Specific Activities and the Trajectories of Cognitive Decline among Middle-aged and Older Adults: A Five-year Longitudinal Cohort Study

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Research

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Abstract

Background: Emerging evidence indicates that leisure activities are associated with higher risk of cognitive impairment and dementia among the older adults, but how specific activities influence cognitive decline among different age groups, especially the late middle-aged and the early old, remains inadequately studied. This study aims to examine association between specific activities with trajectories of cognitive functions in different age groups in China.

Methods: This longitudinal cohort study included 14,161 Chinese individuals aged 45 years or above from the China Health and Retirement Longitudinal Study (CHARLS). Data were collected bi-annually from 2011 to 2015. Cognitive function, including memory and mental status, was measured by Telephone Interview of Cognitive Status (TICS) battery. Mixed effects growth models were applied to analyse the association between specific activities and cognitive functions.

Results: Four activities, respectively interacting with friends, playing Mah-jong or other card games, going to a sport and providing help to others, were found to be significantly associated with participants' cognitive functioning. All four activities are associated with better memory. Infrequently playing Mah-jong or other card games and daily sports are significantly associated with better mental status. In addition, specific effect of each activity varies among population of different age, education level, gender and residence.

Conclusions: This study identifies four social activities that are associated with better cognitive functions, and provides a comprehensive, in-depth understanding on the specific protective effect of each activity among different subgroups. These findings have practical implications for feasible and personalized cognitive health interventions.

Introduction

Dementia increasingly creates burden for both the patients and their caregivers (1, 2), while no effective treatment has been found (3). It is important to identify modifiable risk and protective factors and implement feasible early intervention (2, 4, 5). Scholars have found that overall involvement in leisure activities is associated with reduced risk of cognitive impairment (5-11) and dementia (12, 13) among older adults. However, what specific activities, for whom and under what circumstance are associated with cognitive trajectory remains largely unknown (14, 15). Furthermore, the definition of leisure activities varies across nations and cultures. For research findings to be translated into feasible interventions, it is necessary to study the context-specific association between activities and cognitive trajectories.

Among all the activities studied, most evidence points to the protective effect of cognitive-stimulating activities(16, 17), and some results suggest activities including social interactions and productive work are also beneficial(18, 19). The ideal frequency, forms and target population, however, are less discussed, rendering the results inapplicable in real-life contexts. Only one national-level, longitudinal study focused on the association between specific leisure activities and cognitive impairment among the oldest old (80+

years)(5), while such associations among the younger population remains unclear. Cognitive deterioration in middle life is associated with onset of cognitive impairment and dementia in later years(20). Therefore, it is important to include the middle-aged as well as the late middle-aged population in the study so as to identify effective early interventions. Furthermore, studies may generate conflicting findings if age and regional differences are not taken into consideration. For example, while a regional study including 5,437 participants aged above 55 found that watching TV is associated with higher risk of cognitive impairment(10), the opposite was found among the older adults aged above 80(5). Social contexts may also play an important role on this issue. Most evidence is accumulated in developed countries and regions, with indigenous evidence scantly generated. Even within the same country, regional differences may still exist(21). It has been found that 18% of cognitive capacity disparity could be attributed to urban-rural disparity in terms of social participation(22). This study aims to provide a comprehensive understanding of associations between activities and cognitive decline among Chinese middle-aged and older adults, taking into consideration the distinct effect among groups of different age, gender, education and residence.

Method

Participants

Data used in this study were derived from the China Health and Retirement Longitudinal Study (CHARLS) 2011-2015, and a detailed description of the data collection has been published (23). Briefly, the data were collected biannually from 2011 to 2015 through interviews with a nationally representative sample of adults aged 45 or above. Multistage cluster sampling was adopted for sample selection, and the overall response rate was 80.05% (24). The national baseline survey of CHARLS included 17,705 respondents from 10257 households. We included participants that had responded to at least two waves of surveys. Participants with missing data in both mental status and memory assessments or activities were excluded. A flowchart of the participant enrolment in this study is shown in Figure 1. Different from previous studies that only included participants aged above 65 years, we included participants of all ages and categorized them into three groups, respectively the middle-aged adults (45-54), the late middle-aged adults (55-64) and the older adults (65 or above). We aimed to examine the potential protective effect of activities against cognitive decline in different life phases.

Assessment of activities

The participants were interviewed about their engagement in activities in the last month, including “interacting with friends”, “playing Mah-jong, chess, cards or going to community club”, “providing help to family, friends, or neighbors who do not live with you for free”, “going to a sport”, “taking part in a community-related organization”, “doing voluntary or charity work”, “caring for a sick or disabled adult who does not live with you”, “attending a course”, “stock investment” and “using the Internet”. Frequency of doing the abovementioned activities was asked if the participant answered yes to any of the activities, and the frequency was categorized into “infrequent participation” and “daily participation”. We combined

these two questions and re-categorized the frequency of doing each activity into “no participation”, “infrequent participation” and “daily participation”. Activities with “no participation” rate over 95% were excluded to ensure the activities have considerable acceptability within the studied population. A detailed description of the excluded activities is presented in Table S1. In the end, four activities were selected as independent variables of this study, respectively “interacting with friends”, “playing Mah-jong and other games”, “going to a sport” and “providing help to family, friends or neighbors”.

Assessment of cognitive functions

CHARLS adopted components of the Telephone Interview of Cognitive Status (TICS) battery (25) for cognitive assessment. The TICS evaluated respondents’ cognitive capacity in terms of episodic memory and mental status (26). In this study, we analyzed the protective effect of activities on these two constructs separately.

