Associations Between Physical Activity and Cognitive Function, Daily Physical Function in Chinese With Heart Disease: A Cross-Sectional Study

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Research

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Abstract

Background: To investigate the associations between different dimensions (intensity, frequency, duration, volume, metabolic equivalent) of physical activity (PA) and cognitive function, daily physical function in Chinese with heart disease.

Methods: This study included 2792 individuals from the China Health and Retirement Longitudinal Study (CHARLS) conducted in 2015. PA was divided into vigorous PA (VPA), moderate PA (MPA), and light PA (LPA). Linear regression models and binary logistic regression models were established to assess the associations be-tween indicators respectively.

Results: Compared with taking no PA, MPA and VPA with a frequency of 6-7 d/w had lower risks of impaired daily physical function (OR=0.47, 95%CI: 0.25, 0.91; OR= 0.57, 95%CI: 0.37, 0.88) and higher cognitive function scores (β=1.22, 95%CI: 0.42, 2.03; β=1.08, 95%CI: 0.43, 1.73), while VPA of 3-5 d/w had lower cognitive function scores (β=-1.96, 95%CI: -3.51, -0.40). LPA with a duration of 30-119 min/d had lower risks of impaired daily physical function (OR=0.59, 95%CI: 0.36, 0.97). MPA and VPA of 30-119 min/d had higher cognitive function scores (β=1.43, 95%CI: 0.49, 2.37; β=1.30, 95%CI: -0.56, 2.06). Lower cognitive function scores in volume of ≥ 300 min/w. (β=-1.18, 95%CI: -2.14, -0.23). 1800-8999 METs had lower risks of impaired daily physical function and higher cognitive function scores. 1800-2999 METs had lowest risks of impaired daily physical function and highest cognitive function scores. (OR=0.18, 95%CI: 0.04, 0.75; β=2.94, 95%CI: 1.67, 4.21).

Conclusions: This study found that VPA are associated with lower cognition, MPA and LPA are beneficial to cognition and daily physical function.

Trial registration: IRB00001052-11015.

Background

Heart disease is a major non-communicable disease worldwide, has been a leading cause of death for the past two decades (1). Its prevalence exhibits continual increase and imposes heavy burden on society, which has become a major public health problem (2). According to statistics, ischemic heart disease mortality has increased by 155.4% between 1990 and 2017 in China, resulting in a severe economic burden (3).

Current studies have shown that patients with heart disease are at risk for deterioration of cognitive abilities, such as memory loss (4). Patients with increased cardiac burden typically exhibit reduced hippocampal, cortical gray matter, and total brain volumes and exacerbated cognitive decline (5–7), it has been observed that the greater the cardiac burden is, the faster the rate of episodic memory, working memory, and perceptual decline (8–10). Additionally, related studies have shown that cognitive impairment in patients with heart disease is negatively correlated with the function of activities of daily living (ADL) (11–13). Damage to the structure of the physiological system and deterioration of the cognitive function bring severe symptoms to the patients, reduce the quality of life (14), and may also limit the ability to perform ADL (15). Cognitive decline has been more detrimental than physical failure due to heart disease over time (16). Progression of the disease course accelerates cognitive function as well as regression in the ability to perform ADL, while cognitive decline also accelerates the course of disability (5)。

Previous studies have demonstrated that levels of physical activity (PA) are strongly associated with physical fitness in patients with heart disease, can improve their psychological, cognitive, and social functioning (17, 18). Physical activity is also found to improve attention, processing speed, executive function, as well as memory, among others, and structural brain integrity (19). However, there was no large representative sample study on the associations between PA and cognitive function, daily physical function in patients with heart disease. Therefore, the aim of this study was to investigate the associations between different dimensions (intensity, frequency, duration, volume, metabolic equivalent) of PA and cognitive function, daily physical function in Chinese with heart disease.

