Aging Clinical and Experimental Research (2025) 37:274
https://doi.org/10.1007/s40520-025-03103-7

RESEARCH

The association between playing Ma-jong, chess, and card games and cognitive function improvement in middle-aged and elderly Chinese: cross-sectional evidence from CHARLS

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Received: 30 March 2025 / Accepted: 6 June 2025
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Abstract

Background The relationship between participation in Ma-jong, chess, and card games (PMCC) and cognitive function improvement among middle-aged and elderly adults in China is not well-established. This study aims to investigate the potential association between PMCC participation and cognitive function improvement in this demographic, using data from the China Health and Retirement Longitudinal Study (CHARLS).

Methods Data from the 2018 wave of CHARLS were analyzed. Participants aged 45 and above who met the inclusion criteria were categorized based on their participation in PMCC activities. Cognitive function was assessed using a composite score incorporating episodic memory and mental status, alongside CESD-10 and CSI-D measures. Cross-sectional associations between PMCC engagement and cognitive function were examined using t-tests, chi-square tests, and one-way ANOVA. Group differences were assessed to evaluate the relationship between activity frequency and cognitive outcomes.

Results A total of 19,816 participants (47.13% male; mean age 61.7 ± 10.3 years) were included in the study. The cognitive function related scores were significantly higher in the PMCC group (16.45%) compared to the non-PMCC group (83.55%) ($P < 0.001$). Moreover, the findings revealed significant associations between PMCC frequency and overall cognitive function scores ($P < 0.001$).

Conclusions PMCC activities are associated with cognitive function improvement in middle-aged and elderly adults in China. These findings suggest that engaging in PMCC activities could serve as a potential protective factor for enhancing cognitive health in this population, providing a basis for incorporating PMCC into strategies aimed at promoting cognitive well-being and healthy aging.

Keywords Playing ma-jong, chess and cards · Middle aged · Elderly adults · China health and retirement longitudinal study · Cross-sectional study · Cognitive function improvement

Introduction

The global challenge of an aging population is particularly pronounced in mainland China [1]. By 2050, the elderly population in China is projected to reach approximately 400 million individuals aged 65 and older, accounting for 26.9% of the total population, with 150 million aged 80 and above [1, 2]. This demographic shift presents considerable socioeconomic challenges, including a rise in age-related diseases such as chronic non-communicable diseases (CNCDs), cardiovascular diseases, and mental health disorders [3, 4]. Among these challenges, cognitive decline stands out as one of the most significant health concerns [5, 6].

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Published online: 04 September 2025

Cognitive decline, the hallmark of Alzheimer's disease (AD) and other dementias, significantly increases the risk of functional dependence and diminishes the quality of life among the elderly [7]. Cognitive decline represents one of the most significant challenges associated with an aging population [8]. Age-related cognitive impairment encompasses deficits in memory, processing speed, language, and executive function [9]. Potential mechanisms underlying these impairments include neuroinflammation, oxidative stress, and chronic cerebral hypoperfusion. Beyond aging itself, cognitive impairment in older adults is influenced by various factors, highlighting the need for a comprehensive understanding of its multifaceted nature. The World Alzheimer Report estimates that by 2050, dementia will affect 131.5 million people globally, with the highest prevalence among older adults [10]. The onset of cognitive decline typically begins in midlife but becomes more pronounced with age, leading to an increasing demand for caregiving and healthcare services [11]. The burden of cognitive impairment is not limited to individuals but extends to their families and society at large, placing a substantial strain on social and healthcare systems [5, 6]. The global cost of dementia estimated at $818 billion in 2015 and projected to exceed $1 trillion by 2018 [10].

While cognitive decline is commonly associated with older adults, growing evidence suggests that it may begin during midlife, typically defined as ages 45 to 60. Prior studies have found an increased risk of cognitive impairment in both middle-aged ($45 \leq age < 60$) and elderly individuals ($age \geq 60$) [12]. In the context of developing countries such as China—where aging populations coincide with lagging environmental protections and socioeconomic disparities—the burden of cognitive decline is particularly pressing. Recent literature has emphasized that midlife represents a critical window for dementia prevention, with early interventions showing long-term benefits [13, 14]. Furthermore, large-scale longitudinal evidence from Chinese populations highlights that modifiable lifestyle and social engagement factors may influence cognitive health trajectories across both middle-aged and elderly groups [15, 16]. These findings support the importance of including both age groups in cognitive aging research and justify our inclusion criteria of individuals aged 45 years and older in this study.

To mitigate or delay cognitive decline in the aging population, effective population-based strategies are imperative. Previous studies have identified various contributing factors, including socio-demographic characteristics, lifestyle habits, chronic diseases, and the strength of social networks [17–19]. Understanding and addressing these factors is critical to reducing the societal and economic impact of cognitive decline and improving the well-being of older adults. Among these, social engagement and cognitive stimulation have been shown to play crucial roles in preserving cognitive function and enhancing overall well-being in older adults.

Previous studies have showed that participation in social activities is one of the key determinants of older adults' health outcomes [20]. A study from Korea identified a significant association between reduced participation in social activities and an increased risk of depression among older adults [21]. Furthermore, findings from Spain indicated that social disengagement is a critical risk factor for cognitive decline in community-dwelling older populations [19]. Additionally, Studies also showed that participation in social activities has beneficial effects on cognitive function among the elderly in developed countries [22]. Among these social activities, playing mahjong, chess, and cards (PMCC) are popular entertainment games among Chinese. Older adults are particularly drawn to PMCC due to its cognitive demands, which include attention control, rapid and extensive information processing, and visual-motor coordination [23]. The competitive and gambling aspects of these games further enhance their appeal [24]. Moreover, mahjong contributes to psychological well-being indirectly through its facilitation of social interaction, fostering connections that support mental health [25]. Although these games are widely practiced, there is limited research examining their direct impact on cognitive function improvement in the middle-aged and elderly population, particularly in China. While prior studies have highlighted the physical and cognitive benefits of leisure activities, such as enhanced fine motor skills and improved cognitive performance [20, 23], there is little literature that deciphers the relationship between PMCC and cognitive function among Chinese middle-aged and elderly. To address this gap, the present study utilizes data from the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative dataset [26], to investigate the cross-sectional associations between PMCC and cognitive function in Chinese middle-aged and elderly adults (aged 45 years and above) in 2018.