In CHARLS, memory was assessed by an immediate and a four-minute-delayed word recall of 10 Chinese words that were read to them (25, 27). The total score was calculated by averaging the number of words correctly recalled in the immediate and delayed tests, ranging from 0 to 10. Mental status was assessed by 11 questions: orientation was assessed by asking respondents the current year, season, month, day, and day of the weak; numeric ability was assessed by serial subtraction of 7 from 100 (up to five times); visuospatial ability was assessed by respondents to draw the figure shown to them (two overlapped pentagons). The total score on mental status was the number of correct answers, ranging from 0 to 11 (28). For both assessments, higher scores indicate better cognitive ability.

Assessment of covariates

Sociodemographic information, comorbidity and health behaviors were considered as covariates in this study. Sociodemographic information included age (years), gender (female and male), residence (urban and rural), highest education (illiterate, elementary and below, junior high and above) and marital status (married with spouse or not). Comorbidity included self-reported psychiatric problems (yes or no), hypertension (yes or no), heart disease (yes or no), stroke (yes or no), diabetes (yes or no), and memory disease (yes or no). Health behaviors included smoking (yes or no) and alcohol consumption (drinking more than once a month, drinking but less than once a month or none of these).

Statistical analysis

We fit multilevel growth modelling with an unstructured covariance matrix and random intercept and random slope to examine the association between time-varying activity frequency with changes in global cognition and individual cognition including mental status and memory. In our study, two-level linear growth models were used with time as our level-1 variable and respondents/individuals as the level-2 variable.

In our models, individual’s mental status and memory scores over the 3 waves were modelled as a function of time (years since the baseline including 1, 3, 5). The intercept (individual initial mental status

or memory score at baseline) and slope (the yearly rate of change in both scores) were specified as random at level-2 (person level). The frequency of activity was the predictor variables, and mental status and memory were two separate outcome variables. Age, gender, residence, highest education, marital status, psychiatric problems, hypertension, heart disease, stroke, diabetes, memory disease, smoking, alcohol, and disabled were adjusted for the final multivariate model. Random forest imputation was applied to fill in the missing data on covariates.

First, we used the unconditional means model to estimate the Intraclass Correlation Coefficient (ICC). Second, we used the unconditional growth model to examine the unadjusted association between specific activities and mental status or memory scores. At last, we used a two-level multilevel growth model to model the change in mental status and memory scores over time for older people by different frequency of activity. In this model, level-1 model addressed how individual changes over time and a level-2 model that addressed how changes in mental status and memory scores differs between individual by frequency of activity. All statistical analysis was performed using R version 4.0.0. $P < 0.05$ (two-sided) was considered statistically significant.

Results

Sample characteristics

In total, 14,161 participants were included in this study and the baseline characteristics of the participants were summarized in Table 1. 51.5% of the participants were women, 77.6% of the participants were urban residents, and the percentage of participants aged between 45 to 54, 55 to 64 and above 65 was respectively 34%, 39.7% and 26.3%. In terms of education level, 20.4% of the participants were illiterate, 32.6% of them received elementary education or below, and 28.6% attended school until junior high or above.

Participation in activities

Interaction with friends had the highest participation rate, with 19.9% of the participants infrequently doing it and 17.9% daily doing it. 15.1% of the participants infrequently played Mah-jong and other games and 5.5% of the participants daily engaged in it. Providing help to others and going to sports are comparatively less popular among the respondents, with percentage of infrequent participants being 9.2% and 2.6%, and daily participants 1.0% and 4.9%.

Association between specific activities and cognitive functions

From the unconditional means model, the Intraclass Correlation Coefficient (ICC) was 0.56 for mental status and 0.47 for memory, suggesting that 56% of the total variation in mental status score was attributable to differences between individuals and 47% in memory was attributable to differences between individuals.

Table 2 showed the results of multilevel growth modelling presenting the relationship between frequency of specific activities and cognitive ability of the participants. In the unadjusted model, except for the variable ‘interacting with friends every day’, other variables were statistically significant with cognitive function. In the adjusted model considering basic control variables, compared with the individuals who never participated in playing Mah-jong and other games, ‘infrequent participation’ in these activities () significantly improved mental status; compared with the individuals who never went to a sport, daily participation in a sport () significantly improved mental status.

Interaction with friends, playing Mah-jong and other games, going to a sport and infrequently providing help to others are all significantly associated with better memory. Generally, a dose-response relationship has also been detected between these activities and better memory. Specifically, daily interaction with friends (is more strongly associated with better performance in memory than infrequent interaction (, both in reference to no interaction. Similarly, daily participation in Mah-jong and other games (is more strongly associated with better memory than infrequent participation (, both in reference to no interaction. In contrast, infrequently going to a sport (has more positive effect on memory than daily participation (. In terms of providing help to others, only infrequent participation is significantly associated with higher score on memory (.

