Physical activity and cognitive function among older adults in China: A systematic review

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Abstract

Background: Physical activity (PA) has been shown to benefit cognitive function in older adults. However, the cognitive benefits of exercising for older Chinese adults have not been systematically documented. This study was to conduct a systematic review on evidence that PA is beneficial for cognitive functioning in older Chinese adults.

Methods: Major databases, including PubMed, EMBASE, Cochrane Library, WanFang, CNKI, and VIP, were searched for studies published in English or Chinese between January 2000 and December 2015. Randomized and non-randomized controlled trials (RCTs and non-RCTs), cohort, case-control and cross-sectional studies that evaluated PA and cognitive function among older Chinese adults were included in this review.

Results: Of 53 studies included and reviewed, 33 were observational (22 cross-sectional, 7 case-control, and 4 cohort) and 20 were experimental (15 RCTs, 5 non-RCTs). Observational studies showed an association of reduced risk of cognitive-related diseases (i.e., mild cognitive impairment, Alzheimer’s disease, and dementia) through PA, whereas experimental studies reported exercise-induced improvement in multiple domains of cognitive function (i.e., global cognitive function, memory, executive function, attention, language, and processing recourse).

Conclusion: This systematic review provides initial evidence that PA may benefit cognition in older Chinese adults. Further studies of individuals with cognitive impairments and prospective and RCT studies having high scientific rigor are needed to corroborate the findings reported in this review.

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Keywords: Chinese elderly; Cognition; Dementia; Exercise; Public health; Systematic review

1. Introduction

With the unprecedented economic reform taking place over the past 30 years, China has experienced a significant demographic transition. As a result of an increase in life expectancy and decades of implementing the one-child policy, the Chinese population is aging rapidly. In 2014, it was estimated that in China there were about 212 million adults aged 60 and older, accounting for 15% of its total population. Advancing age is associated with a high risk of decline in cognitive functioning and with an increase in both prevalence and incidence of neurodegenerative disorders, including Alzheimer’s disease (AD), vascular dementia, and dementia with Lewy bodies. In an analysis of epidemiologic studies, the authors estimated that in 2010 the number of dementia cases in China was about 9.19 million (20% of the worldwide total), with 30 million dementia cases predicted by 2050. In the coming decades, various brain-related diseases will begin to exert substantial health and economic burdens on Chinese society and the country’s health care system.

China will undoubtedly continue to face the tremendous public health and socioeconomic challenges that accompany a rapidly aging population who suffers from late-life declines in cognitive function. However, research has shown that one-third of AD cases worldwide (9.6 million) were attributable to modifiable risk factors, including physical inactivity. In fact, studies have shown that physical activity (PA) may be neuroprotective in preventing age-related cognitive decline, reducing the incidence of mild cognitive impairment (MCI) and delaying the onset of dementia. An increasing number of studies also
suggest that PA may be effective in managing cognitive impairment and dementia.\textsuperscript{10}

Although studies conducted in Western countries have shown that there are cognitive benefits to be gained from PA, there is a scarcity of scientific knowledge regarding the health benefits of PA on cognitive function in older Chinese populations. This may be due in part to the absence of systematic reviews of studies conducted in China that provide evidence on the influence of PA on cognition. Access to this information is of high public health importance given the increasing number of older Chinese adults and the continued upward trend in both prevalence and incidence of cognitive impairments in this population. The purpose of this article was to fill this knowledge gap by conducting a systematic review of empirical studies that have evaluated the health benefits of PA on cognitive function among older Chinese adults.

2. Methods

2.1. Data sources and search strategy

We conducted an extensive search using several major electronic databases. These included PubMed, EMBASE, Cochrane Library, WanFang, CNKI, and VIP. The search covered studies published in English or Chinese between January 2000 and December 2015. No other sources or search strategies were sought. A search of article titles and abstracts was conducted by the primary author. The keyword terms used in the search included “physical activity”, “exercise”, “running”, “walking”, “aerobic training”, “cycling”, “Tai Chi” or “Tai Ji”, “Qigong”, “cognition”, “brain”, “neural plasticity”, “hippocampus”, “BDNF”, “dementia”, “Alzheimer”, “neurodegenerative”, “older adults”, “elderly”, “China”, “Chinese”, “Hong Kong”, and “Taiwan”. Review articles were also used as a source in a search for additional studies.

