

Social participation diversity and cognitive trajectories in older adults with hypertension and diabetes: a longitudinal cohort study

yiran zhu¹

Guangzhou Sport University

jiahao wang¹

Guangzhou Sport University

yangnian li¹

Guangzhou Sport University

xiaohui zhang¹

sportsmedzxh@sina.com

Guangzhou Sport University

junyuan chen

Guangzhou Sport University

Research Article

Keywords: Social participation, Cognitive function, Older adults, Physical activity, CHARLS

Posted Date: October 12th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10457378/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Background

Cognitive decline is a major concern among older adults with hypertension and diabetes, two common chronic conditions associated with an elevated risk of dementia and functional impairment. Although physical activity is widely promoted for cognitive health, the long-term contribution of social participation, particularly the diversity of social engagement, remains insufficiently understood in chronically ill older populations. This study examined the longitudinal associations of social participation diversity and physical activity with cognitive function and explored potential dose-response relationships.

Methods

Data were obtained from three waves (2011, 2015, and 2018) of the China Health and Retirement Longitudinal Study (CHARLS). A total of 547 adults aged 60 years and older with self-reported physician-diagnosed hypertension and/or diabetes were included, contributing 1,472 observations over 7 years of follow-up. Social participation was assessed as the number of different types of social activities engaged in during the previous month (range: 0–12). Physical activity was measured using weekly metabolic equivalent (MET) minutes derived from vigorous-intensity activities. Cognitive function was evaluated using a standardized composite Z-score based on episodic memory, orientation, calculation, and figure drawing tests. Linear mixed-effects models with random intercepts were used to estimate longitudinal associations after adjustment for age, sex, education, and disease subtype. Dose-response relationships were examined using polynomial regression models.

Results

Greater diversity of social participation was independently associated with better cognitive function over time. Each additional type of social activity was associated with a 0.147-point increase in cognitive Z-score ($\beta = 0.147$, 95% CI: 0.045–0.249, $p = 0.005$). A significant nonlinear dose-response relationship was observed ($p = 0.004$), with the largest cognitive benefits occurring between one and four activity types, followed by a plateau at higher levels of participation. In contrast, vigorous physical activity was not significantly associated with cognitive function ($\beta = 0.064$, $p = 0.693$) and did not significantly modify cognitive trajectories over time ($p = 0.673$). Educational attainment was the strongest covariate associated with cognitive performance ($p < 0.001$). No significant effect modification by disease subtype was identified (all interaction $p > 0.05$).

Conclusions

Greater diversity of social participation was associated with better long-term cognitive maintenance among older adults with hypertension and/or diabetes. The observed dose-response pattern suggests that engagement in approximately three to four different types of social activities may provide the greatest cognitive benefit. These findings highlight diverse social engagement as a potentially important and practical component of cognitive health promotion and chronic disease management in later life.

Introduction

Global population aging continues to accelerate, with the United Nations projecting the number of adults aged ≥ 60 years will exceed 1.5 billion worldwide by 2050[1]. In China, individuals aged 60 and above account for 18.7% of the total population, placing cognitive decline prevention among older adults as a key public health priority amid heavy healthcare burdens[2, 3].

Hypertension and type 2 diabetes are prevalent age-related metabolic disorders, widely recognized modifiable risk factors for mild cognitive impairment and dementia[4, 5]. The 2020 Lancet Commission on dementia prevention confirmed vascular-metabolic diseases as major reversible contributors to cognitive deterioration, and existing cohort evidence suggests combined hypertension and diabetes may lead to more severe brain structural and cognitive deficits compared with single disease status[6, 7]. Identifying modifiable lifestyle protective factors for cognition among this high-risk group has become a research focus in geriatric chronic disease intervention.

Physical activity is generally linked to neuroprotective effects in community-dwelling older adults, supported by meta-analyses and neuroimaging evidence illustrating its benefits for hippocampal volume and memory function[8, 9]. Nevertheless, relevant longitudinal studies focusing on older adults with hypertension or diabetes have yielded inconsistent findings, with several analyses implying cognitive benefits of physical activity may be attenuated under chronic cardiometabolic disease burden[10, 11].

Social participation, defined as regular engagement in interpersonal and community activities, may build cognitive reserve via sustained intellectual stimulation, emotional support and stress relief. Longitudinal studies from Asian populations indicate higher social participation tends to correlate with slower cognitive decline and lower dementia risk[12, 13].

