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The effectiveness of physical exercise on cognitive and psychological outcomes in individuals with mild cognitive impairment: A systematic review and meta-analysis

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ABSTRACT

Objective: Individuals with mild cognitive impairment (MCI) are at high risk for developing dementia. Physical exercise is a promising intervention for cognitive decline. Systematic reviews regarding the effects of physical exercise on cognitive and psychological outcomes among MCI patients are limited, and a systematic review exploring the effects of exercise modalities on the results has not been conducted. This study evaluated the effects of physical exercise on cognitive and psychological outcomes for MCI patients and attempted to identify which specific modality of exercise is more effective.

Design: Systematic review and meta-analysis.

Data sources: A systematic search of Medline, CINAHL, EMBASE, PsycINFO, SPORTDiscus, and the China National Knowledge Infrastructure was performed.

Review methods: Two reviewers independently assessed the study quality using the Effective Public Health Practice Project Quality Assessment Tool. Meta-analysis was conducted when data were available, with further subgroup analyses for exercise types. A series of sensitivity analyses were conducted to explore the influence of study quality and control types on the primary outcome. A narrative analysis was performed when statistical synthesis was inappropriate.

Results: Eleven studies met the inclusion criteria. The exercise interventions can be classified into three types: (a) aerobic exercise, (b) resistance exercise, and (c) multi-modal exercise. Results showed that physical exercise had beneficial effects for global cognition [standard mean difference (SMD) = 0.30, 95% confidence interval (CI): 0.10–0.49, $p = 0.002$]. Further subgroup analysis demonstrated that aerobic exercise programmes are consistently associated with medium effect size (SMD: 0.54–0.58). However, the effects of physical exercise on domain-specific cognitive function and psychological outcomes in MCI patients remain inconclusive. Results of sensitivity analysis indicated that types of control exert influence on the outcomes.

Conclusions: Physical exercise, aerobic exercise in particular, benefits global cognition in MCI patients. The evidence of physical exercise on domain-specific cognitive function and psychological outcomes remains unclear, more trials with rigorous study design are necessary to provide the evidence.

What is already known about the topic?

- MCI represents a high-risk group for developing dementia, and cognitive enhancement intervention at this stage may be effective to prevent or slow down the progression to dementia.
- Recent systematic reviews indicated the benefits of physical exercise on improving cognitive function among community-dwelling healthy older adults. Integrative evidence to indicate its effects on cognitive and psychological outcomes among MCI patients is lacking, and studies on the effect of exercise modalities on cognition are few, if any, among this cohort.

What this paper adds

- This study provides evidence that physical exercise is beneficial for improving global cognition in MCI patients; particularly, aerobic exercise is associated with better effects.
- More RCTs with rigorous study design are needed to explore the effects of physical exercise on cognitive subdomains and psychological outcomes in MCI patients as the current evidence on these

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health outcomes remains inconclusive.

1. Introduction

The rapid aging of the global population entails an increase in the prevalence among the older generation of cognitive impairment (Daffner, 2010) Effective strategies to prevent or manage the cognitive decline of the older population have become a high-priority agenda in geriatric care. Mild cognitive impairment (MCI) is recognised as a precursor to dementia, where the cognitive change is more substantial than in normal aging, although less severe than that of dementia itself (Petersen, 2004). The estimated global prevalence of MCI ranges from 9.6% to 21.6% (Jia et al., 2014; Lara et al., 2016; Limongi et al., 2017). Given that this clinical cohort is at particularly high risk of developing dementia, early interventions targeting improving cognitive health and thereby preventing further decline is the treatment goal in cases of MCI.

Pharmacological and non-pharmacological therapies are the mainstays of treatment to preserve the cognitive function of the MCI population. With uncertainty about the therapeutic benefits of pharmacological treatment for the cognition of MCI patients (Cooper et al., 2013), there is increasing advocacy of non-pharmacological methods to delay MCI-related decline (Teixeira et al., 2012). Among non-pharmacological interventions, the therapeutic effects of physical exercise have received considerable attention. One review has identified the multiple benefits of an active lifestyle in improving cardiovascular fitness, enhancing favourable cerebrovascular changes and reducing other risk factors of cognitive decline (Bherer et al., 2013). Another study has also indicated that physical exercise delays cognitive decline among MCI patients by reducing the pro-inflammatory cytokines level and improving the peripheral concentration of neurotrophic factors (Nascimento et al., 2014). And Paillard-Borg et al. (2012) further identified the long-term effect of exercise in delaying the onset of dementia among the elderly for a year.