Materials And Methods

Study Population

In this study, we used the data from the China Health and Retirement Longitudinal Study (CHARLS) conducted in 2015. CHARLS is a nationally representative longitudinal cohort study of individuals in China, selecting participants from 28 provinces in China based on a stratified cluster sampling method. It is an authoritative micro survey data on the health status of the elderly in China and conducted further follow-up survey every two years. The ethics committee of Peking University Health Science Center has approved the CHARLS. The ethical approval number was IRB00001052-11015. All participants provided written informed consent for participation.

A total of 21,096 participants were investigated in 2015. Participants included in the study should have complete data such as age, height, weight, gender, educational level, marital status, smoking, drinking, PA record, and diagnosis of heart disease. Samples with missing data, outliers or logical errors were excluded. Finally, 2792 participants were included in this cross-sectional study.

Heart Disease Measurements

Heart disease was defined through the question “Have you been diagnosed with a heart disease by a doctor?” and “Are you now taking any of the following treatments because of your heart disease and its complications? Taking traditional Chinese medicine, taking western medicine, taking other treatments than taking medicine.”. We considered that the individual had been a heart disease when the response was “yes” to either or both of the questions.

Assessment of PA

Each participant reported weekly PA, including vigorous physical activity (VPA)(PA that makes you feel short of breath, such as carrying heavy objects, digging, farming, aerobic exercise, rapid cycling, bicycle loading, etc.), moderate physical activity (MPA)(PA that makes you breathe faster than usual, such as carrying light goods, cycling at regular speed, mopping, Tai Chi, brisk walking, etc.) and light physical activity (LPA)(walking from one place to another at home or at work, and other walking activities for leisure, sports, exercise or entertainment). Each subject was asked, “Do you conduct VPA/MPA/LPA for at least 10 min continuously in a usual week?” If the response was “no”, they would be considered as taking no VPA/MPA/LPA. If the answer was “yes”, they would be further inquired “How many days do you normally take VPA/MPA/LPA in a week?” and “How long do you spend on VPA/MPA/LPA each time?”.

Frequency of PA ranged from 0–7 d/w and was separated into 4 levels: no activity (0 d/w); 1–2 d/w; 3–5 d/w; and 6–7 d/w. Duration of PA was categorized into 5 levels: no activity; 10–29 min/d; 30–119 min/d; 120–239 min/d; and ≥ 240 min/d. Considering that the average of each duration is used in the questionnaire instead of the specific duration (20), we calculated the total volume of VPA/MPA/LPA in a week by multiplying frequency and duration of VPA/MPA/LPA. In this study, referring to the WHO guideline (21), volume of VPA was divided into 4 levels: no activity; 10–74 min/w; 75–299 min/w; and ≥ 300 min/w, whereas volume of MPA/LPA was separated into 4 levels; no activity; 10–149 min/w; 150–299 min/w; and ≥ 300 min/w.

According to previous studies, 1 metabolic equivalent (MET) refers to the amount of oxygen consumed at rest (3.5ml O2/kg/min), VPA can be expressed as 8 METs; MPA can be expressed as 4 METs; VPA can be expressed as 3.3 METs. Total physical activity (METs) was calculated as the sum of scores for VPA + MPA + LPA (20). According to the guidelines of the American College of Sports Medicine (ACSM) (22), the minimum level of total physical activity that is beneficial to health is defined as 600 METs-min/week, METs-min/week was therefore divided into 9 categories (0 to < 600, 600–1199, 1200–1799, 1800–2999, 3000–5999, 6000–8999, 9000–11999, ≥ 12000).

Assessment of Daily Physical Function

Daily physical function was measured by the Activities of Daily Living scale and Instrumental Activities of Daily Living (IADL) scale (23), Each option of both scales was divided into 4 levels: “no difficulties = 0”,“difficulties but still can be completed = 1”，“difficulties, need help = 2”，“unable to complete = 3”. The range of composite scores was 0–43, and a composite ADL / IADL score of ≥ 11 was defined as “any functional loss”, < 11 was defined as “no functional loss” based on the previous studies (23).

