Mental Activity and All-Cause Mortality in Older Adults: A 4-Year Community-Based Cohort

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Abstract

Background

The mental activity, such as reading, playing mahjong or cards and computer use, is common among older adults in China. Previous researches suggest a protective role of mental activity against cognitive impairment. However, the relationship between mental activity and all-cause mortality has rarely been reported.

Objectives

This study aims to explore the effect of mental activity on all-cause mortality in a community-based elderly cohort in China.

Methods

The current study sample comprised 4003 community residents age ≥ 60 y who were enrolled at June 2015, and were followed up every year from 2015 to 2018. Reading, playing mahjong or cards and computer use were measured by questionnaires and summed into a mental activity index (MAI) score. Cox proportional hazards analysis and Kaplan-Meier survival analysis were used to examined the effect of mental activity on all-cause mortality.

Results

During 4 y of follow-up of 4003 participants, 208 (5.2%) deaths were registered. Of all participants, 66.8%, 26.7%, 6.1% and 0.35% reported 0, 1, 2 and 3 MAI score, respectively. There was a strong association between the MAI score and all-cause mortality (adjusted hazard ratio [HR] = 0.72, 95% confidence intervals [CI]: 0.54–0.96, $P = 0.025$). Stratified analysis suggested that higher MAI score was significantly associated with decreased risk of all-cause mortality mainly among those who were male, aged ≥ 80 y, physical inactive, and diagnosed without cancer in past ($P < 0.05$).

Conclusion

Mental activity could reduce the risk for death from all cause, which help promote a comprehensive understanding of health characteristics at advanced ages.

Background

Older population has been increasing around the world, presenting a major challenge to health and social care system. Chronic diseases are the leading causes of death and disability worldwide[1]. Plenty of research has implicated lifestyle risk behaviors, such as smoking[2], alcohol use[3] and physical inactivity[4] et al, in adverse health outcomes, including cardiovascular disease, dementia, diabetes, some cancers, as well as mortality[5]. Hence, substantial disease, mortality, and economic burden could be prevented through modification of lifestyle behaviors[6–8].

Mental activity, such as computer use, reading and playing mahjong or cards, is a type of modifiable lifestyle behavior and popular in old adults especially in the retired people in China. In the past few years, the beneficial effect of mental activity on cognitive function has been reported. For example, computer use has been reported to improve cognitive function in older people[9]. Several studies have also identified that reading[10–14], playing board games (mahjong, chess or poker)[15, 16], and playing cards[14, 17] were associated with reduced risk of cognitive impairment. It is noteworthy that dementia is one of the most common cognitive-related disorders, ranks as the sixth leading cause of death in the United States and the fifth leading cause of death in Americans age ≥ 65 years[18]. It is projected that, by 2050, 1.6 million or 43% of older adult deaths will be due to dementia and Alzheimer's disease[19]. In addition, accumulating evidence have indicated that leisure activity, including watching TV[20], internet use[21] and reading[22, 23], can make a significant contribution to overall life satisfaction[24–26], which have been identified as an important risk factor of mortality in older people[27–29]. All these studies compel us to examine whether mental activity is associated with all-cause mortality, which has rarely been reported.

Using a 4-year prospective cohort study, the present study explores a range of mental activity, including reading, playing mahjong or cards, and computer use. The objective of this study is to examine the association between mental activity and all-cause mortality.

Methods

Sampling and procedures

We recruited a random sample of 4050 participants, representative of the non-institutionalized population age ≥ 60 years in Songjiang District, Shanghai, China. Baseline data collection was conducted from June 2015 to March 2016. At the baseline, demographic and characteristic data was collected via a face-to-face questionnaire survey by trained personnel, including birth date, gender, height, weight, education years, lifestyles, Physical activity(PA), mental activity (reading, playing mahjong or cards and computer use), medical histories of diabetes, hypertension, coronary heart disease (CHD) and stroke (classified as yes or no), et al. Participants joined the study by completing the questionnaire and the written informed consent form.

Measures

Mortality. All-cause mortality and the date of death were ascertained from the Death Surveillance System of Songjiang CDC for all participants after each follow-up, from July 2015 to November 2018. Research coordinators contacted all the participants and asked for the availability of a clinical interview. Those who could not be traced, refused to participate were defined as “lost-to-follow up”. Participants who missed any of three data of reading, playing mahjong or cards and computer use at baseline were excluded.

