951)
Marital_divorced	-.807 (0.537)	-.693 (1.271)	-.752 (1.269)	-.704 (1.270)	-.717 (1.266)	-0.572 (1.269)
Marital_widowed	-1.509 (0.996)	-1.535 (0.968)	-1.570 (0.967)	-1.549 (0.967)	-1.523 (0.965)	-1.402 (0.967)
Residential_city	1.702 (1.481)	1.969 (1.440)	2.082 (1.439)	2.117 (1.439)	1.867 (1.436)	1.870 (1.437)
Residential_integration	1.363 (1.499)	1.673 (1.457)	1.811 (1.457)	1.844 (1.457)	1.608 (1.453)	1.559 (1.455)
Residential_rural	0.109 (1.472)	.505 (1.431)	0.663 (1.430)	0.691 (1.431)	0.536 (1.427)	0.504 (1.428)
CESD		-.195***(0.011)	-.192***(0.011)	-.206***(0.016)	-0.189***(0.011)	-0.200***(0.015)
SP_informal			.970* (0.375)	1.356* (0.603)		
SP_formal			0.458** (0.153)	.199 (0.253)		
CESD_SP_informal				-0.048 (0.060)		
CESD_SP_formal				0.029 (0.023)		
SP_1					-0.008 (0.167)	-0.045 (0.275)
SP_2					0.571** (0.202)	0.632 (0.330)
SP_3					0.045 (0.229)	-0.260 (0.381)
SP_4					0.899** (0.310)	0.685 (0.356)
SP_5					1.003* (0.491)	0.789 (0.784)
SP_6					-0.907 (0.608)	0.097 (1.001)
SP_7					.431 (0.440)	1.192 (0.716)
SP_8					1.033 (0.849)	1.695 (1.430)
SP_9					1.883* (0.857)	2.471 (1.399)
SP_10					.590 (0.235)	0.024 (0.366)
CESD_SP_1						0.005 (0.025)
CESD_SP_2						-.0007 (0.032)
CESD_SP_3						-0.034 (0.035)
CESD_SP_4						0.028 (0.050)
CESD_SP_5						0.029 (0.079)
CESD_SP_6						-0.124 (0.099)
CESD_SP_7						-0.086 (0.065)
CESD_SP_8						-0.085 (0.147)
CESD_SP_9						-0.088 (0.174)
CESD_SP_10						0.073 (0.036)
R^2	0.045	0.098	0.101	0.102	0.108	0.109
Adjusted R^2	0.043	0.096	0.099	0.099	0.104	0.104

Table 3: Regression results for MMSE.

Note: Standard errors are reported in parentheses.

Note: education_1 to 6 = have 1 to 6 years of education, education_7 more = have more than 7 years of education; marital_married = marital status is married, marital_divorced = married status is divorced, marital_widowed = married status is widowed; residential_city = mainly live in the central of city/town, residential_integration = mainly live in urban-rural integration zone, residential_rural = mainly live in rural areas; CESD = depression; SP_informal = have at least one informal social participation; SP_formal = have at least one formal social participation; CESD_SP_informal = the interaction term of CESD and SP_informal; CESD_SP_formal = the interaction term of CESD and SP_formal; SP_1 = "interacted with friends", SP_2 = "played mahjong, chess, or cards or went to a community club", SP_3 = "provided help to family, friends or neighbors who do not live with you", SP_4 = "went to a sport, social or other kinds of the club", SP_5 = "took part in a community-related organization", SP_6 = "did voluntary or charity work", SP_7 = "cared for a sick or disabled adult who does not live with you", SP_8 = "attended an educational or training course", SP_9 = "stock investment", SP_10 = "used the Internet"; CESD_SP_n = the interaction term of CESD and SP_n, n ranges from 1 to 10.

Note: *p < 0.05, **p < 0.01, ***p < 0.001.

Discussion

The current study revealed a direct negative association between depression and cognitive functioning. It further discovered that both formal and informal social participation mitigate cognitive decline among the older Chinese population. It was found that "playing mahjong, chess, or cards or going to a community club", "going to a sport, social or other kinds of the club", "taking part in a community-related organization", and "investing in stock" were particularly helpful in preventing cognitive decline. Importantly, no interaction between social participation and depression on cognitive functioning was found, indicating a failure to detect a modifying effect of social participation on depression's relationship with cognitive functioning.

The study's findings generally replicated previous research on the negative correlation between depression and cognitive functioning among older adults [22,53-55]. Depression plays a significant role in affecting cognitive decline among older adults, even after controlling for demographic factors and social participation. The study also aligned with prior studies on the benefit of social participation on cognitive functioning. More consistent and frequent social engagement was shown to correlate with more favorable cognitive aging trajectories as well as higher cognitive functioning among older adults [36,56,57].

The results of this study suggested that formal social participation has a significant positive effect on the cognitive functioning of older Chinese adults. Specifically, participating in community-related organizations was found to be associated with higher scores on the cognitive test. This finding bridged a gap in the field as previous research primarily focused on informal social activities, such as playing mahjong or cards and interacting with friends [58]. The inclusion of formal activities in this study highlighted the importance of considering the diverse range of social activities that older adults engage in and their potential impact on cognitive functioning.