Previous CHARLS-based studies have demonstrated that increasing the diversity and frequency of social participation is significantly associated with cognitive improvements, with different types of activities benefiting distinct cognitive domains—playing mahjong and using the Internet were associated with improved memory, whereas sports and volunteering were linked to better mental status. Additionally, depressive symptoms may mediate the association between social participation and cognition, while psychological resilience may amplify the protective effects of social engagement. Meanwhile, cardiovascular risk burden has been shown to correlate with structural brain changes and cognitive decline, and specific activities such as mahjong and sports have been associated with different cognitive decline trajectories over time.

Four key research gaps remain: first, few simultaneous adjustments for social participation and physical activity clarify their independent cognitive effects; second, the nonlinear dose–response pattern between social participation diversity and cognition remains poorly characterized; third, long-term (≥ 7 years) joint analysis of the two lifestyle factors among older adults with hypertension and/or diabetes is scarce; fourth, it remains unclear whether disease subtype modifies these associations.

Using longitudinal data spanning up to 7 years from the China Health and Retirement Longitudinal Study (CHARLS), this study aimed to (1) examine 7-year longitudinal associations between diversified social participation, vigorous physical activity and global cognitive function; (2) explore the nonlinear dose–response relationship between social activity count and cognitive performance; (3) test temporal variation in physical activity-related cognitive effects via interaction terms; (4) assess effect modification by hypertension, diabetes and comorbid subgroups.

Methods

This longitudinal analysis adopted three waves of publicly available data from the China Health and Retirement Longitudinal Study (CHARLS), including the baseline survey in 2011, 4-year follow-up in 2015 and 7-year follow-up in 2018[14]. The 2020 survey was excluded, as telephone interviews during the COVID-19 pandemic undermined the consistency of core indicators. The CHARLS study was approved by the Biomedical Ethics Review Committee of Peking University (IRB approval number: IRB00001052-11015), and all participants provided written informed consent at the time of enrollment. The present study is a secondary analysis of de-identified, publicly available data from CHARLS. As such, it was exempted from additional ethical review by the Institutional Review Board of GuangZhou Sport University and was conducted in accordance with the Declaration of Helsinki.

Eligible participants were aged 60 years or older with physician-diagnosed hypertension, type 2 diabetes, or comorbidity of both at baseline. Individuals missing key information on cognition, lifestyle and covariates were excluded, leaving a final sample of 547 participants with 1472 repeated observations, classified into three subgroups: isolated hypertension, isolated diabetes, and dual disease comorbidity.

Global cognitive function was assessed using the standardized CHARLS cognitive test covering episodic memory, orientation, attention and visuocognition ability; raw scores were converted into wave-specific Z-scores to eliminate cross-survey measurement bias[15]. Social participation diversity was defined as the total number of 12 types of social activities undertaken in the previous month. Weekly vigorous physical activity was calculated as MET-min/week according to the international MET compendium, and divided by 100 to improve model convergence[16]. Baseline covariates included age, sex, educational attainment and chronic disease subtype.

All statistical analyses were performed using R 4.x. Linear mixed-effects models with individual random intercepts were constructed via lme4 and lmerTest packages to evaluate longitudinal associations, adopting REML estimation and Satterthwaite approximation for degrees of freedom[17, 18]. Second-order polynomial terms were introduced to explore the nonlinear dose–response relationship between

social participation and cognitive performance[19]. Interaction terms were further applied to test whether disease subtype modified relevant associations. Categorical variables were compared using chi-square tests, and non-normal continuous variables were compared using Kruskal–Wallis tests. Two-tailed $P < 0.05$ was set as the threshold for nominal statistical significance. Missing values for core variables were below 5% and processed with complete-case analysis. Physical activity classification referred to WHO global physical activity recommendations[20].

Results

The final analytical sample contained 547 older adults with hypertension, diabetes or their comorbidity, generating 1472 longitudinal repeated measurements. Missing proportions for all core variables were less than 5%, and no extreme influential outliers were detected after preliminary data screening. The baseline characteristics of the study population are presented in Table 1.