Mental activity index construction. Participants reported on a range of mental activities in the questionnaire. Reading status was derived from the question: “Do you read books or newspapers every day?” With "hardly reading" defined as having no reading habits, while "occasionally reading" and "daily reading" defined as having reading habits. Participants were asked, “Do you often play cards or mahjong?” Among them, "almost do not play " was defined as having no habit of playing cards or mahjong, "several times a month" and "several times a week" are defined as having the habit of playing cards or mahjong. A similar question was also asked, “Do you often use computers to access the internet?” With “Not at all" defined as having no Internet habits, "not every day" and "every day (more than an hour at a time)" defined as having internet habit.

Considering the beneficial role of these three mental activities on cognitive impairment[9, 12, 15–17, 30–33] and the trend of protective effect on death in our study (supplementary Fig. 1) each mental activity was coded as 1(beneficial) or 0 (not beneficial) and summed as mental activity index (MAI) (total score ranging from 0 to 3).

Covariates. Sociodemographic characteristics were collected from participants' self-reports or physical examination. Age, sex, BMI (underweight, normal, overweight and obesity), education (illiteracy, primary school and ≥ junior school), marital status (married and single), and work status (retired, still working, no work). BMI was calculated as weight in kilograms divided by height in meters squared. Based on the BMI classification guidelines of the World Health Organization revised for the Asia-Pacific region, we classified the MCI participants into underweight (BMI < 18.5 kg/m^2), normal (BMI: 18.5 ~ 22.9 kg/m^2), overweight (BMI: 23.0 ~ 29.9 kg/m^2) and obesity (BMI ≥ 30.0 kg/m^2). Smoking status was categorized as current smokers, never smokers, and people who given up smoking. Drinking status was divided into drinking and never drinking. PA was assessed based on self-report of leisure-time activities, such as fasting walking, playing ball, running, or qigong. (Average physical-activity time must exceed 10 minutes per day.) Participants rated their PA levels as (1) inactive, (2) several times a month, (3) 3–4×/week, or (4) almost every day. In addition, we created a dichotomous variable for cardiovascular or metabolic disease, based on the self-report of CHD, stroke, hypertension, and diabetes. Based on the sample distribution, the index of cardiovascular or metabolic disease (CHD, stroke, hypertension, diabetes) was categorized as 0 and 1 (at least one disease). We created an additional dichotomous variable for cancer, based on self-report for the prior to baseline data collection.

Statistical Analysis

All statistical analyses were performed using SPSS version 22.0 (SPSS, Chicago, IL, USA). Hazard ratios (HR) and 95% confidence intervals (CI) were estimated using Cox proportional hazard models for the analysis of association between MAI and mortality. Kaplan-Meier curves was also used to estimate the relationship between MAI and mortality. The outcome variable was survival time, which was measured as the time interval from the date of baseline data collection to death or censoring. All Cox proportional hazards regression models were adjusted for sex, age (continuous variable), BMI (continuous variable), educational attainment, marital status, work status, smoking status, drinking status, and PA, with covariates classified categorically as per Table 1. We also examined the independent association of each mental activity and all-cause mortality.

Table 1
Socio-demographic and health characteristics of adults by mental activity index score.

Variable	Total *n*	Mental activity index score *n* (Column percentage)				*P*
		0	1	2	3	
Total	**4003**	**2674**	**1070**	**245**	**14**	
Sex						<0.001
Male	1746	818(30.6)	708(66.2)	209(85.3)	11(78.6)	
Female	2257	1856(69.4)	362(33.8)	36(14.7)	3(21.4)	
Age						<0.001
60-70y	2498	1531(57.3)	770(72.0)	185(75.5)	12(85.7)	
70–80	1150	846(31.6)	250(23.4)	53(21.6)	1(7.1)	
≥80 y	355	297(11.1)	50(4.7)	7(2.9)	1(7.1)	
BMI						<0.001
underweight	241	177(6.6)	51(4.8)	12(4.9)	1(7.1)	
normal	1482	1034(38.7)	363(33.9)	82(33.5)	3(21.4)	
overweight	2084	1329(49.7)	606(56.6)	140(57.1)	9(64.3)	
obesity	196	134(5.0)	50(4.7)	11(4.5)	1(7.1)	
Marital status						<0.001
Married	3193	2030(75.9)	925(86.5)	225(91.8)	13(92.9)	
Single/ divorced/ separated/ widowed/ spinsterhood	810	644(24.1)	145(13.6)	20(8.2)	1(7.1)	
Educational attainment						<0.001
Illiteracy	2260	1851(69.2)	384(35.9)	24(9.8)	1(7.1)	
Primary school	1181	673(25.2)	412(38.5)	94(38.4)	2(14.3)	
≥junior school	562	150(5.6)	274(25.6)	127(51.8)	11(78.6)	
Work status						<0.001
Retired	2009	1262(47.2)	588(55.0)	148(60.4)	11(78.6)	
Still working	627	408(15.3)	167(15.6)	50(20.4)	2(14.3)	
No work	1367	1004(37.5)	315(29.4)	47(19.2)	1(7.1)	