By addressing this gap, our study aims to investigate the cross-sectional association between PMCC participation and cognitive function among Chinese middle-aged and elderly adults. By using a nationally representative dataset, we aim to provide evidence on the potential cognitive benefits of PMCC activities, as well as the impact of frequency and other different variables in these associations. The results could contribute to the development of non-pharmacological interventions aimed at mitigating cognitive decline and enhancing the quality of life for the middle-aged and elderly adults in China.

Materials and methods

Overview and design of the CHARLS project

The China Health and Retirement Longitudinal Study (CHARLS) is a large-scale interdisciplinary survey jointly conducted by Wuhan University and Peking University [27]. Funded as a major project by the National Natural Science Foundation of China, CHARLS aims to collect high-quality micro-level data representative of Chinese individuals and households aged 45 and above. This data serves as a foundation for analyzing population aging in China, fostering interdisciplinary research on aging issues, and providing a scientific basis for developing and refining related policies. A pilot survey was conducted in 2008 in Zhejiang and Gansu provinces, representing typical socioeconomic contexts in eastern and western China. The national baseline survey followed in 2011, covering over 10,000 households randomly sampled from 150 counties/districts and 450 villages/communities across the country [28]. Subsequent national follow-up surveys were conducted in 2013, 2015, 2018, 2020, and from 2021 to 2023. The CHARLS questionnaire design was informed by international benchmarks such as the U.S. Health and Retirement Study (HRS), the English Longitudinal Study of Ageing (ELSA), and the Survey of Health, Ageing and Retirement in Europe (SHARE). The study employed a multi-stage sampling approach, using probability proportional to size (PPS) sampling at both the county/district and village/community levels. Furthermore, CHARLS pioneered the use of the CHALRS-GIS electronic mapping software to create village-level sampling frames via map-based methods, enhancing the precision and efficiency of the sampling process [16].

Data collection methods of the CHARLS database

The CHARLS database is designed to collect and analyze information on the health, economic conditions, family structure, and retirement issues of Chinese individuals aged 45 and above, along with their spouses [26]. CHARLS employed a multi-stage, stratified probability sampling method to ensure fairness and representativeness. Approximately 17,000 households and 28,000 respondents were selected through a carefully designed four-stage sampling process that progresses from counties/districts to villages/communities, households, and finally individuals. In the county/district and village/community sampling stages, CHARLS used probability proportional to size (PPS) sampling based on population size.

In the first stage, counties/districts were selected using PPS sampling based on 2009 population statistics, stratified by region, urban-rural classification, and GDP. A total of 150 counties/districts were randomly chosen from 30 provincial-level administrative regions across mainland China (excluding Tibet, Taiwan, Hong Kong, and Macau). In the second stage, three villages or communities were randomly selected from each of the sampled counties/districts using PPS sampling, resulting in 450 village/community units. All sampling procedures were conducted using STATA software to maintain consistency and accuracy. To minimize potential biases in population data, the 2009 resident population data for the 450 village/community units were cross-checked against 2007 data. Any discrepancies exceeding a set threshold were verified with the National Bureau of Statistics. Additionally, the selected villages or communities underwent further validation by the Chinese Center for Disease Control and Prevention to enhance the robustness of the sampling process. The CHARLS sample covers 28 provinces, municipalities, and autonomous regions in mainland China. It is nationally representative, encompassing diverse geographic regions, urban and rural settings, and socio-economic backgrounds among individuals aged 45 and older. All the described sampling processes were conducted using the STATA software, ensuring no substitutions were allowed for the selected samples.

Assessment of PMCC

To capture data on PMCC while minimizing response bias, the CHARLS questionnaire included questions about ten types of activities, with options for "other" and "never participate in any social activities" as additional responses. All participants were asked, "Have you done any of these activities in the last month?" Those who selected "yes" were classified as engaging in PMCC. They were further asked about the frequency of those activities over the past month. The responses were classified into three categories: not regularly, almost weekly, or almost daily. This systematic approach ensured comprehensive data collection while preserving the reliability of self-reported activity levels.

Assessment of cognitive function

Cognitive function was assessed across two dimensions [29, 30]. The first dimension, episodic memory, included immediate word recall and delayed word recall, each scored on a scale of 0–10 points. The second dimension, mental status, was evaluated using questions from the Telephone Interview of Cognitive Status (TICS) battery, designed to assess an individual's cognitive integrity and mental state. Mental status was measured through orientation (0–5 points), visuo-construction (0–1 point), and attention (0–5 points). Orientation was assessed by asking participants to identify the current date (month, day, year, season) and the day of the

week; visuo-construction was tested by having participants redraw a previously shown figure; and attention was evaluated through serial subtraction of 7 from 100, performed five times. The total cognitive function score, ranging from 0 to 31 points, was calculated by summing the scores from both dimensions, with higher scores indicating better cognitive performance.

The 10-item Center for Epidemiologic Studies Depression Scale (CESD-10) was utilized to assess depressive symptoms, comprising 10 questions designed to evaluate the frequency of affective and behavioral symptoms experienced by individuals over the past week [31]. Responses to each item were scored on a scale from 0 (rarely or never) to 3 (usually), with higher total scores reflecting more severe depressive symptoms. The CESD-10 total score ranges from 0 to 30, and prior studies have recommended a cutoff score of 10 to dichotomize depression status into two categories: ≥ 10 showing depressive symptoms [32–34].

The CSI-D (Community Screening Instrument for Dementia), developed as part of the 10/66 studies [35, 36], comprises seven cognitive assessment items. These include tasks such as describing the use of a hammer, naming an elbow, pointing sequentially to the window and the door, identifying the nearest store, determining the current season, specifying the day of the week, and recalling three words after a delay. The total score ranges from 0 to 9, with higher scores reflecting better cognitive performance.