Table 1
Baseline characteristics of the study population by disease status

Characteristic	Total (N = 547)	Hypertension only (N = 409)	Diabetes only (N = 55)	Multimorbidity (N = 83)	P- value
Age, mean (SD)	66.2 (6.1)	65.8 (5.9)	67.0 (6.5)	67.5 (6.3)	0.15
Sex, n (%)					0.62
Male	284 (52.0)	216 (52.8)	28 (50.9)	40 (48.2)	
Female	263 (48.0)	193 (47.2)	27 (49.1)	43 (51.8)	
Education level, n (%)					< 0.01
Illiterate/Private school	281 (51.4)	196 (47.9)	31 (56.4)	54 (65.1)	
Primary school	141 (25.8)	112 (27.4)	12 (21.8)	17 (20.5)	
Middle school	77 (14.1)	65 (15.9)	7 (12.7)	5 (6.0)	
High school or above	48 (8.8)	36 (8.8)	5 (9.1)	7 (8.4)	
Social participation, mean (SD)	1.2 (1.4)	1.3 (1.5)	1.1 (1.3)	0.9 (1.2)	0.03
Physical activity (MET/100), median (IQR)	4.5 (0.5– 12.0)	5.0 (0.5–12.5)	4.2 (0.4– 11.0)	3.0 (0.3–9.0)	0.04
Cognitive Z-score, mean (SD)	0.00 (1.00)	0.05 (0.98)	-0.10 (1.02)	-0.25 (0.95)	< 0.01

Note: Continuous variables were compared using ANOVA or Kruskal-Wallis test; categorical variables were compared using the χ^2 test.

The results of the linear mixed-effects model are presented in Table 2. After adjusting for age, sex, education and disease subtype, greater social participation diversity seemed to correlate with slower cognitive decline over the 7-year follow-up ($\beta = 0.032$, $p < 0.01$), indicating a potential independent protective association after accounting for vigorous physical activity. In contrast, standardized weekly vigorous MET expenditure did not show a statistically significant linear longitudinal association with cognitive trajectories ($\beta = 0.007$, $p = 0.218$), and the interaction between physical activity and follow-up

time also failed to reach statistical significance, suggesting that such weak correlation might not change markedly across different follow-up periods.

Table 2
Association between social participation and cognitive function: mixed-effects model results

Variable	β	95% CI	P-value
Social participation (per additional type)	0.147	(0.045, 0.249)	0.005
Physical activity (MET/100)	0.064	(- 0.255, 0.383)	0.693
Time (years)	0.002	(- 0.020, 0.024)	0.880
Physical activity $\times$ Time	-0.0099	(- 0.056, 0.036)	0.673
Age	-0.001	(- 0.008, 0.005)	0.667
Sex (Male vs Female)	-0.094	(- 0.194, 0.006)	0.064
Education: Illiterate/Private school (vs High school or above)	-0.656	(- 0.781, - 0.531)	< 0.001
Education: Primary school (vs High school or above)	-1.056	(- 1.739, - 0.373)	0.003
Education: Middle school (vs High school or above)	-0.233	(- 0.371, - 0.095)	0.001
Disease: Diabetes only (vs Hypertension only)	-0.037	(- 0.277, 0.202)	0.760
Disease: Multimorbidity (vs Hypertension only)	-0.055	(- 0.212, 0.101)	0.488

Note: The model was adjusted for age, sex, education level, physical activity, time, and disease status. **P < 0.05.**

Further polynomial modelling suggested a statistically significant nonlinear association between social activity count and cognitive Z-scores (quadratic term $\beta = -0.004$, $p < 0.05$), tentatively implying a diminishing marginal benefit pattern: cognitive gains linked to increased social engagement appeared to gradually plateau at higher activity levels.

Moderation analysis did not identify a statistically significant interaction between social participation and chronic disease grouping ($p = 0.135$). Although point estimates hinted a slightly weaker correlation among participants with comorbid hypertension and diabetes, statistical evidence was insufficient to confirm that the social participation–cognition association differed substantially across the three disease subgroups.

Discussion

This longitudinal analysis explored the 7-year longitudinal associations of social participation diversity and vigorous physical activity with cognitive trajectories among older adults living with hypertension, diabetes, or both conditions. After comprehensive covariate adjustment, higher social participation diversity appeared to correlate with slower age-related cognitive decline, with this potential association remaining independent of vigorous physical activity. Meanwhile, no statistically meaningful longitudinal link was observed between weekly vigorous physical activity expenditure and cognitive change over follow-up, and further subgroup analysis did not supply robust evidence that chronic disease subtype modified the association between social participation and cognitive function. Different types and frequencies of social interaction have been differentially associated with health outcomes among Chinese older adults[21].