Variable	Total *n*	Mental activity index score *n* (Column percentage)				*P*
		0	1	2	3	
Physical activity						<0.001
Inactive	885	617(23.1)	221(20.7)	44(18.0)	3(21.4)	
Several times a month	117	67(2.5)	41(3.8)	8(3.3)	1(7.1)	
3-4x/week	807	574(21.5)	188(17.6)	43(17.6)	2(14.3)	
Almost every day	2194	1416(53.0)	620(57.9)	150(61.2)	8(57.1)	
Smoking						<0.001
Former	491	237(8.9)	195(18.2)	57(23.3)	2(14.3)	
Current	843	344(12.9)	369(34.5)	122(49.8)	8(57.1)	
Never	2669	2093(78.3)	506(47.3)	66(27.0)	4(28.6)	
Alcohol use						<0.001
Drinker	751	312(11.7)	328(30.7)	103(42.0)	8(57.1)	
Never	3252	2362(88.3)	742(69.3)	142(58.0)	6(42.9)	
Cardiovascular or metabolic disease						0.047
Physician-diagnosed in past	2064	1345(50.3)	590(55.1)	123(50.2)	6(42.9)	
Undiagnosed in past	1939	1329(49.7)	480(44.9)	122(49.8)	8(57.1)	
Cancer						0.860
Physician-diagnosed in past	87	58(2.2)	26(2.4)	3(1.2)	0(0)	
Undiagnosed in past	3916	2616(97.8)	1044(97.6)	242(98.8)	14(100)	

Based on the model with the MAI as the exposure variable, we tested potential effect modification and presented stratified analyses by age group, sex, BMI, educational attainment, PA, whether individuals were diagnosed with cardiovascular or metabolic disease, and whether individuals were diagnosed with cancer. In stratified analyses, PA was stratified into a binary variable to intelligibly explain the interaction of PA and mental activity on all-cause mortality: physically inactive versus physically active (several times a month, 3–4×/week, and almost every day). BMI was divided into two groups, including of overweight (BMI ≥ 23.0 kg/m^2) and non-overweight (BMI < 23.0 kg/m^2) groups, due to the small sample size in the underweight and obesity groups.

Results

Descriptive statistics

Among 4050 participants at baseline, 47 (1.2%) participants were excluded due to missing data of MAI at baseline. The final sample for analyses included 4003 participants with a mean follow-up of 3.08 (SD 0.39) years, of whom 208 died prior to October 31, 2018. Table 1 describes the characteristics and the distribution of the final analytical sample. At baseline, mean age of the participants was 69.37 ± 7.06 years (ranged 60–96). The majority of the participants were female (56.4%), overweight (52.1%), married (79.8%), illiteracy (56.5%), retired (50.2%), physically active almost every day (54.8%), never smokers (66.7%), never drinkers (81.2%), diagnosed with cardiovascular or metabolic disease (51.6%), and undiagnosed with cancer (97.8%).

For mental activity, 14.9% of study participants had reading habits, 23.0% of them played mahjong or cards, and 2.1% of participants used computer. Overall, 66.8% of participants reported no mental activity (MAI score = 0), 26.7% had one mental activity, and 6.1% and 0.35% had a MAI score of 2 and 3, respectively. Higher MAI scores were more prevalent among males, those aged 60-70y, those who were married, those had a junior school degree or higher, and those who were retired($P < 0.05$, Table 1).