Assessment of Cognitive Function

Cognitive function was evaluated through three kinds of tests: Telephone Interview of Cognitive Status (TICS) (orientation and attention), word recall (episodic memory), and figure drawing (visuospatial ability) (24). TICS (orientation and attention) (25): the subjects were asked to answer the current year, month, date, day of week and season, and additionally were asked to calculate 100 minus 7 equal to several, 5 consecutive reductions. Then add the scores of the correct question. Word recall (episodic memory) (26, 27): Subjects were asked to remember and immediately recall as many words as possible in arbitrary order after reading a page consisting of 10 Chinese Nouns (immediate recall). And after 4 to 10 minutes, subjects were asked to recall as many original words as possible (delayed recall). The episodic memory score was the average score of the immediate recall and delayed recall. Figure drawing (visuospatial ability) (26): Subjects were shown a picture of two overlapping pentagon, and were asked to draw a similar number, with a score of 1 for success and 0 for failure. Cognitive function was scored as the sum of the scores of the three parts described above, with higher scores indicating better cognitive function.

Assessment of Covariables

Covariates considered in this study including age (continuous variable), sex (male, female), educational status (junior high school or below; senior high school or vocational school; college or above), marital status (married or partnered; separated, divorced or widowed; never married), drinking (never; former; current), smoking (never; former; current).

Data Analysis

Categorical variables were expressed as frequencies and percentages. Continuous variables were described as a mean value ± standard deviation (SD). Associations between different dimensions (intensity, frequency, duration, volume) of PA, metabolic equivalent (MET) and cognitive function, daily physical function in patients with heart disease were estimated by linear and logistic regressions. Linear regression data are presented as β coefficients and 95% confidence intervals (CI), while logistic regression results are presented as odds ratios (OR) and 95% CI. Covariates were adjusted in the models, include age, sex, educational status, marital status, drinking, smoking, BMI and other potential confounding covariates. Data were analyzed with IBM SPSS Statistics for Windows (Statistics 23, IBM Corporation, New York, USA). If p-value < 0.05, it was considered statistically significant in all analyses.

Results

Our study included 2792 participants, which consisted of 1090 males (38.7%) and 1712 females (61.3%). Among them, 2311 patients (82.9%) were married or living with a partner, 2209 patients (79.1%) had junior high school or below education level, 1735 patients (59.7%) did not smoke and 1915 patients (68.6%) did not drink alcohol. The basic characteristics of the participants are shown in Table 1.

Table 1
Basic characteristics of participants

Characteristic	Overall sample (N = 2792)	
	mean	SD
Age, year	65.26	9.85
BMI, kg/m2	24.94	4.04
Sex (*n* + %)		
Male	1080	38.7
Female	1712	61.3
Marital status (*n* + %)		
Married or partnered	2311	82.8
Separated, divorced, or widowed	464	16.6
Never married	17	0.6
Educational status (*n* + %)		
Junior high school or below	2209	79.1
Senior high school or vocational school	385	13.8
College or above	198	7.1
Smoking (*n* + %)		
Never	1735	62.1
Former	480	17.2
Current	572	20.5
Drinking (*n* + %)		
Never	1915	68.6
Former	146	5.2
Current	731	26.2

Abbreviation: SD, standard deviation; BMI, Body Mass Index.