Sub-group Analysis

Figure 2 presents the sub-group analysis of the association between each selected activity and mental status, and Figure 3 presents the sub-group analysis of the association between each selected activity and memory. With all covariates adjusted, interactions between subgroup characteristics and activities were identified, indicating the distinct effect each activity had on different subgroups. Interaction between age and the protective effect of playing Mah-jong or other games was found. The association between infrequent Mah-jong playing and memory preservation, compared with never playing, is more significant among the middle-aged and late-middle-aged groups than that of the older group, while such association between daily playing, also compared with never playing, is more significant among the older group. Residential differences were also identified in the analysis. The association between infrequent interaction with friends and memory preservation, compared with no interaction, was more significant among the urban participants. In addition, the protective effect of playing Mah-jong and other games on cognitive function is more significant among the rural participants. The protective effect of playing Mah-jong and other games against memory decline is significant among people with no formal education and people with junior high education or above, but not among those who received elementary education. In addition, people with the highest education level benefit significantly more from daily going to a sport (in reference to never doing sports) in terms of memory reservation, compared to other groups. No gender differences were identified in the association between each activities and cognitive function.

Sensitivity analysis

Sensitivity analysis was conducted by excluding participants with missing data on covariates (Supplementary Table S2), and only including participants that had responded to all three waves of

surveys (Supplementary Table S3). No substantial differences from the presented results were identified in the sensitivity analysis.

Discussion

This study has identified significant associations between activity participation and cognitive functions, adjusting for important confounders. Furthermore, we investigated the specific influence of activity types, frequency and population characteristics on this association, providing practical implications on cognition preservation.

Interaction with friends, playing Mah-jong and other games, going to a sport and providing help to others are all significantly associated with better memory, while only daily participation in a sport and infrequent participation in playing Mah-jong and other games are significantly associated with better mental status. These results are consistent with previous evidence on the association between memory improvement and enriched environments, defined as exposure to novel objects, elevated social interactions and exercise (29, 30).

Sub-group analysis provides insights into the association between activities and cognitive function in population with different characteristics. Previous studies have yielded mixed findings regarding whether physical activities alone are associated with cognitive function (31, 32). While our findings suggest overall participation in a sport is associated with better cognitive performances, the protective effect of participation in sports varies among participants of different educational level. It is observed that the protective effect of doing a sport against memory decline is stronger among those who received education until junior high or above, in comparison to participants with lower education. This might be explained by the neurogenic reserve hypothesis, which suggests that exercise preserves the potential for neuroplasticity by maintaining neurogenesis in an activated state, and thus preserves the brain's compensatory potential against neurodegeneration (33-35). The more educated groups may increase the effect of doing sports by integrating more enriched somatosensory, visual and social stimulation into the sports (36), therefore better preserving their cognitive functions. This result is consistent with previous findings that doing sports in mid-life may have preventive effect against risk of dementia in later life (37).

Previous studies have consistently found the association between playing Mah-jong and lower risk of cognitive impairment or dementia, possibly because the cognitive stimulation and interpersonal interactions embedded in these activities (5, 11, 38). Interestingly, although a previous study found these games to have stronger positive effect among people with higher education (5), our findings identified a more nuanced difference. In terms of memory, the protective effect of playing these games are similarly strong among the illiterate group and most educated group, while such effect on mental status increases with education level. Furthermore, the protective effect of playing these games against cognitive is stronger among rural residents than their urban counterparts. This result may be explained by the popularity of Mah-jong and games in less developed regions in China. When players develop

considerable skills through long-term practice, they may enrich the stimulation and interactions embedded in these games regardless of their education level.

Significant interaction between age and the protective effect of playing Mah-jong and other games against cognitive decline has also been found. Infrequent participation in these games is more beneficial for the middle-aged group (45-54) while daily participation is more beneficial for the older group (> 64). Such difference may be caused by difference in living circumstances as well as accessibility to activities.

Compared to other cognitive-stimulating activities, Mah-jong is more widely accepted by people of different backgrounds in China, making it a feasible intervention for cognitive health management. But it is noteworthy that although both frequent and infrequent engagement in Mah-jong and other games are associated with better memory, daily engagement is not associated with better mental status. This might be explained by the possible negative influences of addiction to gambling, including monotonous stimulation and limited social interactions. Therefore, it is important that an appropriate frequency of these activities is recommended.

Social interaction is another widely studied protective factor against cognitive decline (6, 18, 39). This study has found significant association between interacting with friends and memory, but not with mental status. In addition, a previous study has identified the positive effect of productive work for family on cognitive functions (19), but in our study, only infrequently providing help to others is associated with memory preservation, and such effect decreases with education level. This result partially implies the benefits of ‘agentic aging’, a lifestyle in which older adults engage in activities and interactions by their own choice, instead of routinely providing help for their families.

There are several potential limitations of this study. The longitudinal design cannot prove causality between these activities and cognitive functions. Randomized controlled trails should be conducted in the future to further evaluate the effectiveness of these interventions. In addition, although we have controlled several confounding variables, other unknown or unmeasured confounders might still exist.

Conclusions And Implications

Increasing evidence has suggested that enriched and stimulating lifestyle factors are protective against cognitive impairment (40). Our study has expanded evidence on this issue by examining the specific effect of particular activities on cognitive trajectories and subgroup differences. It is recommended that frequent social interactions, frequent engagement in sports and infrequent involvement in Mah-jong and other games might be translated into preventive interventions against cognitive impairment and dementia. Clinical studies on the effect of non-pharmacological interventions for cognitive impairment often yield mixed results (41), probably caused by the ignorance of the individual heterogeneity of the studied population. In this study, we provided more in-depth evidence for developing individualized intervention programs. With the increasing prevalence of cognitive impairment and dementia, it is important for scholars to continuously identify specific and practical approaches for cognitive health management.

Declarations

Ethics approval and consent to participate: We used public secondary deidentified data in this study so ethics approval is not required.

Consent for publication: All authors have agreed to the submission.