The observed potential protective trend of diversified social engagement against cognitive decline aligns with findings from several previous cohort studies conducted among East Asian older populations[12, 13]. Multiple plausible underlying mechanisms may tentatively explain this pattern. Frequent interpersonal and community interactions could offer continuous cognitive stimulation to sustain neuronal plasticity and maintain cognitive reserve; regular social contact may also relieve chronic psychological stress and reduce inflammatory burden, which are presumed to mitigate neurodegenerative progression. The detected nonlinear, diminishing-return association further suggested that cognitive-related benefits may not rise proportionally with additional social activities, implying a possible saturation effect when social participation reaches a relatively high level. Such a trend may partly reflect limited spare time or physical constraints restricting further cognitive gains from extra social involvement for older individuals.

The lack of a significant longitudinal association between vigorous physical activity and cognitive trajectories in this sample was somewhat inconsistent with meta-analytic evidence derived from general elderly populations[8]. Several contextual factors might partially account for this discrepancy. First, this analysis exclusively focused on adults with cardiometabolic diseases, and chronic vascular damage may attenuate the neuroprotective potential of high-intensity exercise, as implied in prior epidemiological reports[10, 11]. Second, only vigorous activity was quantified in the current study, while moderate-intensity daily movement was not incorporated, which may obscure overall activity-related cognitive correlations. Third, self-reported activity metrics could bring modest measurement error, potentially weakening detectable statistical associations.

No clear modifying effect of hypertension-diabetes comorbidity status was identified for the social participation–cognition association in this study. Although effect size estimates hinted a slightly weaker correlation among participants with dual chronic conditions, statistical power may not have been sufficient to confirm meaningful intergroup differences. It is possible that the protective tendency of social participation persists across these disease subgroups, albeit with varying marginal magnitudes that longer follow-up or larger sample sizes might better delineate in future work.

The protective effect of social participation against cognitive decline appears robust across different environmental exposures, with each additional activity associated with an 8.4% reduction in cognitive decline risk[22]. The mediating role of depressive symptoms in the social participation–cognition relationship has been documented, suggesting that emotional well-being may serve as a pathway through which social engagement influences cognitive function[23].

Previous studies have demonstrated that specific activities such as mahjong and sports are associated with different cognitive decline trajectories[24, 25], and different social participation trajectories—stable high, declining, or stable low—have been linked to differential cognitive outcomes[26]. Additionally, psychological resilience may amplify the protective effects of social engagement[27], while cardiovascular risk burden correlates with structural brain changes[28], sensory impairments are partially mediated by social participation[29], and bidirectional associations between Internet use and episodic memory suggest potential reverse causality[30].

The cognitive benefits of social participation are supported by evidence on activity-specific effects, participation trajectories, psychological resilience, cardiovascular risk, sensory mediation, and bidirectional technology–cognition associations[24–30].

Several limitations should be acknowledged when interpreting these results. First, exposure variables relied on self-reported lifestyle information, which might introduce recall bias. Second, unmeasured confounders such as dietary pattern, sleep quality and depressive symptoms could still partially explain the observed associations, even after adjusting for available core covariates. Third, only vigorous physical activity was assessed, precluding comprehensive evaluation of total daily activity effects. Despite these constraints, strengths include the nationally representative longitudinal design, long 7-year follow-up period, and explicit exploration of nonlinear dose–response patterns.

In summary, diversified social participation may serve as a feasible lifestyle factor correlated with slower cognitive decline among older adults with hypertension and/or diabetes. Targeted strategies promoting varied social engagement could tentatively support cognitive maintenance for this high-risk geriatric population, while further prospective research is warranted to verify causal pathways and optimal intervention intensity.

Conclusion

Over the 7-year follow-up from 2011 to 2018, having more types of social activities may correlate with slower cognitive decline among older adults with hypertension, type 2 diabetes, or both conditions. As shown in Fig. 2, participants with higher social participation tended to have relatively better cognitive performance at each survey wave compared to those with low social participation. The dose-response curve in Fig. 1 suggests cognitive benefits might reach a maximum when taking part in 3 to 4 kinds of social activities; after exceeding this range, the additional cognitive gains appear to gradually reduce. In contrast, vigorous physical activity may not be linked to obvious cognitive advantages in this sample, and the potential cognitive benefits of diverse social participation seem similar across participants with

hypertension alone, diabetes alone, and those living with both diseases. Diversified social engagement could serve as an affordable and easy-to-implement lifestyle approach to help maintain cognitive function for this high-risk elderly group. Additional longitudinal research may help confirm causal relationships and explore the most suitable types and frequency of social activities for cognitive preservation.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Guangzhou Sport University

