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Review article

High intensity interval training for people with multiple sclerosis: A systematic review

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ABSTRACT

Background: Aerobic high intensity interval training (HIIT) is safe in the general population and more efficient in improving fitness than continuous moderate intensity training. The body of literature examining HIIT in multiple sclerosis (MS) is expanding but to date a systematic review has not been conducted. The aim of this review was to investigate the efficacy and safety of HIIT in people with MS.

Methods: A systematic search was carried out in September 2017 in EMBASE, MEDline, PEDro, CENTRAL and Web of Science Core collections using appropriate keywords and MeSH descriptors. Reference lists of relevant articles were also searched. Articles were eligible for inclusion if they were published in English, used HIIT, and included participants with MS. Quality was assessed using the PEDro scale. The following data were extracted using a standardised form: study design and characteristics, outcome measures, significant results, drop-outs, and adverse events.

Results: Seven studies (described by 11 articles) were identified: four randomised controlled trials, one randomised cross-over trial and two cohort studies. PEDro scores ranged from 3 to 8. Included participants (n = 249) were predominantly mildly disabled; one study included only people with progressive MS. Six studies used cycle ergometry and one used arm ergometry to deliver HIIT. One study reported six adverse events, four which could be attributed to the intervention. The other six reported that there were no adverse events. Six studies reported improvements in at least one outcome measure, however there were 60 different outcome measures in the seven studies. The most commonly measured domain was fitness, which improved in five of the six studies measuring aspects of fitness. The only trial not to report positive results included people with progressive and a more severe level of disability (Extended Disability Status Scale 6.0–8.0).

Conclusion: HIIT appears to be safe and effective in increasing fitness in people with MS and low levels of disability. Further research is required to explore the effectiveness of HIIT in people with progressive MS and in those with higher levels of disability.

1. Introduction

Exercise is a safe and feasible intervention for people with multiple sclerosis (MS) (Heine et al., 2015) and is recommended for increasing cardiovascular fitness and muscular strength (Latimer-Cheung et al., 2013). Cardiovascular fitness in people with MS is lower compared to healthy individuals (Langeskov-Christensen et al., 2015) and is inversely correlated with disease severity and impairment, with fitness decreasing as disability and fatigue rise (Heine et al., 20142016; Kuspinar et al., 2010; Marrie and Horwitz, 2010; Motl and Fernhall, 2012; Valet et al., 2016). Reviews of trials evaluating the effects of exercise in people with MS have indicated that exercise training is beneficial for increasing and maintaining cardiovascular fitness (Dalgas et al., 2008; Rietberg et al., 2005).

Traditionally, continuous moderate intensity training programmes, to increase fitness and reduce cardiovascular disease risk factors in healthy adults, last 30–60 min at 40–85% of maximal intensity, with higher intensities producing a greater increase in fitness (Garber et al., 2011). High intensity interval training (HIIT), however, involves short bursts of exercise at very high intensity with either a complete or working rest in between bursts. Total time for training sessions typically last around 20 min, have 4–6 cycles of 80–95% of maximal effort for 1–4 min with a similar time of working recovery or rest (Cassidy et al., 2017; Kessler et al., 2012).

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Compared to continuous moderate intensity training, HIIT is more efficient in improving VO_2 max in healthy individuals (Milanovic et al., 2015), people with coronary artery disease (Elliott et al., 2015), increased cardio-metabolic risk (Weston et al., 2014), and heart failure (Haykowsky et al., 2013; Ismail et al., 2013; Smart et al., 2013; Wisloff et al., 2007). HIIT also produces greater or equal effects, to continuous moderate intensity training, in improving cardiovascular risk factors such as high blood pressure and altered glucose metabolism (Fleg, 2016). The main advantage of HIIT over continuous moderate intensity training is the shorter time required to achieve similar energy expenditure, and comparable, or greater benefits (Fleg, 2016). This is due to an increase in oxygen consumption after acute strenuous exercise known as Excess Post-exercise Oxygen Consumption (Gaesser and Brooks, 1984). Furthermore, shorter exercise intervals of 2 min or less have been found to be more enjoyable than continuous moderate intensity training by participants due to the shorter duration of each burst at high intensity (Cassidy et al., 2017).

Previous work examining the effect of HIIT in people with Parkinson's found an increase in Brain Derived Neurotrophic Factor (BDNF) production, decrease parkinsonian rigidity and muscle tone (Marusiak et al., 2015), improved gait parameters (Pohl et al., 2003) and cognitive performance (Alves et al., 2014). In addition there is limited but positive evidence for using HIIT to improve walking endurance in stroke survivors (Boyne et al., 20152016). However, given that only one of five studies compared HIIT to another form of aerobic exercise (Boyne et al., 2016) indicates that HIIT is an emerging modality in these conditions.

High intensity interval training has been recommended as a possible effective intervention for people with MS as it can allow people to exercise at higher intensities while avoiding thermosensitive reactions (Dalgas et al., 2008). Over the past several years there has been increasing interest in HIIT in MS and several interventional trials published; however no systematic review of HIIT in people with MS has been undertaken. Therefore the aim of this review was to establish the efficacy and safety of HIIT in people with MS.