Citations were downloaded into an Excel spreadsheet and assessed for relevance against the prespecified inclusion and exclusion criteria (described later). Full-text articles were obtained for all studies entering the review. Any uncertainties or discrepancies about entering the review were resolved by consensus and, if necessary, by a third reviewer.

2.2. Inclusion and exclusion criteria

Eligible studies included 2 types: (1) experimental studies, comprising randomized controlled trials (RCTs) and non-randomized studies (non-RCTs) and (2) observational studies (cross-sectional, case-control, and cohort). To be eligible, studies must have measured at least 1 cognitive domain and required at least 1 type of PA practiced by older adults (50 years and older) with or without cognitive impairment. Finally, eligible studies had to have been conducted in the Mainland of China, Hong Kong or Taiwan, China.

Studies were excluded if they (1) were published without an English title or abstract, (2) did not include a minimal-attention control condition (in the case of experimental studies), (3) were duplicates of other studies, (4) simply described research protocols, or (5) were review articles.

2.3. Data extraction

Two reviewers extracted data into a form that identified the study methodology and characteristics of each study. Categories included (1) sample, (2) design, (3) details of the outcome (i.e., PA, cognitive function), (4) study duration, (5) intervention including intensity, frequency, and intervention duration, and (6) results. Data were extracted and synthesized separately for experimental studies and observational studies. No meta-analysis was conducted owing to significant variability in study design and methodologies. Instead, a narrative synthesis of all studies was produced.

2.4. Quality assessment

Because of the lack of a consistent instrument to assess methodological quality across studies having various designs, RCTs were the only studies in this review that were assessed using the core criteria from the Cochrane risk of bias assessment tool for RCTs.\textsuperscript{11} Specifically, each RCT was rated initially using a binary coding scheme of 1 (meeting the criteria) and 0 (not meeting the criteria). The rating assessed 5 methodological components: sequence, allocation, blinding, intent-to-treat, and completeness in reporting prespecified study outcomes. RCTs that provided no information on any of these criteria were coded as “not meeting the criteria”. A numerical rating for meeting any of these criteria was tabulated and summarized into 3 quality ratings: low (those that met 1 or 2 criteria), moderate (those that met 3 criteria), and high (those that met 4 or 5 criteria).

3. Results

3.1. Search results and study characteristics

Overall, 540 articles were identified using our search strategy; of these, 487 were excluded from the review. A total of 53 studies met the inclusion and exclusion criteria (Fig. 1) and were subsequently reviewed in full. Of the 53 studies reviewed, 33 were observational (22 cross-sectional, 7 case-control, and 4 cohort) and 20 were experimental (15 RCTs and 5 non-RCTs).

The characteristics of the studies included in the review are summarized, organized by study design, in Table 1 (observational) and Table 2 (experimental). Of the 53 studies, 37 were conducted in the Mainland of China (23 observational (1 also took place in Hong Kong\textsuperscript{7}), 14 experimental), 12 took place in Hong Kong, China (7 observational, 5 experimental), and 5 were conducted in Taiwan, China (4 observational, 1 experimental). Study sample sizes varied significantly, ranging from 135 to 27,651 participants (median = 988) for observational studies and from 29 to 555 participants (median = 84) for experimental studies. Although observational studies enrolled a mix of healthy older adults and those with cognitive impairment, most experimental studies (60%) targeted older adults with cognitive impairment (i.e., MCI and dementia).