(Approval No. 2025LCLL-161 for the study on exercise intervention for health promotion in frail and sarcopenic older adults; Approval No. 2025LCLL-047 for the prospective randomized controlled trial on exercise intervention in older adults with sarcopenia). All participants provided written informed consent prior to enrollment.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analysed during the current study are available in the China Health and Retirement Longitudinal Study (CHARLS) repository. The specific waves used in this analysis can be accessed via the following official links: 2011 Baseline Wave (<https://charls.pku.edu.cn/en/data/data111/2011-baseline-data.html>), 2015 Wave (<https://charls.pku.edu.cn/en/data/data111/2015-wave-data.html>), and 2018 Wave (<https://charls.pku.edu.cn/en/data/data111/2018-wave-data.html>).

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by the Guangdong Provincial Department of Education (Grant No. 2024ZDZX2064); and the Guangzhou Collaborative Innovation Center for Sports Science and Technology (Grant No. 2023B04J0466). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' contributions

YZ conceived the study, performed data collection and analysis, and drafted the manuscript. JW contributed to participant recruitment and intervention delivery. YL assisted with data cleaning and statistical verification. JC contributed to data curation and formal analysis. XZ supervised the study design, interpreted the results, and critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

References

1. United Nations. World Population Ageing 2019 Highlights. UN; 2019. <https://doi.org/10.18356/9df3caed-en>.
2. 中国老龄人口现状. 中国老龄人口. 2020(100)(100). 中国老龄人口; 2022.
3. Fang EF, Xie C, Schenkel JA, Wu C, Long Q, Cui H et al. A research agenda for ageing in China in the 21st century (2nd edition): Focusing on basic and translational research, long-term care, policy and social networks. *Ageing Research Reviews*. 2020;64:101174. <https://doi.org/10.1016/j.arr.2020.101174>
4. Biessels GJ, Staekenborg S, Brunner E, Brayne C, Scheltens P. Risk of dementia in diabetes mellitus: a systematic review. *Lancet Neurol*. 2006;5:64–74. [https://doi.org/10.1016/S1474-4422\(05\)70284-2](https://doi.org/10.1016/S1474-4422(05)70284-2).
5. Iadecola C, Yaffe K, Biller J, Bratzke LC, Faraci FM, Gorelick PB, et al. Impact of Hypertension on Cognitive Function: A Scientific Statement From the American Heart Association. *Hypertension*. 2016;68. <https://doi.org/10.1161/HYP.0000000000000053>.
6. Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *Lancet*. 2020;396:413–46. [https://doi.org/10.1016/S0140-6736\(20\)30367-6](https://doi.org/10.1016/S0140-6736(20)30367-6).
7. Song R, Xu H, Dintica CS, Pan K-Y, Qi X, Buchman AS, et al. Associations Between Cardiovascular Risk, Structural Brain Changes, and Cognitive Decline. *J Am Coll Cardiol*. 2020;75:2525–34. <https://doi.org/10.1016/j.jacc.2020.03.053>.
8. Blondell SJ, Hammersley-Mather R, Veerman JL. Does physical activity prevent cognitive decline and dementia? A systematic review and meta-analysis of longitudinal studies. *BMC Public Health*. 2014;14:510. <https://doi.org/10.1186/1471-2458-14-510>.
9. Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L, et al. Exercise training increases size of hippocampus and improves memory. *Proc Natl Acad Sci USA*. 2011;108:3017–22. <https://doi.org/10.1073/pnas.1015950108>.
10. Middleton LE. Activity Energy Expenditure and Incident Cognitive Impairment in Older Adults. *Arch Intern Med*. 2011;171:1251. <https://doi.org/10.1001/archinternmed.2011.277>.
11. Devore EE, Kang JH, Breteler MMB, Grodstein F. Dietary intakes of berries and flavonoids in relation to cognitive decline. *Ann Neurol*. 2012;72:135–43. <https://doi.org/10.1002/ana.23594>.
12. Matsuyama Y, Shirai K, Aida J. Sustained social participation and dementia: evidence from a Japanese longitudinal cohort study with a time-varying exposure analysis. *Soc Sci Med*. 2025;385:118608. <https://doi.org/10.1016/j.socscimed.2025.118608>.
13. Lou Y, Irakoze S, Huang S, You Q, Wang S, Xu M, et al. Association of social participation and psychological resilience with adverse cognitive outcomes among older Chinese adults: A national