Availability of data and materials: The datasets supporting the conclusions of this article are available on http://charls.pku.edu.cn/pages/data/111/en.html.

Competing interests: There are no competing interests.

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Tables

Table 1
Baseline descriptive statistics

	No./Mean	% /SD		No./Mean	% /SD
Cognitive function			Gender		
Mental status score	8.34	2.51	Male	6864	48.5
Memory score	3.52	1.72	Female	7297	51.5
Interacting with friends			Residence		
No participation	8821	62.3	Urban	3174	22.4
Infrequent participation	2808	19.9	Rural	10987	77.6
Daily participation	2532	17.9	Highest Education		
Playing Ma-jong, etc.			Illiterate	2885	20.4
No participation	11238	79.4	Elementary and below	4619	32.6
Infrequent participation	2143	15.1	Junior high and above	4047	28.6
Daily participation	780	5.5	Marital status		
Providing help to others			Married with spouse	11946	84.4
No participation	12716	89.8	No spouse	2215	15.6
Infrequent participation	1307	9.2	Psychiatric problems (Yes)	128	0.9
Daily participation	138	1.0	Hypertension (Yes)	2887	20.4
Going to a sport, etc.			Heart Disease (Yes)	1493	10.5
No participation	13088	92.4	Stroke (Yes)	242	1.7
Infrequent participation	369	2.6	Diabetes (Yes)	781	5.5
Daily participation	704	4.9	Memory Disease (Yes)	170	1.2
Age (in years)			Smoking (Yes)	4510	31.8
45 ~ 54	4817	34.0	Alcohol (Yes)	4855	34.2
55 ~ 64	5620	39.7	Disabled (Yes)	2133	15.1
65 or more	3724	26.3	Total sample size	14161	100

Table 2

Regression coefficients from two-level growth models (CHARLS, 2011–2015)

	Unadjusted Model		Adjusted Model	
	Mental status	Memory	Mental status	Memory
Interacting with friends (ref. no participation)				
Infrequent participation	0.19 (0.13 to 0.24)***	0.25 (0.21 to 0.29)***	0.10 (-0.02 to 0.23)	0.13 (0.03 to 0.22)**
Daily participation	0.06 (-0.01 to 0.12)	0.09 (0.04 to 0.13)***	0.11 (-0.01 to 0.24)	0.19 (0.09 to 0.28)***
Playing Ma-jong, etc. (ref. no participation)				
Infrequent participation	0.40 (0.33 to 0.47)***	0.32 (0.27 to 0.37)***	0.30 (0.17 to 0.43)***	0.12 (0.02 to 0.22)**
Daily participation	0.40 (0.29 to 0.50)***	0.32 (0.24 to 0.39)***	0.14 (-0.07 to 0.34)	0.26 (0.10 to 0.42)**
Providing help to others (ref. no participation)				
Infrequent participation	0.17 (0.10 to 0.24)***	0.22 (0.17 to 0.27)***	0.11 (-0.06 to 0.28)	0.24 (0.11 to 0.37)***
Daily participation	0.20 (0.00 to 0.41)	0.28 (0.12 to 0.43)***	0.25 (-0.27 to 0.78)	0.30 (-0.09 to 0.69)
Going to a sport, etc. (ref. no participation)				
Infrequent participation	0.34 (0.21 to 0.48)***	0.38 (0.28 to 0.48)***	0.19 (-0.10 to 0.49)	0.31 (0.08 to 0.54)**
Daily participation	0.43 (0.33 to 0.53)***	0.53 (0.46 to 0.61)***	0.24 (0.03 to 0.45)*	0.22 (0.05 to 0.38)**
Sample size	12395	13931	12395	13931