3.2. Quality assessment

A detailed quality assessment of 15 RCTs is summarized in Table 3. Per the quality assessment scheme used in this review, 7 RCTs\textsuperscript{12–18} (47%) were judged to be of high quality, 1 (6%) was
rated as moderate,\textsuperscript{19} and 7 (47\%) were rated as being of low quality.\textsuperscript{26–26}  

3.3. Results from observational studies  

3.3.1. PA and risk of cognitive impairment  

3.3.1.1. Mild cognitive impairment or cognitive impairment. A total of 13 studies reported an association between PA and MCI or cognitive impairment.\textsuperscript{27–39} A cohort study with a 3-year follow-up showed that a lack of exercise in older women was associated with increased risk of cognitive impairment (odds ratio (OR) = 2.2; 95\% confidence interval (CI): 1.2–3.8).\textsuperscript{27} In contrast, a number of studies showed that an increased level of PA was associated with low risk for MCI or cognitive impairment among older adults living in the Mainland of China,\textsuperscript{28–31,33–39} Hong Kong,\textsuperscript{27} and Taiwan, China.\textsuperscript{32} Results from case-control studies also reported a reduced risk of MCI with a high level of PA (OR: 0.382–0.570).\textsuperscript{30,38,39} In addition, several cross-sectional studies reported a negative association between PA and the prevalence of MCI or cognitive impairment in older adults.\textsuperscript{28,29,31–37}  

3.3.1.2. AD. A total of 6 studies examined the association between PA and risk of AD.\textsuperscript{40–45} Results from 4 case-control studies showed that older adults who engaged in PA were associated with a lower incidence of AD.\textsuperscript{40–42,45} For example, Yang et al.\textsuperscript{45} reported that a higher level of leisure PA was associated with a lower risk of AD (adjusted OR (AOR) = 0.45; 95\% CI: 0.30–0.68) and vascular dementia (AOR = 0.38; 95\% CI: 0.23–0.63). In contrast, a study by Hong et al.\textsuperscript{40} showed that compared with healthy controls, older adults diagnosed with cognitive impairment who reported no time spent on daily PA were associated with an increased risk of AD (OR = 1.68; 95\% CI: 1.30–2.172). Cross-sectional studies showed that the complete absence of PA was related to an increased AD prevalence (p < 0.01)\textsuperscript{43} and that a lack of PA in early life was associated with an increased likelihood of AD incidence (OR = 2.537, p < 0.001).\textsuperscript{44}  

3.3.1.3. Dementia. Three studies examined the relationship between PA and risk of dementia.\textsuperscript{46–48} One cohort study with a 6-year follow-up showed that community-dwelling older adults who participated in 2 habitual PAs were associated with a low risk for MCI or cognitive impairment among older adults living in the Mainland of China,\textsuperscript{28–31,33–39} Hong Kong,\textsuperscript{27} and Taiwan, China.\textsuperscript{32} Results from case-control studies also reported that among highly educated older adults, a lack of PA was associated with dementia (OR = 2.56; 95\% CI: 1.18–5.84),\textsuperscript{47} whereas regular exercise was associated with a decreased risk for dementia among community-dwelling older adults (OR = 0.12; 95\% CI: 0.09–0.16).\textsuperscript{48}  

3.3.2. PA and cognitive function  

3.3.2.1. Global cognitive function. A total of 10 studies assessed the relationship between PA and global cognitive function.\textsuperscript{28,49–57} One cohort study\textsuperscript{49} with an 11-year follow-up showed an association between initial levels of PA and a slower decline in late-life global cognitive performance (β = 0.22, p < 0.05) and a positive relationship between changes in PA and changes in cognitive function during the long-term follow-up.
Six cross-sectional studies\(^{28,30,50-54}\) reported significant positive associations between older adults’ PA and global cognitive function. For example, Lam et al.\(^{50}\) showed that older adults with long-term exercise habits of performing aerobic and mind–body exercises had better cognitive test scores, including scores on the Mini-Mental State Examination (MMSE) and Alzheimer’s Disease Assessment Scale–cognitive subscale (ADAS-Cog), with a significantly better performance in the delayed recall test (MMSE) and Alzheimer’s Disease Assessment Scale–cognitive memory, episodic memory) observed in the delayed recall test and digit and visual span test among older adults with higher levels of PA.