Covariates

This study included various covariates to account for potential confounding factors, focusing on demographic characteristics, lifestyle factors, health status, depression, and chronic diseases. Demographic characteristics comprised age, gender, marital status (categorized as married/cohabitating or divorced/separated/widowed/never married), educational level (no formal education, elementary school, middle school, high school or above), and residential area (urban, rural, integration zone, and special zone). Lifestyle factors included smoking and drinking habits (classified as current/past or never) and daily sleep duration. Health status was assessed using self-rated health, categorized as good (including "very good" and "good"), fair, and poor (including "poor" and "very poor"). Health-related status was identified through responses to the question, "Have you been diagnosed by a doctor with any of the following diseases?" and included 14 conditions such as hypertension, diabetes, dyslipidemia, cancer, chronic lung diseases, and memory-related disorders. This information was verified by community healthcare providers. To address missing data in covariates, multiple imputation (MI) was performed using IBM SPSS 27.0 software. MI replaces missing values with multiple plausible estimates, leveraging relationships among variables to ensure accurate predictions and minimize bias. This method preserves data integrity and is robust against model misspecifications [37, 38].

Statistical analysis

Descriptive statistics were used to summarize the characteristics of the study population. Continuous variables were presented as means and standard deviations (SD), while categorical variables were expressed as frequencies and percentages. Independent-sample t-tests and chi-square tests were employed to compare demographic, lifestyle, and health-related variables between participants with and without PMCC activity. In addition, t-tests were also used to assess differences in cognitive function scores, including CESD-10, CSI-D, and total cognition score, between PMCC participants and non-participants. chi-square tests were applied where appropriate to examine the distribution of PMCC activity frequency across subgroups defined by demographic and health-related characteristics (e.g., age, gender, education level, and residential area). One-way analysis of variance (ANOVA) was conducted to examine differences in these cognitive outcomes across three categories of PMCC participation frequency (not regularly, almost weekly, and almost daily). All statistical tests were two-sided, and a p-value of <0.05 was considered statistically significant. Analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 27.

Results

Demographic and health characteristics of PMCC vs. non-engaged participants

As shown in Table S1, a total of 19,816 participants from 28 provinces in China were included in the analysis, providing a representative sample for exploring the potential effects of activities such as playing mahjong on cognitive function in middle-aged and elderly. The mean age of participants was 61.7 years old (SD = 10.3), with 47.13% of the sample being male. The majority of participants resided in rural areas (71.04%) and had an elementary (42.80%) or lower level of education (22.69% illiterate). Of particular interest is the frequency of engagement in activities such as PMCC, Among the participants, 16.45% reported engaging in these activities in the past month. Regarding cognitive function, the participants had a mean CESD-10 score of 9.58 (SD = 5.498). The average CSI-D score was 5.36 (SD = 1.670). Additionally, the mean Cognition score was 17.19 (SD = 5.281).

Table 1 presents the demographic and health characteristics of participants, categorized by PMCC participation status. A total of 19,730 individuals with complete data on PMCC were included, among whom 16.45% reported participating in PMCC. Slight variations in variable-level totals are due to missing or unreported responses. Comparative analysis revealed that individuals with PMCC were more likely to reside in rural areas, had lower educational levels. Significant differences were also observed between the groups in terms of smoking habits and daily sleep duration ($P<0.001$). Additionally, there was a significant difference in cognition-related variables, such as memory-related disease ($P<0.05$), depressive symptoms ($P<0.001$), self-rated health (($P<0.001$) between the PMCC and non-PMCC groups.

Table 2 shows conducted t-tests to examine the differences in cognitive function, CESD-10, and CSI-D scores between the participants who engaged in PMCC and those who did not. The results revealed significant differences in cognitive function, CESD-10, and CSI-D scores between the two groups, with P-values all less than 0.001, indicating a strong association between PMCC participation and these variables. However, when analyzing Attention score within the cognitive function score, the P-value was 0.156, suggesting that there was no significant difference between the two groups specifically in terms of attention performance. Despite this, the overall cognitive function score (total score) still showed a highly significant difference ($P<0.001$) between the groups, and participants engaged in PMCC activities normally show higher scores than non-participants, indicating that PMCC participation is significantly associated with improved cognitive outcomes.

Relationship between PMCC frequency and demographic as well as health-related factors

A cross-sectional analysis was conducted to examine the distribution of PMCC activity frequency (categorized as almost daily, almost weekly, or not regularly) across various demographic and health-related subgroups. Frequency tables were used to calculate the proportion of individuals in each PMCC category within each subgroup (such as, by age, gender, education, and residential area). Chi-square tests were used to assess the statistical significance of these associations. As shown in Fig. 1, the analysis demonstrated a significant relationship between PMCC activity frequency and age, with older participants being more likely to engage in activities almost daily ($P<0.001$). Gender also showed a significant association ($P=0.006$), where male participants were more likely to report frequent PMCC engagement compared to females. Additionally, the frequency of PMCC activities was significantly associated with the educational level of participants ($P<0.001$). In terms of residential area ($P=0.003$), rural residents engaged in these activities more frequently, suggesting a potential geographical disparity in the frequency of PMCC participation.

Regarding depressive symptoms, as measured by the CESD-10 scale, participants who engaged in PMCC activities had significantly lower depressive symptoms ($P<0.001$, as shown in Table 2). However, as shown in Fig. 2, no significant association was found between PMCC engagement and the presence of depression symptoms ($P=0.804$), suggesting that the frequency of participation in PMCC activities did not directly influence the severity of depressive symptoms. Similarly, there was no significant relationship between PMCC activity frequency and the presence of memory-related diseases ($P=0.584$), indicating that participation in PMCC activities did not show any clear impact on the diagnosis of memory-related conditions.

Association between PMCC frequency and cognitive function scores

To evaluate the association between PMCC participation frequency and cognitive outcomes, we conducted one-way ANOVA analyses among participants who reported engaging in PMCC activities. This within-group analysis allowed us to examine whether cognitive function scores, CESD-10 scores, and CSI-D scores varied significantly across different frequencies of participation (not regularly, almost weekly, almost daily), as presented in Table 3. The broader comparison between PMCC participants and non-participants was conducted earlier in the analysis (see Table 1). The results in Table 3 revealed significant associations between PMCC frequency and overall cognitive function ($P<0.001$). Specifically, five cognitive function measures demonstrated significant differences: Immediate word recall ($P<0.001$), Delayed word recall ($P<0.001$), Orientation ($P<0.001$), Drawing ($P=0.003$), Attention ($P=0.438$). Attention score did not show a statistically significant difference across the three PMCC frequency groups. Similarly, no significant differences were found between PMCC engagement frequency and CESD-10 scores ($P=0.819$) or CSI-D scores ($P=0.571$). These findings suggest that while cognitive performance, particularly in recall and orientation tasks, is associated with PMCC activity frequency, no similar pattern was observed with depressive symptoms or memory-related disorders.