2. Methods

An electronic search was undertaken of the following databases in September 2017: EMBASE, MEDline, PEDro, CENTRAL and Web of Science Core collections. The search terms used can be seen in Table 1. The Boolean operators ‘AND’ and ‘OR’ were used to combine searches as appropriate. No limits were placed on time of publication. The reference lists of included articles were also searched.

Articles were eligible for inclusion if they were clinical trials that consisted of an aerobic intervention of HIIT alone or in combination with another type of exercise training (HIIT was defined as intervals of exercise of 5 min or less reaching an intensity of 80% or more of maximal effort in each interval (Fleg, 2016)), included participants with MS, or if in a mixed population, data for people with MS were presented separately, and published in English. Articles were excluded if they were non-human studies, case studies, conference abstracts or focused solely on resistance, core or balance training. To ensure relevant articles were included, if the abstract or title did not provide the exercise intensity, the methods of the articles were read.

Quality assessment was carried out using the PEDro scale which is valid and reliable in methodological rating of studies (de Morton, 2009; Maher et al., 2003). The PEDro scale has 11 criteria but produces a score out of ten as no point is awarded for listing of exclusion and inclusion criteria. Included articles were assessed by at least two reviewers (EC, EHC, LP). Where there was disagreement between reviewers this was settled by discussion. Although primarily for Randomised Controlled Trials (RCTs), the PEDro scale can be used for cohort studies, with points deducted due to lack of randomisation. This has been done in previous systematic reviews of multiple sclerosis interventions (Kjolhede et al., 2012; Martin-Valero et al., 2014).

The following data were extracted from each article into a standardised form: authors, date of publication, study design, sample size, type of MS, disability level, number of drop-outs, adverse events, length of intervention, frequency of training, type of training, number of intervals per session, target intensity ranges, total time spent in high intensity during the intervention, additional exercise training modalities employed, outcome measures and results.

3. Results

The electronic search identified 935 potential articles and hand searching of relevant reference lists provided one additional article. After the removal of 264 duplicates, the remaining 671 articles were screened by title and abstract. From titles alone, 575 were excluded. Following this, another 58 were excluded by abstract. The full text of 38 articles were read for eligibility by at least two members of the research team and 27 were subsequently excluded (Fig. 1). Eleven articles, which described seven studies, were included in this review.

Of the included articles four were RCTs) (described by seven articles) (Bansi et al., 2017; Collett et al., 2011; Farup et al., 2016; Feltham et al., 2013; Skjerbæk et al., 2014; Wens et al., 20152017; Zimmer et al., 2017), one was a randomised crossover trial (Collett et al., 2017) and two were cohort studies (Keytsman et al., 2017; Zaenker et al., 2016).

PEDro scores ranged from three to eight out of ten (Table 2). Eight articles were regarded to be of high quality with a score of seven (Bansi et al., 2017; Feltham et al., 2013; Skjerbæk et al., 2014; Wens et al., 20152017) or eight (Collett et al., 2011; Farup et al., 2016; Zimmer

Table 1
Search strategy.

Database	Search terms
Medline	((exp multiple sclerosis/) OR ((multiple sclerosis or relapsing remitting OR chronic progressive OR secondary progressive OR primary progressive).mp.)) AND ((High intensity interval training OR interval training OR High intensity interval exercise OR interval exercise OR aerobic interval training OR high intensity OR high-intensity OR exercise intensity OR HIIT OR HIT).mp.)
Embase	((multiple sclerosis/) OR ((multiple sclerosis or relapsing remitting OR chronic progressive OR secondary progressive or primary progressive).mp.)) AND ((High intensity interval training OR interval training OR High intensity interval exercise OR interval exercise OR aerobic interval training OR high intensity OR high-intensity OR exercise intensity OR HIIT OR HIT).mp.)
Web of Science core collections	(TS = ("multiple sclerosis" OR "MS" OR "relapsing remitting" OR "chronic progressive" OR "secondary progressive" OR "primary progressive")) AND (TS = ("High intensity interval training" OR "Interval training" OR "High intensity interval exercise" OR "Interval exercise" OR "Aerobic interval training" OR "High intensity" OR “High-intensity” OR "HIIT" OR "HIT"))
PEDro	High intensity multiple sclerosis
CENTRAL	(((multiple sclerosis) OR (relapsing remitting) OR (chronic progressive) or (secondary progressive) OR (primary progressive)) OR (MeSH descriptor: [multiple sclerosis] explode all trees)) AND (((High intensity interval training) OR (interval training) or (High intensity interval exercise) OR (interval exercise) OR (aerobic interval training) OR (high intensity) OR (high-intensity) OR (exercise intensity) or (HIIT) or (HIT)))

Abbreviations: exp: explode; mp: multi-purpose keyword search; TS: Topic Search.