### 3.3.2.3. Executive function

One cross-sectional study\(^{57}\) reported that the total amount of PA positively but mildly correlated with executive function in the Category Verbal Fluency Test (CVFT) \((r = 0.15, p < 0.01)\) but not with the Trail Making Test \((r = 0.02, p > 0.05)\). One cohort study\(^{55}\) also showed no significant association between PA and executive function as measured by the Indiana University Tokens Test \((β = 0.04, p > 0.05)\).
### Table 2
Experimental studies: physical activity and cognitive function.

| Study                  | Region        | Subjects (age, mean ± SD)                  | Study design | Interventions                                                                 | Duration (weeks) | Main outcome          |
|------------------------|---------------|-------------------------------------------|--------------|--------------------------------------------------------------------------------|------------------|-----------------------|
| Lam et al., 2010       | Hong Kong     | 74 older persons with dementia (83.45 ± 6.91) | RCT          | Intervention: functional and skills training; 45 min/session, 2 sessions/week; control: occupational therapy | 8                | Global cognition      |
| Kwok et al., 2011      | Hong Kong     | 40 elderly with normal cognition (79.0 ± 5.8) | Non-RCT      | Intervention: simplified version of Tai Chi; control stretching exercise; both, 40 min/session, 1 session/week | 8                | Cognitive function    |
| Cao and Yang, 2012     | Mainland*     | 163 patients with MCI (73.77 ± 7.20)       | Non-RCT      | Intervention: aerobic exercise (≥3 days/week, ≥30 min/day); control: no exercise | 24               | Cognitive function    |
| Cui and Yang, 2012     | Mainland*     | 29 women with normal cognition (66.18 ± 4.11) | Non-RCT      | Intervention: Taiji ball exercise, ≥3 days/week, 60 min/day; control: no exercise | 48               | Memory                |
| Lam et al., 2012       | Hong Kong     | 389 subjects with aMCI (77.82 ± 6.48)      | RCT          | Intervention: 24-style Tai Chi; control: stretching exercise; both, ≥30 min/day, 3 days/week | 48               | Risk of dementia      |
| Liu, 2012              | Mainland*     | 40 patients with MS (68.05 ± 4.18)         | RCT          | Intervention: Wu Qin Xi exercise, 60 min/day, 6 days/week; control: no exercise | 24               | Cognitive function    |
| Mortimer et al., 2012  | Mainland      | 120 community elderly (67.80 ± 5.80)       | RCT          | Tai Chi and walking group: 50 min/session, 3 sessions/week; social interaction: 1 h/session, 3 sessions/week; control: no intervention | 40               | Cognitive function MRI |
| Liu and Wei, 2013      | Mainland*     | 190 healthy older adults (63.96 ± 2.61)    | Non-RCT      | Aerobic exercise and mental activities group: ≥3 days/week, ≥30 min/day; control: no intervention | 48               | Cognitive function    |
| Zheng et al., 2013     | Mainland*     | 90 older adults with MCI (64.77 ± 5.37)    | RCT          | Intervention: Six Healing Sounds, twice a day, 30 min/time, ≥25 days/week; control: no exercise | 24               | Cognitive function EEG |
| Hu et al., 2014        | Mainland      | 198 patients with MCI (age ≥ 65 years, mean ± SD: NR) | RCT          | Intervention: jogging (30 min/session) and Tai Chi (60 min/session), 1 session/week; control: no exercise | 24               | Cognitive functions   |
| Law et al., 2014       | Hong Kong     | 83 older adults with MCI (73.8 ± 7.1)      | RCT          | Intervention: functional and skills training, 13 sessions (40–50 min/session); control: cognitive training, 6 sessions (60 min/session) | 10               | Cognitive function    |
| Wei and Ji, 2014       | Mainland      | 60 older adults with MCI (66.00 ± 5.08)    | RCT          | Intervention: handball training, 30 min/day, 5 days/week; control: no training | 24               | Global cognition EEG (P300 test) |
| Zhang et al., 2014     | Mainland      | 150 healthy older adults (64.79 ± 4.50)    | Non-RCT      | Swimming, running, square dancing, and Tai Chi groups: 65%–75% VO₂max, 30–60 min/day, ≥4 days/week; control: no exercise | 72               | Cognitive function    |
| Lü et al., 2015        | Mainland      | 45 community elderly with MCI (69.73 ± 4.78) | RCT          | Intervention: movement-based dumbbell training, 1 h/session, 3 sessions/week; control: no training | 12               | Cognitive function    |
| Lam et al., 2015       | Hong Kong     | 555 older adults with MCI (75.38 ± 6.47)   | RCT          | Physical exercise: 1 stretching/toning, 1 MB and 1 aerobic exercise session in a week; cognitive activity: 3 sessions/week; cognitive-physical exercise: 1 cognitive and 2 MB exercise; social activity: 3 sessions/week; all sessions lasted 1 h | 48               | Cognitive function    |
| Sun et al., 2015       | Mainland      | 150 healthy elderly with 138 included in analysis (66.55 ± 6.71) | RCT          | Intervention: Yang-style Tai Chi, 60 min/session, 2 sessions/week; control: no exercise | 24               | Global cognition      |
| Yang et al., 2015      | Mainland      | 50 patients with mild AD (71.96 ± 6.92)    | RCT          | Intervention: cycling training with 70%/VO₂max, 40 min/day, 3 days/week; control: health education | 12               | Global cognition Biomarkers |
| Yeh et al., 2015       | Taiwan        | 34 adults with physical disability (79.09 ± 10.40) | RCT          | Intervention: physical (35 min resistance training) and cognitive (50 min cards, paired and reading) intervention, 2 sessions/week; control: no exercise | 12               | Cognitive function    |
| Zheng et al., 2015     | Mainland      | 45 healthy older adults with 34 included in analysis (70.12 ± 5.06) | RCT          | Intervention: combined eighteen 1 h cognitive, eighteen 1 h Tai Chi, six 90 min group counseling sessions; control: two 120 min health education sessions | 6                | Cognitive function MRI |
| Zhu et al., 2015       | Mainland*     | 86 DM patients with MCI and 78 included in analysis (69.92 ± 6.41) | RCT          | Intervention: Ba Duan Jin, 40 min/day, 5 days/week; control: no exercise | 48               | Global cognition      |