Table 1 Characteristics of participants in the CHARLS 2018 survey by number of no PMCC and PMCC

	Variables	Total	No PMCC	PMCC	Pearson χ^2	*P*-value
		19,730 (100%)	16,485 (83.55%)	3245 (16.45%)		
Age	Middle-aged (45–60 years old)	8642 (44.5%)	7169 (44.3%)	1473 (45.7%)	2.360	0.124
	Elderly (≥60 years old)	10,771 (55.5%)	9024 (55.7%)	1747 (54.3%)		
Gender	Male	9302 (47.1%)	7450 (45.2%)	1852 (57.1%)	153.558	<0.001
	Female	10,428 (52.9%)	9035 (54.8%)	1393 (42.9%)		
Martial status	Married/cohabitating	16,798 (85.1%)	13,911 (84.4%)	2887 (89.0%)	44.987	<0.001
	Divorced/separated/widowed/never married	2932 (14.9%)	2574 (15.6%)	358 (11.0%)		
Highest Education level	Illiterate	4477 (22.7%)	4119 (25.0%)	358 (11.0%)	388.599	<0.001
	Elementary school	8444 (42.8%)	7044 (42.7%)	1400 (43.1%)		
	Middle school	4302 (21.8%)	3393 (20.6%)	909 (28.0%)		
	High school	1609 (8.2%)	1262 (7.7%)	347 (10.7%)		
	College or above	897 (4.5%)	666 (4.0%)	231 (7.1%)		
Location of Residence Address	Central of City/Town	3918 (20.2%)	3123 (18.9%)	858 (26.4%)	119.597	<0.001
	Urban-Rural Integration Zone	1606 (8.1%)	1295 (7.9%)	311 (9.6%)		
	Rural	14,039 (71.2%)	11,973 (72.6%)	2066 (63.7%)		
	Special Zone	104 (0.5%)	94 (0.6%)	10 (0.3%)		
Smoking	Current/past	911 (7.4%)	736 (6.9%)	175 (10.3%)	25.336	<0.001
	Never	11,439 (92.6%)	9923 (93.1%)	1516 (89.7%)		
Alcohol drinking habits	Current/past	1111 (49.9%)	927 (50.0%)	184 (49.5%)	0.040	0.842
	Never	1114 (50.1%)	926 (50.0%)	188 (50.5%)		
Daily sleeping duration	≤5	6350 (32.2%)	5414 (32.8%)	936 (28.8%)	35.507	<0.001
	6–8	11,635 (59.0%)	9570 (58.1%)	2065 (63.6%)		
	≥9	1745 (8.8%)	1501 (9.1%)	244 (7.5%)		
Self-rated health	(Very) Good	4572 (25.0%)	3717 (24.5%)	855 (27.5%)	54.804	<0.001
	Fair	8932 (48.9%)	7327 (48.3%)	1605 (51.7%)		
	(Very) Poor	4758 (26.1%)	4112 (27.1%)	646 (20.8%)		
Hypertension	Yes	2186 (15.1%)	1872 (15.5%)	314 (13.1%)	8.567	0.003
	No	12,306 (84.9%)	10,228 (84.5%)	2078 (86.9%)		
Dyslipidemia	Yes	1906 (11.0%)	1550 (10.7%)	356 (12.9%)	11.579	<0.001
	No	15,393 (89.0%)	12,984 (89.3%)	2409 (87.1%)		
Diabetes	Yes	1050 (5.8%)	854 (5.6%)	196 (6.6%)	4.761	0.029
	No	17,197 (94.2%)	14,427 (94.4%)	2770 (93.4%)		

Table 1 (continued)

	Variables	Total	No PMCC	PMCC	Pearson χ^2	*P*-value
Cancer	Yes	259 (1.3%)	214 (1.3%)	45 (1.4%)	0,160	0.689
	No	19,281 (98.7%)	16,110 (98.7%)	3171 (98.6%)		
Chronic lung diseases	Yes	993 (5.5%)	836 (5.6%)	157 (5.4%)	0.239	0.625
	No	16,932 (94.5%)	14,155 (94.4%)	2777 (94.6%)		
Liver disease	Yes	633 (3.3%)	513 (3.2%)	120 (3.9%)	3.414	0.065
	No	18,359 (96.7%)	15,385 (96.8%)	2974 (96.1%)		
Heart attack	Yes	1370 (8.0%)	1147 (8.0%)	223 (7.9%)	0.054	0.815
	No	15,834 (92.0%)	13,218 (92.0%)	2616 (92.1%)		
Stroke	Yes	974 (5.1%)	829 (5.1%)	145 (4.6%)	1.854	0.173
	No	18,305 (94.9%)	15,276 (94.9%)	3029 (95.4%)		
Kidney disease	Yes	761 (4.2%)	648 (4.2%)	113 (3.7%)	1.378	0.240
	No	17,767 (95.9%)	14,843 (95.8%)	2924 (96.3%)		
Stomach disease	Yes	1551 (10.1%)	1304 (10.2%)	247 (9.5%)	1.241	0.265
	No	13,782 (89.9%)	11,433 (89.8%)	2349 (90.5%)		
Emotional problems	Yes	229 (1.2%)	199 (1.2%)	30 (0.9%)	1.932	0.165
	No	19,233 (98.8%)	16,054 (98.8%)	3179 (99.1%)		
Memory-Related disease	Yes	445 (2.3%)	390 (2.4%)	55 (1.7%)	5.758	0.016
	No	18,936 (97.7%)	15,786 (97.6%)	3150 (98.3%)		
Arthritis	Yes	1516 (11.2%)	1276 (11.4%)	240 (10.0%)	3.864	0.049
	No	12,046 (88.8%)	9893 (88.6%)	2153 (90.0%)		
Asthma	Yes	409 (2.2%)	335 (2.1%)	74 (2.4%)	0.772	0.380
	No	18,563 (97.8%)	15,507 (97.9%)	3056 (97.6%)		
Depressive symptoms	Yes	7942 (43.8%)	6725 (44.7%)	1217 (39.3%)	30.051	<0.001
	No	10,207 (56.2%)	8328 (55.3%)	1879 (60.7%)		