Figures

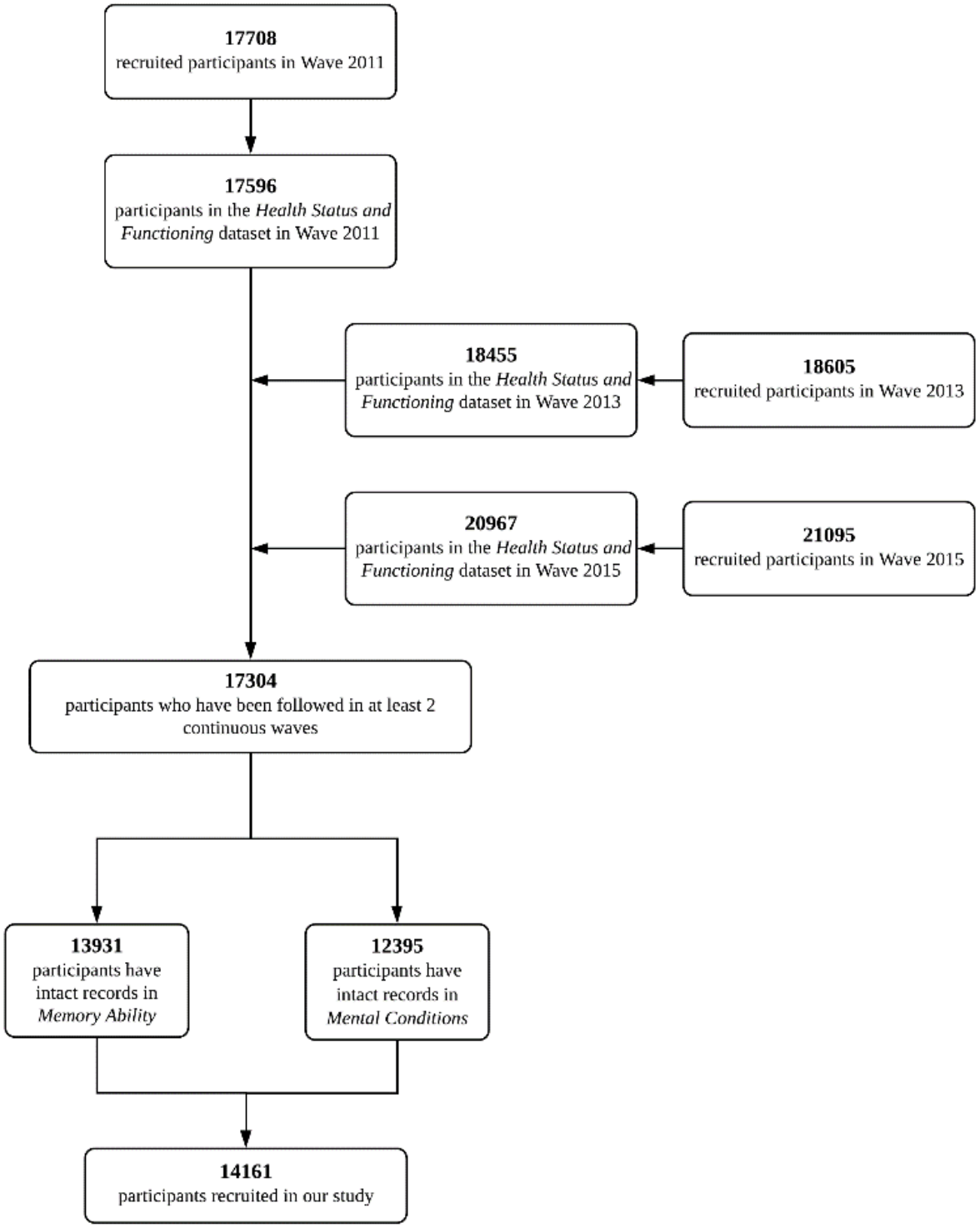


Figure 1

Flowchart of selection process of participant enrolment in this study

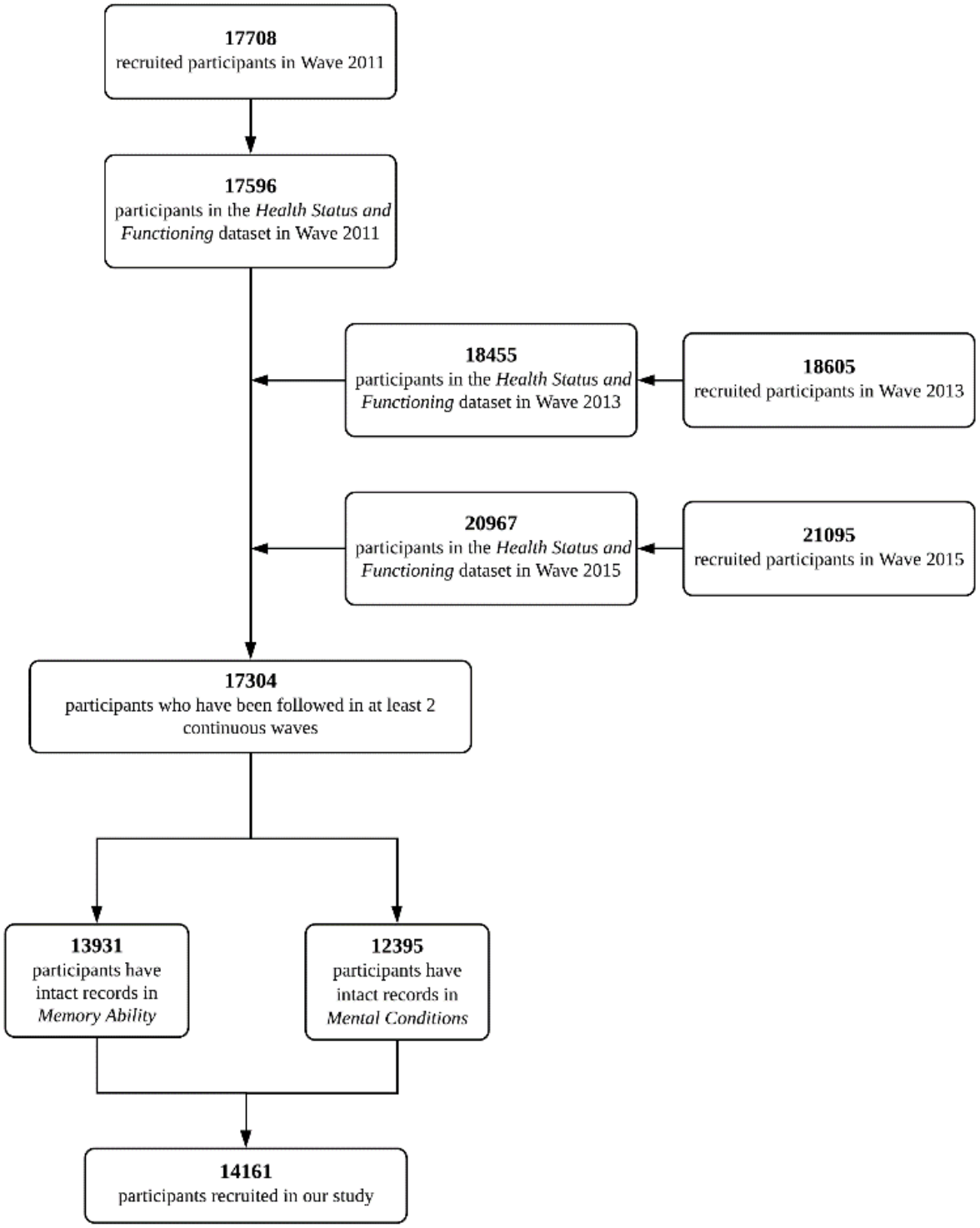