* Published in Chinese.

Abbreviations: aMCI = amnestic mild cognitive impairment; DM = diabetes mellitus; EEG = electroencephalography; FcTsim = simulated functional tasks; fMRI = functional magnetic resonance imaging; Hong Kong = Hong Kong, China; Mainland = the Mainland of China; MB = mind-body; MRI = magnetic resonance imaging; MS = metabolic syndrome; NR = not reported; RCT = randomized controlled trial; Taiwan = Taiwan, China; VO₂max = maximum oxygen uptake.
3.3.2.4. Attention. Two cross-sectional studies\textsuperscript{50,59} showed that healthy community-dwelling older adults participating in regular aerobic and mind–body exercises (e.g., Tai Chi, yoga) showed better sustained and selective attention. However, these benefits were not supported in a cohort study in which PA was found not to be associated with attention among older adults living in Hong Kong, China and the Mainland of China.\textsuperscript{57}

3.3.2.5. Language. Both cohort\textsuperscript{55} and cross-sectional\textsuperscript{50,57} studies demonstrated a significant positive association between PA and verbal fluency as measured by the CVFT or the animal fluency test. However, in a cross-sectional study,\textsuperscript{58} researchers from Hong Kong, China found that language function in older adults was weakly associated with PA.

3.3.2.6. Processing resource. Only 1 study examined PA and its relationship to processing resource in older adults. In a cross-sectional study, Gao et al.\textsuperscript{59} reported that older adults who regularly exercised tended to perform better in a number of cognitive processing outcome measures, including sensory function, processing speed, and reasoning and processing capacity.

3.4. Results from experimental studies

3.4.1. Aerobic exercise

A total of 4 studies (3 non-RCTs and 1 RCT) conducted in the Mainland of China showed that aerobic exercise, when compared with a non-exercise control condition, resulted in a significant improvement in cognitive function (e.g., global cognitive function, executive function, language)\textsuperscript{24,60–62} and reductions in disease symptoms associated with AD.\textsuperscript{24} For example, an RCT study reported by Yang et al.\textsuperscript{24} showed that a 3-month cycling intervention resulted in a significant improvement in immediate memory (as indexed by reduced P2, N2, and P3 latencies and response time). In addition, a stronger effect was observed among those who participated in the Tai Ji Quan exercise when compared with those assigned to other 3 exercise groups. Not all aerobic-based exercises were found to be effective in improving cognition. For example, 1 RCT\textsuperscript{14} involving a 40-week walking intervention showed no improvement in cognition among community-dwelling older adults.