Table 2 shows the relationship between frequency of PA and daily physical function. Compared with individuals taking no PA, individuals taking MPA and VPA with a frequency of 6–7 d/w had lower risks of impaired daily physical function (OR = 0.47, 95%CI: 0.25, 0.91; OR = 0.57, 95%CI: 0.37, 0.88). Furthermore, as the relationship between frequency of PA and cognitive function shows (Table 2), individuals with

MPA 1-2d/w as well as 6-7d/w all had higher cognitive function scores (β = 1.51, 95%CI:0.02, 3.00; β = 1.22, 95%CI:0.42, 2.03), individuals with LPA 3-5d/w as well as 6-7d/w all had higher cognitive function scores (β = 2.06, 95%CI:0.75, 3.36; β = 1.08,95%CI:0.43, 1.73), while individuals taking VPA 3–5 d/w had lower scores of cognitive function (β= -1.96, 95%CI: -3.51, -0.40).

Table 2
Associations between PA and daily physical activity ability and cognitive function of patients with heart disease.

Variables	Daily Physical Function		Cognitive Function	
	OR	95% CI	β	95% CI
Frequency				
VPA				
No activity	1.00		1.00	
1-2d/w	N/A	N/A	-0.53	-2.26, 1.20
3-5d/w	1.48	0.43,5.11	-1.96	-3.51, -0.40 *
6-7d/w	1.09	0.41,2.90	-0.92	-2.03, 0.19
MPA				
No activity	1.00		1.00	
1-2d/w	0.38	0.09,1.62	1.51	0.02, 3.00 *
3-5d/w	0.25	0.06,1.08	0.76	-0.50, 2.01
6-7d/w	0.47	0.25,0.91 *	1.22	0.42, 2.03 **
LPA				
No activity	1.00		1.00	
1-2d/w	1.59	0.53,4.79	0.80	-1.18, 2.77
3-5d/w	0.52	0.19,1.47	2.06	0.75, 3.36 **
6-7d/w	0.57	0.37,0.88 *	1.08	0.43, 1.73 **
Duration				
VPA				
No activity	1.00		1.00	
10–29 min/d	N/A	N/A	0.58	-3.05, 4.21
30–119 min/d	0.79	0.18,3.43	-1.06	-2.72, 0.59
120–239 min/d	0.98	0.23,4.27	-1.29	-2.86, 0.29
≥ 240 min/d	0.97	0.32,2.99	-0.99	-2.22, 0.24

Abbreviations: OR, odds ratio; β, Regression coefficients; CI, confidence interval; PA, physical activity; VPA, vigorous physical activity; MPA, moderate physical activity; LPA, light physical activity; Model was adjusted for age, sex, educational status, marital status, drinking, smoking, BMI; N/A denoted that no applicable value was observed; **: $p < 0.05$; **: $p < 0.01$.*

Variables	Daily Physical Function		Cognitive Function	
	OR	95% CI	β	95% CI
MPA				
No activity	1.00		1.00	
10–29 min/d	0.51	0.15,1.67	1.78	0.34, 3.21 *
30–119 min/d	0.64	0.32,1.27	1.43	0.49, 2.37 **
120–239 min/d	0.30	0.09,1.01	0.98	-0.17, 2.13
≥ 240 min/d	N/A	N/A	0.67	-0.59, 1.93
LPA				
No activity	1.00		1.00	
10–29 min/d	0.47	0.20,1.11	1.18	-0.08, 2.29 *
30–119 min/d	0.59	0.36,0.97 *	1.30	0.56, 2.04 **
120–239 min/d	0.58	0.27,1.25	0.83	-0.16, 1.82
≥ 240 min/d	1.32	0.55,3.18	0.75	-0.56, 2.06
Volume				
VPA				
No activity	1.00		1.00	
10–74 min/w	N/A	N/A	-0.66	-5.60, 4.28
75–299 min/w	N/A	N/A	-0.71	-2.74, 1.33
≥ 300 min/w	1.06	0.45, 2.48	-1.18	-2.14, -0.23 *
MPA				
No activity	1.00		1.00	
10–149 min/w	0.57	0.22, 1.49	1.67	0.46, 2.87 **
150–299 min/w	0.95	0.22, 4.15	2.02	-0.18, 4.06
≥ 300 min/w	0.35	0.17, 0.72 **	0.89	0.09, 1.68 *
LPA				

