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Does high-intensity exercise better improve ambulation in the population with chronic stroke, as compared to standard care?: A Systematic Review of the Literature

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Each year approximately 15 million strokes occur worldwide, making stroke the leading cause of death disability. The prevalence of stroke is predicted to increase with the growth of the aging population, and as a result, the population of those living with disability post-stroke is expected to rise significantly. Following a stroke, survivors’ walking deficits often include decreased strength, altered gait, and impairments in cardiovascular fitness. Post-stroke walking deficits have been shown to have a profound impact on functional independence, and therefore are a major contributor to adult disability.

Historically, physical therapy has been successful in the recovery of walking for this population. Previous studies suggest that physical therapists who utilize a combination of intensive mobility training, functional strengthening, balance exercises, aerobic training, and variable walking task training are generally successful with improving gait ability in the population with stroke. However, the most recent research suggests that it is not only the type of training that is important to achieve maximal results, but also how the training is implemented. Much of the functional improvement that occurs with activity during physical therapy is in response to neuroplastic changes in the brain and intensity of exercise has been shown to be one of the key principles impacting the induction of neuroplastic changes. This leads to the question: does high-intensity exercise have a greater impact on the recovery of walking than standard care in chronic stroke survivors?

Currently, there is a lack of evidence regarding whether interventions performed at sufficient high-intensity in the population with chronic stroke have an effect on improving gait. Given that high-intensity exercise has been shown to induce neuroplastic changes, we hypothesize that high-intensity training will better facilitate neuroplasticity and result in greater improvements in gait than standard care.

Purpose

To assess the effectiveness of high-intensity exercise on the improvement of gait deficits in survivors of chronic stroke as compared to standard care.

Methods

A literature search was conducted during July and September of 2015 (Figure 1). The databases searched were PubMed, Ovid, Cochrane, Scopus, and CINAHL. The search terms used were “high intensity” AND “stroke” AND (walk OR gait). The search included the following limiting filters: English language, human participants, and publication in the last 10 years (2005-2015). The final inclusion criteria was as follows:

1. Intensity as defined by ≥65% HRR, ≥80% max HRR, RPE scale ≥15, ≥80% HRR predicted HRmax ≥180 BPM.
2. ≥12 months post-stroke.
3. ≥2 gait-related outcome measure

Seven articles were chosen for final inclusion in this systematic review and were assessed for risk of bias using the PEDro scale. The PEDro scale is used to weigh the varying quality of evidence from individual research articles with the intent to draw scientifically sound, clinical conclusions.

Across the seven papers chosen for inclusion in the systematic review, high-intensity training was achieved in all studies via multiple-weeks, treadmill and over ground training (with and without body weight support), lower extremity cycle ergometry, and resistance training. The results of each study are reviewed below:

Six studies utilized high-intensity treadmill training as a means of improving high-intensity outcomes. All six studies evaluated walking endurance outcomes. The following results were found:

- All six studies reported significant improvements in walking endurance outcomes immediately post intervention (2012-2015).
- Two of the three studies that included follow-up periods found retention of walking endurance improvements (2015).
- Five of the six studies utilized an aerobic outcome measure to measure changes in walking outcomes. The following results were found:
  - The six studies measuring VO2 peak or max VO2 reported significant improvements immediately post-intervention (2012-2015).
  - Neither of the two studies which included follow-up periods demonstrated maintenance of improvements in aerobic capacity (2015).
  - All six studies utilized gait speed as a walking outcome measure. The following results were found:
    - Five of the six studies reported significant improvements in gait speed immediately post intervention, while the sixth study reported a non-significant increase in gait speed (2012-2015).
    - The three studies that included follow-up periods all reported maintenance of gait speed improvements (2015).
  - One of the six studies analyzed change in gait mechanics. The following result was found:
    - Significant increase in single-leg stance on post-stick and a non-significant trend for improvement in step-length symmetry immediately post intervention and at follow-up (2015).

One study utilized high-intensity exercise without stepping as a means of high-intensity exercise (See Table 1). The following results were found regarding walking endurance, aerobic capacity, and gait speed:

- Non-significant improvements in 6MWT in all groups, however none of the improvements were maintained at follow-up.
- High-intensity cycling group reported significant VO2 improvements immediately post intervention.
- High-intensity cycling group and control groups had non-significant improvements in peak VO2 immediately post intervention, however none of the groups demonstrated maintenance of improvements at follow-up.
- High-intensity cycling group reported non-significant improvements in walking speed immediately post intervention.
- High-intensity resistance training group and control groups reported significant improvements in walking speed immediately post intervention, and these results were maintained at follow-up.

This study evaluated positive findings supporting high-intensity as a feasible and effective means of improving walking outcomes measures in the population with chronic stroke. In total, only one adverse event was reported. Therefore, this review supports the following conclusions:

- Task-specific walking interventions were found to be better facilitated improvement in walking outcomes when incorporated into the modes of exercise. According to Klein and Basson’s research on the principles of neuroplasticity, specificity of training facilitates the process of neuroplasticity. The findings below support the idea that task-specific training better facilitates recovery of function than practicing other unrelated tasks.
- Six articles utilized various high-intensity walking interventions and found either significance or trends for improvement in all outcome measures related to walking endurance, walking velocity and gait characteristics.
- One article utilized high-intensity cycling and resistance interventions, resulting in inconsistent findings across all gait-related outcome measures.

Discussion

This review included studies published 2012-2015 which were relevant to high-intensity walking interventions for persons with chronic stroke. The 2015 Cochrane review, “Interventions for improving walking post stroke,” summarized results of 20 randomized controlled trials. The review found that: Exercise post rehabilitation is necessary in order to retain improvements.

Conclusion

The results of this review suggest that high-intensity exercise is effective in improving ambulation in the population with chronic stroke; however, due to insufficient evidence, we cannot say with certainty that high-intensity exercise is superior to standard care at this time. We also suggest that walking-specific high-intensity exercise is superior to less-task specific high-intensity exercise.

The evidence suggests that continued exercise is necessary to maintain acquired gait improvements. This notion is further supported by multiple studies that suggest continued exercise training results in maintenance, and even improvement, in various walking outcome measures.

Future Research

In order to determine the superiority of high-intensity walking-specific exercise to other commonly used physical therapy interventions, future research should focus on the following:

- Direct comparison of high-intensity walking training and standard care in order to allow for a more definitive determination as to whether high-intensity is in fact a superior method of improving walking outcomes in survivors of chronic stroke.
- Identifying specific dosage parameters for high-intensity walking interventions in order to potentially aid in the establishment of a standard of care for survivors of stroke that utilizes high-intensity walking training.
- Solving the positive effects of continued training in this population by identifying if adherence to a structured exercise program can result in increased long-term effects on gait outcomes.

References