3.4.2. Traditional Chinese exercises

3.4.2.1. Tai Ji Quan. Three RCTs\textsuperscript{13,14,19} and 3 non-RCTs\textsuperscript{62–64} evaluated the cognitive health benefits of Tai Ji Quan (or Taiji ball).\textsuperscript{14,19,62–64} In an RCT, Mortimer et al.\textsuperscript{14} showed that a 40-week Tai Ji Quan intervention in a sample of healthy community-dwelling older adults resulted in a significant increase in brain volume and improvements in cognitive function as indexed in several neuropsychological measures, including the Mattis Dementia Rating Scale, Trail Making Test, Auditory Verbal Learning Test, and CVFT.

Two other RCTs involving older adults with MCI also showed consistent results of cognitive benefits from Tai Ji Quan.\textsuperscript{12,22} For example, in a 1-year study of 389 older adults with MCI, Lam et al.\textsuperscript{13} showed that compared with those in a control group, participants in the Tai Ji Quan exercise group significantly lowered their risk of developing dementia (OR = 0.21; p = 0.04) and improved their delay recall. Similarly, Hu et al.\textsuperscript{22} showed that a 6-month Tai Ji Quan intervention for older adults with MCI resulted in a significant improvement in immediate memory (p < 0.001) and delayed recall (p = 0.004) function.

3.4.2.2. Qigong. Three RCTs conducted in the Mainland of China showed the cognitive benefits of Qigong exercises (e.g., Wu Qin Xi, Ba Duan Jin, and Six Healing Sounds).\textsuperscript{20,21,26,65} One of these studies, a 6-month RCT,\textsuperscript{21} showed that the Six Healing Sounds exercise significantly improved the global cognitive function (i.e., in MMSE and Montreal Cognitive Assessment (MoCA)) and electroencephalographic results among older adults with MCI. Two other RCTs involving patients with metabolic disease evaluated the effects of Wu Qin Xi and Ba Duan Jin exercises and showed improved cognitive outcomes (i.e., in

3.4.2.3. Tai Chi. Three RCTs\textsuperscript{13,14,19} and 3 non-RCTs\textsuperscript{62–64} evaluated the benefits of Tai Chi (e.g., Yangjilu, Tai Chi Chuan) on cognitive function among older adults. In a 6-month RCT,\textsuperscript{13} participants in the Tai Chi exercise group significantly improved their global cognitive function (as indexed in the MoCA) and immediate and delayed recall (p < 0.01). In another 6-month RCT,\textsuperscript{14} participants in the Tai Chi exercise group showed significant improvements in memory (as indexed by the CVFT and animal fluency test).

Note: \( T = 1 \) meeting the criteria; \( 0 = \) not meeting the criteria.

| Study          | Sequence | Allocation | Blinding | Intent-to-treat | Completeness in reporting prespecified study outcomes | Overall quality |
|---------------|----------|------------|----------|-----------------|------------------------------------------------------|---------------|
| Lam et al., 2010\textsuperscript{12} | 1        | 1          | 1        | 1               | 0                                                    | High         |
| Lam et al., 2012\textsuperscript{13} | 1        | 1          | 1        | 1               | 0                                                    | High         |
| Lam et al., 2015\textsuperscript{17} | 1        | 1          | 1        | 1               | 0                                                    | High         |
| Law et al., 2014\textsuperscript{19} | 1        | 1          | 1        | 1               | 0                                                    | High         |
| Liu, 2012\textsuperscript{20}     | 0        | 0          | 0        | 0               | 0                                                    | Low          |
| Lü et al., 2015\textsuperscript{16} | 1        | 0          | 1        | 1               | 0                                                    | High         |
| Mortimer et al., 2014\textsuperscript{21} | 1        | 0          | 1        | 1               | 0                                                    | High         |
| Hu et al., 2014\textsuperscript{22} | 0        | 0          | 0        | 0               | 0                                                    | Low          |
| Sun et al., 2015\textsuperscript{18} | 1        | 1          | 0        | 0               | 0                                                    | Moderate     |
| Wei and Ji, 2014\textsuperscript{23} | 0        | 0          | 0        | 0               | 0                                                    | Low          |
| Yang et al., 2015\textsuperscript{14} | 1        | 0          | 0        | 1               | 0                                                    | Low          |
| Yeh et al., 2015\textsuperscript{19} | 0        | 0          | 0        | 0               | 0                                                    | Low          |
| Zheng et al., 2013\textsuperscript{21} | 1        | 1          | 0        | 0               | 0                                                    | Low          |
| Zheng et al., 2015\textsuperscript{19} | 1        | 1          | 0        | 0               | 0                                                    | High         |
| Zhu et al., 2015\textsuperscript{16} | 1        | 1          | 0        | 0               | 0                                                    | Low          |