Figure 1

Flowchart of selection process of participant enrolment in this study

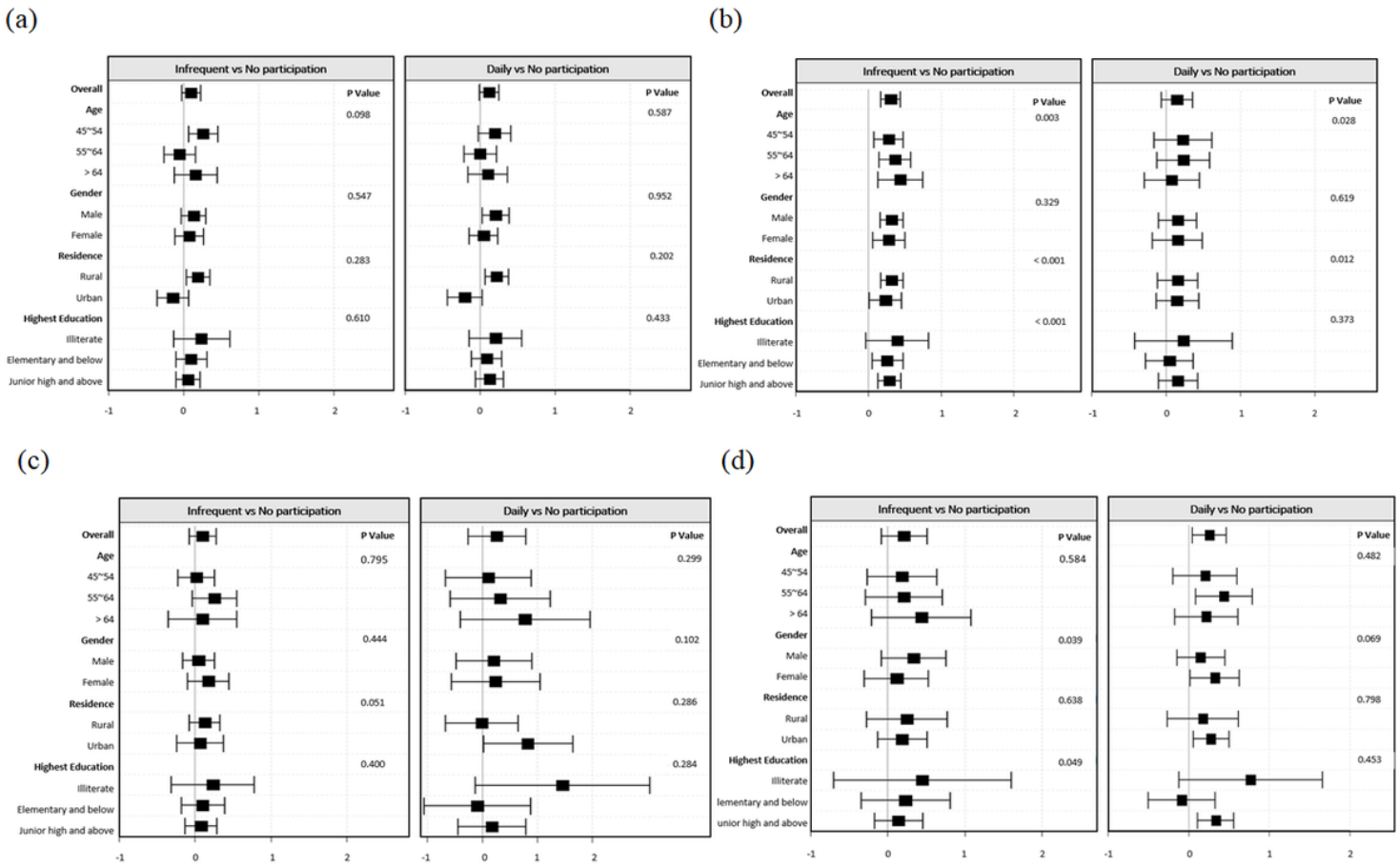
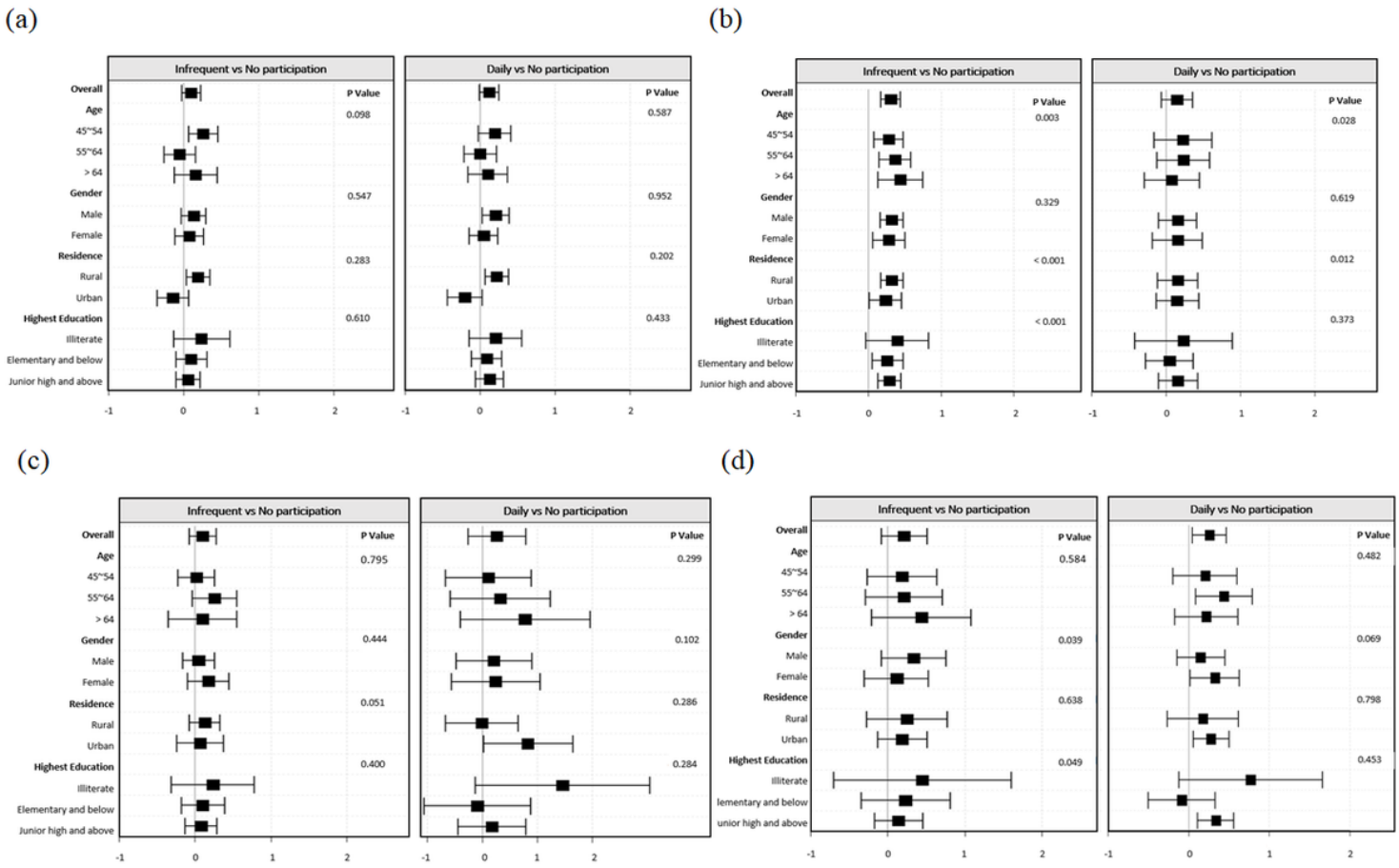


