

ICPEsk 2015 : 5th International Congress of Physical Education, Sports and Kinetotherapy

Aerobic or Resistance Exercise Training to Improve Cognitive Function? Short Review

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Abstract

<http://dx.doi.org/10.15405/epsbs.2016.06.13>

Decline in cognitive function leads to several diseases and impairments. Findings from literature explain that exercise training may reduce the negative effects and enhance cognition. The review aims to present aerobic and resistance exercise training programs with the most beneficial outcomes regarding enhancement of cognitive function and related diseases. Electronic literature of SPORTDiscus, PubMed, and Google Scholar databases in English language between 2003 and 2015 was used to search for cognitive function in relation to exercise training. A total of 99 abstracts were examined; 43 abstracts were excluded for using animal subjects, derivative data, and languages other than English. A total of 56 articles were fully read; 11 of those were excluded due to lack of evidence, to reach a narrowed outcome. Outcomes indicate that aerobic exercise has more benefits on cognitive function rather than resistance training (e.g. enhancing memory, learning, cognitive speed). On the other hand, combined resistance and aerobic training has better results than aerobic training alone. In addition, exercise training is not only beneficial on cognitive function, but also reduces and prevents related cognitive diseases such as Alzheimer's disease and Cushing's syndrome. Several studies have indicated that aerobic exercise training improves cognitive function as well as reduces related cognitive diseases. Further studies are necessary in order to attain sufficient evidence and neglect the conflict regarding the effect of resistance exercise training on cognitive function.

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Keywords: Executive function; cognitive function diseases; Alzheimer's disease; Cushing's syndrome.

1. Introduction

In order to attain a disease-free and healthy lifestyle, one should engage in regular exercise training. Exercise training has been reported to decrease all-cause mortality, enhance cardiovascular function, decrease coronary heart disease, improve cognitive functioning, decrease fall risk and improve



depression (Graff-Radford, 2011). Exercise training is a more structured (and planned) form of physical activity that is done with a specific purpose in mind. Cognitive function, the process of thought to conceptualize, recognize, and process stimuli (Buckworth, 2013) is one of the most important factors that should be maintained and improved to assure healthy and disease-free lifestyle. The most sensitive brain areas to the impact of glucocorticoid are the hippocampus and prefrontal cortex; the hippocampus is involved in learning and memory consolidation, whereas prefrontal cortex involves in executive functioning and emotion regulation. Post age of 30 years old leads to decline in cognitive processes due to structural decline within the frontal, parietal and temporal lobes of the brain. In addition, total brain volume is reduced by approximately 5% per decade after the age of 40 (Park & Reuter-Lorenz, 2009).

What are the benefits of aerobic and resistance exercise training on cognitive function, and which training program is better to enhance cognitive function and attain promising results to prevent from related cognitive function diseases?

2. Materials and methods

Electronic literature of SPORTDiscus, PubMed, and Google Scholar databases in English language between 2003 and 2015 were used to search for cognitive function in relation to exercise training. When using these databases, relevant keywords were used to refine the search and narrow down the topics. The main keywords used while searching were: cognitive function, executive function, aerobic exercise, resistance training, cognitive function diseases, benefits, combined training, exercise effect, intensity, duration, and training program. A total of 99 abstracts were examined; 43 abstracts were excluded for using animal subjects, derivative data, and languages other than English. A total of 56 articles were fully read; 11 of those were excluded due to lack of evidence, to reach a narrowed outcome of 45 articles.

3. Results

3.1. Aerobic exercise

Aerobic exercise training has been proven by literature to have an extreme positive effect on cognitive and brain function. Several previous researchers examined the benefits of aerobic training on cognitive function in all different age categories (children, adults, and elderly), regardless of gender. Aerobic exercise enhances overall cognitive function through improving memory, selective and divided attention, learning, cognitive capacity and flexibility, cognitive speed, planning, inhibition, problem solving, decision making, concentration, and processing speed (Hillman et al., 2009; Ke et al., 2011; Liu-Ambrose et al., 2010; Man, Tsang, & Hui-Chan, 2010; Scherder et al., 2010; Smith et al., 2010; Van der Borgh et al., 2007; Teixeira et al., 2012). Furthermore, aerobic exercise training enhances cerebral blood flow, brain-derived neurotrophic factor (BDNF), cerebral structure, increases development factor inflection, vascularization, cerebral electrical activity and neurotransmitter secretion, in addition to reduction in memory loss, brain volume loss, and neural apoptosis (Erickson et

al., 2009, 2011; Flöel et al., 2010; Hillman et al., 2009; McAuley et al., 2011; Nation et al., 2011; Colcombe et al., 2006; Swain et al., 2003; Vaynman & Gomez-Pinilla, 2004).