Table 3

Quality rating of randomized controlled trials.

\textsuperscript{Note: 1 = meeting the criteria; 0 = not meeting the criteria.}
3.4.3. Specialized exercises

There were 4 specialized exercise interventions conducted with older adults who had MCI or dementia. These involved handball exercise,23 functional tasks exercise,12,15 and momentum-based dumbbell training.16 All 4 studies showed a significant improvement in cognitive function. For example, an RCT reported by Lü et al.16 showed that a 12-week momentum-based dumbbell intervention significantly improved cognitive performance (i.e., global cognitive function, executive function, immediate memory, and attention) in older adults with MCI.

3.4.4. Multimodal exercise-based interventions

There were 5 RCTs that used multimodal exercise-based or lifestyle interventions.17,18,22,25,61 These modalities involved a combination of various types of exercises (e.g., aerobic, strength, body–mind exercises) or activities related to cognitive health (e.g., cognitive training, social interaction). One 48-week RCT17 conducted in Hong Kong, China showed a significant improvement in ADAS-Cog, delayed recall test, and verbal fluency test. Another RCT conducted in Taiwan, China25 also showed that a 12-week resistance exercise program combined with cognitive training significantly improved MoCA and its subscales (i.e., naming, attention, delayed recall, and orientation).

The remaining 3 RCTs focused on a multicomponent exercise intervention in patients with MCI22 and a cognitive-psychological-physical intervention in healthy older adults.18,61 Li and colleagues18,66,67 showed that a 6-week cognitive-psychological-physical intervention was effective in maintaining a healthy brain and improving executive function. Using functional magnetic resonance imaging, the study also showed exercise-induced brain functional plasticity, including reorganized regional homogeneity of spontaneous fluctuations, improved resting-state functional connectivity, and enhanced intrinsic brain activity in brain regions correlated with cognition.

4. Discussion

4.1. Summary of evidence

Over the past 15 years, a growing number of studies in China have examined the potential of PA for positively affecting cognitive health in older adult populations. This review has synthesized for the first time both observational and experimental studies that have contributed to our initial understanding of the relationship between PA and cognitive function among older Chinese adults.

Preliminary evidence presented in this systematic review suggests an important protective role of PA in preventing age-related cognitive decline and improving cognitive function for healthy older Chinese adults and those with cognitive impairment. Findings from observational studies indicate that in general, physically active older Chinese adults, especially those with long-term engagement or participation in PA early in life, are likely to have a lower risk of cognitive impairment and have better cognitive health and cognitive performance later in life.9,45,46 Similarly, some findings consistently indicate that exercise-based interventions can have a positive effect on lowering the risk of developing dementia and improving multiple domains of cognitive function, with the greatest benefits achieved through aerobic exercises23 and traditional Chinese physical activities such as Tai Ji Quan.13,14

Although most studies have documented some positive associations or effects between PA and cognitive function, a few discrepancies in the findings were noted across both observational55–57 and experimental studies.14 These discrepancies can likely be attributed to differences in the selection of study populations, the type of PA or intervention, and/or methodological limitations. In addition, this review provides no evidence suggesting that the type, intensity, or frequency of various physical activities leads to a reduction in the incidence of MCI or AD or to improved cognitive function.