Figure 2

Forest plot of subgroup analysis of the association between four activities and mental status.



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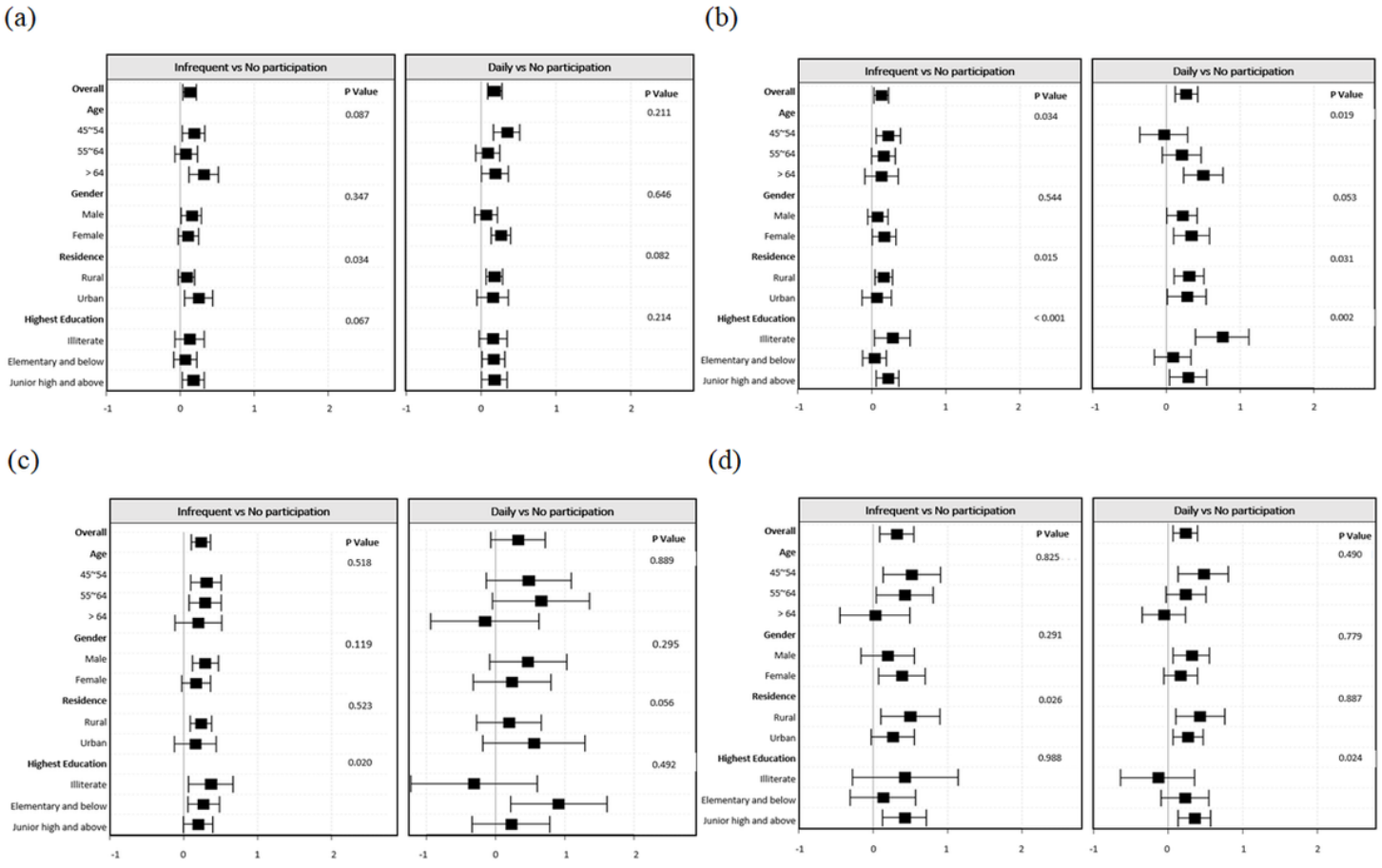