Abbreviations: OR, odds ratio; β, Regression coefficients; CI, confidence interval; PA, physical activity; VPA, vigorous physical activity; MPA, moderate physical activity; LPA, light physical activity; Model was adjusted for age, sex, educational status, marital status, drinking, smoking, BMI; N/A denoted that no applicable value was observed; **: $p < 0.05$; **: $p < 0.01$.*

Variables	Daily Physical Function		Cognitive Function	
	OR	95% CI	β	95% CI
No activity	1.00		1.00	
10–149 min/w	0.64	0.31, 1.33	1.25	0.19, 2.30 *
150–299 min/w	0.27	0.04, 2.04	1.24	-0.69, 3.16
≥ 300 min/w	0.59	0.38, 0.92 *	1.26	0.59, 1.93 **

Abbreviations: OR, odds ratio; β, Regression coefficients; CI, confidence interval; PA, physical activity; VPA, vigorous physical activity; MPA, moderate physical activity; LPA, light physical activity; Model was adjusted for age, sex, educational status, marital status, drinking, smoking, BMI; N/A denoted that no applicable value was observed; **: $p < 0.05$; **: $p < 0.01$.*

Table 2 shows the relationship between duration of PA and daily physical function. Compared with individuals taking no PA, no significance in risks of impaired daily physical function between MPA and VPA of any duration, whereas only individuals taking LPA with a duration of 30–119 min/d had lower risks of impaired daily physical function (OR = 0.59, 95%CI: 0.36, 0.97). Furthermore, as the relationship between duration of PA and cognitive function shows (Table 2), compared with individuals taking no PA, individuals with MPA 10–29 min/d as well as 30–119 min/d all had higher cognitive function scores (β = 1.78, 95%CI:0.34, 3.21; β = 1.43, 95%CI:0.49, 2.37), individuals with LPA 10–29 min/d as well as 30–119 min/d all had higher cognitive function scores (β = 1.18, 95%CI: -0.08, 2.29; β = 1.30, 95%CI: -0.56, 2.06).

Table 2 shows the relationship between volume of PA and daily physical function. Compared with individuals taking no PA, individuals taking MPA and LPA with a volume of ≥ 300 min/w had lower risks of impaired daily physical function (OR = 0.35, 95%CI: 0.17, 0.72; OR = 0.59, 95%CI: 0.38, 0.92), whereas no significance between VPA of any volume and risks of impaired daily physical function. Furthermore, as the relationship between volume of PA and cognitive function shows (Table 2), compared with individuals taking no PA, whereas lower scores of cognitive functions in volume of ≥ 300 min/w. (β= -1.18, 95%CI: -2.14, -0.23). a volume of 10–149 min/w, of ≥ 300 min/w in MPA (β = 1.67, 95%CI: 0.46, 2.87; β = 0.89, 95%CI: 0.09, 1.68) and LPA (β = 1.25, 95%CI: 0.19, 2.30; β = 1.26, 95%CI: 0.59, 1.93) all had higher cognitive function scores.

Table 3 shows the relationship between METs and daily physical function, cognitive function. Compared with individuals taking no PA, individuals taking 1800 to < 2999METs, 3000 to < 5999METs and 6000 to < 8999METs had lower risks of impaired daily physical function (OR = 0.18, 95%CI: 0.04, 0.75; OR = 0.29, 95%CI: 0.14, 0.60; OR = 0.24, 95%CI: 0.08, 0.77) and higher cognitive function scores (β = 2.94, 95%CI: 1.67, 4.21; β = 1.23, 95%CI: 0.40, 2.06; β = 1.32, 95%CI: 0.21, 2.43). Furthermore, Individuals with 1800–2999 METs had lowest risks of impaired daily physical function and highest scores of cognitive functions. (OR = 0.18, 95%CI: 0.04, 0.75; β = 2.94, 95%CI: 1.67, 4.21).