Individual Mental Activity and All-Cause Mortality

When all three dichotomized individual mental activities were entered in the model with all covariates, playing mahjong or cards showed independent associations with all-cause mortality ($P = 0.007$, supplementary Figure S1). Reading and computer use also displayed potential beneficial role in all-cause mortality, but with no significant association with all-cause mortality (supplementary Figure S1).

Mental Activity Index and All-Cause Mortality

Kaplan-Meier survival analysis showed that participants with higher MAI score have significantly decreased risk of death ($P = 0.043$, Fig. 1). Cox proportional hazards regression analyses also showed the inverse association between the MAI scores and all-cause mortality (HR = 0.72, 95%CI 0.54–0.96, $P = 0.025$), adjusted for age, sex, BMI, educational attainment, marital status, work status, smoking status, alcohol use status, and physical activity (Fig. 2). All-cause mortality HRs compared to individuals without mental activity were 0.71 ($P = 0.045$) and 0.47 ($P = 0.049$) for those with 1 and 2 mental activities in univariate analysis, while these significances were not found in multivariate analysis (Fig. 2).

Stratified analyses suggested an inverse association between MAI scores and all-cause mortality among participants who were aged ≥ 80 y (HR = 0.48, 95%CI 0.24–0.94, $P = 0.033$), those who were male (HR = 0.67, 95%CI 0.49–0.93, $P = 0.016$), those with non-overweight (HR = 0.65, 95%CI 0.42–0.99, $P = 0.044$), those who were PA inactive (HR = 0.57, 95%CI 0.33–0.99, $P = 0.047$), and those without cancer diagnosis (HR = 0.71, 95%CI 0.53–0.96, $P = 0.026$) (Fig. 3).

Discussion

This is the first study to our knowledge to investigate a MAI incorporating reading, playing mahjong or cards and computer use in relation to all-cause mortality. We found that multiple mental activities among older Chinese adults were associated with a decreased risk for all-cause mortality over 4 y of follow-up. There was a clear association between the number of mental activities, as indicated by MAI score, and all-cause mortality.

Previous evidence is accumulating on the cognitive health of the mental activities. Li and colleagues indicated that reading and computer use were associated with lower risk of mild cognitive impairment in a population-based study[34]. Lindstrom et al. found an inverse relationship between intellectual activities (reading, playing cards, playing a musical instrument, and letter writing) and Alzheimer's disease or other forms of dementia in a US-based population[17]. Verghese et al reported that cognitive activities (reading, writing, doing crossword puzzles, playing board games or cards, and playing musical instruments) were associated with a reduced risk of dementia[14]. Despite the heterogeneous measures, risk classification, sample characteristics, and follow-up time of these studies, the association between mental activities and cognitive health has been consistent, suggesting the generalizability of these findings. Such beneficial role of mental activities is furthered here by implicating its protective role against all-cause mortality in older people in our study. Cognitive impairment has a significant impact on mortality and disability of order population[35]. According to data from the Centers for Disease Control and Prevention (CDC), 121,404 people died from Alzheimer's disease in 2017 and the rate of death from Alzheimer's disease dramatically with age, especially after age 65[18]. Therefore, a potential mechanism by which mental activities influence mortality is through protecting the cognitive impairment, at least in part.

It is worthy to note that, among the three dichotomized individual mental activities, playing mahjong or cards showed independent association with all-cause mortality. One explanation is that playing mahjong or cards incorporates social engagement. Social engagement, defined as the maintenance of many social connections and a high level of participation in social activities, has been indicated to prevent cognitive decline in older persons[36–38]. Additionally, social activities predominantly affect the immune system and influence inflammatory processes in the brain [39, 40]. All these results support our findings that playing mahjong or cards has an independent protective role in all-cased mortality.

Stratified analysis showed a significant relation between mental activity and all-cause mortality among participants with physical inactivity in late life, indicating the supplemented role of mental activity in healthy living, especially for the older people who is unable to perform effective physical activity due to severe chronic disease. Physical activity is a pivotal lifestyle behavior. Regular physical activity has been irrefutably identified as protective factor for all-cause mortality[41–43], and the benefit of physical activity was independent of the type of physical activity [44]. Here our study showed the consistent effect of mental activity with PA on all-cause mortality in older population. In addition, some studies have indicated that the cognitive function and physical function influenced each other in a feedback loop.[45, 46]. A protective effect of physical activity against cognitive impairment has been reported in many studies[47–50] and the benefits of physical activity on cognitive function can be attributed to an

ameliorated overall health condition[51]. Conversely, mental activity has been reported to be associated with enhanced memory, executive function, language, and cognitive skill[52], which may influence the practice of regular physical activity. For example, the execution functions, including of volition, planning, purposive action, performance monitoring and inhibition[53], may enable people to consistently engage in physical activity in older to achieve long-term health benefits[54].

