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Review

Effects of combined cognitive and exercise interventions on cognition in older adults with and without cognitive impairment: A systematic review

Lawla L.F. Law[a,*], Fiona Barnett[b], Matthew K. Yau[a], Marion A. Gray[c]

[a] Occupational Therapy Discipline, School of Public Health, Tropical Medicine & Rehabilitation Sciences, James Cook University, Queensland, Australia
[b] Institute of Sport & Exercise Science, School of Public Health, Tropical Medicine & Rehabilitation Sciences, James Cook University, Queensland, Australia
[c] Cluster for Health Improvement, School of Health and Sport Sciences, University of the Sunshine Coast, Maroochydore DC, Queensland, Australia

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ABSTRACT

Global concern on the potential impact of dementia is mounting. There are emerging calls for studies in older populations to investigate the potential benefits of combining cognitive and exercise interventions for cognitive functions. The purpose of this systematic review is to examine the efficacy of combined cognitive and exercise training in older adults with or without cognitive impairment and evaluate the methodological quality of the intervention studies. A systematic search of Cinahl, Medline, PsycINFO, ProQuest, EMBASE databases and the Cochrane Library was conducted. Manual searches of the reference list from the included papers and additional internet searches were also done. Eight studies were identified in this review, five of which included a cognitively impaired population and three studies included a cognitively healthy population. The results showed that combined cognitive and exercise training can be effective for improving the cognitive functions and functional status of older adults with and without cognitive impairment. However, limited evidence can be found in populations with cognitive impairment when the evaluation included an active control group comparison. Further well-designed studies are still needed to explore the potential benefits of this new intervention paradigm.

Contents

* Corresponding author at: Occupational Therapy Discipline, James Cook Drive, Douglas; School of Public Health, Tropical Medicine and Rehabilitation Sciences, Rehabilitation and Exercise Sciences Building, James Cook University, Townsville, QLD 4811, Australia. Tel.: +61 7 47816678.
E-mail addresses: lan.law@my.jcu.edu.au (L.L.F. Law), fiona.barnett@jcu.edu.au (F. Barnett), matthew.yau@jcu.edu.au (M.K. Yau), marion.gray@usc.edu.au (M.A. Gray).

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1. Introduction

The increasing prevalence of cognitive impairment with age intensifies the potential impact upon global health and health care. It has been projected that there will be 7.7 million new cases of dementia each year, implying a new case of dementia every 4 s (WHO and ADI, 2012). The World Health Organization (WHO) has urged global efforts to take a serious focus on the potential impacts of dementia on the societal and health care systems worldwide. Individuals with mild cognitive impairment (MCI) are at high risk of progressing to Alzheimer's diseases and other dementias, with reported conversion rate of 50% in 2–3 year (Amieva et al., 2004) and even up to 60–100% in 5–10 years (Morris et al., 2001; Petersen, 2004). Addressing the lack of pharmacological treatment for individuals with MCI (Alzheimer's Association, 2013), it is critical to explore the potential effects of non-pharmacological interventions.

The benefits of exercise on cognition are widely recognized (Cotman and Berchtold, 2007; Kramer and Erickson, 2007; van Praag, 2009). Animal studies have consistently shown exercise increases cell proliferation and neurogenesis in the dentate gyrus of the hippocampus (Fabel et al., 2003; Kronenberg et al., 2006), an important brain area for learning and memory. Exercise regulates a number of growth factors such as brain-derived neurotrophic factor (BDNF), which plays a crucial role in neuroprotection and synaptic plasticity (Adlard et al., 2005; Vaynman et al., 2004); insulin-like growth factor 1 (IGF-1), which promotes neuronal growth and improves cognitive performance (Cotman and Berchtold, 2002; Liorens-Martin et al., 2010); vascular endothelial growth factor (VEGF), which stimulates angiogenesis and vasculogenesis (Tang et al., 2010; Zhang et al., 2013) and promotes brain ischemic tolerance (Zhang et al., 2011). Furthermore, exercise reduces inflammatory cytokines and oxidative stress, which suggests anti-inflammatory and antioxidant effects on the brain (Pervaiz and Hoffman-Goetz, 2011; Santin et al., 2011).

Colcombe et al. (2006) also found that exercise correlates with an increase in brain volume over the frontal, parietal, and temporal cortices in humans. Studies also have shown that exercise can promote cerebral blood flow which enhances neurogenesis and improves learning (Farmer et al., 2004; van Praag et al., 2005), as well as promotes cardiovascular fitness and therefore reduces peripheral risk factors (e.g. hypertension) for cognitive decline (Cotman et al., 2007; Pereira et al., 2007).

Whilst the uniqueness of exercise-induced effects to enhance brain health and cognitive functions through multiple routes is evident, results of intervention studies on single exercise intervention are disappointing (Busse et al., 2009; Etnier et al., 2006). A recent systematic review showed that strong evidence to support the effects of exercise interventions on cognitive functions of older adults is still lacking (Snowden et al., 2011).

It has been proposed that exercise has to occur in the context of a cognitively challenged environment in order to be effective for inducing neural and cognitive benefits rather than exercise alone (Fabel and Kempermann, 2008; Fabel et al., 2009). Studies also have found that a combination of exercise and an enriched environment induces more new neurons and benefits the brain greater than either exercise or an enriched environment alone (Fabel and Kempermann, 2008; Fabel et al., 2009; Olson et al., 2006). An animal study reported significant improvements in cognitive ability when combined physical and cognitive training was undertaken (Langdon and Corbett, 2012). A combination of exercise and cognitive interventions, either sequentially or simultaneously, appears to have the potential effect to maintain or improve cognitive functions (Langdon and Corbett, 2012; Schaefer and Schumacher, 2011). Indeed, there are emerging calls for studies in older populations to investigate the potential benefits of combined cognitive and physical interventions to accomplish an optimal outcome (Amoyal and Fallon, 2012; Kraft, 2012; Rebok, 2008; Thom and Clare, 2011).

The aims of this review were: (1) to assess the efficacy of combined cognitive and exercise training to improve cognitive functions in older adults with and without cognitive impairment; (2) to examine the methodological quality of the included studies; and (3) to summarize the latest results on combined cognitive and exercise training in older adults with or without cognitive impairment.

For the purpose of this review, combined cognitive and exercise interventions are structured interventions that combine cognitive training and exercise, either conducted in sequence or simultaneously under dual-tasking paradigms. Cognitive training are defined as structure repeated practice on tasks with an inherent problem, using standardized tasks targeting specific cognitive domains and/or teaching strategies and skills in order to optimize cognition