Note: Variable-level totals may differ due to missing or unreported data

Table 2 Comparison of cognitive function, CESD-10, and CSI-D scores between participants engaged in PMCC activities and Non-Participants

		No PMCC	PMCC	t	*P*-value
Cognitive function	Immediate word recall	3.081 ± 2.034	3.529 ± 1.954	-11.135	<0.001
	Delayed word recall	4.278 ± 2.855	4.988 ± 2.687	-12.568	<0.001
	Orientation	3.523 ± 1.437	3.896 ± 1.201	-15.201	<0.001
	Drawing	0.5036 ± 0.500	0.6216 ± 0.4851	-12.256	<0.001
	Attention	3.469 ± 1.698	3.526 ± 1.706	-1.419	0.156
	Overall (0–31)	17.17 ± 5.184	17.66 ± 5.007	-4.069	<0.001
CESD-10		9.68 ± 5.617	9.08 ± 4.843	5.580	<0.001
CSI-D		5.28 ± 1.708	5.78 ± 1.399	-11.376	<0.001

Discussion

The findings of this study underscore the potential benefits of PMCC participation for improving cognitive function among Chinese middle-aged and elderly. Our results suggest a significant association between engagement in PMCC activities and better cognitive outcomes. This aligns with existing research that emphasizes the positive effects of cognitive and social activities on mitigating cognitive decline and promoting healthy aging [20, 39, 40]. Specifically, PMCC activities, which combine cognitive stimulation and social interaction, appear to offer dual benefits for mental well-being and cognitive health in older adults.

The integration of mental and physical components in PMCC games is likely a key factor in their cognitive benefits. These activities require participants to engage in strategic thinking, problem-solving, and memory tasks, all of which contribute to maintaining cognitive reserve [41]. Cognitive reserve is critical in buffering against the onset of cognitive decline, and the mental stimulation provided by PMCC could play a vital role in delaying cognitive impairment. Moreover, the social aspect of PMCC, which often involves interactions with peers and friends, may help

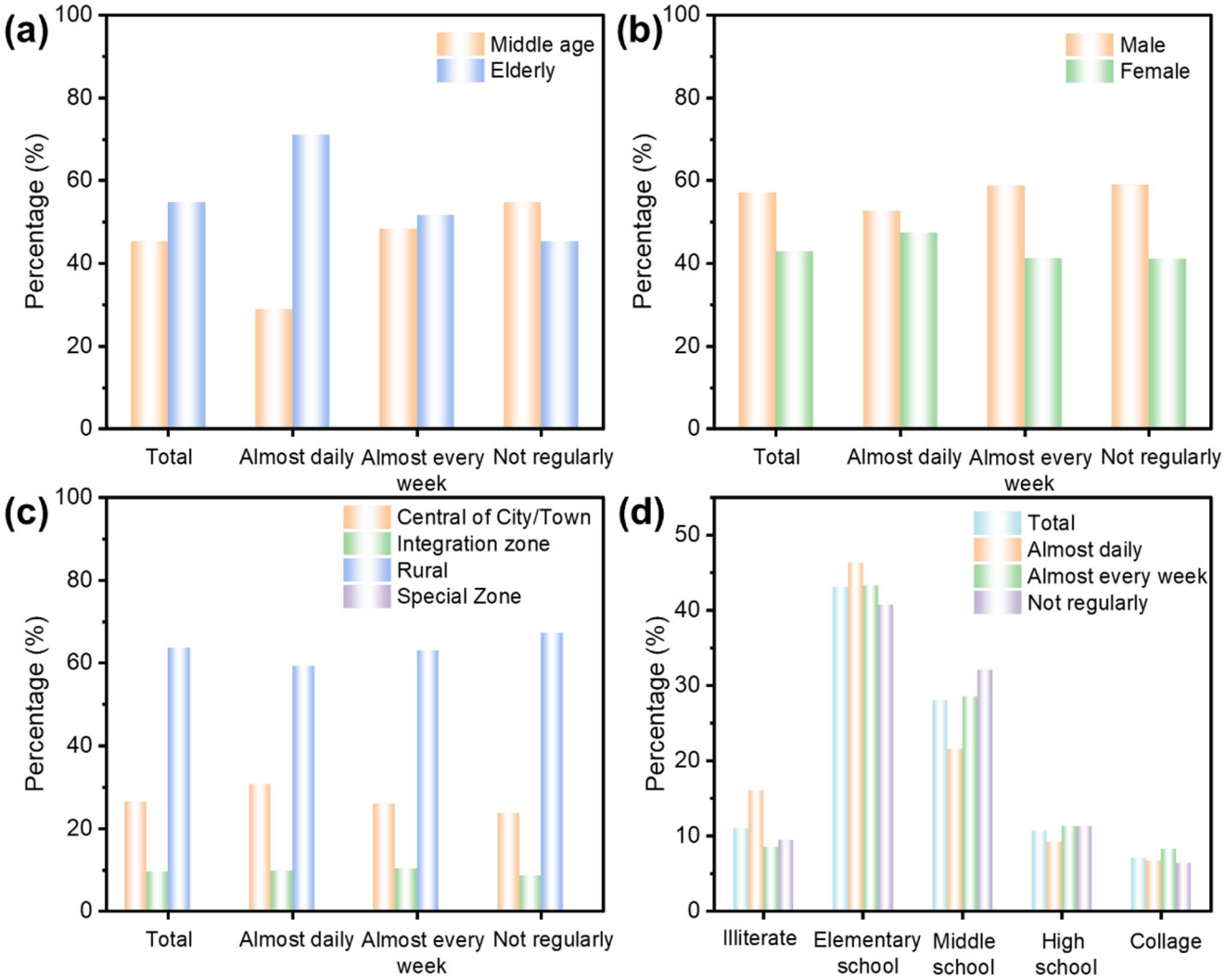

Fig. 1 PMCC engagement frequency by (**a**) age ($P<0.001$), (**b**) gender ($P=0.006$), (**c**) location ($P=0.003$), and (**d**) educational level ($P<0.001$). A P-value < 0.05 considered statistically significant

reduce feelings of isolation and stress, both of which are known to negatively affect cognitive health in aging populations [42]. By fostering emotional well-being and creating a sense of community, PMCC may mitigate some of the psychosocial factors that contribute to cognitive deterioration.