We also found that MAI score was associated with lower all-cause mortality in participants without cancer, but not in cancer patients. In fact, many studies showed the beneficial effect of mental activity or social activity on the quality of life which was reported to decreased the risk of breast cancer mortality and recurrence[55], enhanced the colorectal cancer overall survival[56], and influenced the cancer patient outcomes, including physical burden, psychosocial burden, and financial burden[57]. Hence, we believe that whether from improving the mental health of cancer patients or improving the survival rate of non-cancer patients, mental activity should be concerned in older people health. In addition, we also found the potential protective role of MAI in all-cause mortality among participants who were diagnosed with cardiovascular or metabolic disease (HR = 0.67, P = 0.025 in univariate analysis, HR = 0.70, P = 0.067 in multivariate analysis, Fig. 3). Accumulating evidence have indicated that leisure activity, including watching TV[20], internet use[21] and reading[22, 23], can make a significant contribution to overall life satisfaction and psychological well-being[24, 25], which in turn is associated with lower risk of cardiovascular disease[58, 59]. Thus, a potential pathway by which mental activity influence all-cause mortality may be through reducing the risk of cardiovascular disease or reducing the effect of cardiovascular disease on mortality.

Limitations in the current study should be acknowledged. Firstly, it is important to acknowledge that not all three mental activities contribute to mortality similarly and that their combined effects may not be additive. However, because of the short follow-up period and small sample size, we didn't get the enough prevalence of specific combination pattern of mental activities to analysis their associations with all-cause mortality (e.g., prevalence of combination of reading and computer use, combination of playing mahjong or cards and computer use, and combination of both three mental activities were 1.0% (n = 41), 0.2% (n = 9) and 0.4% (n = 14), respectively). Secondly, time spent in each activity was not measured, this may modify the effect of mental activity on mortality. Thirdly, the effect of mental activity on mortality was not adjusted for cognition status because there was an absence of measure of cognition at baseline. Baseline participation in mental activities may have been influenced by cognition and future studies incorporating the cognitive data are needed to illustrate the modifying effect of cognition status on mortality caused by mental activity. Fourthly, this study could be further strengthened by including cause-specific mortality outcomes, but these data are not yet available for the time period studied. Finally, this study was composed of older Chinese adults living in a large city, Shanghai, thus potentially limiting the generalizability of our results.

Conclusion

This study demonstrates the importance of mental activity in health lifestyle, here evidenced for adults aged 60 y and older. This analysis investigated three mental activities, namely, reading, playing mahjong or cards and using the computers, which may be added to behavioral indices or risk combinations to quantify health risk of the older people in China. In addition, our findings advance current knowledge on the older people health and provide a new prevention strategy in older populations.

Abbreviations

PA
Physical Activity
MAI
Mental Activity Index
HR
Hazard Ratio
CI
Confidence Intervals
BMI
Body Mass Index
SPSS
Statistical Product and Service Solutions

Declarations

Ethics approval and consent to participate:

This study was approved by the Research Ethics Committee of Division for the Prevention and Control of Chronic Non-communicable Diseases, China Center for Disease Control and Prevention and the Ethics Committee of Department of Public Health in Fudan University, Shanghai, China. All participants or their legally acceptable representatives have provided their written informed consent.

Consent for publication:

Not applicable

Availability of data and materials:

Datasets used during the current study are available from the corresponding author on reasonable request and with permission of The National Center for Chronic and Noncommunicable Disease Control and Prevention.

Competing interests:

The authors declare no conflict interest.

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Author’s contributions:

Study conception and design: QX. Data collection: LH, YG, and SS. Acquisition, analysis, or interpretation of data: XL, YR. Statistical analysis: XL, YR. Manuscript drafting: XL and QX. Review and comment to manuscript: JG and HF. All authors read and approved the final manuscript.