Even though aerobic exercise is beneficial on cognitive function, it can only deliver affective outcomes by managing the intensity, duration, and frequency of the training program. Moreover, moderate-intensity aerobic exercise provides more effective and beneficial results on cognitive function (Magnan, Kwan, & Bryan, 2013). Previous authors suggest that aerobic exercise intensity effects cognitive function in the inverted-U shape, where moderate-intensity exercise improves cognitive function, whereas high-intensity exercise impairs cognitive function (Kashihara et al., 2009). Recently, Alves et al. (2014) assessed the effect of high-intensity interval aerobic training (HIIT = 90% HRmax) on cognitive function (selective attention, short-term memory) and showed an improvement in selective attention and a decrease in short-term memory. Labelle et al. (2014) also assessed the effect of exercise intensity on executive control (processing speed, perceptual abilities, short-term and working memory, cognitive flexibility, cognitive activity) for both young (20-29 years) and elderly (60-70 years). The results showed improvement of 40 to 60% in PPO (Peak Power Output), while there was an increased rate of error between 60 to 80% of PPO, meaning that low- to moderate-intensity aerobic exercise training is better and more beneficial on cognitive function rather than submaximal exercise training intensity. Finally, Hawkes, Manselle and Woollacott (2014) reported that aerobic exercise training 30 min/session, three times/week, showed improvement in cognitive function compared to sedentary through an increase in switch reaction time, percent local switch costs, P3b switch amplitude, and P3b switch amplitude. Thai Chi, meditation, and exercise may provide better results than aerobic training alone, whereas the Thai Chi group showed better results on percent local switch costs and P3b switch amplitudes rather than the aerobic group. Moreover, the meditation group showed significant results compared to the sedentary group on SwRT (Switch reaction time), SCosts (Percent local switch costs), P3b Amp (P3b switch amplitude), and P3b Lat (P3b switch latency), while the aerobic group showed better results than the sedentary group but not as much as the meditation group.

3.2. Resistance exercise training

Opposite to aerobic training, there is no sufficient number of research articles provided by literature that studies the benefits of resistance exercise training on cognitive function. Regardless of research articles limited in number, the few existing studies (Lachman et al., 2006; Liu-Ambrose et al., 2010; Pontifex et al., 2009) reported an enhancement in brain-derived neurotrophic factor (BDNF), epinephrine, and norepinephrine, in addition to improvement of speed, reaction time, occupied recall duration, reaction inhibition, memory, precision, and learning competence during and following resistance training.

Alongside the benefits of resistance training on cognitive function mentioned by the literature, in order to attain those benefits one should work with the intensity of 60 to 80% of 1RM, two sets with seven repetitions on each set followed by a 2-minute rest between each set, at least twice/week for 12 months working on the major muscle groups (Liu-Ambrose et al., 2010). Resistance training with an

intensity of 80% 1RM is more beneficial on cognitive function rather than 50% of 1RM (Cassilhas et al., 2007).

3.3. Exercise and related cognitive function diseases

Exercise training improves cognitive function by enhancing memory recall where memory loss is the main factor influencing Alzheimer's disease (AD). Physical activity can improve balance, stride length, motor sequencing and performance of activities of daily living for people that suffer from AD. Additionally, it improves cognitive abilities and enhances mood (Faulk et al., 2014). Mild cognitive impairment (MCI) signals increase the risk of having AD, while engaging in moderate-intensity exercise training for 150 min/week will enhance cognitive function impairments and decrease the likability of attaining AD through improving cardiovascular fitness by about 10%, memory performance and neural efficiency while engaged in memory retrieval tasks (Blake, 2013).

Alongside AD, Cushing's syndrome, which indicates the exposure of high amount of cortisol, also decreases one's cognitive function. The prolonged exposure to cortisol leads to a reduction in hippocampal neurogenesis, hippocampal atrophy and memory impairment, which can be monitored easily through exercise training (Pruessne et al., 2007). Alderman, Olson and Mattina (2014) mentioned that engaging in aerobic exercise training (such as cycling or fast walking) 5 days/week, at 50-60% VO_2 max intensity, 30 min/day for 6 months, improved cognitive function in patients with Cushing's syndrome.

4. Discussions and conclusions

One can benefit from aerobic training by improving overall cognitive function, given that aerobic training enhances memory, selective and divided attention, learning, cognitive capacity and flexibility, cognitive speed, planning, inhibition, problem solving, decision making, concentration, and processing speed. Even though literature suggests that resistance training improves cognitive function by enhancing brain-derived neurotrophic factor (BDNF), epinephrine, and norepinephrine, as well as the speed, reaction time, occupied recall duration, reaction inhibition, memory, precision, and learning competence, other studies showed no benefits on cognitive function following resistance training (Kimura et al., 2010; Komulainen et al., 2010).

Some of the limitations in these studies could be that they combine resistance training with other routines such as balance and meditation, which increases the error and decreases the sufficient evidence; in addition, the intensity and duration of the training programs are not the same through these studies. Further studies should be done in order to attain sufficient evidence and neglect the conflict between these studies. Exercise training, whether aerobic or resistance training, has beneficial effects on both physiological and psychological factors. By improving these factors, exercise training prevents from several diseases, and most importantly which was discussed in this paper, exercise training prevents from related cognitive diseases such as Alzheimer's disease and Cushing's syndrome.

In addition to the benefits of aerobic and resistance exercise training which were mentioned, individuals who participate in combined training have greater benefits than those who only participate

in aerobic training, where it can be due to more assorted appearance of cognitive developments retrieved from benefits of both training conditions (Colcombe & Kramer, 2003).

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