The limited number of studies examined, the wide range of sample sizes, the use of limited-exposure assessments and self-report measures, and the lack of rigorously designed studies temper the findings described in this review. All these factors may have contributed to results that are not always consistent across different types of study design, settings, and interventions. In this respect, the interpretation and generalizability of the findings presented here may be limited to only a few of the studies that displayed a high degree of scientific rigor in their designs and methodologies. In addition, of the 33 observational studies reviewed here, a vast majority (n = 22, 67%) were cross-sectional in design, making it impossible to infer causality. Similarly, only a few longitudinal studies on the relationship between PA and the incidence of cognitive impairment have been conducted in China.

Of the 15 RCTs reviewed, only a limited number were rigorously designed and were rated as being of high quality or showing low risk of bias. Many of the RCTs had notable limitations, including poorly defined clinical characteristics of study participants, poorly executed randomization procedures without proper concealment of allocation, an absence of interventions that specifically integrated a cognitive component with exercise training, and the small and often inadequately powered study sample sizes. These limitations make conducting meta-analyses and planning for the future quite difficult.

4.2. Future research

The evidence for the cognitive health benefits that older Chinese adults might gain from participating in PAs remains fragmented and inconclusive owing to the limited epidemiologic studies in this area and their lack of quality and scientific rigor. Given the increased life expectancy in China,1 long-term cohort studies are needed to better understand the relationship between PA and development of MCI, AD, and other types of dementia. Differences in the types and levels of PA and their relative benefits for cognitive function should be examined across various ethnic groups, urban–rural settings, and gender. For example, data from a representative cross-section of the...
Given the limited number of RCTs exploring the relationship between exercise and cognitive function, especially from the Mainland of China, additional trials are clearly needed to corroborate the findings reported in this review. Interestingly, aerobic and low-intensity exercises such as Tai Ji Quan or Qigong appear to offer great potential in preventing cognitive decline and delaying the onset of dementia or slowing down its progression. Intervention studies that target older adults who are at higher risk of developing AD and dementia are urgently needed. In addition, new interventions that combine exercise movements and cognition components that might stimulate brain health should be developed and tested.

4.3. Implications for public health

The findings described in this review provide initial evidence regarding the potential cognitive health benefits of PA for older Chinese adults. These findings, however, must be corroborated by future studies, especially RCTs. It is also important to conduct research on the type, intensity, and frequency of PA that is needed to produce the greatest cognitive health benefits. Given this lack of research and evidence, it is not possible to develop up-to-date public health guidelines that make dependable recommendations for specific PAs that will prevent cognitive decline. Nevertheless, the mounting evidence in the PA literature indicating that PA offers older adults multiple health benefits, including improved cognitive function, supports the idea that PA should be considered a primary prevention tool in maintaining normal cognitive function, preventing cognitive decline, and reducing the incidence of AD and dementia.

4.4. Limitations

This review has several limitations: (1) it is restricted to studies that were published within the past 15 years; (2) it may have omitted studies from the “gray” literature; and (3) it lacks an assessment of effect sizes. In addition, the quality assessment of the RCTs reviewed was limited in scope and depth. Future reviews should include a more detailed assessment of quality and include elements of design, analysis, and reporting of key information (i.e., dropout rates and consistency and clarity in reporting trial outcomes). Given these methodological limitations, caution should be exercised when interpreting the synthesized results presented here.

5. Conclusion

This systematic review provides some initial evidence showing that PA is beneficial for the cognitive health of older Chinese adults. Additional research is needed, including prospective studies examining relationships between PA and cognitive function over time and RCTs evaluating the efficacy of aerobic-based exercises specifically designed to preserve cognitive health in older Chinese adults and to slow down progression of cognitive decline in individuals with cognitive impairments.

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Authors’ contributions

JL participated in design of the study, searched articles, extracted data, performed quality assessment, drafted the manuscripts, and approved the final manuscript. WF participated in the data extraction and read and approved the final manuscript. YL conceived of the study, participated in its design and helped to draft the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

None of the authors declare competing financial interests.

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