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Figures

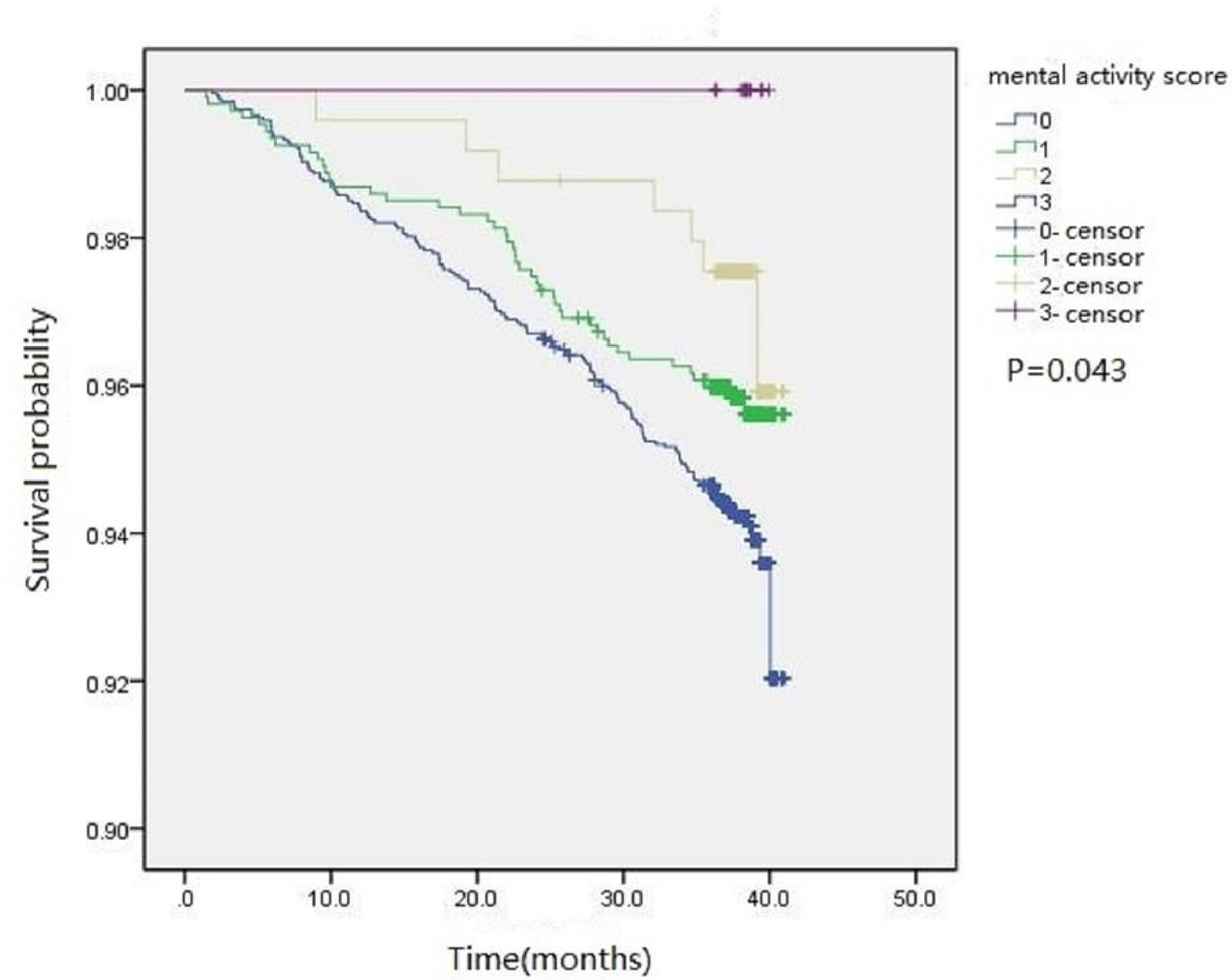
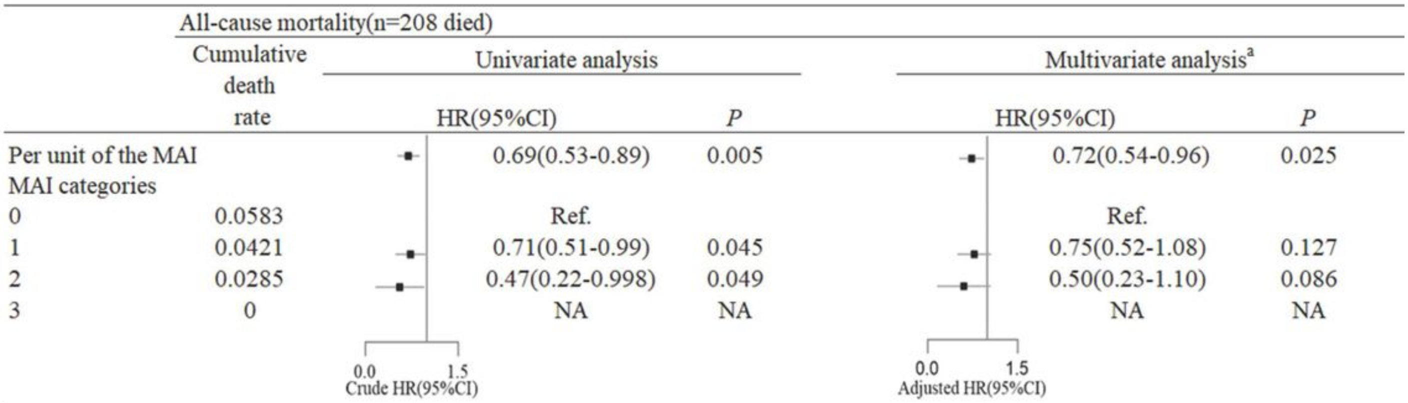


