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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 1.5 million strokes occur worldwide, making stroke the leading cause of adult 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 similarly. Following a stroke, survivors’ walking deficits often include decreased velocity, alterations in walking mechanics, 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 chronic stroke. However, more 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 during activity through 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 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 run. The search included the following limits: English language, human participants, and publication in the last 10 years (2005-2015). The final inclusion criteria was as follows:

1. High-intensity as defined by ≥60% HR reserve, ≥max HR, RPE scale (5-20), BMI ≥30, age predicted HRR ≥50% HRmax
2. 6 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 weight the varying quality of evidence from individual research articles with the intent to draw scientifically sound, clinical conclusions. 11

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

Six studies utilized high-intensity treadmill training as a means of achieving a high-intensity intervention. All studies measured walking endurance outcomes. The following results were found:

• All six studies reported significant improvements in walking endurance outcomes immediately post-intervention 12,13,14,15,16,17
• 2 of the three studies that included follow-up periods noted retention of walking endurance improvements 13,15,18

Five of the six studies utilized an aerobic outcome measure to measure changes in walking outcomes. The following results were found:

• 3 of the five studies measuring VO2 max or peak VO2 reported significant improvements immediately post-intervention 12,13,15
• Neither of the two studies which included follow-up periods demonstrated maintenance of improvements in aerobic capacity 12,13

All six studies utilized gait speed as a walking outcome measure. The following results were found:

• 5 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 12,13,15,16,17,18
• The three studies that included follow-up periods all reported maintenance of gait-speed improvements 12,13,15,18

One of the six studies analyzed change in gait mechanics. The following result was found:

• Significant increase in single leg stance on paraplegic and a non-significant trend for improvement in split-second gait symmetry immediately post intervention and at follow-up 18

Discussion

This review established positive findings supporting high-intensity as a feasible and effective means of improving walking outcomes in the population with chronic stroke. In total, only one adverse event was reported. 18

• Task-specific walking interventions were found to better facilitate improvement in walking outcomes when compared to traditional modes of exercise. According to Klein and Bosco’s research on the principles of neural plasticity, specificity of training facilitates the process of neuroplasticity. 19 The findings below support the idea that task-specific training better facilitates recovery of function than practicing other unrelated tasks. 20

• Six articles utilized various high-intensity walking interventions and found either significant trends or findings for improvement in all outcome measures related to walking endurance, walking velocity and gait characteristics. 12,13,15,16,17,18

• One article utilized high-intensity cycling and resistance interventions, resulting in inconsistent findings across all gait-related outcome measures. 20

Another principle of neuroplasticity, ‘neuroplasticity was employed by all of the studies. Each study included in this review explicitly defined high-intensity within certain parameters. However, these parameters varied throughout the studies. Multiple of the included studies also used different means to increase the level of intensity of exercise. All variations of high-intensity walking interventions showed at least a trend toward improved walking outcome measures, supporting the importance of intensity as a principle of neuroplasticity. 6 However, the variety of approaches makes it difficult to comment on which, if any, method of increasing intensity is superior.

Multiple studies included in this review used the RPE scale rather than HRR to determine high-intensity exercise for participants who were taking beta blockers. The effects of beta blockers prevent this group of participants from reaching the established high-intensity training zone. 21,22,23 Therefore, the validity of the use of the RPE scale for participants on these medications can be questioned.

Some of the included studies in this review reported information about the activity performed during follow-up periods, while others did not. One study reported that some of the participants continued treadmill training during the follow-up period and demonstrated significantly better results on the 6MWT and a trend for better peak VO2 and maximal walking speed than those who did not exercise during follow-up. 18 This suggests that continued exercise is necessary to maintain acquired gait improvements. This notion is further supported by multiple studies that suggested continued exercise training results in maintenance, and even improvement, in various walking outcome measures. 12,13,15

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.

Clinical recommendations:

1. Physical therapists should consider the use of high-intensity walking interventions as an effective means of gait rehabilitation for persons with chronic stroke
2. Physical therapists should make recommendations for continuing walking exercise post rehabilitation.

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:

1. 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
2. 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
3. Solidifying 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

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