Table 3
Associations between Mets and the daily physical activity ability and cognitive function of patients with heart disease.

Variables	Daily Physical Function		Cognitive Function	
	OR	95% CI	β	95% CI
Mets				
0 to < 600				
600 to < 1199	0.31	0.07, 1.31	1.28	-0.49, 3.05
1200 to < 1799	0.60	0.34, 1.06	1.29	0.317, 2.26 **
1800 to < 2999	0.18	0.04, 0.75 *	2.94	1.67, 4.21 **
3000 to < 5999	0.29	0.14, 0.60 **	1.23	0.40, 2.06 **
6000 to < 8999	0.24	0.08, 0.77 *	1.32	0.21, 2.43 *
9000 to < 11999	0.29	0.07, 1.19	0.71	-0.75, 2.17
≥ 12,000	0.42	0.17, 1.04	0.98	-0.10, 2.05

Abbreviations: OR, odds ratio; β, Regression coefficients; CI, confidence interval; Model was adjusted for age, sex, educational status, marital status, drinking, smoking, and BMI; **: $p < 0.05$; **: $p < 0.01$.*

Discussion

The results of the study have shown that high frequency, high duration, as well as high volume VPA in patients with heart disease have poorer cognitive function; MPA and VPA with a frequency of 6–7 d/w and duration of 30–119 min/d, and PA in 1800-2999METs-min/week are most closely related to better cognitive function and better daily physical function.

With regard to VPA. Cognitive function is associated with various processes related to specific regions of the brain (28). The competition between different brain regions for limited metabolic resources would occur in VPA, and more metabolic resources were allocated to motor and sensory cortices when VPA was performed at the expense of metabolic resources supplied to the prefrontal cortex (29). VPA impairs metabolism in the prefrontal cortex of the brain in patients with heart disease and ultimately cognitive performance (30, 31). Cerebral blood flow is increased by the activation of local neurons to meet metabolic demand (32), during exercise, cerebral blood flow is regulated by a complex interplay between neuronal activity and metabolism, blood pressure, sympathetic nervous system activity, partial pressure of oxygen and carbon dioxide, and cardiac output (33, 34). Cerebral blood flow during exercise depends on the intensity of exercise, and during maximal exercise, cerebral blood flow decreases progressively, mainly as a result of hyperventilation, suggesting that cerebral metabolic demand may be unmet during high-intensity exercise (34), this may be one of the reasons why the results of the present study showed worse cognition in cardiac patients with VPA. In addition, it has been shown that patients have impaired cardiac function and that the myocardium may not pump sufficient tissue for blood supply, and thus, VPA intervention does not necessarily improve mobility in patients with coronary heart disease or heart failure (35), which is consistent with the result that the VPA shown in the present study has no association with the ability of daily physical function in patients with heart disease.