Figure 1

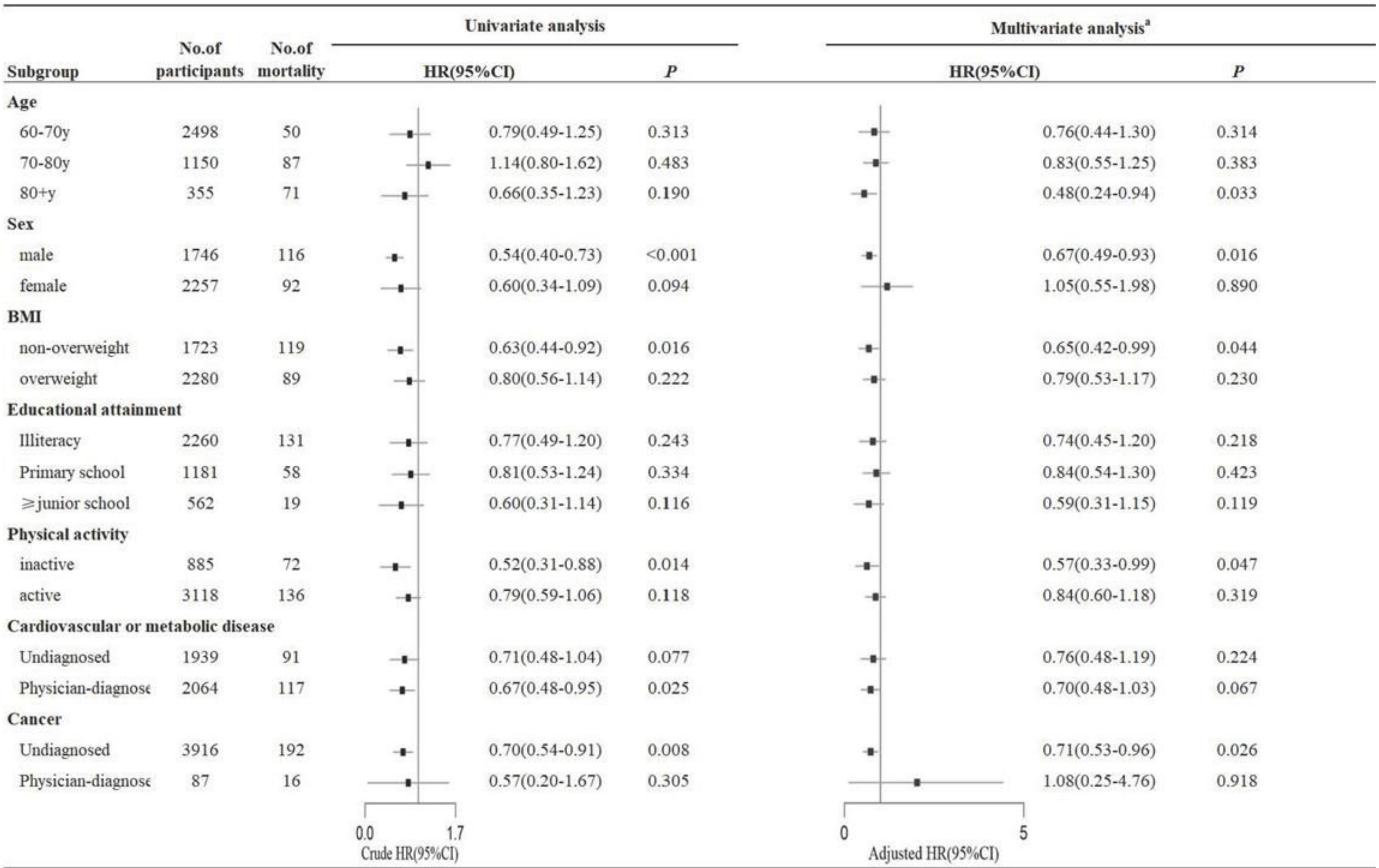
Kaplan-Meier survival curves of mental activity index with survival.