Systematic reviews of randomised controlled trials (RCTs) have presented fairly consistent evidence of the effects of exercise on improving cognitive function among community-dwelling healthy older adults (Angevaren et al., 2008; Smith et al., 2010). As a result, different types of physical exercise have increasingly been used to delay cognitive decline among MCI patients. The exercises tested included aerobics, resistance training and multi-modal exercise (combining aerobic exercise, resistance training etc.). Integrating such research findings can provide important insights not only into the therapeutic benefits of exercise, but also into which form of exercise is associated with greater improvements in cognitive health (Bherer et al., 2013).

Three systematic reviews of RCTs on the cognitive benefits of physical exercise among MCI patients were published between 2013 and 2014 (Gates et al., 2013; Ohman et al., 2014; Wang et al., 2014). Two conducted data pooling: one with pooling for all cognitive domains identifying a small effect size of physical exercise on improving global cognition (Wang et al., 2014), and the other with pooling for cognitive sub-domains (i.e. memory and executive functions) finding a small effect size of physical exercise improving performance in one test of executive functions (Gates et al., 2013). Another systematic narrative review recognised the cognitive benefits of physical exercise when seven out of eight of the studies it had reviewed reported statistically significant improvement on at least one cognitive outcome (Ohman et al., 2014). These findings are promising, but challenges remain because none of the studies considered heterogeneity in the design and training modality of physical exercise in conducting data synthesis. The lack of sensitivity analysis to address this limitation reduces the level of insights to inform nursing practice concerning the cognitive health promotion of the MCI population. In addition, although the three studies also reported the effects of physical exercise on important secondary outcomes, such as depression and health-related quality of life (HRQoL), they did not synthesise such evidence with the transferability of cognitive gains to psychological outcomes. The aim of the present review is therefore to address these knowledge gaps.

The objectives of this review paper were: i) to identify the effects of physical exercise on the cognitive health, depression and HRQoL of patients with MCI, and ii) to examine the differential effects, if any, of different designs of exercise programmes on the above health outcomes.

2. Methods

2.1. Search strategy

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guideline to report the present meta-analysis (Moher et al., 2009). We carried out a comprehensive search of five English databases: CINAHL, EMBASE, Medline, PsycINFO, together with SPORTDiscus, which covers key areas of sports medicine and related fields. The most comprehensive Chinese database, China National Knowledge Infrastructure (CNKI), was also included to extend the search to material published in Chinese. All the databases were searched from inception to October 31, 2017, using the PICO framework to identity the keywords. They included “cognitive disorders”; “mild cognitive impairment”; “memory disorders”; “memory decline”; “exercise”; “physical exercise”; “physical activity”; “aerobic exercise”; “resistance training”; “cognition”; “cognitive function”; “executive function”; “memory”; “neuropsychological test”; “depression” and “quality of life”. In addition; the following search filters were applied: “human”; “all adults” and “Chinese or English”. The full electronic strategy for Medline is presented in Supplementary Table 1.

2.2. Inclusion criteria

Only RCTs published in full-text papers were included, abstracts in conference proceedings or letters to the editor being excluded because they had insufficient detail to be evaluated. Acceptable studies had to meet the inclusion criteria set out in Table 1.

2.3. Study selection

Two reviewers independently screened all the citations and determined whether the studies were considered to be eligible for this review. The two reviewers had to discuss the eligibility of two studies in order to reach consensus, and finally reached 100% agreement on the studies to be included.

Table 1
Description of the inclusion criteria.

Inclusion criteria	Description
Participants	Adults with MCI aged 18 or above. Studies needed to adopt validated methods to confirm the MCI diagnosis.
Interventions	This review focused on physical exercise as the intervention. Physical exercise was defined as “planned, structured, and repetitive movement to maintain one or more components of physical fitness” according to the definition of American College of Sports Medicine (ACSM) (Nelson et al., 2007).
Comparison	All types of control were considered as eligible.
Outcomes	The primary outcome was global (i.e. domain general) cognition. Secondary outcomes were domain-specific cognition (e.g. memory, executive function), depression and HRQoL. All the outcomes needed to be evaluated by validated measurement tools.