Our results also highlight the importance of frequency and engagement in these activities. While participation in PMCC was generally associated with improved cognitive outcomes, the frequency of engagement may be a crucial factor in maximizing its benefits. Further research is needed to explore how varying levels of PMCC participation—daily, weekly, or irregular—affect cognitive function and whether a threshold exists beyond which additional participation does not yield further cognitive benefits.

However, several limitations must be acknowledged. First, while we adjusted for various covariates such as age, education, and health status, residual confounding may still exist. Factors such as overall physical activity levels and dietary habits, which could influence both PMCC engagement and cognitive function, were not comprehensively controlled for in this study. Additionally, some of the data relied on self-reporting, which may introduce recall bias. Participants may have overestimated or underestimated their frequency of engagement in PMCC activities, or may have inaccurately reported their cognitive function. The lack of detailed information on the specific nature, duration, and intensity of PMCC activities also limits the ability to draw firm conclusions about the mechanisms behind the observed cognitive benefits. It is possible that different types of PMCC activities, or their duration and intensity, could have varying impacts on cognitive health. Lastly, while our findings suggest an association between PMCC participation and improved cognitive function, causality cannot be definitively established from this observational study.

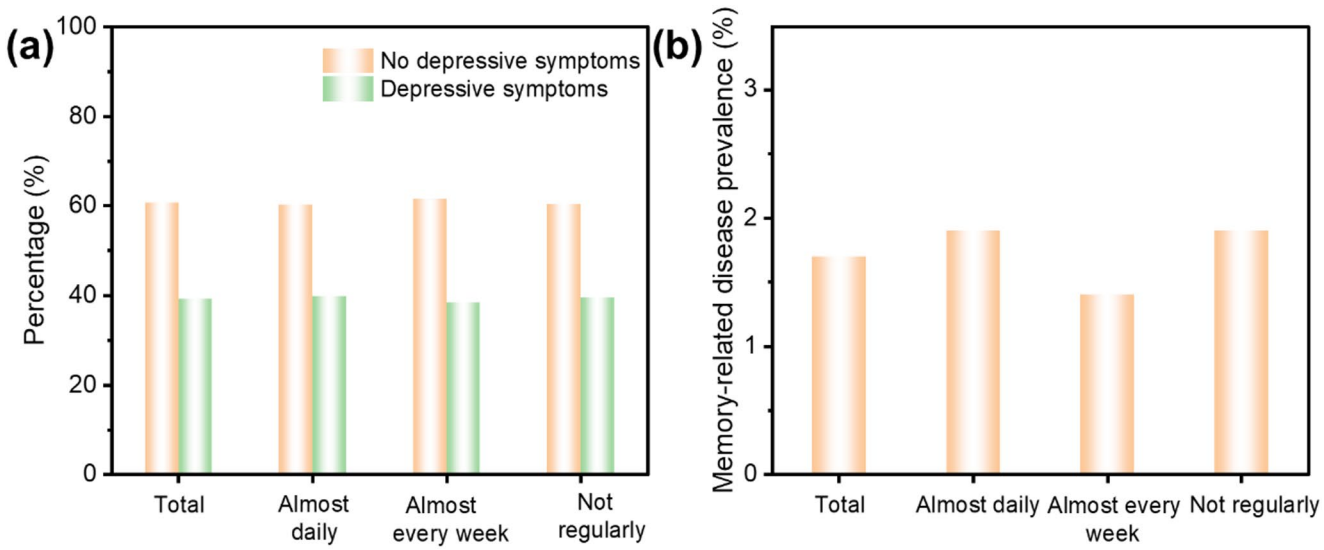

Fig. 2 PMCC engagement frequency by (**a**) depression symptoms ($P=0.804$), (**b**) memory disease status ($P=0.584$). A P-value < 0.05 considered statistically significant

Table 3 ANOVA results for the relationship between PMCC activity frequency and cognitive function, CESD-10, and CSI-D scores

	PMCC Frequency				F	*P*-value
		Almost daily	Almost every week	Not regularly		
Cognitive function	Immediate word recall	3.168 ± 2.016	3.652 ± 1.863	3.686 ± 1.948	18.808	<0.001
	Delayed word recall	4.454 ± 2.806	5.185 ± 2.557	5.201 ± 2.656	20.498	<0.001
	Orientation	3.755 ± 1.283	4.014 ± 1.125	3.903 ± 1.188	10.649	<0.001
	Drawing	0.574 ± 0.495	0.639 ± 0.480	0.6412 ± 0.480	5.718	0.003
	Attention	3.490 ± 1.688	3.590 ± 1.688	3.496 ± 1.733	0.826	0.438
	Overall (0–31)	16.97 ± 5.24	17.89 ± 4.719	17.95 ± 5.040	7.471	<0.001
CESD-10		9.01 ± 5.057	9.05 ± 4.673	9.14 ± 4.823	0.199	0.819
CSI-D		5.75 ± 1.426	5.84 ± 1.274	5.76 ± 1.477	0.560	0.571

Note: P-value < 0.05 considered statistically significant

Experimental studies, including randomized controlled trials, are needed to further investigate the causal relationship and explore the underlying mechanisms of this association.

In conclusion, this study provides evidence that PMCC participation is associated with better cognitive function in middle-aged and elderly Chinese adults. This suggests that incorporating PMCC activities into regular routines could serve as an effective strategy for promoting cognitive health and preventing cognitive decline in aging populations. Given the rapid aging of China's population, further research exploring the optimal frequency and types of PMCC activities, as well as their long-term impact on cognitive function, will be crucial in developing evidence-based interventions for healthy aging. Additionally, understanding the mechanisms through which PMCC may protect cognitive function will be important in refining these interventions and optimizing their effectiveness.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40520-025-03103-7.