All-cause mortality(n=208 died)					
	Cumulative death rate	Univariate analysis		Multivariate analysis[a]	
		HR(95%CI)	*P*	HR(95%CI)	*P*
Per unit of the MAI		0.69(0.53-0.89)	0.005	0.72(0.54-0.96)	0.025
MAI categories					
0	0.0583	Ref.		Ref.	
1	0.0421	0.71(0.51-0.99)	0.045	0.75(0.52-1.08)	0.127
2	0.0285	0.47(0.22-0.998)	0.049	0.50(0.23-1.10)	0.086
3	0	NA	NA	NA	NA

Figure 2

Crude cumulative death rates and hazard ratios for all-cause mortality by mental activity index score among a community-based Chinese elderly samples (2015–2018, n = 4003). HR = hazard ratio; CI = confidence interval. a HR adjusted for age, sex, BMI, smoking status, alcohol use status, marital status, education level, work status, physical activity.



Subgroup	No.of participants	No.of mortality	Univariate analysis HR(95%CI)	P	Multivariate analysis[a] HR(95%CI)	P
Age						
60-70y	2498	50	0.79(0.49-1.25)	0.313	0.76(0.44-1.30)	0.314
70-80y	1150	87	1.14(0.80-1.62)	0.483	0.83(0.55-1.25)	0.383
80+y	355	71	0.66(0.35-1.23)	0.190	0.48(0.24-0.94)	0.033
Sex						
male	1746	116	0.54(0.40-0.73)	<0.001	0.67(0.49-0.93)	0.016
female	2257	92	0.60(0.34-1.09)	0.094	1.05(0.55-1.98)	0.890
BMI						
non-overweight	1723	119	0.63(0.44-0.92)	0.016	0.65(0.42-0.99)	0.044
overweight	2280	89	0.80(0.56-1.14)	0.222	0.79(0.53-1.17)	0.230
Educational attainment						
Illiteracy	2260	131	0.77(0.49-1.20)	0.243	0.74(0.45-1.20)	0.218
Primary school	1181	58	0.81(0.53-1.24)	0.334	0.84(0.54-1.30)	0.423
≥junior school	562	19	0.60(0.31-1.14)	0.116	0.59(0.31-1.15)	0.119
Physical activity						
inactive	885	72	0.52(0.31-0.88)	0.014	0.57(0.33-0.99)	0.047
active	3118	136	0.79(0.59-1.06)	0.118	0.84(0.60-1.18)	0.319
Cardiovascular or metabolic disease						
Undiagnosed	1939	91	0.71(0.48-1.04)	0.077	0.76(0.48-1.19)	0.224
Physician-diagnose	2064	117	0.67(0.48-0.95)	0.025	0.70(0.48-1.03)	0.067
Cancer						
Undiagnosed	3916	192	0.70(0.54-0.91)	0.008	0.71(0.53-0.96)	0.026
Physician-diagnose	87	16	0.57(0.20-1.67)	0.305	1.08(0.25-4.76)	0.918

Figure 3

The association between mental activity index and risk of all-cause mortality in stratified subgroup. HR = hazard ratio; CI = confidence interval. a HR adjusted for age, sex, BMI, smoking status, alcohol use status, marital status, education level, work status, physical activity.

Supplementary Files

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

- Questionnaire.pdf
- supplementarymaterial.docx