Figure 3

Forest plot of subgroup analysis of the association between four activities and memory.

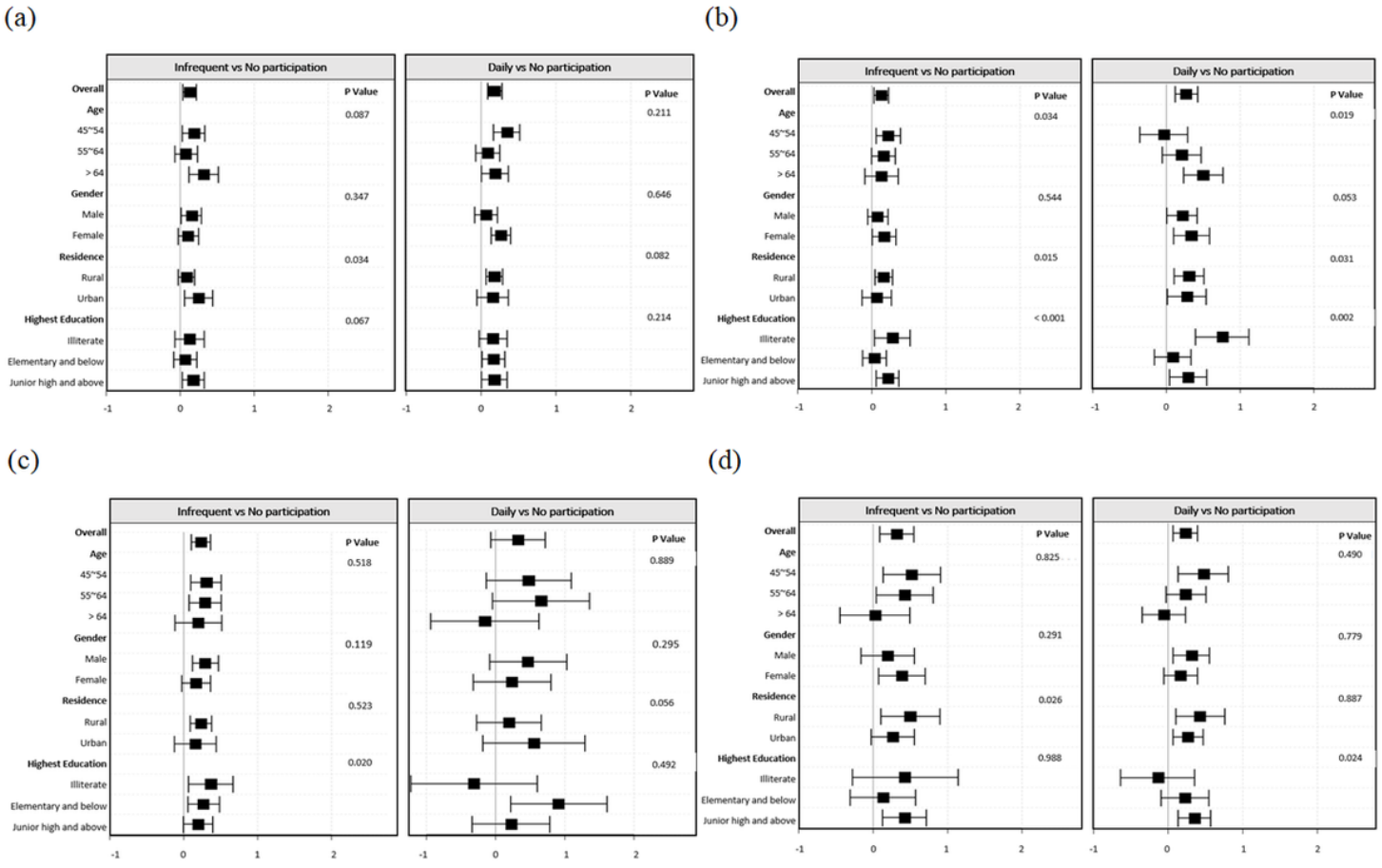

Figure 3

Forest plot of subgroup analysis of the association between four activities and memory.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplimentarytable.docx
- Supplimentarytable.docx