Acknowledgements We sincerely thank the China Health and Retirement Longitudinal Study (CHARLS) team and the students involved in the survey for their valuable cooperation. This survey would not have been possible without the support and understanding of all the volunteers, staff, and households that participated in the CHARLS project. This work was supported by the First Hospital of Lanzhou University In-Hospital Fund [Grant/Award Number: ldyyyn2019-49], Lanzhou Science and Technology Plan Project [Grant/Award Number: 2023-ZD-96)], Key Research and Development of Gansu Province [Grant/Award Number:24YFFA034].

Author contributions J.Y. designed the study. J.W. and J.C. collected and analyzed the data. Y.D. performed the statistical analysis. G.L. prepared the figures and tables. Y.D. wrote the main manuscript text. All authors contributed to manuscript review, revision, and approved the final manuscript for submission.

Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical approval The study adhered to ethical and professional conduct principles, with informed consent obtained from all participants. Ethical approval was granted by The First Hospital of Lanzhou Uni-

versity (LDYYLL2025-89).

Competing interests The authors declare no competing interests.

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References

1. Zhou L, Ma X, Wang W (2021) Relationship between cognitive performance and depressive symptoms in Chinese older adults: the China health and retirement longitudinal study (CHARLS). J AFFECT DISORDERS 281:454–458. https://doi.org/10.1016/j.jad.2020.12.059
2. Fang EF, Scheibye-Knudsen M, Jahn HJ, Li J, Ling L, Guo H, Zhu X, Preedy V, Lu H, Bohr VA et al (2015) A research agenda for aging in China in the 21st century. AGEING RES REV 24:197–205. https://doi.org/10.1016/j.arr.2015.08.003
3. Yang G, Wang Y, Zeng Y, Gao GF, Liang X, Zhou M, Wan X, Yu S, Jiang Y, Naghavi M et al (2013) Rapid health transition in china, 1990–2010: findings from the global burden of disease study 2010. Lancet 381(9882):1987–2015. https://doi.org/10.1016/S0140-6736(13)61097-1
4. Zhang B, Li J (2011) Gender and marital status differences in depressive symptoms among elderly adults: the roles of family support and friend support. AGING MENT HEALTH 15(7):844–854. https://doi.org/10.1080/13607863.2011.569481
5. Qiu Q, Qian S, Li J, Jia R, Wang Y, Xu Y (2020) Risk factors for depressive symptoms among older Chinese adults: A meta-analysis. J AFFECT DISORDERS 277:341–346. https://doi.org/10.1016/j.jad.2020.08.036
6. Lopez AD, Murray CJL, Bank W (1996) Global Health Statistics: a compendium of incidence, prevalence, and mortality estimates for over 200 conditions. World Health Organization Harvard School of Public Health World Bank ii
7. Lara E, Koyanagi A, Caballero F, Domènech-Abella J, Miret M, Olaya B, Rico-Uribe L, Ayuso-Mateos JL, Haro JM (2017) Cognitive reserve is associated with quality of life: A population-based study. EXP GERONTOL 87:67–73. https://doi.org/10.1016/j.exger.2016.10.012
8. Köhler S, Allardyce J, Verhey FRJ, McKeith IG, Matthews F, Brayne C, Savva GM (2013) Cognitive decline and dementia risk in older adults with psychotic symptoms: A prospective cohort study. Am J Geriatric Psychiatry 21(2):119–128. https://doi.org/10.1016/j.jagp.2012.10.010
9. Lipnicki DM, Crawford JD, Dutta R, Thalamuthu A, Kochan NA, Andrews G, Lima-Costa MF, Castro-Costa E, Brayne C, Matthews FE et al (2017) Age-related cognitive decline and associations with sex, education and Apolipoprotein E genotype across ethnocultural groups and geographic regions: a collaborative cohort study. PLOS MED 14(3):e1002261
10. Prince MJ, Wimo A, Guerchet M, Ali G, Wu Y, Prina MA (2015) World Alzheimer Report 2015 - The Global Impact of Dementia: An analysis of prevalence, incidence, cost and trends. In:; 2015
11. Aartsen MJ, Smits CHM, van Tilburg T, Knipscheer KCPM, Deeg DJH (2002) Activity in older adults: cause or consequence of cognitive functioning? A longitudinal study on everyday activities and cognitive performance in older adults. J Gerontol B Psychol Sci Soc Sci 57(2):P153-P162.10.1093/geronb/57.2.P153
12. Yao Y, Wang K, Xiang H (2022) Association between cognitive function and ambient particulate matters in middle-aged and elderly Chinese adults: evidence from the China health and retirement longitudinal study (CHARLS). SCI TOTAL ENVIRON 828:154297. https://doi.org/10.1016/j.scitotenv.2022.154297
13. Oh SS, Cho E, Kang B (2021) Social engagement and cognitive function among middle-aged and older adults: gender-specific findings from the Korean longitudinal study of aging (2008–2018). SCI REP-UK 11(1):15876. https://doi.org/10.1038/s41598-021-95438-0
14. Livingston G, Huntley J, Liu KY, Costafreda SG, Selbæk G, Alladi S, Ames D, Banerjee S, Burns A, Brayne C et al (2024) Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. The Lancet: 404(10452):572-628.10.1016/S0140-6736(24)01296-0
15. Zhou S, Song S, Jin Y, Zheng Z (2020) Prospective association between social engagement and cognitive impairment among middle-aged and older adults: evidence from the China health and retirement longitudinal study. BMJ OPEN 10(11):e040936. https://doi.org/10.1136/bmjopen-2020-040936
16. He Y, Yuan C, Wang Y, Xu H, Song W, Liu W (2024) Is playing ma-jong, chess and cards associated with a lower incidence of shoulder pain in Chinese elderly adults? The cross-sectional and longitudinal evidence from CHARLS. EXP GERONTOL 194:112518. https://doi.org/10.1016/j.exger.2024.112518
17. Tervo S, Kivipelto M, Hänninen T, Vanhanen M, Hallikainen M, Mannermaa A, Soininen H (2004) Incidence and Risk Factors for Mild Cognitive Impairment: A Population-Based Three-Year Follow-Up Study of Cognitively Healthy Elderly Subjects. Dementia and Geriatric Cognitive DisordersDementia and Geriatric Cognitive Disorders 17(3):196-203.10.1159/000076356
18. Tuon T, Valvassori SS, Lopes-Borges J, Fries GR, Silva LA, Kapczinski F, Quevedo J, Pinho RA (2010) Effects of moderate exercise on cigarette smoke exposure-induced hippocampal oxidative stress values and neurological behaviors in mice. NEUROSCI LETT 475(1):16–19. https://doi.org/10.1016/j.neulet.2010.03.030
19. Zunzunegui M, Alvarado BE, Del Ser T, Otero A (2003) Social Networks, Social Integration, and Social Engagement Determine Cognitive Decline in Community-Dwelling Spanish Older Adults. The Journals of Gerontology: Series BThe Journals of Gerontology: Series B 58(2):S93-S100.10.1093/geronb/58.2.S93
20. Fu C, Li Z, Mao Z (2018) Association between social activities and cognitive function among the elderly in china: A Cross-Sectional study. Int J Environ Res Public Health 15(2):231
21. Min J, Ailshire J, Crimmins EM (2016) Social engagement and depressive symptoms: do baseline depression status and type of social activities make a difference? Age and AgeingAge and Ageing 45(6):838-843.10.1093/ageing/afw125
22. Saczynski JS, Pfeifer LA, Masaki K, Korf ESC, Laurin D, White L, Launer LJ (2006) The Effect of Social Engagement on Incident Dementia: The Honolulu-Asia Aging Study. American Journal of EpidemiologyAmerican Journal of Epidemiology 163(5):433-440.10.1093/aje/kwj061
23. Tsang WWN, Wong GCK, Gao KL (2016) Mahjong playing and eye-hand coordination in older adults—a cross-sectional study. J