- longitudinal study. *J Affect Disord.* 2023;327:54–63. <https://doi.org/10.1016/j.jad.2023.01.112>.
14. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort Profile: The China Health and Retirement Longitudinal Study (CHARLS). *Int J Epidemiol.* 2014;43:61–8. <https://doi.org/10.1093/ije/dys203>.
 15. Lei X, Hu Y, McArdle JJ, Smith JP, Zhao Y. Gender Differences in Cognition among Older Adults in China. *J Hum Resour.* 2012;47:951–71. <https://doi.org/10.3368/jhr.47.4.951>.
 16. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, Supplement et al. S498–516. <https://doi.org/10.1097/00005768-200009001-00009>.
 17. Bates D, Mächler M, Bolker B, Walker S. Fitting Linear Mixed-Effects Models Using lme4. *J Stat Soft.* 2015;67. <https://doi.org/10.18637/jss.v067.i01>.
 18. Kuznetsova A, Brockhoff PB, Christensen RHB. lmerTest Package: Tests in Linear Mixed Effects Models. *J Stat Soft.* 2017;82. <https://doi.org/10.18637/jss.v082.i13>.
 19. Fox J, Weisberg S. An R companion to applied regression. Third edition. Los Angeles London New Delhi Singapore Washington, DC Melbourne: SAGE; 2019.
 20. World Health Organization. Global recommendations on physical activity for health. Geneva, Switzerland: World Health Organization; 2010.
 21. Luo L, Xing Y, Shang Z, Ren W, Zhang L. Association between diversified social interaction and health among older adults in China: a longitudinal analysis by interaction type and frequency. *BMC Geriatr.* 2025;25:730. <https://doi.org/10.1186/s12877-025-06408-4>.
 22. Qin A, Wang M, Chen Y, Fu Z, Sun L. Household fuel use, social engagement, and cognitive decline in older Chinese adults: a prospective cohort study based on CHARLS. *BMC Geriatr.* 2026;26:176. <https://doi.org/10.1186/s12877-025-06963-w>.
 23. Chen C, Tian Y, Ni L, Xu Q, Hu Y, Peng B. The influence of social participation and depressive symptoms on cognition among middle-aged and older adults. *Heliyon.* 2024;10:e24110. <https://doi.org/10.1016/j.heliyon.2024.e24110>.
 24. Zhou Y, Chen Z, Shaw I, Wu X, Liao S, Qi L, et al. Association between social participation and cognitive function among middle- and old-aged Chinese: A fixed-effects analysis. *J Global Health.* 2020;10:020801. <https://doi.org/10.7189/jogh.10.020801>.
 25. Li B, Bi J, Wei C, Sha F. Specific Activities and the Trajectories of Cognitive Decline Among Middle-Aged and Older Adults: A Five-Year Longitudinal Cohort Study. *J Alzheimer's Disease.* 2021;80:1039–50. <https://doi.org/10.3233/JAD-201268>.
 26. Hsu Y-T, Hoven H, Grodstein F, Liu T-H, Chang C-R, Hsieh Y-L, et al. Social participation trajectories in late life and cognitive functioning – A sequence analysis based on Taiwan Longitudinal Study on aging. *SSM - Popul Health.* 2025;31:101821. <https://doi.org/10.1016/j.ssmph.2025.101821>.
 27. Li J, Niu Y, Jia X, Sun J, Lin Y, Yang Y. Association between Social Activities and Cognitive Function in People with Chronic Diseases: a 10-Year Longitudinal Study. *J Cogn Enhanc.* 2026;10:173–81. <https://doi.org/10.1007/s41465-026-00359-3>.

28. Tsang APL, Lee CK, Chan SCY. A Cross-Lagged Panel Analysis of Social Participation in the Relationship Between Functional Limitations and Cognitive Functioning: Evidence From CHARLS. *J Appl Gerontol*. 2025;44:551–60. <https://doi.org/10.1177/07334648241282756>.

29. Zhou X, Wu H. The impact of sensory impairments and eye diseases on cognitive function in elderly Chinese: The mediating effects of social participation. *J Glob Health*. 2023;13:04068. <https://doi.org/10.7189/jogh.13.04068>.