In comparison to similar studies in China, the finding that formal social activities have a positive effect on cognitive functioning was consistent with previous research. For example, Luo et al., [59] also found that participation in formal social activities, such as volunteer work, was associated with better cognitive functioning in older adults. However, the specific types of formal activities that have a positive effect on cognitive functioning may vary across cultural contexts. In a Korean longitudinal population-based study, older adults who participated in senior citizen clubs or senior centers had better cognitive functioning [33]. These findings suggested that promoting formal social activities may be a valuable strategy for improving cognitive functioning in older adults and that tailoring interventions to the specific cultural context may be important.

The results of the current study showed that informal social participation had a positive association with cognitive functioning. Specifically, informal activities such as "playing mahjong, chess, or cards", "going to a community or social club", and "stock investment" were found to have a significant positive effect on cognitive functioning. These results aligned with previous studies. In comparison to similar studies in China, the study by Fu et al., [60] found that participating in informal social activities, such as visiting friends or relatives, was positively associated with cognitive functioning among older adults in China, while the current study showed that older adults who engaged in more informal social activities had better cognitive functioning, including better attention, memory, and processing speed.

Moreover, Tomioka et al., [61] found that engaging in informal social activities, such as visiting friends or relatives, was associated with a lower risk of cognitive decline. Similarly to our findings, participants who engaged in more than one activity per week had a lower risk of cognitive decline compared to those who did not engage in any activities.

The current study failed to find the interaction effect between social participation and depression on cognitive functioning. To be more specific, participating in formal or informal social activities did not significantly alter the impact of depression on the cognitive level of older Chinese adults. In addition, the interaction effect was not found when considering specific types of social participation either. This result did not support previous indications. One possible reason is that the number of older adults participating in formal activities in our sample was much smaller than those participating in informal activities, suggesting potential insufficient power for detecting the interaction effect. Additionally, the cognitive functioning of older adults was influenced by a bunch of factors, including demographic factors, mental health conditions, and so on [8,-14,22]. A non-significant interaction effect might be a result of the highly complex interrelationships among these factors.

Limitations and Future Direction

One limitation of this study is its cross-sectional design, which makes it difficult to draw causal conclusions about the relationship between depression, social participation, and cognitive functioning. Longitudinal studies that follow older adults over time would provide stronger evidence of causality and allow for the examination of the temporal relationships between these variables. Future studies could aim at drawing conclusions about the potential causal relationships. Additionally, the dataset used in this study relied on self-reported measures of social participation, which may be subject to recall bias and social desirability bias. Future studies could use objective measures of social participation, such as attendance records or activity logs, to provide more accurate data. Finally, the study focused on older Chinese adults, and the results may not be generalizable to other populations with different cultural and social contexts. Therefore, caution should be taken when applying these findings to other populations. Based on that, collecting information on other potentially relevant factors such as physical health, lifestyle factors, and environmental factors would allow for a more comprehensive understanding of the complex interplay between depression, social participation, and cognitive functioning in older adults.

Conclusion

Overall, this study replicated previous research on the correlation between depression and cognitive decline and, more importantly, supported the idea that both formal and informal social participation benefit cognitive functioning. Particularly, stock investment, as a type of informal social participation, has a greater impact than other types of social participation on improving cognitive functioning among older Chinese adults. This study contributes to existing knowledge through evidence-based statistical analyses. The insights of this study will be of interest to Chinese policymakers, geriatric institutions and communities, psychologists, doctors, and older adults in improving the national mental health states of older Chinese adults.

Declarations

Ethics approval and consent to participate

In this study, all methods were carried out in accordance with relevant guidelines and regulations. The study was waived of IRB approval by the Ethics Committee of Kunming Medical University (Ethic number: KMMU2021MEC118). As the data received for analysis was already de-identified, and there was no new data collection or interaction with human subjects involved, IRB approval was not required for this analysis. The secondary analysis of CHARLS data in this study was conducted under the CHARLS Data Sharing Agreement, which outlines the conditions for accessing and utilizing the data while ensuring participant privacy and confidentiality. The CHARLS study itself was approved by the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015).

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed during the current study are available from the China Health and Retirement Longitudinal Study (CHARLS) repository, http://charls.pku.edu.cn/en/. Access to the data requires registration and a request process. To obtain the data, interested researchers should register an account using their email address on the CHARLS dataset website. Once registered, researchers can navigate to the specific wave of data relevant to their study and click the "apply" button to send a request. After the request is reviewed and permission is granted, the "apply" button will be replaced with a "download" button. Researchers can then click the "download" button to obtain the dataset.

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution

MX conceived and designed the study. DM conducted the literature review. GR and ZP performed the statistical analyses and prepared the tables. RL reviewed and revised the manuscript. All authors contributed to the manuscript revisions and approved the final version.

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