Phys Therapy Sci 28(10):2955–2960. https://doi.org/10.1589/jpts.28.2955
24. Cheng S, Chan ACM, Yu ECS (2006) An exploratory study of the effect of Mahjong on the cognitive functioning of persons with dementia. INT J GERIATR PSYCH 21(7):611–617. https://doi.org/10.1002/gps.1531
25. Ross CE, Zhang W (2008) Education and Psychological Distress Among Older Chinese. J AGING HEALTH 20(3):273-289.10.1177/0898264308315428
26. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G (2014) Cohort Profile: The China Health and Retirement Longitudinal Study (CHARLS). INT J EPIDEMIOL 43(1):61-68.10.1093/ije/dys203
27. Zhao Y, Strauss J, Chen X, Wang Y, Gong J, Meng Q, Wang G, Wang H China health and retirement longitudinal study wave 4 user's guide. National School of Development, Peking University 2020:5–6
28. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G (2012) Cohort Profile: The China Health and Retirement Longitudinal Study (CHARLS). International Journal of EpidemiologyInternational Journal of Epidemiology 43(1):61-68.10.1093/ije/dys203
29. Lei X, Smith JP, Sun X, Zhao Y (2014) Gender differences in cognition in China and reasons for change over time: evidence from CHARLS. J Econ Ageing 4:46–55. https://doi.org/10.1016/j.jeoa.2013.11.001
30. Luo Y, Pan X, Zhang Z (2019) Productive activities and cognitive decline among older adults in china: evidence from the China health and retirement longitudinal study. SOC SCI MED 229:96–105. https://doi.org/10.1016/j.socscimed.2018.09.052
31. Li Z, Hicks MH (2010) The CES-D in Chinese American women: construct validity, diagnostic validity for major depression, and cultural response bias. PSYCHIAT RES 175(3):227–232. https://doi.org/10.1016/j.psychres.2009.03.007
32. Liu H, Li D, Zhao X, Fang B, Zhang Q, Li T (2021) Longitudinal impact of frailty States and sleep duration on subsequent depressive symptoms of older adults. J AM GERIATR SOC 69(4):1003–1011. https://doi.org/10.1111/jgs.16999
33. Ning H, Zhang H, Xie Z, Jiang W, Xie S (2023) Relationship of hearing impairment, social participation and depressive symptoms to the incidence of frailty in a community cohort. J AM GERIATR SOC 71(4):1167–1176. https://doi.org/10.1111/jgs.18164
34. Hu H, Cao Q, Shi Z, Lin W, Jiang H, Hou Y (2018) Social support and depressive symptom disparity between urban and rural older adults in China. J AFFECT DISORDERS 237:104–111. https://doi.org/10.1016/j.jad.2018.04.076
35. Prince M, Acosta D, Ferri CP, Guerra M, Huang Y, Jacob KS, Llibre Rodriguez JJ, Salas A, Sosa AL, Williams JD et al (2011) A brief dementia screener suitable for use by non-specialists in resource poor settings—the cross-cultural derivation and validation of the brief community screening instrument for dementia. INT J GERIATR PSYCH 26(9):899–907. https://doi.org/10.1002/gps.2622
36. Chan TS, Lam LCW, Chiu HFK, Prince MJ (2002) Validity and applicability of the Chinese version of community screening instrument for dementia. DEMENT GERIATR COGN 15:10–18
37. Austin PC, White IR, Lee DS, van Buuren S (2021) Missing data in clinical research: A tutorial on multiple imputation. CAN J CARDIOL 37(9):1322–1331. https://doi.org/10.1016/j.cjca.2020.11.010
38. Enders CK (2017) Multiple imputation as a flexible tool for missing data handling in clinical research. BEHAV RES THER 98:4–18. https://doi.org/10.1016/j.brat.2016.11.008
39. Owen R, Berry K, Brown LJ (2022) Enhancing older adults' well-being and quality of life through purposeful activity: A systematic review of intervention studies. Gerontologist 62(6):e317–e327
40. Seinfeld S, Figueroa H, Ortiz-Gil J, Sanchez-Vives MV (2013) Effects of music learning and piano practice on cognitive function, mood and quality of life in older adults. FRONT PSYCHOL 4:810
41. Stern Y (2012) Cognitive reserve in ageing and alzheimer's disease. Lancet Neurol 11(11):1006–1012. https://doi.org/10.1016/S1474-4422(12)70191-6
42. Vlaeyen JWS, Linton SJ (2012) Fear-avoidance model of chronic musculoskeletal pain: 12 years on. Pain 153(6):1144–1147. https://doi.org/10.1016/j.pain.2011.12.009

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