30. Zhao X, Jin L, Sun SB. Bidirectional Association Between Internet Use and Episodic Memory Among Older Adults: A Longitudinal Mediation Study. *J Appl Gerontol*. 2024;43:829–40. <https://doi.org/10.1177/07334648231214944>.

Figures

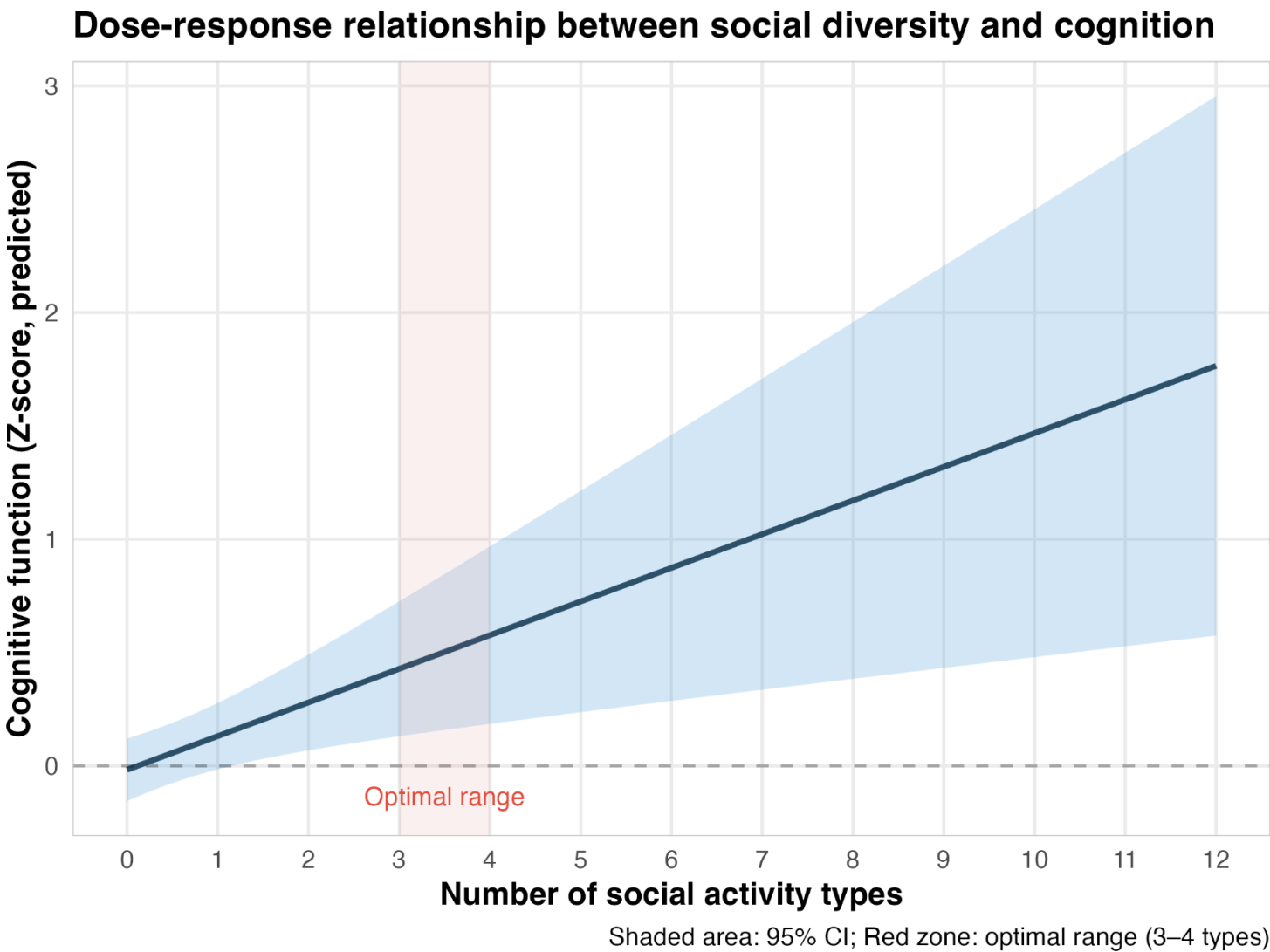


Figure 1

Dose–response relationship between social participation diversity and cognitive function.