With regard to MPA and LPA. The current study confirms cardiorespiratory fitness as a health indicator strongly associated with mortality, functional health, and cognitive decline (36). The relationship between exercise intensity and cognition was assumed to be inverted U-shaped (37, 38), MPA and LPA are easier to achieve and more acceptable to patients. Australian and British guidelines recommend patients on light to moderate intensity aerobic exercise as exercise intensity for cardiac rehabilitation (39). Furthermore, autonomic regulation ability and neurotransmitter function were positively correlated with the frequency of PA (40), improvement in neurotransmitter function and autonomic regulatory capacity was most marked in patients with heart disease who underwent 6 days of light to moderate intensity aerobic exercise per week. Studies have shown that frequent exercise (≥ 6 times / week) in patients with heart disease is associated with improved cardiopulmonary exercise capacity and psychosocial function, with significant improvements in mobility (41), which is consistent with the findings from this study that 6–7 days per week MPA and LPA have benefits for both cognition and daily physical function in patients with heart disease. In addition, previous studies have confirmed that sustained 45 min exercise not only improves attention, memory, and visuospatial abilities in patients with heart disease, but also increases serum brain-derived neurotrophic factor (BDNF) levels and cerebral blood flow in the middle cerebral artery (42), MPA of 75 minutes per week had the best effect on cognition (43), these are compatible with the results in the present study that 30–119 min/d of MPA and LPA of exercise has the most beneficial effects on cognition and daily physical function. However, the present study found that the duration of MPA was not associated with daily physical function. The controversial effects of PA on daily physical function have been reported in previous relevant studies, which may be related to the intensity of exercise (44). High-quality studies are still needed. Relevant studies have shown that MPA and LPA may play a protective role on the ability to perform daily physical function, and MPA and LPA have a significant favorable effect on physical performance indicators of daily physical function with MPA having the greatest effect (45). In addition, MPA and LPA contribute to cognition, whereas vigorous, very vigorous, and maximal intensity PA confers no benefit on cognition (38, 46). The apparent measurable decline in cognition found after VPA may be explained by the fact that prolonged VPA can lead to dehydration and exhaustion of energy stores, which can lead to cognitive decline (47), which is consistent with the result in this study that MPA and LPA ≥ 300 min/w conferred the most benefit on cognition and daily physical function in patients with heart disease.

With regard to MET. Our results showed that cardiac patients with 1800–8999 METs have better cognition and daily physical function than patients with insufficient exercise, patients with 1800–2999 METs min/week had the best cognition and daily physical function. Previous studies have shown that cardiac patients with less than 3000 METs/week of PA show larger gains in daily physical function and diminishing returns above 3000 METs/week of PA (48). PA delays the decline in cognitive function, and MPA (140×4×4 = 2240METs) may have the most beneficial effects (49), which were all consistent with the results of the present study. Therefore, controlling physical activity in patients with heart disease within reasonable metabolic equivalents is likely to result in better cognitive function and better improvements in daily physical function.

We used a large representative sample from China in this study. However, this study is a cross-sectional study, which cannot accurately explain and analyze the cause-and-effect relationship, and no detailed differentiation of PA. Further high-quality studies are needed to further explore this matter.

Conclusions

This study revealed a dose-effect relationship between different dimensions (intensity, frequency, duration, volume, metabolic equivalent) of PA and cognitive function, daily physical function in Chinese with heart disease. After adjustment for potential confounders, VPA was associated with lower cognitive function in the total sample, but not with daily physical function. MPA and LPA were beneficial to the cognitive function and daily physical activity of Chinese with heart disease, which benefited the most with duration of 30–119 min/d, whereas no significance between total physical function and MPA of any duration. 1800–8999 METs were beneficial to the cognitive function and daily physical activity in the total sample, and 1800–2999 METs benefited the most. These findings can supply more evidence on the associations between PA and cognitive function, daily physical function in Chinese with heart disease. A prospective design is needed to determine the association further deeply.

List Of Abbreviations

ADL
Activities of daily living; PA:Physical activity; CHARLS:China Health and Retirement Longitudinal Study; VPA:Vigorous physical activity; MPA:Moderate physical activity; LPA:Light physical activity; MET:Metabolic equivalent; ACSM:American College of Sports Medicine; IADL:Instrumental Activities of Daily Living; TICS:Telephone Interview of Cognitive Status; SD:Standard deviation; CI:Confidence intervals; OR:Odds ratios; BDNF:Brain-derived neurotrophic factor.

Declarations

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of Peking University Health Science Center. The ethical approval number was IRB00001052-11015.

Consent for publication

Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Availability of data and materials

The datasets used or analyzed during the current study are available in the CHARLS repository, http://charls.pku.edu.cn/

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions:

MD was responsible for the conceptualization and investigation. NJ, YZ and XD conducted the analysis and interpretation of the data. MD and NJ drafted the initial manuscript. CT substantively revised the work. All authors read and approved the final manuscript.

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