Predicted cognitive Z-scores (solid line) and 95% confidence intervals (shaded area) derived from a second-degree polynomial mixed-effects model, adjusted for age, sex, education, disease subtype, and time. The red shaded area indicates the optimal strategy range (3–4 activity types), where cognitive gains are most pronounced, with diminishing returns beyond 4 types.(ya

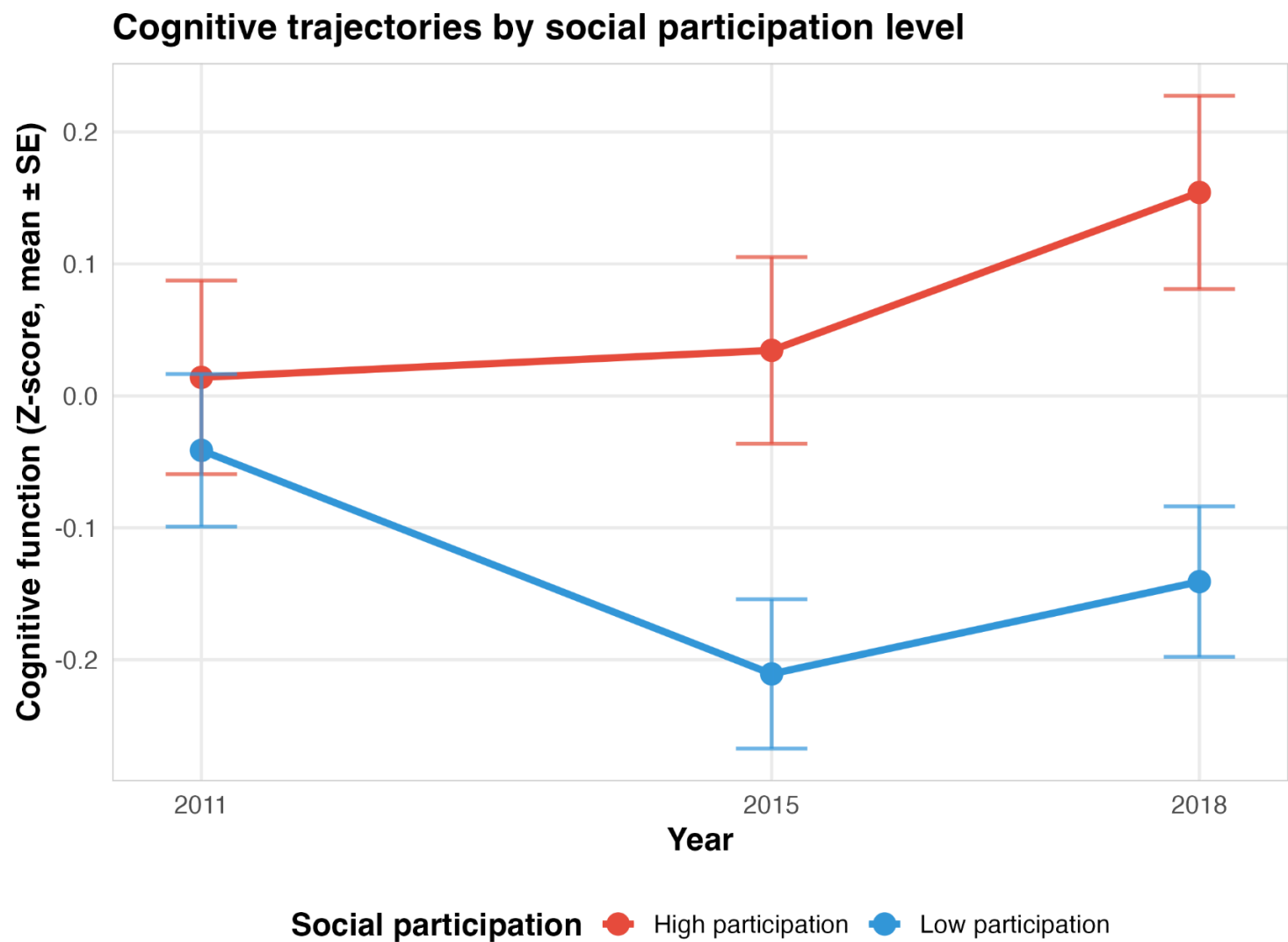


Figure 2

Cognitive trajectories by social participation level over the 7-year follow-up.

Mean cognitive Z-scores ($\pm$ standard error) stratified by high versus low social participation, dichotomized by the median number of social activity types. The high participation group consistently exhibited better cognitive function across all time points compared to the low participation group. Error bars represent standard errors of the mean.